Final Report

Nursery and Garden Industry Communications 2013-2015

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Summary

Project NY12011 Nursery and Garden Industry Communications 2013-2015 commenced in April 2013 and was completed in December 2015. The program was developed to support two key industry objectives noted in the Nursery Industry Strategic Investment Plan; Objective 2 - Enhance the capacity and efficiency of the industry's resources through upgrading industry skills, knowledge and practice and; Objective 3 - Build industry support through shaping government, public and related industry understanding of the industry’s benefits, and enhance these benefits through communication.

The primary target audience for the project was growers within the nursery industry, with secondary audiences including the extended industry value chain as well as government and the public.

During the course of the project 30 Nursery Papers were published covering a variety of topics pertinent to the nursery industry including industry R&D as well as business and technical topics. The Nursery papers were distributed to industry via the commercial trade publication Hort Journal and online via the NGIA website which saw over 29,000 downloads of papers during the project period.

The project also saw the delivery of a monthly electronic direct mail (Your Levy at Work) to in excess of 1600 recipients. This electronic direct mail was supported by an online blog (www.yourlevyatwork.com.au).

Four industry policy positions were developed during the project covering; communication, water, plant labelling and environmental sustainability. During the course of the project the NGIA policy pages had in excess of 10,000 views.

Communication to industry and the extended value chain was additionally supported through social media channels including Facebook (1785 “Likes”), Twitter (1294 followers) and LinkedIn (227 followers).

The project was independently reviewed by RM Consulting Group in project NY15000, which found that the participants in industry consultation felt that the approach and delivery of the current communications project was appropriate and valuable. The review also confirmed that the project was also delivered in a cost effective manner. Scope for future communication programs centred on improved project management processes.

The key recommendations for future nursery industry communications projects include;

1. NGIA retains direction and control of communication of levy funded activity in order to better leverage the synergies it can provide through its networks and linkages to R&D, industry and the wider value chain both domestically and internationally.
2. Industry policy development continues. Constraints regarding levy funding for policy in future communication program put this area at risk (refer to the succeeding nursery industry communications program NY15006). Industry may need to be fund policy development out of other industry funds to assist in better interaction with government and community through a set of common articulated industry policy positions.
3. Further development of social media is focused upon by industry to leverage the cost benefits of this communication medium for the delivery of information as well as the opportunity to amplify communication and drive practice change.

4. The Nursery papers continue to be developed and published as these are a key tool in communicating R&D outcomes to industry as well as influencing practice change.

Keywords

Nursery & Garden Industry; Communication; Extension; Nursery Papers; Policy; Adoption; Content; Channels; Practice change.

Introduction

The Australian nursery industry is one of the most diverse horticultural sectors and is located in all states and territories in urban, peri urban, regional and rural localities. Unlike other horticultural industries the nursery and garden industry operates in a range of markets that are not dependent on share of plate but space for plants within the urban environment, planting of property developments, natural landscape rehabilitation and exports of products or technologies to all countries.

While a strength, the diversity of growing regions and distance from major markets makes cooperation and communications of new technologies and R&D that can improve production efficiency difficult. The Australian nursery industry has through a targeted communications enabled all participants to have access to reports and communications on where their levy has been invested.

Project NY12011 was aligned with both the Nursery Industry 2010–2015 Strategic Plan and the Nursery Industry Strategic Investment Plan 2012-2016 to ensure the Australian nursery industry has the capacity to respond to growth opportunities and challenges that impact on its growth and sustainable development. This relates predominately to market development opportunities by creating a need for more green life in urban environments.

In addition to market growth, the Strategic Plan identifies several key issues that are of an environmental or technical nature which require focus, including; how regulatory pressures in relation to biosecurity policies restrict market access and plant movements and how increasing input costs relating to energy, water and fertiliser use impact on the long term sustainability of the NGI.

Project NY12011 provides the tools utilised by NY12012 Technical Communications and Policy Development for the Australian Nursery Industry, to ensure targeted and focused communication mechanisms are in place for all industry activities. This will result in an industry which can make better informed decisions through engagement of industry stakeholders (levy payers and extended value chain), while also building constructive relationships with the external decision makers and influencers. An industry that is engaged with the outcomes of their levy investment will be more likely to adopt outcomes of that investment.

This project was aligned to the Nursery Industry Strategic Investment Plan, which identified communication both internal and external to industry as one of the critical areas for investment over the 2012-2016 periods. Communication influences two of the key industry objectives noted in the Nursery Industry Strategic Investment Plan;

Objective 2 - Enhance the capacity and efficiency of the industry's resources through upgrading industry skills, knowledge and practice (internal)

Objective 3 - Build industry support through shaping government, public and related industry understanding of the industry’s benefits, and enhance these benefits through communication (external).

Both of these objectives were aimed at delivering the outcome of communicating the benefits of plants and green life to all industry sectors, influencers at all levels of government and consumers of the products of the nursery and garden sector. This communication project NY12011 has built on the previous successful development of industry communications delivered through project NY10010 which covered Nursery Papers, digital communications and the preparation of industry policy documents & position papers distributed via industry channels.

The National Technical and Policy Officer employed under project NY12012 managed this project to ensure it met its objective and was aligned with the Nursery Industry Strategic Plan 2010-2015.

Project NY12011 has delivered a variety of outputs developed by this project ranging from Nursery Papers and Policy Positions through to targeted communications highlighting opportunities in relation to greater recognition of the Urban Forest and benefits from greening the urban environment. These outputs have been communicated to industry using a variety of channels including digital media and traditional print.

Methodology

To address the objectives and priority investment areas identified in the Nursery Industry Strategic Investment Plan (SIP), the industry engaged a National Technical Communications and Policy Development Officer (NY12012). This position reported to the National Research and Market Development Manager (NY13000) and later directly to the NGIA CEO as well as to the NGIA Board via progress reporting. Regular updates on the role were provided to the Nursery Industry Advisory Committee (IAC) during its operation. Likewise communication on the project was provided to HAL/HIA via regular milestone reporting.
The NY12011 project funded the tools utilised by industry to facilitate effective communications with levy payers and industry stakeholders.
Specific aspects of this project included;

1. Industry Nursery Papers

Series of semi technical papers covering research outcomes and issues relevant to industry
National distribution as an insert in a commercial magazine (Hort Journal) to over 6000 readers supported by online delivery.

2. Industry digital newsletter/blog

The Your levy at work Electronic Direct Mail (EDM) facilitated through the Your levy at work blog (www.yourlevyatwork.com.au) was distributed monthly and communicated to industry stakeholders providing summaries and updates of levy funded programs. It is linked to the NGIA website where levy funded industry final reports are available. This communication enabled stakeholders to remain informed on the investment of the funds.

3. Industry technical communications within the NGIA website

The NGIA website is digital repository for all data relating to the industry. It provides technical, business and marketing data of interest to levy payers.
The website is linked to industries other social media sites Facebook and Twitter.

4. Position papers

Preparation of industry position papers enables industry to be consistent in approaches on major issues which impact the industry.

The project was initially contracted to finish in August 2015 however this was extend by HIA until November 2015.

Outputs

Key outputs from this project will include:

Development of key internal and external communication resulting in better decisions informed by industry knowledge and consistent messages

Development of targeted communications at governments to facilitate better understanding of the industry

Targeted, relevant and factually communications developed utilizing a variety of communication channels detailing relevant project outputs

Clear and complete policy solutions that deliver the needs of industry

Clear and concise industry position papers

Nursery papers:

A core output of this project was the continuing publication of the industry semi technical paper; Nursery Papers. The Nursery Papers were first published in 1996 and remain a key extension tool for the communication of R&D outcomes within the Australian nursery industry.

During the project period the Nursery Papers were published as an insert in the commercially available Hort Journal. This provision provided opportunity to gain increased exposure through the industry as well as providing a mechanism for professional design and layout. Once the papers are published in Hort Journal, PDF files of the Nursery Papers are incorporated into the catalogue of Nursery Papers freely available on the NGIA website (www.ngia.com.au). Likewise older editions of Hort Journal including the Nursery Papers insert are available for view on the Hort Journal website (www.hortjournal.com.au).

Table 1 details the Nursery Papers published during the project period. For further information the complete papers are included in appendix 1.

The Nursery Papers are well regarded by industry and as indicated in appendix 7, older papers are regularly referred to for information. In excess of 29,000 viewing of nursery papers occurred during the project period.

During the course of this project 30 Nursery Papers were published on a wide range of technical and business topics as well as levy funded R&D. Authors of the papers included researchers involved in levy funded research, levy funded nursery industry development officers and NGIA staff.

Table 1 - Nursery Papers published during project operation

Serial	Date	Title
1	Apr-13	Urban Vegetation and Heat Related Mortality
2	May-13	Emerging Biosecurity threats and industry preparedness.
3	Jun-13	Management of fungus gnats in nursery production
4	Jul-13	Managing iron in nursery irrigation systems

5 Aug-13 Bridging the Ebusiness Technology Gap in the NSW Nursery and Garden Industry
6 Sep-13 Automating Irrigation Scheduling in Nursery Production

7 Oct-13 Certified Budwood Schemes
8 Nov-13 Managing Chemicals of Security Concern across the Industry Supply Chain
9 Dec-13 Valuing the urban forest in Sydney
10 Feb-14 Accurately diagnosing weeds, pests and diseases affecting nursery crops
11 Mar-14 Pruning & Staking- Back to Basics
12 Apr-14 Pesticide Application on Edibles
13 May-14 The Importance of Suitable Sources of Irrigation Water to Nursery Businesses
14 Jun-14 Growing Media Storage
15 Jul-14 A Systems Approach to Managing Pests, Diseases & Weeds BioSecure HACCP
16 Aug-14 Indoor Heat Stress Mitigation with Urban Vegetation and Tree Shading
17 Sep-14 American Study Tour 5-16 July 2014
18 Oct-14 Barcodes – Beyond compliance
19 Nov-14 Street tree diversity & canopy quality influences urban microclimate and pedestrian thermal comfort.
20 Dec-14 Design Issues and Beneficial Outcomes from Greening a Childcare Outdoor
21 Feb-15 Efficacy of Organic Amendments Used in Plant Production
22 Mar-15 Waste Management and disposal in the nursery industry
23 Apr-15 The importance of the greenhouse environment in successful growing & merchandising of plants
24 May-15 Plant photosynthetic growth and photo morphogenesis under LED light
25 Jun-15 The use of gas in nursery management
26 Jul-15 Nursery Production Pest Monitoring, Inspection and Surveillance Methodology
27 Aug-15 How efficacious are chlorine, chlorine dioxide and ultraviolet radiation as disinfectants against waterborne pathogens in irrigation water?
28 Sep-15 Roots, Hormones and in-between - Back to Fundamentals
29 Oct-15 Australian Standard AS2303:2015 Tree stock for landscape use.
30 Nov-15 National Plant Health and Biosecurity Project delivers benefits for Australian production nurseries

Policy Positions:

Four policy positions were developed through project NY12011. These policies include;

Environmental Sustainability Policy
National Plant Labeling Policy
Water Policy
Communications Policy

Details of the policies developed can be found in appendix 2. The number of page views for policy on the NGIA website has exceeded 12,000 page views since the start of the project in April 2013 through to November 2015. Monthly page views can be seen in appendix 8.

The National Plant Labeling Policy has seen use with plant suppliers of Bunnings Pty Ltd being required to comply with the guidelines. The National Plant Labeling Guidelines have also been referenced within AS2303:2015 Treestock for landscape use, in relation to true to type tree stock.

Website:

The NGIA website (www.ngia.com.au) and the Your Levy at Work website (www.yourlevyatwork.com.au) were both used by the project to host information relevant to the nursery industry. Examples of this information include; final reports from levy funded research, digital based tools funded through levy investment, Nursery Papers etc. Images of the websites can be seen in appendix 3 with associated metrics for the NGIA website can be seen in appendix 4. Note: The period Aug 14 - Mar 15 is lacking data due to the tracking code for google analytics not being properly installed during website upgrading.

Electronic Direct Mail (EDM):

The Your Levy at Work website core use was as a blog highlighting levy funded RD&E. The content of the blog was emailed as a monthly EDM to persons registered with the site which included levy payers as well as members of the extended industry value chain. During the reporting period 150 articles were published on the Your Levy at Work Blog and these were communicated to industry via a monthly EDM. In excess of 1600 subscribers currently receive the EDM. Metrics for the Your Levy at Work EDM can be found in appendix 5.

Social Media:

NGIA maintains three key social media tools for communication, namely Facebook, Twitter and LinkedIn. Facebook and Twitter are used to communicate industry information to stakeholders who prefer this communication medium; this includes levy payers as well as members of the extended industry value chain. Likewise these mediums also facilitate the reach of industry communication through the ability of followers to share this information and amplify the audience exposure. Currently the NGI Facebook page has 1785 likes and the twitter account 1294 followers.

The LinkedIn group NGI - Business Improvement provides a mechanism for facilitated discussion and professional networking on issues pertinent to industry improvement. The forum currently has 183 people engaged and this compliments the NGIA business LinkedIn following of 227 persons and the 202020 Vision LinkedIn group.

Examples of the NGIA social media accounts can be found in appendix 3. Detailed metrics for the NGI Facebook account are located in appendix 6.

Outcomes

The project had the following intended outcomes;
 Improved internal and external communication resulting in better decisions informed by industry knowledge and consistent messages
 Increased communications targeting governments need for better understanding of the industry
 Improved uptake of tools and resources developed and extended to the whole of industry through traditional and non-traditional means
 Strengthened government relationships resulting in strong support for industry initiatives, programs and policy positions
 Improved perception of the value of the industry's products by key stakeholder groups
 Improved awareness of the contributions made by the industry towards better environments and wellbeing in Australian communities and among industry circles
 Increased awareness of industry policy priorities across all stakeholder groups

The project has achieved the intended outcome for improved internal and external communication resulting in better decisions informed by industry knowledge. This is evidenced by the engagement which industry and the extended value chain has with the communications program as evidenced through the project review which noted that industry felt that the approach and delivery of the program was appropriate and valuable. Likewise industry agreed that the mix of internal and external focused communication was suitable. It should also be noted that over two thirds of the project review respondents felt that the communications program has informed decisions relating to their business.
An improvement to the uptake of tools and resources developed and extended to the industry was demonstrated by the project. The nursery papers closely followed by the NGIA website are still seen by industry as the most important tools in the uptake of information and in driving practice change. The review found that 65% of industry survey respondents preferred their information via email, with 12% preferring print and only 2% preferring social media. These figures are reflected in the higher than average open rates seen for the Your Levy at Work EDM and relatively low social media engagement noted in the review. The lack of engagement in social media may change as the demographics of the industry changes over time and hence focus should still remain in this area. Likewise engagement in online tools such as eLearning is limited at this stage but for industry this still remains a novel extension method and it is anticipated that as industry becomes more comfortable with e-delivery of extension material adoption rates will increase.
Improved perception of the value of the industry's products by key stakeholder groups and awareness of the contributions made by the industry towards better environments and wellbeing in Australian communities and among industry circles has been demonstrated; over half of the respondents to the project review survey thought that the program had improved community and government perception of the value of the industry and its products. Likewise the exposure the industry has had in the areas around urban greening over the course of the project have indeed improved the perception of the value of the industry's product with key stakeholder groups such as local government and the broader community.

The project has improved awareness of the contributions made by the industry towards better environments and wellbeing in Australian communities and among industry circles. Much work has been publicised of research and development undertaken by the industry in this space including research into the urban heat island effect and the other positive benefits which industry contributes towards

The number of hits received on the NGIA website policy's page, in excess of 12,000, during the project period is evidence of increased awareness of industry policy priorities across stakeholder groups. Likewise evidence of policy referencing also provides an example of the increasing awareness of industry policy.

Industry has seen strengthened government relationships demonstrated through its engagement with government at multiple levels. Examples of this engagement with government include industry participation in government enquiries, committees and work groups, the engagement with government in areas surrounding urban greening as evidenced through initiatives such as the 202020 Vision program and linkages with government representatives. This increased level of engagement with government has assisted in developing a better understanding of the needs and issues of industry by government. The messages around the industries increased targeted communication with government however needs further promotion, as the review noted that many of the respondents to its survey felt that the government did not have a sound understanding of the issues impacting the nursery industry. Communication with governments was also considered in light of avoiding agripolitical activity or industry advocacy which is precluded through levy funded activity.

Evaluation and Discussion

Project NY15000 conducted by RM Consulting Group undertook an extensive review of the Australian Nursery Industry Communications program with particular emphasis on projects NY12011 and NY12012.

The review was facilitated by a structured interview of 20 industry stakeholders as well as an online survey which received in excess of 200 responses. The review assessed the appropriateness, effectiveness, impact and efficiency & value for money delivered by the communications program.

With regards to the appropriateness of the communications program, NY15000 noted that the approach used by NGIA has been an effective and appropriate method for communicating R&D outcomes and issues of significance to the nursery industry. Furthermore the nursery industry communications program as managed by NGIA had adhered to the project plan for NY12011.

With respect to the effectiveness of the project the review noted that whilst over half of the respondents felt they were adequately aware of R&D outcomes there was scope for improvement. Key areas noted were improving the engagement of industry and providing more clarity around the purpose of R&D. It must be noted that a caveat given was the diversity of the industry subsectors and that whilst R&D outcomes may be applicable to one subsector it may not be to another and hence this limits the engagement of industry in R&D communication.

The review noted most of the industry interviewees felt sufficiently aware of R&D findings and that there was a general awareness of R&D being undertaken; however the applicability of the R&D to their specific business was an issue. Interviewees noted that they usually sourced R&D information when required to respond to a specific issue or problem within the business. This is an issue which is difficult to address simply due to the sheer diversity of the industry which covers every horticultural commodity produced in the country as well as utilizing a variety of production systems, across multiple climatic regions as well as servicing varied supply chains across multiple markets.

This lack of applicability or timing of R&D may however put future levy funded R&D in jeopardy if steps are not taken to address the question of relevance to growers. The Nursery Papers do provide a mechanism to address this given their longevity; As seen in appendix 7 older papers are regularly viewed and this indicates that businesses are possibly adopting the information but using it in a just in time or as needs fashion. Likewise the NGIA website was noted for its use as an online library for technical research and combined with NGIA printed resources, represented two out of the top three information sources for industry.

The projects impact was highly rated with the key outputs of the project; Nursery Papers & the Your Levy At Work EDM noted as being valued by industry and having informed business decision making. Social media at present did not greatly contribute to practice change though it was suggested that this could change and that these mediums are useful for raising awareness. It was recommended that for future communication programs greater emphasis be given to these mediums.

The synergies between the communications program and the industry development project (NY12006) were noted with communication being cited as only the first step in practice change.

With regards to efficiency and value for money the review noted the program appeared to be well managed but future programs could benefit from the implementation of some project management processes. The metrics associated with project websites compared favourably with other agricultural sectors and likewise the open and click rates for the Your Levy at Work EDM was higher than industry averages implying an engaged readership. From a financial perspective the review concluded that the project had been delivered in a cost effective manner based upon comparisons of production costs across HIA for printed and digital publication.

The review highlighted that 95% of industry felt that the communications program should include industry policy and submission development. However given the potential conflict this has with regards to levy funding arrangements this facility has been removed from the future communication project (NY15006). It should be noted that this is an area of risk for industry moving forward in articulating its needs for market development and its position on aspects of the community it is essential to. Contrasting to other horticultural sectors the nursery industry has a mature and considered approach to formal policy development.

Recommendations

Project NY12011 was conducted over a three year period having built upon the previous industry communications project, NY10010. In August 2015 RM Consulting Group conducted a review of project NY12011 through project NY15000 and overall the project was evaluated favourably. Based upon the outputs, outcomes and evaluation of the project the following recommendations are made with respect to nursery industry communication going forward.

1. NGIA retains direction and control of communication of levy funded activity in order to better leverage the synergies it can provide through its networks and linkages to R&D, industry and the wider value chain both domestically and internationally.
2. Industry policy development continues. Constraints regarding levy funding for policy in future communication program put this area at risk (refer to the succeeding nursery industry communications program NY15006). Industry may need to be fund policy development out of other industry funds to assist in better interaction with government and community through a set of common articulated industry policy positions.
3. Further development of social media is focused upon by industry to leverage the cost benefits of this communication medium for the delivery of information as well as the opportunity to amplify communication and drive practice change.
4. The Nursery papers continue to be developed and published as these are a key tool in communicating R&D outcomes to industry as well as influencing practice change.

Scientific Refereed Publications

None to report

Appendices

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NY12011 Nursery & Garden Industry Communications 2013-2015

Appendix 1

Nursery Papers April 2013 to November 2015

• Your Levy at Work •
The production and distribution of Nursery Papers is funded jointly by your Nursery Industry Levy and the Commonwealth Government via
Horticulture Australia Limited

Urban Vegetation and heat Related Mortality

In this month's Nursery Paper, Dr Dong Chen and the team from Commonwealth Scientific and Industrial Research Organisation (CSIRO) look at urban vegetation and its impact upon heat related mortality. This research represents one of the first attempts to develop quantitative estimates of the potential benefit of urban vegetation in reducing heat related mortality. It was undertaken by a research team from CSIRO working closely with the NGIA, and involved modelling of vegetation and mortality relationships for the summer of 2009 and projected future climates in 2030 and 2050 for the city of Melbourne. The team found some differences among the results for 2009, 2030 and 2050, but the overall trend was that urban vegetation can potentially reduce excess heat related mortality. Different urban vegetation scenarios were tested, with the forest scheme predicted to achieve 60-100% reduction in excess mortality rate in comparison with the CBD vegetation scheme. From these results it is recommended that urban vegetation be a key component in heat wave mitigation and for preventative health.

Extreme environmental temperature can cause serious health impacts and can lead to increased mortality. The heat wave event in Melbourne during the summer of 2009 is estimated to have claimed 374 excess deaths over what would normally have been expected for that period (DHS, 2009). The relationship between heat and mortality has long been recognised (Haines et al. 2006) and several researchers have attempted to quantify this relationship for the city of Melbourne. Nicholls et al. (2008) analysed the mortality rate in Melbourne for people over 65 from 1979 to 2001. They reported that excess heat related mortality amongst the population over 65 may increase rapidly when the mean daily temperatures (the average of yesterday's maximum and this morning's minimum) exceed 30°C. Consequently, a 30°C mean daily temperature was recommended for Melbourne's trigger point for its heat alert system. Chen and Wang (2012) also observed a triggering mean daily temperature of around 30°C for Melbourne based on analysis of historical mortality data from 1988 to 2009 for people over 75. In almost all previous research, the focus has been on the linkage between ambient weather conditions and the mortality rate. Finding this linkage is important and can lead to improved public health alerts and emergency preparedness. However, with increasing focus on health prevention, a better strategy is to try and mitigate the heat stress in the first place, such as through improvements to urban vegetation coverage and the use of cool roofs. Cadot et al. (2007) reported that 74% of excess

Urban Vegetation and Heat Related Mortality

Urban vegetation can potentially reduce excess heat related mortality.

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deaths during the 2003 summer heat wave in Paris occurred among those who were living at home. They concluded that the most important risk factors for dying was being a female 75 years old and living alone. Although there is little available information on the locations and specifics of heat stress related excess deaths in Australia, being old and living alone have been identified as significant heat related health risk factors. Consequently, more research effort should be directed towards the indoor thermal environment, particularly those housing vulnerable populations, and mitigating the heat stress in residential buildings. The current study aims at quantitatively estimating the potential benefit of urban vegetation in reducing heat related mortality through improvement to the indoor thermal environment.

2 Methodologies and Modelling Results

2.1 Weather Data Preparation

Using a CSIRO developed urban climate model known as UCM-TAPM (Thatcher and Hurley 2012), the impact of different urban vegetation schemes on the local climate can be estimated as the change in monthly-mean ambient temperature, monthly-mean daily maximum temperature and daily minimum temperature relative to the Melbourne CBD vegetation scheme. Table 1 lists the main characteristics of the urban vegetation schemes investigated in this study. The predicted changes in the above three mean air temperatures associated with different vegetation schemes were then used to modify the 2009 weather data and the projected 2030 and 2050 average weather data for Melbourne. Climate change projections used in the study were based on the MIROC global climate model using the A1FI emission scenario.

2.2 Sample Residential Buildings

In Melbourne, detached houses represent around 76% of the residential housing stock, while the remainder consists of semi-detached buildings, flats, units and apartments (ABS, 2011). In this study, three residential buildings were used which include a detached single-storey four bedroom house, a semi-detached three bedroom two-storey townhouse, and a two bedroom apartment at the top of a two-storey building. It was assumed there was no insulation in these buildings in order to represent low-end Melbourne housing stock and potential exposure of occupants to health risks during heat waves.

The elderly are most at risk from excess heat related mortality.

Table 1 The main characteristics of the urban vegetation schemes investigated in this study

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2.3 Indoor Thermal Performance Modelling
The residential building simulation software AccuRate developed by CSIRO (Delsante 2005) was used to calculate the indoor thermal environment in the three sample buildings with the generated weather data for 2009, 2030 and 2050. The buildings were assumed to be without space heating and air conditioning. It was also assumed that occupants would actively operate the windows and doors to minimise extremes in indoor air temperatures, based on the following assumptions about behaviour:

• Windows and doors are closed if indoor air temperature is below 22°C; and

• If indoor air temperature is above 24°C and ambient air temperature is below indoor air temperature, windows and doors are opened. Otherwise, windows and doors are closed.

Using the AccuRate software, hourly air temperatures in the living room and the master bedroom were predicted using the generated weather files, and recorded for use in the mortality rate analysis.
2.4 Impact on Mortality Rate
Historical mortality data from 1988 to 2009 were obtained from the Australian Bureau of Statistics (ABS) for the Melbourne Statistical Division. This data was organised by the place of usual residence, by sex, and by two age groups, i.e. 0-75 and 75+. The Melbourne Statistical Division covers the metropolitan area of Melbourne as well as its surrounding urban fringe, including the Dandenong Ranges, the Yarra Valley and the Mornington Peninsula. It defines an area with a population of over 3.5 million, and accounts for approximately 70% of the entire Victorian population.
To understand the potential linkage between indoor air temperature and mortality rate in Melbourne, hourly simulations were carried out for the 20 year period from 1st January 1988 to 31st December 2007 for the three buildings and four different building orientations (i.e. north, east, south and west).
Considering that occupants are normally in the living room during daytime and in the bedroom at night time, the mean daily indoor temperatures for a building were defined here as the average of yesterday’s daytime (after 7am) maximum in the living room and this morning’s (before 7am) minimum in the master bedroom. Over the 20 year period from 1st January 1988 to 31st December 2007 there was a total of 7305 days. These 7305 mean daily indoor temperatures for each building and four facing directions were then grouped into consecutive temperature bands of 0.5°C. The average mortality rates corresponding to a particular mean daily

indoor temperature band were then obtained. For example, the average mortality rate corresponding to the mean daily indoor temperature band from 28°C to 28.5°C is the average of the mortality rates for all the days (in the 20 years) within that band. With the three different buildings and four building orientations, 12 sets of relationships between the mean daily indoor temperatures and average mortality rate can be established. Figure 1 shows the 4 sets of relationships for the house in four orientations between the average mortality rates for males and females over 75 years old and the mean daily indoor temperature. It is seen that high mean daily indoor temperature of the buildings corresponds to high average mortality rates. This is especially true for females over 75 years old. Based on these 12 relationships between the mean daily indoor temperatures and average mortality rate, the impact of urban vegetation can then be estimated using AccuRate simulations of the indoor thermal performance for the three buildings. The impact assessment considered the three buildings and their four orientations using the generated climate data for 2009, 2030 and 2050 with different urban vegetation schemes.
The potential impact on excess mortality rate has been estimated in this research as the difference in the heat related mortality rate when the entire Melbourne metropolitan area has a specific urban vegetation scheme, as outlined in Table 1, relative to the Melbourne CBD vegetation scheme as a baseline.

Figure 2 shows the potential impact on excess mortality rate with different urban vegetation schemes in 2009, 2030 and 2050 relative to the Melbourne CBD vegetation scheme. While there are differences among the results for 2009, 2030 and 2050, the overall trends are consistent in finding that urban vegetation can potentially reduce the rate of excess heat related mortality. In general, the reduction in the excess mortality rate increases with an increase in vegetation coverage and intensity. The leafy urban scheme for the Melbourne region is predicted to reduce 20-60% mortality rate in comparison with the CBD vegetation scheme.
The forest scheme (assuming the Melbourne Statistical Division is converted to forest) is predicted to achieve the best performance with a 60-100% reduction in excess mortality rate in comparison with the CBD vegetation scheme. Although total forest coverage for the Melbourne area is unrealistic, the research attempts to show the maximum benefit that may be achieved through urban greening.

This research serves as one of the first attempts to relate the indoor thermal environment with excess heat related mortality, quantifying the impacts of various urban vegetation schemes. The model established as part of this study is currently undergoing further testing, verification and development.

CONCLUSIONS

Simulations of indoor thermal environment were carried out using the AccuRate software to quantify the potential benefit of urban vegetation in reducing heat related mortality. This was done for the 2009 summer and also for projected 2030 and 2050 future climates in Melbourne. Results show that urban vegetation can potentially reduce excess heat related mortality. The forest scheme in particular, was predicted to deliver a 60-100% reduction in excess heat related mortality in comparison with CBD vegetation scheme. Urban vegetation is therefore recommended as a vitally important component of heat wave mitigation strategies for urban planning.

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acKnOWleDGeMenT

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Figure 1. Relationships between mean daily indoor temperature of the house and average mortality rate in Melbourne from 1st January 1988 to 31th December 2007

Figure 2. The potential impact on excess mortality rate with different urban vegetation schemes relatively to the CBD vegetation scheme

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emerging Biosecurity threats and industry preparedness.

Biosecurity is an ongoing challenge for our Industry with new exotic plant pests and diseases emerging around the globe. In this month's Nursery Paper NSW Industry Development Officer Michael Danelon looks at some of these emerging threats to Australia and how our industry is positioned to deal with these.

A large amount of plants introduced, grown and sold by the nursery industry are threatened by a range of different pests across different climatic conditions and environments in Australia.

Freedom from exotic pests not known to exist in Australia is vital to the future profitability, productivity and sustainability of Australia's plant industries. It is also key in protecting the natural environment and landscapes of Australia.

Should exotic pests be detected, how will industry and the government look to respond to their presence and set about eradicating them? This nursery paper will define what biosecurity is, the biosecurity tools and framework available for the nursery industry, current threat list and outline the process in responding to a pest once identified.

WHAT IS BIOSECURITY?

Biosecurity is a set of measures which can be implemented at national, regional or business levels to protect against the introduction and spread of new pests and to effectively deal with them should they arrive.

The definition of a nursery industry pest is all: insects, mites, snails, nematodes, pathogens (diseases) and weeds that may harm plants or plant products. Exotic pests are those not currently known to exist in Australia, whilst established pests are those already present.

Biosecurity is a whole of community responsibility, however for the nursery industry it begins at the farm level. Growers have the responsibility to maintain sound on-farm biosecurity practices to protect their plants, livelihood and the greater industry from both established and exotic pests.

Nursery hygiene is critical to maintaining effective biosecurity. Hygiene is more than just using clean nursery inputs and supplying clean outputs to the wider industry. It is very much about assessing the risk of what is introduced to the nursery and how these inputs are managed to maintain freedom of pests throughout the product cycle. Personal hygiene for example is often overlooked. For example, dirty clothes may carry pathogens or pests and boots may carry soil borne pathogenic spores.

BIOSECURITY THREATS LIKELY TO INCREASE

Australia has been fortunate to be geographically isolated. This has been of great benefit as the isolation has made the introduction of exotic pests difficult as long travel times provided an inherent form of quarantine. However much has changed in recent years. For example, air travel has made access to exotic locations across the globe much easier to access, new tourist destinations have opened up and the value of the Australian dollar has made travel more affordable. The internet has also opened up a new level of small scale trading allowing facilities for individuals to source and supply goods across the world with ease. All of these developments have

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preparedness.

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increased our risk of exposure to new exotic pests and increased the likelihood of border protections being penetrated and an incursion occurring. In view of this, it is likely that the nursery industry will continue to be threatened with biosecurity issues.

NEW BIOSECURITY LEGISLATION

The current legislation concerned with biosecurity in Australia is the Quarantine Act 1908. This legislation is being reviewed and will be replaced with a new piece of legislation in the near future. This new Bill is the Biosecurity Bill 2012 and was submitted to federal parliament in November 2012. Several issues with this Bill were identified by industries and it was forwarded for further review by the Senate Rural and Regional Affairs and Transport Legislation Committee who will report their findings on 24th June 2013.

BIOSECURITY AWARENESS OF AN EXOTIC PEST – MYRTLE RUST

Myrtle Rust (Uredo rangelii) is a recently introduced disease which has heightened the need for awareness of exotic diseases and the potential impact they may have if they are detected but are not contained.

The first formal detection of Uredo rangelii (Myrtle rust) was in April 2010 on a cut flower and foliage property in the Central Coast region of NSW. Within 8 months from the first detection, numerous Myrtle Rust infections were reported across NSW and also into South East Queensland in gardens, public areas and nurseries which made eradication impractical. Since then it has been detected and declared as established in areas of Victoria.

The financial cost to industry is difficult to measure, however we do know there are costs which businesses continue to absorb in:

• prevention, treatment and management of the disease,
• complying with market access requirements should they exist and
• loss of potential markets from quarantine restrictions.

Myrtle rust is the first and nor is it likely to be the last exotic plant pest to affect the nursery industry and environment. For example there are several exotic pests classified as significant to the nursery industry being managed now with the objective to eradicate them from Australia. These include chestnut blight and red imported fire ants.

The need for early detection followed by a rapid and coordinated approach to eradication is critical to limit the potential establishment of exotic pests in Australia. To assist in this area, the Nursery and Garden Industry has undertaken a number of initiatives to assist in the prevention of exotic plant pests and disease incursion and plans for the eradication of exotic plant pests and diseases if they occur.

PREPARING FOR EXOTIC PLANT PESTS

The nursery and garden industry in partnership with Plant Health Australia (PHA) has examined the potential threats to the industry. Through the support of industry levy funds, the nursery industry has developed a number of Threat Specific Contingency Plans for priority exotic pests. These plans were developed with consultation and support of PHA which is the national coordinator of the government-industry partnership for plant biosecurity in Australia.

The contingency plans provide guidelines and options for steps to be undertaken and considered when developing a Response Plan for incursion of exotic plant pests or diseases. Any Response Plan developed using information in whole or in part from this contingency plan must follow procedures as set out in PLANTPLAN under the EPPRD and be endorsed by the National Management Group prior to implementation.

There are 12 Specific Contingency Plans for the industry to be aware of:

- Aphid transmitted viruses - Potyviridae (include Plum pox potyvirus; Asparagus potyvirus)
- Asian gypsy moth (Lymantria dispar)
- Banded greenhouse thrips (Echinothrips americanus)
- Glassy winged sharp shooter (Homalodisca coagulate)
- Guava rust (causal agent Puccinia psidii)
- Longicorn beetles (Anolophora chinensis and A. malasiaca)
- Pierce’s disease (Xyella fastidiosa) linked with Glassy winged sharp shooter contingency plan
- Serpentine leaf miner (Liriomyza huidobrensis)
- Sudden oak death (Phytophthora ramorum)
- Tarnished plant bug (Lygus lineolaris)
- Thrips transmitted viruses - Tospovirus (including Chrysanthemum stem necrosis tospovirus; Impatiens necrotic ringspot tospovirus and Tomato spotted wilt tospovirus) and
- Whitefly transmitted viruses – Various (including Tomato yellow leaf curl virus; Tomato leaf curl virus; Lettuce infectious yellows virus and Diodia vein chlorosis virus)

The contingency plans have been incorporated into the Nursery Industry Biosecurity Plan and are available from NGIA and PHA. Each contingency plan provides guidelines to assist in developing a Response Plan to this exotic pest incursion and proposed eradication. This nursery paper does not aim to set out the specific detail of each Contingency Plan. However, the aim of this nursery paper is to raise the awareness of industry participants (growers/ retailers and allied suppliers) of these contingency plans in order to become familiar with the exotic pests threatening the Australian nursery industry.

HOW INDUSTRY CAN RESPOND TO EXOTIC PESTS

The NGIA is engaged in several biosecurity initiatives across Australia. These initiatives include the Nursery & Garden Industry Biosecurity Plan (IBP), Biosecurity Manual for the Nursery Production Industry, the EPPRD and Nursery Production Farm Management System - BioSecure HACCP Guidelines for managing biosecurity in nursery production.

INDSUSTRY BIOSECURITY PLAN (IBP)

The Nursery and Garden IBP provides a framework for biosecurity risk mitigation measures in the nursery industry. The current IBP was launched in 2008 and provided a blueprint for the exclusion,

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eradication and control of key exotic pests relevant to the nursery and garden industry. The IBP has been developed to ensure the industry has the capacity to minimise risks of exotic pests and respond effectively to any exotic pest threats, ensuring the future sustainability and viability of the industry.

An updated release of the IBP is due in mid-2013.

BIOSECURITY MANUAL – PRODUCTION NURSERIES

Nursery & Garden Industry Australia in partnership with PHA have developed The Biosecurity Manual for the Nursery Production Industry. The manual was formally launched in August 2010 by Dr Anthony Kachenko and provides the framework to reduce the risk of pests entering and becoming established in production nurseries.

The Biosecurity Manual has been designed to assist nursery producers and the industry from the introduction of new and invasive pests by offering six simple routine biosecurity practices which can be embedded into the daily management of the nursery. The practices include:

• awareness of biosecurity threats
• using only clean, pest-free and certified production nursery inputs
• practicing good sanitation – keep it clean
• frequently monitoring crops and the nursery
• abiding by the law and
• reporting anything unusual to the Exotic Plant Pest Hotline on 1800 084 881.

A key aspect to consider is the implementation by responsible businesses will reduce the risk of exotic pests to the wider industry.

EMERGENCY PLANT PEST RESPONSE DEED (EPPRD)

In 2005, NGIA became a signatory to the EPPRD. As a signatory to the EPPRD, NGIA is at the forefront of developments in biosecurity. The EPPRD is a progressive partnership arrangement between governments and NGIA that sees Australian industries and Governments cooperating as equal parties in the management of emergency plant pests (or exotic pests).

As part of this deed, NGIA is directly involved in categorising the emergency plant pests based on their likely environmental, human health, trade, economic and industry impacts. In the event of an incursion, NGIA is also directly involved in decision making about mounting and managing emergency plant pests relevant to industry.

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BIOSECURE HACCP - AN ON-FARM BIOSECURITY MANAGEMENT SYSTEM FOR PRODUCTION NURSERIES

BioSecure HACCP is the industry specific, on farm biosecurity program for production nurseries, designed to assist growers in assessing their current and future pest risks. The program guides businesses in the implementation of management strategies at critical control points and provides a systematic approach to assess on-farm biosecurity hazards and responsibilities, detailing how to best manage identified risks.

The program validates many of the best management practice strategies employed under the Nursery Industry Accreditation Scheme Australia (NIASA).

WHAT CAN YOU DO?

Emergency pest threats are very real for the nursery industry and need to be considered and provisions made by businesses and industry to prepare for them. Obtaining the resources which have been developed and implemented biosecurity practices in your businesses and becoming familiar with exotic pests are critical.

SPOTTED ANYTHING UNUSUAL?

When it comes to dealing with exotic pests, speed is of the essence. Detecting an exotic pest early and mounting a swift eradication response is crucial in order to successfully eradicate an emerging exotic pest threat.

Businesses should be constantly on the lookout for something unusual in their nursery. Nursery workers’ eyes and experience are the most important tools that we have.

If you have spotted something unusual, or suspect a pest that represents a risk to your business and the Australian nursery industry, simply call the Exotic Plant Pest Hotline on
1800 084 881

Your call will be
forwarded to an
experienced person in
the state department of
agriculture who will ask
some questions about
what you have seen and
may arrange to collect a
sample. Every report will
be taken seriously, checked out and treated confidentially.

CONCLUSION

Biosecurity planning provides a system for the nursery and garden industry, government and other relevant stakeholders to assess current and future biosecurity needs and practices. Biosecurity planning identifies procedures that can established to reduce the likelihood of pests reaching our borders and minimise the impact if a pest incursion occurs.

Everyone involved in the Australian nursery industry has a role to play in adopting biosecurity practices. Prevention of introducing new pests is far better than dealing with the long term consequences of a new pest. Considering the risks and implementing changes to protect your business, industry and the environment are surely worth doing for everyone's sake.

nursery Papers

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EXOTIC PLANT PEST HOTLINE 1800 084 881

Spottedanythingunusual?

These pests attack a wide range of hosts and would have serious consequences for the nursery and garden industry and Australian agriculture if they were to become established.

If you see anything unusual, call the Exotic Plant Pest Hotline on 1800 084 881.

Guava rust• Causes brown-grey lesions on young leaves and shoots• Can kill shoot tips, causing loss of leaders and bushy growth habit• Bright yellow spores are produced on older lesions• Brown spots with no spore production occurs on resistant hosts Sudden oak death

• Diffuse dark-brown spots with fuzzy margins, usually at shoot tips• Shoots become blackened and can drop foliage• Flattened cankers which ooze dark red to black sap can occur low on the trunk

Glassy winged sharp shooter• Vector of Pierce’s disease (Xylella fastidiosa)• Large (13–14 mm in length), dark insect, with yellow dots in its head• Eggs laid in side-by-side rows on the underside of leaves• Produce a white excrement that sticks to leaves• Pierce’s disease (insert image) is characterised by leaf scorch, starting with sudden drying of parts of the leaf, which then turn brown with adjacent yellow or red colour

Asian gypsy moth• Female moth – white body with yellowish hairs and white wings with black wavy bands (wingspan of 4–7 cm)• Male moth (insert image) – grey-brown body and dark wing markings (wingspan of 3–4 cm)• Larvae colour starts as grey-black (when 3 mm in length) and develops black, yellow, blue and red patterns (growing to 70 mm)• Larvae feed on buds leadi to defoliation

Red palm weevil

• Large weevils (up to 35 mm long), reddish-brown with a long curved snout• Eggs (2.5 x 1 mm) are creamy-white, oblong and shiny• Larvae (35–50 mm long) have a brown head and white body with 13 segments Citrus longicorn beetle• Large black beetles with white spots (21–37 mm long) and antennae that are 1–2 times the length of their body• Larvae grow up to 56 mm with a yellow-white body and black head, developing within the host trunk• Produce frass at the base of infested trees and rou exit holes

Division of Plant Industry Archive, Bugwood.org

PaDIL

Both images: J. O’Brien, USDA Forest Service, Bugwood.orgBoth images: J.H. Ghent, USDA Forest Service, Bugwood.orgR. Garcia III, USDA ARS, Bugwood.orgPaDIL

Both images: Luigi BarracoBoth images: Bugwood

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Management of fungus gnats in nursery production

Fungus gnats (Bradysia spp., Sciaridae) are small, mosquito-like flies which are a common problem in production nurseries and propagation greenhouses where seedlings are being grown. Larvae can cause significant damage, substantial economic loss and both adults and larvae can spread fungal diseases such as Chalara, Botrytis, Pythium, Phytophthora, Chalara, Fusarium, Rhizoctonia and Verticillium. Management of fungus gnats requires careful and deliberate planning.

This months nursery paper was prepared by Andrew Manners (Senior Entomologist at the Queensland Department of Agriculture, Fisheries and Forestry) in conjunction with the 'Fungus gnat pest management plan for production nurseries' as part of a levy funded project NY11001 Plant health, biosecurity, risk management and capacity building for the nursery industry. This nursery paper summarises aspects of the more detailed pest management plan which is also available at www.ngia.com.au.

General biology

Adult fungus gnats are small mosquito-like flies which fly in erratic zig-zag patterns over growing media and around plants. Eggs are laid in the soil or potting media and hatch after about 4 days (depending on temperature). Larval fungus gnats are white maggots with a shiny black head and are 1-8 mm in length (Fig. 1) that tend to inhabit the top 3 cm of growing media. Larvae are primarily fungus feeders and will readily feed on organic matter in the growing media. They will also feed on root hairs and callus, present in the growing media, including leaves touching the soil in the absence of fungus food. Large larvae may feed on the insides of roots and large infestations may see larvae boring into larger roots or stems in the soil. Furthermore, larvae and adults can spread diseases, which can cause significant crop loss. Establishment of disease may also be enhanced from wounds created by larval feeding, particularly at high densities.

Managing fungus gnats

Sole reliance on synthetic pesticides to control fungus gnats will eventually fail. Preventative measures, predators and biopesticides can be used very effectively to the exclusion of all traditional insecticide applications. Taking an integrated approach, using a wide array of options to minimise and manage fungus gnat populations, is very effective for keeping fungus gnats under damaging levels. Populations should be actively monitored and a pest management plan established and updated over time to account for the individual nature of your business and the plant species that you grow.

Management of fungus gnats in nursery production

Fig. 1. Fungus gnat larvae heavily infesting a plant cutting (top) and an adult on a tomato seedling (bottom).

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Technical
Monitoring fungus gnats
Plants should be inspected daily with results of monitoring recorded weekly. Frequent monitoring will enable infestations to be spotted while they are still light, and thus easier and cheaper to manage. Different methods can be used for monitoring adults and larvae. For more information on monitoring fungus gnats, refer to the nursery production fungus gnat pest management plan.
Monitoring adults:
1. Yellow sticky traps are essential in cuttings and seedlings (Fig. 2). Position traps about 10 cm above the crop canopy, particularly near susceptible crops. Traps should also be placed near doors, vents and any susceptible crops or areas. At least one trap per 100 m2 for greenhouse crops, more in varieties that are known to be susceptible to fungus gnats. Inspect sticky traps at least weekly and change traps every 2 to 4 weeks. Numbers less than 20 flies per trap/week may be under the economic threshold but will vary with each crop variety. Sticky traps also physically kill adults, precluding their ability to reproduce and further infest the crop.
2. Visual inspection of the crop can also provide valuable qualitative information about the abundance of adult populations. If relatively large numbers are observed when plants are disturbed further investigation should be undertaken.
Monitoring larvae
3. Visual inspection of cuttings and surrounding media can reveal the presence of fungus gnat larvae but is time consuming and may damage cuttings/roots. Small larvae can also be difficult to detect.
Cultural control for fungus gnats
Growing media and storage
• Use growing media low in organic content. High organic content can promote fungus gnats. However, this must be balanced by using a mix that provides beneficial growth properties for the plant species in question.
• Store growing media in a clean, dry area. Storage of media in an unprotected area subject to rain or other sources of moisture may promote fungal growth, which in turn will promote fungus gnat populations. Ideally, cover unused media in a sealable container to prevent further infestations.
• Pasteurise media prior to use to ensure that it is not contaminated.
Protect your growing area

• Prevent entry to the growing area by using an insect proof glasshouse or tunnel.
• Check incoming stock and growing media, either before purchase or on arrival for signs of infestation.
• Quarantine incoming stock as per NIASA Best Practice Guidelines and monitor plants for fungus gnats and other pests prior to incorporation in production areas.
• Grow cultivars that are more resistant to fungus gnats.

Irrigation and fertilising

• Avoid excess watering. Fungus gnat numbers are lower when moisture levels are relatively low.
• Fertilise using the minimum amount required to maintained required growth. Excess fertiliser will favour the growth of algae in the growing area which will promote fungus gnat populations.

Sanitation and general hygiene

• Reduce fungus growth in the media and growing area.
• Disinfest growing surfaces and paths to remove algae
• Ensure that growing surfaces, below benches, walkways and areas around the growing area are free-draining and free of algal growth.
• Remove weeds and plant waste regularly.
• Modify the growing area so water does not pool in or near the growing area; regrade floors if necessary.
• Remove unsold or unsaleable infested crops from the growing area quickly to reduce populations spread.

Fig. 2. Yellow sticky trap with fungus gnats
and close-up of adult on sticky trap in topright corner.

Fig. 3. Poor establishment caused by fungus gnats.

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4. Potato plugs can be used to lure larvae to the surface. Place a slice of uncooked potato about 3-5 cm in diameter (and about a cm thick) without skin face down on the growing media. Smaller chunks or slices can be used in small plugs/ containers. Ensure that most of the surface is in contact with the media so that the potato does not dry out. After 24-48 hours, lift the potato plug and first examine the growing media under the potato, as larvae will rapidly vanish from view on the surface. Then check the potato itself for larvae. It is recommended to mark pots or plugs where potatoes are placed so you can find them more easily. If not removed, potato chunks can rot, sprout, promote fungus gnats and other pests e.g. mice.

Keep long-term records to assist identifying areas and varieties that are more susceptible to fungus gnat infestations. It is also important to continue monitoring following application of biological control agents and other control measures to determine the effectiveness of each treatment. These records can assist with making management decisions in the future. For example, one might modify the composition of growing media to reduce infestations or select varieties that are found to be more resistant to fungus gnat attack. Insect monitoring data sheets are available in the BioSecure HACCP protocols. Alternatively, simple spread sheets can be created and modified to suit your farm.

Pesticides and fungus gnats

Pesticides can be used to assist management of fungus gnat larvae. In Australia, there have not been any confirmed cases of pesticide resistance in horticultural or mushroom crops. However, resistance has been reported for certain organophosphates (e.g. diazinon) and permethrin overseas and it is possible that resistance occurs in Australia but has not been reported. It is important to rotate between products from different mode of action groups regularly. Do not to continue using a product that has failed (particularly if it was applied correctly and good control has been achieved in the past). For more information on use of pesticides refer to the nursery production fungus gnat pest management plan.

Biological control of fungus gnats

Biological control is very effective against fungus gnats and is most effective when released in a preventative manner, so that populations of predators are always present in the growing area. If predators are only released after a large infestation has occurred it will take longer to manage the population (regardless of whether predators or pesticides are employed). It is recommended to release predators routinely, particularly after potting-up to reduce the likelihood of populations reaching damaging levels. A brief summary of commercially available predators are provided below with more detail in the nursery production fungus gnat pest management plan.

Predatory mites

There are two species of predatory mites available from Biological Services listed as the products Hypoaspis A and Hypoaspis M. These relatively large, brown to orange coloured mites feed on fungus gnat larvae, thrips pupae and on a variety of other soil organisms, including nematodes, springtails, root aphids and mites. While soil predators may have some protection from foliar sprays of insecticides, run-off from high impact pesticides can still have a severe negative effect on predators, particularly if they have long residual activity.

Rove beetle

Adults and larvae of the rove beetle, Dalotia coriaria, feed on a range of small insects and mites, feeding heavily on fungus gnat and shorefly eggs and larvae and thrips pupae. Adults have wings and may fly to find food. Adults live about 21 days and lay up to

Case study #1 Propagation Australia, Queensland

In the past, fungus gnats have been a big problem for us, particularly in poinsettias, gerberas, young carnations and all bedding plants. A long time ago, we didn't treat the growing media when it arrived; we used to accept that the media was clean and pot-up. On a couple of occasions we lost entire crops, a large amount of stock. Now, we rarely have such problems because we manage fungus gnats from the beginning of the production cycle. We assume that all potting media is infested with fungus gnats when it arrives at our nursery. We pasteurise media for very sensitive plants that have zero tolerance (e.g. plants in quarantine, plants grown from tissue culture and nuclear stock), however the volume of media used across all crops doesn't allow us to pasteurise everything. Regardless, all stored media is kept covered and dry.

Cultural management practices make a big difference.

Fungus gnats love water and we have noticed that areas that remain over-watered for a period of time tend to have larger populations than less watered areas. Therefore, our irrigation is monitored daily and modified to suit climatic conditions on a daily basis. This helps reduce algal growth, which promotes fungus gnats. Much of our growing area is within insect-proof tunnels and this significantly reduces populations of many pests, including fungus gnats. In addition, we use two types of yellow sticky traps. Long rolls of sticky traps are used in the growing areas with susceptible crops and remain in the crop for the entire season; this acts as a mass trapping device. Smaller, more traditional, sticky traps are used for weekly monitoring (both available at Bugs for Bugs).

Unfortunately, we’ve found fungus gnats to be very persistent and almost impossible to eliminate completely. We use an IPM crop consultant on a weekly basis to make sure that all pests, including fungus gnats, are managed before they reach economically damaging levels. We have a regular regime for management of fungus gnats (described below) but sometimes additional treatments are necessary; our crop consultant informs us when these are needed.

When we first pot-up, we treat the media with entomopathogenic nematodes and we reapply nematodes on a fortnightly basis. On the off week we drench with Vectobac. In addition, for important stock which has very low tolerance we will drench with a imidacloprid on three consecutive weeks. These applications are made after a tunnel has been completely filled. We will also sometimes apply Agri-50 if numbers of adults are relatively high. Agri-50 acts like yellow sticky traps, but can be sprayed on plants, physically trapping adults and killing them; it doesn’t damage most plant varieties. By doing all of these things we now have very few problems with fungus gnats.

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about 8 eggs per day, and may eat up to about 150 fungus gnat larvae. Adults prefer to eat fungus gnat larvae more than shorefly or western flower thrips pupae, when given a choice. Biological services is the only provider of D. coriaria in Australia.

Insect-killing nematodes (e.g. Steinernema feltiae)

Insect-killing (entomopathogenic) nematodes (ENs) are tiny, very slender, worm-like, soil-dwelling organisms that are a little less than 1 mm in length. The ENs must be drenched into the growing media. Once they come in contact with a host, they enter and kill it. Application of ENs can be completed using a high volume low pressure spray to drench nematodes into the media a short distance or through existing irrigation. In either case, ensure that all filters are removed and speak to your distributor for more specific instructions before applying for the first time. ENs are UV sensitive, so application when the area is in high levels of direct sun is not recommended. There are two suppliers of insect-eating nematodes in Australia, Ecogrow and Becker Underwood. Ecogrow produces nematodes in Australia, Becker Underwood imports their nematodes from the UK.

Bacillus thuringiensis subsp. israelensis (Bti)

Bacilllus thuringiensis subsp. israelensis (Bti) is an entomopathogenic bacteria which causes diseases in insects, e.g. Vectobac or Bactivate. After ingestion by an insect host, the bacteria produce a number of substances which cause cell disruption and other physiological problems which cause the cuticle to disintegrate and the insect to die. There are a large number of Bt subspecies which are specific to certain pest groups, e.g. flies or caterpillars. Bti is specific to various fly larvae, including fungus gnats. Research has shown that Bti is mainly effective against first instar fungus gnat larvae, not larger second or third instars. This is because larger larvae must consume more bacteria to cause mortality than smaller larvae. If using Bti one must apply the product when fungus gnats first appear and may require multiple applications.

Conclusion

Managing fungus gnats without pesticides is feasible but may require modifying the growing environment through cultural

management practices. The fungus gnat pest management strategy
for production nurseries provides a good basis but may need to be
altered to suit your region and growing environment. Be creative
and record changes in fungus gnat populations with different
management techniques.

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Available at: http://www.ngia.com.au/Story?Action=View&Story_id=1259

Case Study #2 Brocklands Nursery, Tasmania

In the past I used a one application of Crown, Confidor and Azamax over a four week period. At the time, I thought this managed fungus gnats, even though there were adults found commonly on yellow sticky traps. I modified my irrigation system to super-fine foggers which wet the soil but dissipated before reaching the ground. In effect, propagation plants received adequate water, without being too wet, and walkways remain dry. Despite this water saving, relatively dry system, I still had major fungus gnat problems, although it was not recognised at the time. I investigated the use of the product Bactivate primarily for the control of mildews in the propagation house. I now drench Bactivate, which is a combination of five beneficial bacteria active against fungus gnats and pathogens and increasing uptake of certain nutrients, e.g. phosphorous. After the first application, dead fungus gnat larvae appeared everywhere on the surface of the media and resembled a world war battle scene. Now fungus gnats only ever remain at very low levels, plants show higher nutrient uptake and have increased rooting rate.

Fig. 4. Fungus gnats that surfaced and died after
application of Bactivate.

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Managing iron in nursery irrigation systems

Having a source of good quality water is vital to any professional nursery operation. In this month's Nursery Paper, Victorian Industry Development Officer David Reid examines iron content in nursery irrigation systems, covering why it may be of concern and how best to manage it.

Iron is one of earth's most common resources, making up at least 5% of the earths crust. The action of rainfall seeping through this crust dissolves iron and then transports it into natural water sources. The majority of groundwater sources in irrigation systems will exhibit at least some level of dissolved iron.

Although iron in nursery irrigation water could be an essential nutrient, when coming into contact with oxygen in the air it will oxidise, often appearing as an insoluble reddish-brown sediment. Levels of this sediment above 1mg/L of water will ultimately play havoc with a production nursery environment:

- Blocking drippers, filters and spray nozzles through sediment and bacteria that thrive in iron rich environments;
- Contributing to scale build-up in irrigation pipes;
- Decreasing water pressure and overall irrigation efficiency;
- Increasing maintenance and replacement costs over time;
- Staining nursery structures;
- Depositing sediment on foliage, impairing photosynthetic efficiency and ultimately their sale quality (in systems where the level of iron in water exceeds 3-4mg/L).
- Problems may be increased when an iron rich water source is combined with fertigant (calcium salts or unchelated phosphates), accelerating the natural process of iron precipitation considerably.

Water from dams, or surface waterways are unlikely to have iron levels that will contribute to problems within irrigation systems as the iron will have dropped out the water prior to being extracted. The use of a town source or that collected from rainwater are also unlikely to exhibit iron induced problems, unless it comes in contact with degraded steel tanks or pipes.

The problem of iron in irrigation water centres on its extraction from iron-rich groundwater, with bore water a key source. As soil-types are highly variable, groundwater quality at different bore depths will also exhibit variable iron levels.

NB: The document Minimum construction requirements for water bores in Australia suggest numerous methods to mitigate the presence of iron prior to accessing underground water sources.

As more nurseries look to draw water from sources other than town water or a source with low iron concentration, the following may provide some direction to manage iron levels in your irrigation water.

Types of iron

The presence of iron in a nurseries water source may be appear in many different forms; chelated, organic and precipated, with these forms including:

• ferrous (Fe^{2+}) or dissolved iron, which is soluble and colourless when dissolved in water. It is this form that can be introduced into an irrigation system.

• ferric (Fe^{3+}), which occurs when ferrous iron is moved to the surface and oxidised to highly insoluble or oxidised (rusted) iron, appearing when precipitated as brownish red colored particles suspended in the water. If this water is left to settle most of the rust particles will sink to the bottom of the storage vessel (tank/ dam) over time.

The conversion from the soluble ferrous to the insoluble ferric is affected by numerous factors, with the dominant being:

• pH - Iron is more soluble at lower pH values and iron precipitation can be caused by raising the pH.

• O2 content – the ferrous form occurs when oxygen concentration is low (i.e.: bore water). When water is moved from anaerobic (without O2) to aerobic (with O2) conditions above ground the ferrous form rapidly converts to ferric, with resulting precipitation. Precipitate usually coagulates near O2 sources such as leaking pipes or emitters.

• temperature – lower temperatures contribute to longer oxidation reaction times

For example, for 90% ferrous iron, oxidation at:

• pH 7.0, it will occur within 1 hour at 21ºC and 10 hours at 5ºC.

• pH 8.0, it will occur within 30 seconds.

• At pH 6.0, it will occur within 100 hours.

The critical dissolved oxygen concentration is 2mg/L (2ppm). Below this concentration, ferrous iron oxidation occurs very slowly.

So what is the first step to fixing the issue?

Regardless of how clean the water looks, a full elemental water test should be completed on at least a yearly basis to determine iron content.

Not only is it prudent to discover the level of iron that is being sent through your irrigation system and onto your plants, it is vital to your business to identify the presence of other potential contaminants that could compete/react with the iron.

Understanding your water’s pH, electrical conductivity (EC) and numerous other elemental characteristics are also important, as some of these may inhibit management approaches.

These characteristics may vary greatly between different sites, water sources and times of the year, so regular monitoring is required to ensure your management choices are suitable and able to maintain the quality of your water.

Nutrient and other factor levels in irrigation water for general ornamental plant production.

Based on Hart (1974); Ayres and Westcot (1976), Aikman (1983), Degremont (1991), Yeager et al (1994), Bienbaum 1993.

Factor	Phytotoxic limits
Nitrate (as NO3 not N)	<100mg/L (excessive soft growth)
Phosphorus (as phosphate)	<15mg/L for phosphate sensitive plants

Iron (Fe^{++}) (Yeager et al) 5mg/L
Copper 0.2mg/L
Boron 0.3mg/L
Zinc 2.0mg/L
Manganese 0.2mg/L
Aluminium 5.0mg/L
Molybdenum 0.01mg/L
pH (nutrient imbalances) 5.5 to 7.0
Salinity (EC–dS/m) 0.75 to 3.0 (low to severe problem*)
Chloride 200mg/L
Sodium 100mg/L
Alkalinity 40 to 500mg/L $CaCO_3$ (low to severe problem)

* Safe salinity limits will depend on the type of crops grown.

The optimum levels of nutrients in irrigation

Plugging potential of drip irrigation system water sources

<0.1mg/L should not present much of an issue
0.1-1.5mg/L minor to moderate clogging of drippers. Iron bacteria will develop
>1.5mg/L severe clogging
>3mg/L iron rust stains and discoloration of foliage plants in overhead application.
>4mg/L phytotoxicity (this will occur w/ lower value if pH is less than 5.5. Values above this are difficult and expensive to treat.

Before implementing any management options, samples must be taken.

• Draw water sample directly from source
• Place into a plastic container; filling completely.Iron precipitate can clearly be seen in this example (picture courtesy of Mr Phil Heath Botanica Nurseries)

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• Seal tightly to avoid oxidation
• Send off to lab for analysis. Portable test kits are available (speak to IDO in your state for further information.

Clear water samples does not mean that iron is not present, as invisible iron may be present as ferrous bicarbonate ($Fe(HCO_3)_2$). However, during sampling and by the time the water sample reaches the laboratory, oxidation of some or all iron can occur and turbidity may show up in the results. Ferrous bicarbonate, when oxidised, changes into ferric hydroxide $Fe(OH)_3$] producing carbon dioxide and lowering the pH.

Water testing is needed before considering or selecting the appropriate treatment equipment for effective and efficient removal of iron.

Depth of irrigation intake

After identifying that iron content in bore water is causing some of the aforementioned issues, a good first step is to ensure that the irrigation intake is located 50-75cm below the surface of the water. When an intake is too close to the bottom, settled iron sediment will be drawn from the bottom of the pond and those too close to the surface will draw higher levels of the oxidised form and other organisms that flourish on the oxidized from, such as iron fixing bacteria.

Managing emitter blockages /filters

In addition to staining of plants and structures, the blocking of irrigation equipment with iron sediment is a common problem if not managed. This issue of emitter plugging may not be from iron levels alone, but other particulates from soil or water sources.

Filters are the first line of defence against particles entering the irrigation system, with the best approach being to install the best filtration system you can afford and regularly maintaining it.

A screen filter is ideal for removing particles from the water source prior to distributing them throughout the irrigation system, with multiple screens system recommended for surface water sources.

Disc filters trap particulates on adjacent discs as water flows from outside edges toward the inside of the discs, with filtered water exiting through the central conduit.

Filtration alone does not remove iron efficiently as it only removes particles of oxidised iron. A sand media filter is the most appropriate filter for removing ferric oxide.

The recommended treatment to remove iron is oxidation, sedimentation and filtration, with the use of settling, aeration, chlorination and even potassium permanganate. Aeration and oxidation should take upstream of the filter.

Aeration and settling to precipitate iron

Where iron concentration is above 1mg/L, aeration and settling is recommended prior to use in irrigation systems. Pumping water from the bore and spraying it into the air over a dam (or into a tank) is a reliable way to remove the iron. Another option is cascading the bore water over baffles. Allowing the water to flow over a large surface such as rocks, a corrugated surface or baffle plates will encourage aeration, before settling in a dam.

As previously mentioned, during the aeration process the iron is oxidised into is insoluble form that can then be settled in the dam/tank. A clear disadvantage is that the water must be double pumped, with an extra pressurisation required after aeration.

If you wish to settle it in a tank, it is ideal to draw the water off from a high level outlet and into another storage tank, with a regular drawing off of the iron rich sludge from the settling tank via a bottom outlet plug.

Chlorination to control iron

Chlorination can be utilised as a further control following aeration and sedimentation. As well as controlling zoospores and spores of particular pathogens, if the pH is below 6.5 and the iron concentration is less than 3.5mg/L chlorination can also manage iron content.

NB: If pH is above 6.5, the iron concentration must be below 1.5mg/L.

Chlorination can be considered as a treatment method, especially when iron exists in organic form. Chlorination breaks down the organic complexes, and the iron then may be oxidised and precipitated by aeration and pH adjustment. Iron is more soluble at lower pH, with the ideal precipitation value is likely to occur at a pH of 7.2, so it may require the addition of hydrate lime to raise pH. Prudent use of lime is encouraged as too much will create hard water.

Furthermore, chlorination also kills iron bacteria (a type of brown-reddish slime that precipitates from water that contains iron) on contact. The bacteria can live on iron or sulphur and produce a mass of slime that quickly attach to PVC and polyethylene tubing and clogs emitters and filters. This slime can also act as an adhesive to bind other solids together to exacerbate clogging. They can also cause soluble iron and sulphur to precipitate out of the water. A continuous residual rate of 1-2ppm of free available chlorine at the distant end of the irrigation system should be sufficient. (Bucks and Nakayama 1980)

Bore pump Iron precipitate can decrease pump performance and lead to pump failure

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Ion exchange / softeners filters

A further option is through softeners to remove the ferrous bicarbonate in water. The simplest method (but not necessarily the most cost effective) is to remove ferrous bicarbonate iron from the water by passing it through an air tight water softener containing a resinous cation exchanger: an insoluble matrix normally in the form of small (1–2mm diameter) beads, fabricated from an organic polymer substrate with a surface that easily traps and releases ions in a sodium ion exchange using coated resin beads or zeolite process called ion exchange. The capacity for removing iron depends on the capacity of resin.

By using a basic softener regenerated with sodium chloride, iron can be removed along with calcium and magnesium. Filters such as these require regular backwashing to maintain effectiveness.

Potassium permanganate

This compound is another option for iron removal from irrigation water, often combined with manganese greensand, acting as a filter to capture ferrous oxide, by oxidising the iron into an insoluble oxide (1:1.06mg/L) The main advantage is the high rate of reaction, many times faster than that of chlorine. The reaction is also not sensitive to pH within the range of 5 to 9.

After backwashing to remove the insoluble iron oxide, regeneration with potassium permanganate solution is carried out to maintain the process. The greensand is recharged until pink water flows out of the greensand media. The flow is then decreased until a slight pink colour appears. There should be no pink colour after filtration. Other products such as zeolites and birm can be used instead of greensand and potassium permanganate to improve the oxidation process.

Complexing the iron to stop oxidisation

If the iron in the water is complexed to stop oxidation, precipitate will not form and blockages are not likely to occur.

A simple means of complexing the iron is to add sodium silicate to the water with an injection pump located near the main pump. Sodium silicate is a dense sticky liquid available in 200L drums. Each litre of sodium silicate contains 450g of silicate. To help mix it sodium silicate may be pre-mixed with water to make it less sticky, but do not dilute with more than two parts of water to one part of sodium silicate.

The amount of sodium silicate required depends on the amount of iron in the water. The recommended rate is 7g of silicate per 1g of iron. This is the equivalent to 0.015L of sodium silicate, pet 1mg/L of iron, per 1kL of water.

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Bridging the Ebusiness Technology Gap in the NSW Nursery and Garden Industry

In this month's Nursery Paper NGINA Business Skills Development Officer, Bob Wynyard reports on recent work undertaken in developing E business solutions and training in the Nursery Industry.

1.Background

A 2009 industry supply chain review in Australia's nursery and garden industry confirmed the need to up-skill all industry sectors. It concluded that urgent action was necessary to improve efficiency, reverse declining profit margins, capture market opportunities and improve business sustainability. Importantly, adoption levels of Information and Communication Technology (ICT) in the industry were very low and a significant impediment to development of strong supply chain management.

In line with Nursery & Garden Industry Australia's (NGIA) strategic objectives and with the aid of a grant from the NSW Department of Education and Community's Skills Enhancement Program (SEP) an ebusiness project was initiated . SEP projects are designed to develop and deliver complementary training activities leading to broader skill development, improved business productivity and better job outcomes for individuals.

From the outset, the project focus was aimed to provide managers and employees of the many industry Small and Medium Enterprises (SME) with improved ICT skills. Through the enhancement of individual skill-sets, would flow; improved processes in stock ordering, invoicing, delivery, sales and payment, as well as identifying and preventing waste.

The project also presented the opportunity to provide a better understanding of how costs are constituted, resulting in the inclusion of an interim Stage 2. This stage focussed on reviewing, upgrading and simplifying costing activities in production nurseries, as well as complementing subsequent developments from the main project.

The project's first major task was to define the ebusiness skill shortages which formed the greatest impediment to improving productivity. Subsequent matching of the relevant units of competency chosen to fill the skill gaps was then tested in a series of pilot workshops. Represented in these workshops were a range of industry owner/managers and employees. Subject to the final outcome of this stage and with any refinements made, NGINA would then be in a position to roll training out to industry and make it available nationally.

Key tangible objectives of the project include;

- A major overhaul of the nursery costing program including development of a workshop and associated resources.
- Building e-business skills and competencies across the industry through the development of a workshop, templates and resources.

Table 1 Summary of the 6 stages in the project

Bridging the Ebusiness Technology Gap in
the NSW Nursery and Garden Industry

BUSINESS

2. Ebusiness Skills a Must for Efficiency and Profitability

The primary objective of Stage 1 was research and gathering information for which Gerard McEvilly (Horticulture Supply Chain Services) was commissioned to assist. His work consisted of in depth interviews with 30 key industry players, scrolling through literally hundreds of research publications and producing a report identifying likely threats and opportunities. His initial observations identified the following key emerging patterns:

- The challenge of getting up to speed on e-business practices is across industry, including production, retail, landscape, all other channels and end users.
- A common occurrence across the industry known as ‘Monday Madness’ describes the disorderly nature of weekly greenlife ordering, with little knowledge of stock-outs until delivery.
- Training targets are likely to be aimed at more willing ‘ready adopters’.
- Lack of e-business preparedness will almost certainly compromise business success in the next 5 years.
- Promoting e-business involvement needs to focus on communicating cost benefits.
- Maintaining post-project momentum will need to focus on adoption of industry guidelines.

More importantly McEvilly identified a broad training pathway based on eight key topics. Further refinement by a subcommittee and a cross section of growers using the criteria of ‘most needed’ and ‘most achievable’ resulted in the publication of the “Better e-business Skills underpin Industry Supply Chain Blueprint, which included related skills listed below:

1. Step-wise introduction and development of e-business capability

SKILLS: Need and benefits of using e-technology; Introduction to technology used in the supply chain; Performing tasks across industry

2. Development of guidelines and protocols to maximise e-business efficiencies in the supply chain

SKILLS: Industry conventions; Protocols and gaining maximum efficiency; Understanding the supply chain.

3. Introduction of online stock availability

SKILLS: Writing electronic supply catalogues; developing online templates and ordering procedures.

4. Smarter inventory management

SKILLS: Inventory management; Stock control; Planning and forecasting.

5. Effective communication between producer and consumer

SKILLS: Effective customer relationship management; Better B2B communication

6. Costs, benefits and implementation of barcoding

SKILLS: Implementation of stock ID; Electronic data interchange (EDI)

3. Management and Communication; Stronger from Improved Ebusiness Skills

A separate survey was conducted to gauge ebusiness proficiency. In general this supported the view that better ebusiness skills would result in better management and improved communication. Whilst this was conducted via Survey Monkey and the sample was small here are some of the key points:

- 90% of managers/owners are comfortable using computers
- 45% of staff have their own work email address.
- 60% of respondents have never used social media.
- Most respondents use computer/internet for invoicing, data storage, sales quotes and banking.
- When asked to rate their workforce skill levels, ‘Accounting System’ was the only category rated as ‘good’ by over half (52.6%) of the respondents.
- Cost, hardware/software required and time to set up new system were listed as the 3 major obstacles to improving electronic business skills.
- Businesses with websites seemed more aware of cost than all other groups.
- In order of priority the greatest needs for e-business skills improvements were in Sales and Marketing, Customer Database, Inventory Management and Social Media.
- 75% of all respondents have websites but 39% take 3 months or more to update them.

4. Eureka! The True Farm Gate Cost of a Plant

Stage 2 of the project was a review of production costing. This involved a total rework undertaken by Andy Cameron (Nursery Management Systems) prior to rigorous testing at a pilot workshop and then subsequent review by workshop attendees. The key objective was to enable growers to accurately determine the cost of a plant before it leaves their nursery. This information enables more accurate decisions to be made on factors affecting profitability:

- Setting a selling price which returns a desired profit margin
- Evaluating production costs
- Improving productivity techniques
- Eliminating unprofitable lines.

Rather than being over analytical this system takes a more pragmatic approach, allowing grouping plants according to their size, growth characteristics and production requirements. As a starting point a grower may select all 140 mm pots and calculate the costs overall. They can then work back to look at specific crops that have different cultural requirements, or particular costs which appear to be excessive. Note that this component of the project is an Excel based Costing Calculator which (once key data is determined) can quickly arrive at the farm gate cost. The next step is to roll the workshop out to industry and workshops are already planned for NSW. It's worth noting that this Level 4 Unit of Competency can now be studied towards a Cert IV or Diploma qualification.

Quote from a NSW grower

"This is a must for every nursery business. It forces you to look at every part of the business and even allows you to calculate your productivity per hour. It's a business health check which is why it's so valuable."

5. Content Finalised for e-business Skills Training Program

Working in consultation with the Project Steering Committee (representing stakeholders) the next major step was to match needs to skills. Assistance from key staff from the logistics and IT faculty at Nirimba College in western Sydney was paramount in finalising content and materials for the delivery of four pilot workshops and a contract was signed with TAFE NSW - Western Sydney Institute (WSI). Three of the six priority Blueprint needs listed in section 2 above with were selected and delivery outcomes defined:

1. Step-wise introduction and development of e-business capability

TRAINING OUTCOME: The availability, benefits and application of current technologies to support efficiencies and productivity in nursery business operations

2. Development of guidelines and protocols to maximize e-business efficiencies in the supply chain

TRAINING OUTCOME: The development of protocols and standards of practice relevant to current market conditions and emerging trends and how this impacts on performance

3. Smarter inventory management

TRAINING OUTCOME: Creating a structured strategic framework to planning, forecasting and managing inventory appropriate to business needs.

The Units of Competency selected and contextualised to the industry were:

BSBEBU501A Investigate and Design e-business Solutions

TLX4028A Apply Knowledge of Logistics

ICAICT306A Migrate to New Technology

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For more information
Nursery paper November 2009 Supply Chain Management holds the key to the viability of nursery enterprises.
Gerard McEvilly, Horticulture Supply Chain Services and Tom Rafferty, Supply Chain STO
NURSERY PAPERS
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6. Delivery of Pilot Workshops

The first workshop was broad ranging touching on live inventories and the perceived difficulties in running them in production nurseries. A number of more common problems or opportunities were teased out and became the centre of attention in the next two workshops with great interest in the opportunities for more effective methods of B2B communication. This led to exploring a range of applications on offer with first- hand experience.

The second workshop had an in depth look at inventories and their management. It highlighted the difficulty of keeping an accurate inventory. It was apparent that some growers are becoming frustrated as demands of trading partners threaten to compromise profit. The reasons why accurate inventories are important include:

- Delivery of short or incorrect orders will steer your customer to more reliable suppliers.
- It’s impossible to know if profits are real or not without an accurate inventory.
- Overstocking chews up cash which could be better used elsewhere in your business.
- Better control on theft and losses
- Knowing you have accurate information means you can trust your systems.
- Makes for more efficient stocktake and end of year process.
- Meets the needs of the ATO to ensure correct tax is paid.

A healthy ensuing discussion looked at stocktaking and the need for robust business management practices to deal with variances.

Perhaps the biggest opportunity ebusiness presents for small business however is the capacity for them to punch above their weight with cloud computing, smart phones and the access to so many new applications. During the workshops participants either trialled or had demonstrations on many of these and other aids to business improvement including: MailChimp, DropBox, CRM, Office HQ, CMS Platforms, Search Engine Optimisation, CRM, EDI and many others. Following the four 6 hour pilot workshops each participant is followed up for a further 4 hour face-to-face mentoring session culminating in an Action Plan.

Next Steps for Ebusiness Skills Program

The completion of the pilot workshops capped off nearly two years of groundwork involving many people across industry. Once the current student assessments are completed and a report is received from Nirimba College, a series of workshops will be rolled out to industry, although it is not yet decided what form these will take.

Finally

It is worthy to note that in order for the industry to become more efficient, many issues need to be addressed both vertically and horizontally. Many listed below are not ebusiness problems but if not addressed will continue to have a profound effect on ongoing efficiency:

- A better understanding is needed of how cost activities (especially labour) are made up and could be deployed more effectively.
- The lack of effective live inventories is compromising the ability of many SME to satisfy customer needs and operate efficiently.
- Modification and improvement is needed in the many nursery stock handling processes– in fact poor systems and procedures severely compromise e-technology.
- Retraining nursery people to be IT experts rarely works – better to set up the right system at first attempt.
- Cloud computing and advanced software applications mean small businesses can perform well above their size in many areas.
- More effective industry communication either are widely available with a raft of affordable applications either internally, business-to-business or business-to-customer
- There is a role for industry organisations to become repositories for access to ebusiness information, applications and templates.

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automating irrigation Scheduling in nursery Production

Traditionally irrigation scheduling in production nurseries has been determined by past experience (gut feel) and the setting of specific run times depending on the season. Other common methods employed include manual moisture assessment of individual containers, daily evaporation measurements or using a weight method to determine a container's water holding capacity. In this month's Nursery Paper Queensland Industry Development Manager John McDonald and Research Scientist David Hunt describe the water use efficiency and cost savings achieved through the automation of irrigation scheduling.

Managing plant production and increasing productivity through reduced input cost is an ongoing issue for all production nurseries. Whether the crop is vegetable or forestry seedlings, containerised fruit trees or ornamental plants, the resource inputs and costs of production are a constant. Retail prices may fluctuate due to post-production expenses and varying profit margins but the actual resources and costs involved in producing a plant are relatively fixed. Therefore developing new methods and technologies to assist producers in managing input resources and costs e.g. water, nutrients and energy is paramount for ongoing sustainable development of the horticultural industry.

Irrigation scheduling for nursery crops is the science of establishing a balance between the application rate of an irrigation system and the time period that is required to replace the amount of water previously lost from a container or to re-fill the container to the capacity of the growing media. It allows us to replace the water lost through plant transpiration and evaporation (Evapotranspiration) and maintain the growing media water content at a point that does not drought or waterlog the crop, therefore providing the optimum growing conditions.

Modern manufacturing techniques and design methods allow irrigation distribution systems, e.g. pipes, pumps and emitters, to be designed with highly accurate and constant application rates, if installed and maintained correctly. The use of blended organic growing media with known and relatively stable water holding capacity, air filled porosity and infiltration rates are available and only change due to plant/root growth. As the physical properties of the irrigation system and growing media remain fairly constant, developing an irrigation control system that responds to the plants daily water requirements can help to reduce input costs and improve both water and energy use efficiency.

Automating Irrigation Scheduling in Nursery Production

NGIQ Weight Based Irrigation Scheduling Controller (WBIC) research project - Redlands Research Station

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Technical

Most of the current systems employed by production nurseries to schedule irrigation are either dictated by the season, e.g. summer = two irrigations/day (am & pm) at 20 minutes each and in winter = one irrigation/day at 10 minutes or variations to this based on "testing" container moisture content by feel and visual assessment or weight by lifting a container. A system also used in the past by a few growers has been through the measurement of daily evaporation (Class A Evaporation pan) and replacing the water lost each day in the next day's irrigation.

The operating parameter common to all of the above scheduling systems is they are all an approximation, at a given point in time, of the amount of water lost to evapotranspiration and what is required to re-fill to container capacity. With many growers unsure of the initial total water holding capacity of their growing media, crop wilting points, container recharge points, etc the whole scheduling system requires greater and more accurate tools for production nurseries.

Over the past four years NGIQ has been actively researching the technology available to automate irrigation scheduling in container crops through a dedicated research program funded under the South East Queensland-Irrigation Futures (SEQ-IF). Field based crops have for many years been able to use a range of soil moisture measuring tools from tensiometers, neutron probes, capacitance probes and Enviroscans to support infield irrigation scheduling and apply water at the precise time the crops require it. The research has shown that many of the technologies used in soil based cropping are either not suitable or will require alterations to container cropping practices e.g. reduced air filled porosity, that render them inappropriate for use.

The one area that has shown promising results in container irrigation scheduling is through the use of electronic loadcells measuring the container weight and through basic calibration the water content of a container (container capacity). The loadcells can take a number of "sample" containers in-situ that represent the crop in the field and through the averaging of the weights give a very accurate water content measurement at any given time. As a result of the NGIQ research the gravimetric weight method utilising loadcells has been developed into a complete weight-based irrigation controller (WBIC) that monitors plant container weights and triggers irrigation according to the plants daily water use. The WBIC has the flexibility to allow pre-set irrigation times, multiple zones, frost settings, individual trigger points for both re-charge and container capacity and can operate off a PC or a standalone touch screen controller.

Research Results

The use of loadcells to schedule irrigation has demonstrated significant savings in water use and energy consumption as well as improving the overall operation of the irrigation system by removing the ‘human factor’ from most of the decision making. Data from a trial completed in 2010 is described below which demonstrated water saving between WBIC and timed irrigation can be as high as 70% (Figure 1). Water use for the trial was calculated on the output flow rate of four MP1000 sprinklers (6.93 L/min) per irrigation zone. The irrigation system met NGIA best management practice for minimum requirements of uniformity with the system measured at 85% coefficient of uniformity, mean application rate of 17.7 mm/hr and a scheduling coefficient of 1.5.

Irrigation events were initiated within seconds of container weights reaching the lower trigger weight and continued until the upper stop weight was reached. Irrigations varied between the three loadcell groups according to plant water use. An irrigation event is characterised by a sharp increase in weight, while the rate of water use is represented by the angle or slope of the decline in weight and shows that during the period of high evapotranspiration two irrigations were triggered during the day and the rate of moisture loss was high, represented by the steep decline in container weight (Figure 2). During periods of lower evapotranspiration (B), only one irrigation occurred and the rate of moisture loss was slower, represented by a slower decline in container weight. Evapotranspiration reduces or stops during the night and is seen as a constant container weight or horizontal line between 6 p.m. and 6 a.m.

The research also identified the need to accommodate plant growth and the impact on the weight of the container and the relationship to the re-charge/re-fill trigger. A pre-set stop weight would need to be adjusted to account for weight increases attributed to foliage or root growth, and a reduction in the water holding capacity due to growing media degradation. The development of a self-adjusting or feed-back mechanism that identifies when the maximum water holding capacity of the container, or a state of constant weight, has been reached would account for these variations and is being built into the WBIC.

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Weight Based Irrigation Controller (WBIC)

The weight-based irrigation controller (WBIC) was developed by Pacific Data Systems Pty Ltd (PDS) specifically for the NGIQ research trials (Figure 3-7). The system uses a 2-wire network to communicate between the master controller and remote nodes positioned throughout the production area. Each node has the capability to connect a variety of digital and analogue sensors, solenoids or inputs. Other systems and sensors such as pump and filter pressure transducers could be connected as an advance warning of equipment failure or an entry switch could be connected to pause irrigation for zone access.

The WBIC can be programmed with different levels of security using passwords to allow access to different functions. The nursery manager could setup a low level password for staff to use for minor adjustment or corrections but restrict access to the core program. Several irrigation alarms have also been included to monitor any system failures. For example, a wilt alarm can be programmed to inform the manager that an irrigation zone needs immediate attention or a high water alarm can be programmed to trigger if container water content goes above the irrigation stop point. These will provide a self-check mechanism to ensure that plants are not over or under irrigated and highlight any issues with the irrigation system or program.

The main difference between this irrigation controller and other irrigation controllers is it incorporates the use of loadcells, or a weighing device, to monitor plant growth and water use. The WBIC uses a method similar to the gravimetric water holding capacity method mainly used for research to determine the water holding capacity of a growing medium. The WBIC combines this with the concept of evapotranspiration (ET) to control and trigger irrigation according to the plants water usage. This weight-based irrigation scheduling method has the potential not only to improve water and energy use efficiencies in a containerised production nursery, via reduced pumping times, it also allows the plant to control irrigation in real-time as the growing environment changes.

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Figure 3: An in-field WBIC network node for connection solenoids, weighing devices and other sensors

Figure 5: Loadcell used to monitor plant weights and trigger irrigations

Figure 4: WBIC unit with touch screen interface Figure 6: WBIC unit with touch screen interface and security logon screen

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Further information
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Weight Based Irrigation Controller (WBIC) Features
Figure 7: WBIC Touch Screen – diagrammatic view for setting Stop Point, Start Point, Wilt Point and over irrigation alarm point.
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Certified Budwood Schemes – helping to protect: you, your business, industry, environment and the community.

The ability of the nursery industry to secure "high-health" plant propagation material does exist for some commodities via certification and improvement schemes. However, material is not available for all types of material needed by plant industries In this month's Nursery Paper, NGINA Industry Development Officer Michael Danelon looks at some of the options available to the industry to secure plant propagation material with the purity, authenticity and reliability to perform and enhance both the industry and environment.

The nursery and garden industry propagates, grows and sells a wide range of plants to a variety of market sectors and customers.

The outbreak of Myrtle Rust (now referred to as Eucalyptus/ Guava Rust) on the east coast of Australia in May 2010 has been at a significant cost to the nursery industry, environment and community. However, it has helped to highlight the importance of biosecurity risks associated with moving nursery plants around the country and the impact exotic pests and diseases can have.

Anyone growing and selling plants needs to be aware of the pest and disease threats to the plants you grow and sell and what steps are required to prevent and manage them for your long term viability. Awareness and adoption of industry best management practice, guidelines and industry policy position should be common place for those in the nursery and garden industry.

To support the professional operation of the nursery industry, Nursery & Garden Industry of Australia (NGIA) through the support of levy funds from Horticulture Australia (HAL) developed the Nursery Production Farm Management System (NPFMS) for production nurseries, growing media manufacturers and greenlife markets.

The NPFMS is the framework supporting a sustainable future by allowing businesses to evaluate and manage areas of concern to them. The three industry on-farm programs consider:

• NIASA – Nursery Industry Accreditation Scheme Australia detailing industry best management practice
• EcoHort – Environmental Management System to demonstrate sound environmental stewardship and natural resource

management and

• BioSecure HACCP – Biosecurity program to assist businesses to assess their current and future pest, disease and weed risks for imported and exported material.

Supporting NIASA accreditation as a source of consistent product and product performance is the BioSecure HACCP certification program. BioSecure HACCP addresses hazards through anticipation and prevention rather than reliance of end point inspection and treatment of products. BioSecure HACCP builds the integrity of the products by implementing critical control points within the business with the aim of achieving a high-health status product.

Industry accreditation and certification of
production nursery inputs

Stock within Auscitrus citrus repository

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International certification entry requirements for australia

Imported plant material (seed, cuttings, budwood, cutflowers, live plants, tissue culture etc.) introduced to Australia requires assessment and formal testing as outlined by the import conditions (ICON) set by Department of Agriculture, Forestry and Fisheries1 (DAFF). These conditions are based on the probable threat/risk of introducing pests and diseases with the imported material. For example, tissue culture flasks may be visually inspected for the presence of disease symptoms, or entry into an approved DAFF Post-Entry Quarantine facility may be required to assess high risk material for pest and diseases before release.

Refer to the DAFF ICON1 website database listed below for more information on importing conditions.

Not all plant propagation material may display disease symptoms

In all plant production systems pests and diseases (e.g. insects, mites, fungi, bacteria, nematodes, viruses, viroids etc.) can cause varying degrees of damage and affect the quality of the plant, including its vigour and longevity.

Fortunately most of these pest problems can be managed, although some can be more challenging to detect and may go unnoticed for a period of time or disease expression may be masked under certain environmental conditions.

Graft-transmissible diseases pose threats to production nursery inputs

Viruses and other graft-transmissible diseases pose a significant threat as they can be difficult to detect and prevent if infected plant material is not managed appropriately. Graft-transmissible diseases are usually viruses or viroids which can be transferred from plant to plant by mechanical transmission (pruning/budding/grafting) or through infected propagation material. Some diseases can also be spread by insect vectors like aphids and thrips.

To reduce the risk of transferring virus and virus-like diseases in plant propagation material nursery hygiene and Biosecurity practices are paramount.

A number of methods are used to check the health status of plant propagation material. Tests include greenhouse biological indexing (transfer of sap and expression of the disease to indicator plants under ideal environmental conditions) and laboratory based molecular techniques.

When virus and virus-like diseases have been diagnosed and no source of healthy planting material is available, the infection can be eliminated from diseased material of some plant types via nucellar production (derived from cells of a maternal tissue in the ovule/seed without sexual reproduction), tissue culture, thermotherapy (hot water treatment/exposure) and shoot-tip micrografting.

Development of certified budwood schemes for specific plant inputs

Management of viruses or other graft-transmissible diseases can be achieved for some commodities using healthy (virus-free) planting material. The maintenance, testing and distribution of healthy stocks form the framework of a phytosanitation programme for certified seed, budwood and plant propagation material.

Such phytosanitary programs and repositories (a collection of ‘clean’ pest and disease-free germplasm to be utilised for propagation) do exist in certain intensive horticultural industries in Australia with some examples being: Almond Budwood Program (Almond)2, Auscitrus Certified Budwood and Seed (Citrus)3, Australian Pome Fruit Improvement Program Ltd (Apple and Pear)4 and the National Vine Accreditation Scheme (Grape)5.

Phytosanitation programs provide industry with an ongoing supply of high health status propagation material of the varieties sought by growers, including new material with commercial potential.

Auscitrus citrus repository

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Case study - auscitrus certified budwood and seed
Citrus is one of the most important commercial fruit crops grown throughout the world. It provides a basis for local agricultural industries, generates employment, raises income and provides an important source of foreign revenue. It is also a widely planted tree by gardeners.
The Australian Citrus Propagation Association (Auscitrus) was started in 1927 by a group of NSW Citrus nurserymen as a not for profit organisation to protect the citrus industry from various pest and disease problems. They have become the primary supplier of certified citrus seed and the only supplier of scientifically tested citrus budwood to citrus nurseries.
Auscitrus works in close partnership with New South Wales Department of Primary Industries (NSW DPI) who provide independent laboratory and greenhouse testing at the Elizabeth Macarthur Agricultural Institute (EMAI) in Camden NSW.
One particularly serious exotic citrus disease is Huanglongbing (HLB) which has not been detected in Australia. Within the Nursery Industry, HLB is considered a pest threat not only for citrus but also Murraya paniculata (Orange Jessamine) and M. koeniggii (Curry Leaf plant) which are hosts of this disease.
Internationally, HLB has forced many citrus nurseries and orchardists out of business in Florida in the United States (US), Brazil and South Africa and threatens to impact the industry in California in the US where it was detected in 2012.
HLB is a graft-transmissible bacterial disease that is also spread by insect vectors. If HLB and an insect vector (one of which is the Asian Citrus Psyllid) were to arrive in Australia, it could have a catastrophic effect on the Australian citrus industry, citrus nurseries and ornamental nursery growers of the host Murraya sp.
Diseases that are endemic (i.e. known to occur in Australia) of most concern to citrus include:
Citrus exocortis viroid (CEVd). CEVd or scaly butt, infection can lead to bark scaling below the bud union as well as severe dwarfing and decline. The disease is caused by a viroid that is symptomless in most citrus varieties but symptoms typically appear when infected budwood is grafted onto a susceptible rootstock. Studies have found that production can be reduced by up to 70%.
Citrus tristeza virus (CTV)6 There are many strains of CTV and some strains can cause a range of disease symptoms. Most citrus trees in Australia are likely to carry various mild strains of CTV that can be spread by aphids and infected plant material.

There are severe strains of CTV that cause stem pitting, tree decline and reduced production in infected grapefruit and sweet orange trees. The sweet orange stem pitting (OSP) strains are only known to occur in Queensland. Government legislation is in place prohibiting the movement of citrus propagating material (with the exception of seed) from Queensland to other states.

For over 40 years CTV has been successfully managed in grapefruit orchards by inoculating trees with a mild strain of CTV to protect against the more severe stem pitting strains.

The diseases mentioned above are symptomless in certain rootstock/scion combinations. This means an old tree in an orchard or backyard may appear healthy, but may in fact be carrying a serious graft transmissible disease. If budwood was sourced from this tree and was grafted onto a susceptible rootstock the resulting

Citrus repository Nursery Auscitrus

Healthy citrus versus citrus with CEVd.Auscitrus nursery

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tree will begin to show symptoms and become a possible host for wider infection.

If you can't see the disease, how can you control it?

Auscitrus has extensive plantings of the majority of the commercially significant citrus varieties, and many of the more ornamental citrus lines. These plantings are regularly tested for disease (indexed) and maintained under strict biosecurity conditions to prevent cross-infection (hygiene/access restrictions/facilities/staff training/preventive measures).

Plantings are tested for trueness to type, and are actively managed for budwood production in field plantings and a NIASA accredited citrus nursery.

Citrus viruses and viroids can be killed by sterilising cutting tools with a fresh solution of 1.25% (12 000ppm) chlorine. A 10 second dip of cutting tools is adequate and should be followed by a rinse in clean (distilled/deionised) water.

Obligations to supply clean pest and disease free plant material

Any nursery producing or distributing plants has a responsibility to ensure that they are not distributing pest and diseases around Australia. To honour your obligations under federal and/or state/territory legislation consider:

- only propagating plants from parent material of a known high health status
- obtain plant propagation material from clean disease-free suppliers
- ensure internal controls are in place to prevent cross infection
- maintain records of source material and plant movements (allow traceability) and
- abide by the quarantine regulations of intra and interstate plant movements.

Securing clean plant material – think about the future

In many situations it may be a challenge to secure plant propagation material with the purity, authenticity and reliability to perform and enhance your business. There are however options individual businesses have in requesting and working toward

receiving the type of material you are wanting from your suppliers.
Plant health and the integrity of the plant products with regard to possible pest and disease infection are often taken for granted until it is too late.

Whilst there is the industry NPFMS programs available to all within the industry, the adoption by industry and industry stakeholders is one area where it should be recognised to help secure the future of businesses propagating, growing and selling plants. At the end of the day you are better to invest in a product with low risk rather than one produced in an environment that may cost you money in the long term.

Further Information

• NIASA Best Management Practice Guidelines, 5th edition 2013.
• National Nursery and Garden Industry Biosecurity Plan ver 3.0. Plant Health Australia/NGIA, May 2013.
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Acknowledgements

Dr Nerida Donovan, Plant Pathologist, New South Wales Department of Primary Industries

Mr Tim Herrmann, Manager, Auscitrus. www.auscitrus.com.au

Websites – reference

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2 Almond Budwood Program - http://www.australianalmonds.com.au/industry/aba/aba_programs_services#budwood

3 Auscitrus Certified Budwood and Seed- http://www.auscitrus.com.au/docs/why_auscitrus.asp

4 Australian Pome Fruit Improvement Program Ltd (APFIP) was established in February 1997 by the Australian Apple and Pear Growers
Association Inc (AAPGA – now Apple and Pear Australia Ltd) for the benefit of the Australian pome fruit (apple and pear) industry
http:www.apfip.com.au/1102.aspx

5 National Vine Accreditation Scheme - http://www.avia.org.au/pdf/accreditationscheme.pdf

6 Citrus Tristeza Virus - http://www.daff.qld.gov.au/__data/assets/pdf_file/0019/71830/Citrus-Citrus-tristeza.pdf

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Managing Chemicals of Security Concern Across the Nursery & Garden Industry Supply Chain

The Council of Australian Governments has identified 11 chemicals that are considered high-risk because they can be used to make homemade explosives. Australian governments in partnership with industries have developed a voluntary National Code of Practice for Chemicals of Security Concern to provide information and guidance on minimising the risk of these chemicals falling into the wrong hands.

In this month’s Nursery Paper, NGIA Research & Market Development Manager, Dr Anthony Kachenko provides an overview of the voluntary code as well as existing industry resources to manage chemicals of security concern across the nursery & garden industry supply chain.

A large and diverse number of chemicals are used in fertilisers and pesticides and for other horticultural applications by members of the nursery & garden industry supply chain on a regular basis. Of these chemicals, a small percentage can be used for unlawful purposes, which includes lethal homemade bombs and terrorist attack.

Australian intelligence and law enforcement agencies have identified 96 chemicals as being attractive for these unlawful purposes. A full list of these ‘Chemicals of Security Concern' can be viewed at www.chemicalsecurity.gov.au. These chemicals include chlorine, which is commonly used to disinfest irrigation water in production nurseries, and hydrochloric acid which is commonly used in production nurseries as an effective neutralisation agent for alkaline irrigation water. Other chemicals on this list and used by members of the nursery & garden industry supply chain include hydrogen peroxide and nitric acid (at a concentration of 30% or higher).

Eleven of these 96 chemicals have undergone a risk assessment and deemed as being particularly high risk because they have been identified as precursors to homemade explosives. These 11 chemicals include hydrogen peroxide and nitric acid.

For these chemicals, Australian governments in partnership with industries have developed a voluntary National Code of Practice. It

is important to note that although this Code of Practice applies to the 11 chemical precursors to homemade explosives; it could apply to any of the 96 chemicals of security concern in the near future.
A key part of the voluntary Code is common sense and good business practice. The voluntary Code aims to promote effective chemical security management practices throughout the chemical supply chain from manufacture and distribution through to retail and use. Indeed, all members of the nursery & garden industry supply chain that handle chemicals, irrespective of the risk they may pose to a business and the wider Australian community, should be aware of the voluntary Code.
Managing Chemicals of Security Concern Across the Nursery Industry Supply Chain
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Objective of the Voluntary National Code of Practice

The Voluntary National Code of Practice has three key objectives to:

1. Protect against the diversion of chemicals for terrorist and criminal purposes.
2. Encourage cooperation between businesses and organisations that handle chemicals and law enforcement agencies on chemical security matters.
3. Educate and train staff to be alert to warning signs and report suspicious activity.

How can I use the voluntary Code?

The voluntary Code is not about making it harder to access chemicals, but rather, about users keeping an eye out for anything suspicious. Nursery & Garden Industry Australia (NGIA) and several other industry Associations were engaged in the development of the voluntary Code to ensure it didn't create unnecessary hurdles or excessive red tape for industry.

Several practical measure are detailed in the voluntary Code that can be implemented without spending too much time or money, to reduce the likelihood that chemicals will be diverted or misused for terrorist or criminal activities. Indeed, many of these measures support those listed within the Nursery Production Farm Management System (FMS) and the Australian Garden Centre Accreditation Scheme (AGCAS).

Nursery Production FMS

The Nursery Industry Accreditation Scheme Australia (NIASA) – Best Management Practices is the cornerstone of industry best practice in production nurseries, greenlife markets and growing media manufacturers. This third party audited industry program is voluntary and includes guidance and support from an experienced team of technical officers operating regionally across Australia. Section 1.2.4 of these guidelines details industry best practice on storing and using chemicals as well as information on appropriate record keeping.

Building on from NIASA is EcoHort, which promotes best practices in environmental and natural resource management. This industry program is also voluntary and like NIASA, is third party audited by an experienced team of technical officers. Section 3 calls for business to be aware of legislative requirements affecting them. In addition to this, Section 5.2 provides further detailed information on using pesticides and chemicals responsibly including safe storage and disposal. For example, EcoHort stipulates that pesticides and chemicals should be stored in a lockable, weatherproof, fire-proof and well-ventilated area.

Both NIASA and EcoHort should be considered a necessary part of good business practice by all production nurseries, greenlife markets and growing media manufacturers across Australia. These programs incorporate years of industry and international research to ensure businesses engaged with these programs are up-to-date with world's best practice.

AGCAS

This voluntary third party audited business improvement program for retail garden centres also contains pertinent information on safe retailing of chemicals and associated products. For example, these guidelines request that relevant chemicals and associated products are stored to meet the statutory requirements of state and territory legislation. Like NIASA and EcoHort, AGCAS should be considered an integral component of good business practice in all retail garden centres.

Security Risk Management

The following information is part of good business practice and should be integrated into business culture and philosophy across all members of the Australian nursery industry supply chain.

Assign Responsibility

Security management within the business should be assigned to a person(s) to undertake the following tasks:

- Introduce and maintain security measures based on threat and risk and ensure compliance with relevant legislation.
- Establish relationships with government agencies and others (where applicable) to address security issues.
- Develop and manage reporting systems.
- Assist in raising employee security awareness.
- Include security in employer and contractor training and induction.

In addition to the above, it is vitally important that suspicious incidents and security breaches are investigated and reported to the National Security Hotline 1800 1234 00. These incidents may be internal or external to your business. Examples of suspicious incidents could include:

- Unauthorised entry into restricted areas such as chemical sheds.
- Unexplained losses of chemicals.
- Unexplained disruptions to business processes.
- Major cyber-attack on internal process controls or inventory systems.

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Unusual behaviour in purchasing chemicals should also be regarded as a suspicious incident, such as attempts to purchase chemicals for no clear purpose.

Security Measures

A suite of security measures are listed within the voluntary Code. Some of the key measures that should be considered by members of the nursery & garden industry supply chain are summarised in table 1.

Table 1: Examples of recommended security measures and for whom such measures are likely to be relevant.

Measure	Suggested Actions	Relevant To
Employee and contractor checking	• Basic background checking prior to and during employment • Educate staff on security issues and controls • Verify identity and referee information and follow up on anomalies	Manufacturer, Importer, Processor, Transport/Logistics, Wholesaler, Retailer, End User (Business)
Personnel security awareness	• Educate staff on potential misuse of chemicals being handled in induction and on-going training and provide clear instructions	

for reporting
suspicious activity
Manufacturer,
Importer, Processor,
Transport/Logistics,
Wholesaler, Retailer,
End User (Business)
Physical access • Install deterrent
signage
• Require visitors to
sign in
• Control access
to keys to secure
areas
Manufacturer,
Importer, Processor,
Transport/Logistics,
Wholesaler, Retailer,
End User (Business)
Personnel access • Restrict access
to authorised
personnel
• Always escort or
monitor visitors
and contractors
Manufacturer,
Importer, Processor,
Wholesaler, Retailer,
End User (Business)
Point of sale
procedures
• Only sell to
customers with
known identity
and verified
legitimate use
• Report suspicious
transactions
(including unusual
or different
sales to account
customers)
Manufacturer,
Importer, Processor,
Wholesaler, Retailer

Sale and distribution procedures

- Only sell to customers with known identity and verified legitimate use
- Report suspicious transactions (including unusual or different sales to account customers)
- Do not leave chemicals unattended at point of delivery

Manufacturer, Importer, Processor, Wholesaler, Retailer

Transporting chemicals of security concern procedures

- Ensure chemicals are secure at all times during transport
- Do not leave vehicles unattended
- Use secure parking for loads in transit
- Monitor the location of vehicles transporting chemicals

Manufacturer, Importer, Processor, Transport/Logistics, Wholesaler, Retailer, End User (Business)

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Conclusions

The examples of security measures indicate that it is important to have an open and trustworthy relationship with supply chain partners. This is vital in order to share safety and security advice, expertise, resources and to foster awareness of chemical security.

The following six tips are important consideration for you to secure your chemicals:

1. Adopt industry best practice through NIASA, EcoHort and AGCAS programs
2. Ensure prospective, seasonal or casual employees are trustworthy
3. Limit access to your chemicals
4. Lock your chemicals up when they aren’t being used
5. Keep track of your chemicals
6. Educate and train your staff to be aware of suspicious behaviours

If you suspect it, report it to the National Security Hotline on 1800 1234 00 or hotline@nationalsecurity.gov.au

Further Information

More resources on assessing, identifying and addressing your security risks, including the National Code of Practice for Chemicals of Security Concern and guidance materials are available on the chemical security website: www.chemicalsecurity.gov.au

References

Commonwealth of Australia (2013) National Code of Practice for Chemicals of Security Concern, Australian Government, Canberra
www.chemicalsecurity.gov.au

Further Information

For additional information, consult the following nursery papers which are all available electronically from www.ngia.com.au

• What is NIASA and how can it benefit you? Issue Number 3. May 2008.

• EcoHort™ - the environmental management system for Australian nursery production. Issue Number 12. December 2006.

• The benefits of being professional - accreditation. Issue Number 1. February 2003.

• NIASA Greenlife Market Accreditation. Issue Number 2. March 2011.

www.chemicalsecurity.gov.au

NATIONAL CODE OF PRACTICE FOR

CHEMICALS OF SECURITY CONCERN

I am storing it for a friend

No, I want to pay cash for these chemicals

I am just stocking up in case I run out

I know it's a lot of fertiliser, what's it to you?

No, I don't have an ABN

Why do you need to know what I am using it for?

Hydrogen peroxide

Potassium nitrate

Aluminium phosphide

Nitric acid

Paraquat Phosphorous

Chlorine gas Sulphuric acid

NitromethaneAluminium phosphide

Nitric acid

Potassium nitrate

Paraquat Phosphorous

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Valuing the urban forest in Sydney

Any grower can tell you the price of a tree but how many can tell you the value that trees offer to the community? The objective of the project “Understanding the carbon and pollution mitigation potential of Australia's urban forest” was to test and improve methodologies for evaluating the ecological and social value of the urban forest. In this nursery paper Dr Marco Amati of La Trobe University explains how this was done along two major highways in Sydney.

The urban forest holds a particular role in the Australian urban landscape. A mixture of remnant, native and exotic trees, it exists at once as an expenditure for local authorities while providing a range of unquantified benefits such as habitats for wildlife, air pollution removal and flood prevention. Despite its prominence as an identifier for an urban area or as the backdrop in the lives of urban residents, the urban forest continues to be undervalued as part of the policy process.

The aim of this project was to contribute to the development of tools that help value the urban forest, while seeking an understanding of the feelings of residents towards urban trees.

Current planning policies and recent research work highlight the urgency of this task. For example, the current ‘Draft Metropolitan Strategy for Sydney' outlines that by 2036 Sydney's population is expected to reach 6 million, an increase of 1.7 million since the 2006 ABS Census, which means Sydney will need to provide 770,000 more homes than in 2006 (NSW Government, 2013). Much of this development will be suburban infill and redevelopment at higher density leading to potential losses of green space. At the same time, research on housing has described how houses in all capital cities in Australia are getting larger and backyards are disappearing (Hall, 2010). The twin drivers of ‘densification’ through policy and preference work against the well-documented positive impacts that green spaces and especially trees can have on the sustainability of suburban areas. Trees and green spaces can reduce the need for storm water provision, prevent floods and save on air conditioning, mitigating greenhouse gas emissions and improve biodiversity (Stone and Rodgers, 2001).

While a great deal of research exists internationally on urban forests, little work has been undertaken to ensure that this research is appropriate to Australian conditions, which include soils with a uniquely low nitrogen content and frequent drought conditions. A model for the city of Canberra was developed by Cris Brack, one of the researchers in this study (Brack, 2002). Some postgraduate level research has been performed to evaluate the use of the US model STRATUM on street trees in Melbourne, funded by the NGIA. The City of Melbourne has applied i-Tree to its local government authority (LGA) area. CITYgreen and UFORE are two of the most well known models for calculating carbon benefits of tree canopy cover. UFORE's models have been incorporated into i-Tree and the package has been recalibrated to Australian conditions. ‘i-Tree’ can estimate tree composition, carbon sequestration and storage potential, storm water benefits, air pollution mitigation capability, energy savings and related economic benefits (US Forest Service, 2012). It requires field sample tree data to be collected from a number of sample plots or all plots distributed across the study area. So far the suitability of these packages to Australian conditions remains an ongoing topic of investigation.

Method:

Our study focused on two corridors both 400 m wide: 11 km along the Parramatta Road and 19 km along the Pacific Highway, with both cutting through a variety of different suburbs in Sydney. Figure 1 shows a map of the overlapping study areas.

The area shaded in blue shows the area of hyperspectral data collected, the area inside the red line shows the area of LIDAR data collected, the black lines show the area for the sample sites used in the i-Tree component of the study.

Post-graduate students Shi-Hsien Yung and Angela Maria Gomez used the i-Tree methodology to measure trees and model the benefits that derive from the canopy throughout most of 2012. At the same time another student, Mingzhu Wang scheduled an aerial survey of the roads. The survey collected Light Detection and Ranging (LiDAR) and hyperspectral data of the ground surface and canopy. The LiDAR system scans the ground with a radar pulse to a very high degree of accuracy (Figure 2). This data was initially analysed with the help of the company DiMAP in Perth. Subsequently, Mingzhu used the data to identify the shape and extent of the canopy cover and employed a GIS to model the impact that the canopy would have on reducing the solar radiation on building and roofs. This research is ongoing and is part of her PhD project at Macquarie University.

Lastly, during the final quarter of 2012 and the first half of 2013 another post-graduate student, Natalia Saldarriaga, designed and conducted a postal response survey of 1500 residents on their views about the trees in North Sydney and Parramatta LGA areas. The aim of her survey was to identify and evaluate the positive and negative attitudes of residents' towards trees and their willingness to plant and manage trees on their private land according to their socio-economic situation. She received a response rate of 8-19%. This research is an ongoing project as part of a Masters of Philosophy at the University New South Wales, and Natalia will undertake a second survey with council officers responsible for the management of trees along the two transport corridors used in this study.

Results:

The i-Tree data shows that the Pacific Highway has a much larger coverage of trees when compared with Parramatta Road (40.3% versus 14.2%). This means that at a basic kilometre-by-kilometre comparison, the Pacific Highway performs better on all of the variables looked at.

I-Tree enables the estimation of a variety of parameters related to the ecological value of the canopy. For example, the canopy along the Pacific Highway is estimated to remove 11 tonnes of air pollution per year. This is equivalent to $5,200 per year. The total value of ecological services delivered by the canopy along the Pacific Highway is $97,700 per year and is $18,100 along the Parramatta Road. For the Pacific Highway the lion’s share of this value is delivered by the savings on building heating and cooling at $55,700 per year whereas for the Parramatta Road, carbon sequestration comprises the most important function at $13,200 per year.

Figure 1

Figure 3

Figure 2

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More surprisingly, the results showed that the urban forest along the Pacific Highway corridor is also adding more value per tree to the urban environment than its Parramatta Road counterpart. It is in the areas of pollution removal and building energy savings (and therefore avoided carbon emissions) where the biggest differences between both sites are seen.
According to i-Tree the trees along the Pacific Highway are 1.7 times more effective at removing pollution when compared to those along Parramatta Road. Building energy savings delivered by a tree on average are 5 times higher for the Pacific Highway than for the Parramatta Road.
A large amount of data is produced from the i-Tree software that can also show differences between sites. Firstly, the most prevalent species along the Pacific Highway is Syagrus romanzoffiana (Queen Palm) which typically has a sparse canopy. The model within i-Tree, however, calibrates the importance of this tree by adding the percent leaf area and the species percentage. This means that trees such as the third most-prevalent species, Eucalyptus saligna (Sydney blue gum), which are larger and have a denser canopy and a higher leaf area, contribute proportionately more to pollution removal and building energy savings (cf. Saunders et al., 2011).
In general, the institutional, recreational and other (IRO) land uses are where the greatest density of trees is found (112 trees/ha along the Pacific Highway and 92 trees/ha for Parramatta Road). It is in these schools, parks and other open spaces such as hospital grounds where trees are able to flourish and where a large amount of control can be exerted on planting and maintenance by government authorities.

Along the more urbanised Parramatta Road corridor, trees on IRO lands constitute islands of native vegetation. The IRO tree density here is significantly higher than for residential land uses (92 trees/ha compared with 42 trees/ha residential), whereas along the Pacific Highway the residential tree density is comparable to the IRO tree density (both around 110 trees/ha). A consideration of the land use is important since this will affect the overall management of the urban forest canopy.

These initial comparisons of the two roads are reinforced by the results from the LiDAR and hyperspectral data. Mingzhu Wang compared the average solar radiation in WH per square meter (WH/m2) modelled for the whole area when trees are to be included and when they are removed. As Figures 3 and 4 show the data when modelled can clearly show the detail in the reduction of the solar radiation that i-Tree cannot. At the peak of summer for example the trees along Parramatta Road can reduce the solar radiation from a potential radiation of 7136.7 WH/m2 to 6424.5 WH/m2 as seen in Figure 5.

An area where a difference between the two roads cannot be seen is in the attitude of residents of North Sydney and Parramatta local government areas towards the trees. Despite some differences in the characteristics of respondents along both corridors, both show a striking similarity in their responses. Groups along both roads cite beauty as the most common reason to value trees, followed by a tree's role in environment processes. The aesthetic value judgement also plays out in the response

Figure 5

Figure 4

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Further Information

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(Nursery and Garden Industry Australia), Shih-Hsien Yung (University of Technology Sydney), Mingzhu Wang (Macquarie
University), Natalia Saldarriaga (University of New South Wales) and Angela Maria Gomez (Macquarie University).
Further details
can be obtained in the final report for the project: Amati, M. Ghosh, S. Shrestha, K. McManus, P. Brack, C. Kachenko, A. Wang,
M. Yung, S.-H. Saldarriaga, N. Gomez, A. M. (2013) Understanding the carbon and pollution mitigation potential of Australia's
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towards the view of trees as a problem - for
which the most popular answer was that
they are unattractive. This indicates that
respondents are highly sensitive to the

aesthetics of different trees.

Discussion

A key contribution of this study is to show the difference between LiDAR and i-Tree methodologies for measuring trees in the urban environment. The i-Tree methodology requires relatively low levels of technological input but does require a certain degree of expertise to measure trees, collect samples and input data accurately. i-Tree certainly provides more complete information than the LiDAR hyperspectral components.

It would be impossible to calculate the amount of stored carbon in the tree using airborne LiDAR for example. The modelling that i-Tree uses to calculate the value of the tree canopy is peer-reviewed and has been developed over many years. The outputs provided in dollar terms certainly proves a powerful argument for the use of the tool in policy work. On the other hand, we would argue that the LiDAR technique has enormous potential moving forward. The technique does not require a stratified random sample that i-Tree uses. i-Tree's sampling technique is based on 19th century methods and the LiDAR method makes full use of the latest technology. LiDAR can also provide a much more accurate picture of the shape and height of the canopy, allowing accurate modelling of the shading on nearby buildings as we have shown. This modelling could also be performed for the canopy's impact on pollution removal. Further work is required to bring this work to the same level of policy relevance as i-Tree, but the basis for advances is stronger being based on actual measurements as opposed to the allometric calculations that form the basis of i-Tree. Furthermore, rapid development in the use of drones for carrying out LiDAR surveys, suggests that this technique will become cheaper in the future. The possibilities of mapping the trees using

LiDAR and hyperspectral data also open up the potential to map other aspect of the tree canopy, for example the distribution of different groups of trees. Finally, it is important to note that both techniques could be used in a complementary way. LiDAR could be used to measure the heights of the trees making the field survey for i-Tree quicker and cheaper.

In conclusion, this project sought to improve the valuation and monitoring of the urban forest – a crucial resource as cities adapt to climate change in the future. The work moving forward will be of relevance to policy makers and planners by highlighting the ecological value of the services that the urban forest provides and showing how valued this green infrastructure is by the community in two very different areas of Sydney.

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accurately diagnosing weeds, pests and diseases affecting nursery crops.

Accurately diagnosing weeds, pests and diseases affecting nursery crops can be challenging. If left unchecked these pests can increase costs
and reduce productivity. Therefore it is important to take action early to prevent widespread infestations through correct diagnostics.

This months nursery paper was prepared by Andrew Manners* (Senior Entomologist and manager of Grow Help Australia) and John Duff*
(Senior Plant Protectionist) as part of the levy funded project 'NY11001 Plant health, biosecurity, risk management and capacity building for
the nursery industry'.
* Based at the Queensland Department of Agriculture, Fisheries and Forestry

Infestations of pests, diseases and weeds can reduce growth rates and crop uniformity, as well as increase throw-outs and other costs associated with the crop. Active and regular monitoring can reduce the extent and impact of infestations.

Once a problem is observed, it is of critical importance to make an accurate diagnosis. For very obvious symptoms, e.g. presence of spider mites, aphids, caterpillars, etc, a field diagnosis is possible. However, identical symptoms can be produced by multiple diseases and can sometimes be confused with damage produced by insects or mites. In other cases multiple causal agents may be present and identifying the primary cause of symptoms may not be straight forward (e.g. Fig 1). Incorrect diagnosis can lead to increased costs due to inappropriate treatments and allow the pest or pathogen to spread and infect healthy plants.

Information accompanying a plant submitted for diagnosis

It is critical to send detailed information

with any plant sent in for diagnostics. This helps the diagnostician put the symptoms and any pest or disease observed/isolated from the plant into perspective and give the most accurate diagnosis possible. If thorough information does not accompany a sample, incorrect recommendations may be provided. For example, if a plant with a leaf spot symptom is submitted and no pathogen is associated with the spots it
Accurately diagnosing weeds, pests and diseases affecting nursery crops.
Fig.1. Bracteantha infected with Ralsonia solanacearum. This species cannot be identified without specialist knowledge and diagnostic capacity.
When submitting diagnostic samples provide as much information about the crop as possible:

- Species and variety of plant.
- Where the crop has been grown.
- How the crop is being grown, e.g. in containers or in-ground, containers on the ground or raised on benches or under protected cropping.
- History of the crop, e.g. age of plants, length of time the crop has had symptoms, if your plants have ever experienced these symptoms in the past and how they were successfully and or unsuccessfully managed.
- Symptoms of the crop, e.g. leaf spot, root rot etc.
- The percentage of crop affected and the size of the crop (area, number of plants).
- Treatments that have been applied to the crop (fertiliser, insecticides, fungicides or anything else). Provide an estimate of when these treatments were applied.
- Environmental conditions, e.g. rainfall, temperature, high wind, frost, hail etc.
- Provide a photo of the whole crop.

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could be due to the spot being caused by 1) a physiological reaction associated with environmental or growing conditions, 2) fertiliser burn, 3) pesticide phytotoxicity, 4) recent application of a fungicide which has reduced the pathogen to such an extent that it can no longer be isolated from the leaf spot or 5) some other factor. Without further information an incorrect diagnosis may occur, so it is recommended to include as much detail as possible.

Collecting samples for disease diagnosis

Plant pathogens tend to grow in and on plant material. For most groups, pathogens cannot be readily identified from symptoms and must be isolated from the plant (see exceptions below). This involves taking small pieces of plant material from the advancing margin of pathogen activity (e.g. the leading edge of a stem rot or leaf spot) and placing it on a specific media for the pathogen to grow. Once growing on the media it can be examined in various ways to determine its identity. The pathogen must be taken from the advancing margin as secondary pathogens (bacterial and fungal) rapidly develop on dead plant material. For this reason, dead plants are not suitable for the diagnosis of plant diseases as secondary pathogens are likely to mask the primary pathogen. Not all pathogens can be isolated in this way. Some pathogens will not grow on specialist media and spores must be collected and identified directly from plant tissue, e.g. powdery mildew, downy mildew and rusts.

Plant selection can greatly impact a diagnostician’s ability to isolate and accurately diagnose the causal agent. It is therefore extremely important that plants with advancing symptoms be presented to diagnosticians. If possible, send in multiple plants so diagnosticians can observe which symptoms are consistent. Having plants with early, intermediate and advanced symptoms (but never dead plants) is beneficial and gives the best chance of isolating the causal agent.

It can be tempting to submit only symptomatic plant parts, particularly in cases of stem or leaf dieback. While these symptoms can be caused by pathogens that may be isolated from above ground parts it is also possible that the causal agent is acting upon the roots of the plant. It is always better to submit whole plants and allow the diagnostician to determine from which areas to isolate, however, for large plants this is not always possible. In such cases, send in symptomatic parts of the plant, along with soil and root samples.

Molecular techniques are increasingly part of diagnosing plant pathogens, particularly viruses. Isolations often are able to determine the genus of a pathogen from the morphology of spores and other structures. Determining the species of a pathogen from morphology can be difficult and time consuming. Molecular biology can often be used to ascertain the species identity and confirm initial morphological examinations.

Collecting insect and mite samples

Insects and mites tend to be easier to identify than plant pathogens, at least to a common group e.g. caterpillars, spider mites, aphids, scarab beetles etc. Species level identifications can often require laborious preparations and may not be possible for groups for which diagnostic keys do not exist. However, often knowing the group of insect is sufficient for nursery production managers to put in strategies to reduce the impact of arthropod pests. Sometimes this is not the case, particularly when one species is resistant to insecticides, e.g. western flower thrips or green peach aphid, and other species may have no or differing levels of resistance. In such cases it can be advisable to gain a species level identification. Contact the diagnostic service you plan to use prior to sending insect or mite samples for species level identification as certain organisms have special requirements, e.g. flies cannot be identified using larvae and spider mites must have males and females for identification. In general, it is easiest to submit plants infested with pests as opposed individual insects or mites (Fig. 2). This allows the diagnostician to pick which individuals will be selected for closer examination and avoids sending preservatives in the mail which are most often considered dangerous goods, e.g. 70% ethanol, methanol or other substances.

Provide your diagnostic provider a photo of the entire crop and individual plants. This can assist your diagnostician in the diagnosis by putting the symptoms in perspective. It can be beneficial to email photos prior to sending the sample, particularly when whole plants can not be submitted.

Fig.2. Waterhausia with stunted growing tips (left) caused by eriophyid mites (right). Eriophyid mites are not visible to the naked eye and require at least x20 magnification to be observed. Adults are about 0.1mm in length, eggs about a third of this size.

ADULT

EGG

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Diagnosing pathogens in growing media and water

Many plant pathogens are spread through the movement of growing media and/or in water. As such, it is extremely important to purchase and use pathogen free growing media and appropriately disinfested water. However, pathogens may still occur in growing media and water sources and could therefore require testing. Since many saprophytic fungi and bacteria are often present in growing media and water, testing for these pathogens must be specific. These tests, commonly called baits, should only be undertaken when you suspect a particular pathogen, or when it has been isolated from plants during previous tests. Baiting growing media and water may then serve to determine where the infection has or has not originated.

Baiting involves using a seedling, leaf or other plant material from a species which is particularly sensitive to a specific pathogen. Such plant material is the ‘bait’ from which the pathogen can then be readily observed and isolated.

Soil and growing media

Phytophthora is the most commonly baited soil, growing media and water-borne pathogen, though many pathogens can be baited using different methods. To facilitate your diagnostician completing a Phytophthora bait, collect a number of sub-samples of soil or growing media and roots (up to a depth of 15cm) beneath each plant in a certain location. Multiple plants may be bulked together to make a representative sample for each location. For each sample, include about 500g soil or growing media and roots from plants with early and advanced symptoms. It is particularly important to include roots in the sample as this will increase the accuracy of the test. Include several samples if practical to narrow down which areas are being affected. Soil or growing media and roots are then sent to a diagnostic laboratory for analysis.

As mentioned above, many other baits can be completed to test for specific pathogens. For example Cylindrocladium, and allied genera, can be baited using caster oil leaves, black root rot (Thielaviopsis sp.) using carrots and Pythium and Phytophthora can be baited using a variety of leaves including lemon, umbrella tree, azalea, avocado and apple flesh. Refer to your diagnostic service provider if you would like a specific test completed.

Irrigation and dam water

The same principles apply to pathogen baiting in water used for irrigation. Many fungal and bacterial pathogens can be spread in water including Pythium, Phytophthora, Fusarium, Cylindrocladium, etc. The same baits can be used for baiting water as used for growing media ; they are simply left in irrigation water for a period of time and examined for fungal activity. For example, for Phytophthora, poke holes in semi-mature umbrella tree leaves and place them inside plastic bottles. Thoroughly cleaned milk containers work well as they have an easy handle from which a string can be tied. The bottle can then be ‘floated’ in irrigation water such that the entire bottle remains under the surface for 1-2 days before being sent to a diagnostic provider for further testing. This may require a small weight to be attached to one part of the bottle so that the opening remains under the water, but the entire bottle is still at the surface. Testing water can be beneficial, however rainfall and other events can drastically alter the species present in irrigation and dam water over short periods of time.

Nutrient analyses

Growing media and water is of utmost importance to growing high quality plants. It is recommended to monitor such parameters as EC, pH and other nutrients on a regular basis to ensure that growing conditions are optimal. For more information on sampling water and growing media for nutrient analysis refer to the 'Sampling for Analysis' nursery paper, September 2011. Relatively inexpensive commercial EC and pH meters are readily available through many scientific equipment suppliers.

Weeds

In simple terms, a weed is a plant out of place. Weeds are able to spread rapidly and have unwanted economic, environmental or social impacts. Weeds can be very difficult to identify, and may be confused with plants that are not weeds, including native or endangered species. Sometimes weeds look very different between their juvenile and mature stages.

It is important to correctly identify a weed to ensure that control methods are effective and appropriate. Some factors to consider when identifying a weed are where and when the weed grows, its shape, size, leaf form and flower colour. There are several online tools to help you identify weeds on your property.

The Biosecurity Queensland edition of the Weeds of Australia identification tool and the A-Z listing of weeds help to easily identify a weed based on the features of a particular plant. The tool includes over 1000 current and potential weeds. Once you have confirmed the identity of a weed, you can then access management information. Another Australian Weed identification tool provides a detailed summary of major weeds specific to each regional area of each state and territory. If you cannot identify the plant using online tools or weed identification publications, you can send a sample to your state herbarium for analysis (this usually incurs a fee – check their website for details). Their websites provide information on collecting and preparing weed specimens for identification. Information or the ability to submit plants or photos of weeds is often available through your state department of agriculture or primary. For more information from local community groups refer to the National Landcare Directory.

Packaging considerations

Regardless of the type of material you are sending, be it plants for pest and disease diagnosis, weed or insect identification, water or growing media, it is important to ensure that your sample gets to its destination in good condition (Fig. 3). Samples that become crushed, overheated or stay in transit for long periods can become too degraded for analysis. For this

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reason it is recommended to use express post or overnight couriers whenever possible. Wrap plant material in paper towels or newspaper, which can be lightly dampened to prevent desiccation (important for seedlings). If containerised plants are being posted, wrap containers so that growing media does not contaminate the entire sample (Fig. 4). Provide adequate support so that plants cannot move or become damaged if tipped. Alternatively, bare root plants (bag roots if significant amounts of growing media cannot be removed easily) and provide about 500g of growing media bagged separately within the package. For seedlings and delicate plants, it is recommended to package plants in a box to prevent squash damage. Remember to pack with enough padding so that plants do not move around.

For insect or mite pests, send in whole plants (though roots may not be required for above ground pests). It is often important to include growing tips as damage often occurs in this region, even if it is not evident until leaves grow-out. Place samples in a sealed plastic bag or unbreakable container. Sending samples in ethanol or other preservative is not recommended due to current regulations associated with posting dangerous goods; refer to your diagnostic service provider if this is required.

Label each sample clearly with a waterproof marker or with pencil and paper within each bag. Most diagnostic laboratories require a sample submission form to be submitted with the sample. If this form is not submitted, samples will either be delayed or not completed at all. Each laboratory is likely to have slightly different guidelines, refer to your service provider for more detail.

Finally, ensure that you use the correct address. Incorrect addresses can result in samples going missing for days or even weeks, particularly if the diagnostic laboratory is part of a large, multi-organisational facility. In many cases this can result in a sample becoming too degraded for analysis. When in doubt, contact your diagnostic service provider.

Diagnostic services

Diagnostic samples can be sent to your local Department of Agriculture, Primary Industries or Biosecurity branch and sometimes to your state herbarium. Private consultants are also available. Each service is slightly different, offering different tests and with different costs. In addition, as part of a nursery levy funded project, Grow Help Australia provides contract rates to all nursery producers.

Fig.3. Begonias delivered to diagnostic service provider in plastic bags for disease diagnosis. Such a sample would require hand delivery or be packaged in a box such that plants could not move or be damaged in transit.

Fig.4. Plants should be packaged to preserve the current state of the plant (left), not so it can fall out of the pot and become contaminated with soil (right).

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Grow Help Australia http://www.daff.qld.gov.au/plants/health-pests-diseases/grow-help

Weed Identification tool http://www.weeds.org.au/weedident.htm

Nursery Paper September 2011 Sampling for Analysis

Further information

Refer to your State Departments of Primary Industries, Biosecurity Authorities or Herbariums

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Pruning & Staking- Back to basics

In light of the recent work being conducted to draft an Australian standard for tree stock, there has been renewed focus throughout the industry on tree quality. In this month's Nursery Paper NGINA IDO for the Northern Rivers Des Boorman will undertake a back to basics review of the importance, use and techniques of root control, pruning and staking stock for consistent quality production.

How do we address this?

Root Quality

Root number and structure are fundamental in development of quality plants for all applications, especially when being utilised for growing on into advanced specimens where stability and longevity are crucial to success. A root system that develops in the first few months of a plants' life will be with it for the life of the plant so it is critical to get the first step right. Root remediation can be carried out on small plants such as tubestock at potting-on but this causes significant set-back to the plant and additional costs to the production cycle.

If quality root systems are not produced in the initial stages of production the issue will be compounded throughout the life of the plant if not remediated. Rather than undertake costly remediation conditions should be specified for the production cycle, such as root number and quality.

Root circling and root direction are fundamental when attempting to produce quality stock be they tree, shrub or groundcover so that they will perform post production. Unfortunately due to a range of reasons root quality issues have been broadly ignored or dismissed as a 'luxury' that we can't afford in recent years.

Pricking out

There are basic processes such as pricking out seedlings, taproot pruning and the correct technique to insert seedlings into the container to prevent J-rooting that need to be addressed. There are also other issues associated with this such as lateral root development that also compound poor pricking out activities, contributing to the need for root remediation and subsequently

staking.
Direct seeding is not necessarily the answer either as many seedlings can still develop poor root characteristics when direct seeded into the growing container especially.
Active management of processes and excellent pricking out or tubing technique are the key to success rather than leaving them to their own devices. The first opportunity to grade plants for quality is at the pricking out / tubing stage where defects and poor quality can be rouged out.
Cutting grown stock should also be graded prior to potting and any defects removed from production, it is cheaper to throw out a cutting than a potted plant.
Staffing
Staff should be selected on their aptitude and ability to undertake training. Once they have achieved trade level they should be encouraged to regularly undertake additional training to ensure continual improvement of their technical knowledge and maintenance of their skills.
Staking Trunks
Flexible rubber tie loosely tied to trunk and secured to wire allow for movement but prevent the tree falling over (Image 1). Of note is the double twist which prevents the tie slipping on the wire.
Tie systems are available that allow the tree to move independently of the trellis which allow for secondary thickening to occur as in image 2, which is the system used at Dooralong Valley Native Plants. (image 2 courtesy of F, Howarth Dooralong Valley Native Plants).
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Technical

Systems where the stake to support the tree is not anchored into the media also facilitate the development of secondary thickening and is a technique used at Dooralong Valley Native Plants to help produce quality trees (image3)

This is opposed to the following picture Image 4, which demonstrates that poor staking and tying can actually be detrimental to plant performance. In addition poor tying of plants to stakes can also cause failure of the plant and render it unsaleable.

The other focus for quality trees of either clonal or seed origin is to ensure secondary thickening or taper. This is critical as secondary thickening is what gives trees the ability to support themselves and produce healthy trunk characteristics. Secondary thickening is the laying down of lignin (wood) within or between the cell walls in plants as a response to movement of the stem typically from wind. This also has root implications as roots also respond to secondary thickening pressures and compression or tensile strain from the trunk and canopy mass offsetting their growth to compensate for the strain.

In the book Modern arboriculture, Shigo et al 1998 states that ‘Conifers form compression wood as a type of reaction wood’ & ‘In hardwoods cell walls thicken on the upside of the lean; hardwoods have tension wood as a type of reaction wood’ (Shigo 1998, pg 63) This is well documented research and shows the importance of self-support for trees to produce suitable trunk characteristics.

He also states that roots react to similar forces of tension and compression changing their profile to more elliptical when exposed to load forces. Depicted in Image 5 (pg 63 Shigo et al 1998), RT shows the centre of a root as being on the lower side of the root indicating additional wood is laid down above the centre to provide the required compression support. Buttress roots are an extreme example of this. The B diagram shows a branch reaction. In both the dot is the centre of the branch/ root.

Image 6 depicts a Eucalyptus tereticornis trunk base showing definite secondary thickening i.e. broadening towards the base of the trunk compared to an olive tree on the right (Image 7) that has been rigidly tied for too long. Note: consistent trunk calliper top to bottom and an inability for the plant to support top mass. Hence it bends over and would likely snap in adverse wind conditions.

The E. tereticornis pictured above (Image 6) is a seedling recruit in a small container, was in heavy shade and not staked yet still produced an exceptionally strong trunk conformation with visible secondary thickening of the base. Conversely the cutting grown olive tree pictured (Image 7) is showing the classic signs of over staking resulting in ‘sag’ once ties were removed. These two pictures show all too well the differences as highlighted by this section.

Staking has become the default situation rather than as it should be used, on a needs basis. This has developed from the desire to grow plants faster to sell more in any given production period but at the detriment of trunk quality.

Nutrition and growth rates are critical with specific requirements being highly variable between plant types. Generic nutrition regimes and poor understanding of specific nutritional requirements can also exacerbate the issue of secondary thickening

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and over-staking due to vigorous growth rates often associated with nutrient imbalances particularly excess nitrogen.

Pruning

As with any cutting activities hygiene is crucial to ensure success with pruning activities and reduce the likelihood of disease transmission. All tools should be regularly cleaned, serviced and be free of debris.

Branches

Branching and branch placement is also critical in tree and shrub quality. Branches may develop different crotch angles some of which may be structurally weaker or create bark inclusions that ultimately weaken the trunk. These are also illustrated below so there is a clear understanding of what is acceptable and not. Quite often poor branch or trunk conformation will not fail until 5 or more years post planting when the tree is large and the loss of such a tree will put a significant cost and gap into a landscape.

Eucalyptus tereticornis on left (image 8) with open crotch angle and convex branch bark ridge while in the centre (Image 9) is a Eucalyptus tereticornis with a highly acute crotch angle and included bark, features that result in significantly weak trunk and branch attachments. The image on the right (Image 10) Brachychiton sp. Black Wall Range shows callus already forming in the acute crotch angle and cracking associated with pressure and movement, this trunk while small now, is destined to fail.

Smaller container grown trees often don’t have that light competition or ‘space’ and may produce two or many co-dominant stems with poor trunk confirmation a result.

Obviously this can be a major issue with some tree types having prevalence for branch faults. This prevalence may be due to the growing environment not giving them enough stretch, as in forests or rainforests when a canopy hole is produced by a larger tree falling or being damaged. This acute branch growth while seemingly ‘normal’ is a symptom of paddock form ie open area growth form that has not been produced in ‘normal’ competitive successional environments. Examination of these trees will reveal that when exposed to serious stress they may fail like any other tree with poor branch conformation. Typically trees in Sapindaceae are prone to this acute crotch angle, however many grow without failing Cupaniopsis, Harpulia, Toechima, Diploglottis, Guoia and Lepiderema being some of the genera, with Cupaniopsis being a significant street tree of warm coastal and sub-coastal situations and an excellent tree adaptable to a diverse range of conditions.

(Boorman pers comm. 2014)
Pruning activities should be carried out with knowledge of where branch collars are and where to cut to ensure that trunk tissue isn't damaged in pruning activities and that a stub isn't left that is likely to promote disease ingress.
The images below demonstrate some of the key points identified with arrows.
Image 11 depicts trunk defect due to trunk wood exposure from incorrect pruning activities Of note is the callus tissue around edges but clear dead wood in the centre is already decaying.
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Illustrated in Image 12 is a Brachychiton australis branch collar where the arrow indicates where to cut the branch.

In Image 13 the arrow indicates a branch abscission scar that is part of the trunk as seen in the previous picture, as a raised collar at the branch base that shrivels and drops out of the trunk post pruning.

A Tabebuia argentia branch, with no visible branch collar is depicted in image 14 showing the different expression of branch collars as compared to the B. australis above (images 12 & 13).

Branch removal should be perpendicular to the branch where it intersects the trunk on the top side so often a small stub will remain on the bottom side of the cut. This will heal over as a normal part of wound repair.

Pruning methods and amounts need to be stipulated to ensure trees are pruned correctly and not so that it detrimentally affects the canopy size, shape or trunk integrity.

Grafted trees also present some unique issues as graft unions may be unsightly or not be smooth or uniform for physical reasons such as poor graft technique or as a result of buds growing towards the sun and producing the classic hockey stick effect. If the bud is faced to the south in the southern hemisphere it will grow up straight to the north results in the hockey stick form. This simple process will alleviate the need for heavy straightening staking activities.

Budded or grafted trees may produce side shoots from the bud or graft that without correct placement or care can produce undesirable results such as the 'hockey stick' style of growth seen on the right (Image 15). While on the left is a bud that has grown up and will fill in to produce a straight trunk (Image 16).

Conclusion

There are numerous documents and books available to provide growers with the technical information to produce excellent quality trees and shrubs without relying on excessive staking to obtain straight upright trunks. Nutrition, competition, container and growing environment are critical factors to ensure successful healthy plant production.

With timely technically proficient pruning activities branch and

trunk damage can be minimised and unsightly wound scars
reduced in size and impact.

Train and keep training, it is critical to maintain a continual
improvement model for technical knowledge when producing any
plant stock.

additional information

There are numerous different texts available on pruning and tree physiology but one which is highly recommended is;

Modern Arboriculture 1998 Alex L. Shigo (Sherwin Dodge Printers)

This book has numerous detailed drawings and descriptions for the large number of pruning options and well explained technical
content relating to wound healing, disease management and tree physiology.

Shigo & Trees Associates has produced numerous educational books, brochures and DVDs including two soft cover books on pruning.

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Pesticide application on edibles

Pesticides are an essential tool in the control of pests in nursery production. However special consideration should be given to the use of pesticides on edible crops especially those with potential to be readily eaten. In this month's Nursery Paper Grant Dalwood (NGISA) and Chris O'Connor (NGIA) remind industry of some of the key considerations when it comes to pesticide application in edible crops.

In light of the growing popularity of the 'grow your own' trend with home gardeners, recent years have seen an increasing demand for ready to eat consumable produce in the nursery retail sector . Examples include ready to eat herbs, advanced vegetables and advanced potted patio or dwarf fruit trees such as citrus or apples.

In conjunction with this trend, there have also been some realignments of Interstate Certifications Assurances (ICAs), so it is timely to remind growers of their need to be cognisant of the end users of their product, as well as the legal and moral obligations of providing a product which is safe for consumption and fit for purpose.

Maximum Residue Limits

Chemicals applied to crops will undergo change; they will break down over time through metabolic processes or environmental influences. What remains within the crop, either as the original chemical form or product of that form is known as a chemical residue.

Maximum Residue Limits or MRL's are the maximum concentration of a chemical residue legally permitted in agricultural produce, resulting from the registered use of an agricultural or veterinary chemical. The MRLs are set by the Australian Pesticides and Veterinary Medicine Authority (APVMA) and specific attention is given to produce intended as food stuffs.

Before any agricultural or veterinary chemicals are released for sale and/or use in Australia they are rigorously evaluated for registration by the APVMA. As part of this evaluation process MRLs are determined to ensure that the levels determined are not hazardous to human health either through chronic exposure or as an acute dose.

Once the MRL for the agricultural or veterinary chemical is set, these are then in the case of food products recommended to Food Standards Australia New Zealand (FSANZ) and incorporated into the Foods Standards Code. This code has been adopted by state and federal laws so the MRL becomes the maximum concentration of chemical legally permitted in or on a food or agricultural commodity as a result of the legal application of agricultural or veterinary chemicals.

It is important to note that these MRLs are not likely to be exceeded if the agricultural or veterinary chemicals are used as per the approved label instructions.

There are many facets which influence how agricultural chemicals perform in a crop situation and these are considered in the process of determining the MRLs and throughout the registration process.

From the APVMA some considerations include;

• how rapidly the chemical may be processed by either plant and/or animal tissues
• how rapidly the chemical may be degraded by soil and other environmental processes
• how frequently and at what intervals the

chemical is used, taking into account the potential for bio-accumulation
• how close to harvesting of plants the chemical is used (including withholding periods)
• the acceptable dietary exposure to low levels of chemicals in food
• how accurately the chemical and/or toxicologically significant metabolites can be measured in plant material
• any differences in MRLs and residue definitions between Australia and its major trading partners and those of the Codex Alimentarius Commission of the United Nations

The factors noted above constitute a wide array of possible influences upon the efficacy and likely impact of agricultural chemicals. The same chemical can behave very differently between plant species and between environmental conditions. It is for this reason that chemicals are registered for specific crops in specific situations along with specific application doses and withholding periods.

Product Labels and Minor Use Permits

The product label is the most important source of information in regards to the legal use and application of an agricultural chemical and is in itself is a legal document. It includes essential information on;
• active constituents of the chemical
• directions for use
• modes of action
• any specific restraints or restrictions on use
• withholding periods
• safety information

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In all situations and especially so with edible crops, the directions on the label must be followed including the rate of chemical used, the frequency of application and any specific instructions such as withholding periods or environmental parameters during application (e.g. do not apply if ambient air temperature exceeds 30ºC).

Victoria differs from many jurisdictions in Australia in that it routinely allows off label use. Off label use applies to situations where a chemical is used in a way not specified by the label, for example using it to control a different pest or in a different crop situation. Some restrictions to off label use however do apply, these include;

• using a chemical at a higher rate than is listed on the label
• applying a chemical at a higher frequency than listed on the label
• not following specific label statements (i.e. DO NOT statements)

Outside of these situations a specific permit is required from the APVMA.

The Victorian Department of Environment and Primary Industries (DEPI) advise that any person using chemicals in an off label manner accept responsibility for the efficacy of the chemical, any residues in the environment and produce and any health and safety issues. The Victorian DEPI also notes that with food crops, great care must be taken with off label use. Victorian DEPI advise that in cases where a chemical is not registered for use in a particular crop, that it is unlikely that a MRL is established and so any chemical residue in the end product would be unacceptable.

The assessment of agricultural chemicals is a costly venture, and so not all chemicals are registered in all possible crop situations. There is still however a need for growers to legally access and use chemicals to target specific pests in small crops, to access new chemistry and to manage pesticide resistance for pest control in emergency pest situations. In these circumstances Minor Use Permits or Emergency Permits are available.

Minor Use Permits are issued by the APVMA and are designed to allow growers legal access to use a chemical in a crop situation. In effect they become an extension of the information on the label. Like label directions, Minor Use Permits must be used in accordance with the described crop, pest and situation. For example many Minor Use Permits available for our industry are for ornamental crops and not food crops, so are not suitable for use on edibles. Minor Use Permits are also registered for a specific time frame so before using a chemical with a Minor Use Permit ensure that you have a valid permit within its expiration date.

Awareness of Withholding Periods

According to the APVMA "A withholding period (WHP) is the time period that is set at registration for a chemical, to guide users of the chemical as to when residues will be below the MRL. It is based on the rate at which the chemical breaks down on the crop/animal. It is the minimum length of time between treatment of a crop or animal, and the suitability of the harvested crop or the animal product for human consumption."

As noted earlier, different chemicals are processed by plants at different rates, and this processing or breaking down of the chemicals is influenced by many factors such as environmental conditions (temperature, rain, humidity) and the method of application (e.g. foliar application versus media drenching). So because of this variance it is important to pay particular attention to the directed withholding periods as stipulated by the label.

Awareness of withholding periods applies to both growers and retailers when dispatching product for sale. For retailers, any stock which falls within a withholding period must be removed from sale and not reintroduced until the completion of the withholding period. Retailers should also be aware of what chemical practices their suppliers (growers, brokers and trade marts) are using.

Compliance records

Businesses involved in any level of pesticide application should keep records of pesticide application. A main driver to record keeping is to demonstrate compliance with various Quality Assurance programs associated with food safety and production such as Freshcare or those programs required by large supermarkets and to meet Work Health and Safety requirements. Appropriate record keeping is also a requirement of the Nursery Industry Accreditation Scheme Australia (NIASA) program.

Records for spray applications can also be used for other benefits beyond just compliance such as;

- resistance management e.g. cycling modes of action
- aiding future decision making through better purchasing plans, budgeting and forecasting along with product performance reviews
- assistance in emergency situations
- assistance in determining the causes of any associated issues if they arise

Examples of records which should be kept include;

- equipment Calibration records,
- spray application records,
- pesticide manifests

Detailed examples of these records are available on the NGIA website as part of the Nursery Industry Pesticide Management Diary and more information on your legal recording obligations are available from your state DPI’s.

Growers and retailers need to manage withholding periods of pesticides, especially in those products such as advanced fruit trees which may be readily consumed.

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Interstate Market Access Requirements

Biosecurity and domestic quarantine is of paramount importance to the Australian nursery industry. Supporting domestic quarantine are many Interstate Certification Assurances (ICAs) which require growers to treat stock prior to interstate shipment. Awareness of exactly what is required by these ICAs is essential to growers.

For example, in the case of movement of greenlife stock between SA and NT, there is an operational procedure in place (CA-10) that has recently highlighted a major concern for SA based nurseries that were sending potted edible herbs and vegetable plants to the NT. These issues were based on appropriateness of chemicals used for spraying consignments (before 9th May 2013) that had been prescribed under the Plant Movement NT (PMNT) arrangement.

Spinosad & Bifenthrin were originally prescribed for spraying edibles to combat Western Flower Thrips (WFT) and Scale insects entering the NT. However, Bifenthrin was identified as possessing properties that would impact the health of people who may have eaten the product within the withholding period once the product had arrived in the NT.

Through NGISA and the relevant government bodies the procedure was amended so that, vegetable and herb seedlings for transplanting must be treated with Bifenthrin as per Permit 9795 Version 7. This ensures that the residue of the chemical will be mitigated with the onset of time and the transplanting process.

The complimentary option for Vegetable and herb plants for growing on or pot culture is that they must be treated with white oil as per APVMA Permit 11815

Version 1. Plants that are deemed to be available for immediate consumption by humans are required to only be sprayed with a measured dose of white oil as per instruction in the APVMA Permit. This will ensure a reduction of risk to consumers but still manage the quarantine requirements of NT.

This demonstrates that growers must be aware of the intended use of their products once they have left dispatch and remain up to date with market access requirements for treatment of nursery stock.

Key Points for Keeping Residues Below the MRL

The following points may assist you in keeping residues below the MRL in your products.

- Use the right product – is it registered for the pest, crop and situation?
- Be aware of the product configuration and end user – Will it be potentially eaten straight away e.g. advanced vegetables or will it need to be planted out/grown on e.g. vegetable seedlings?
- Comply with any withholding periods and schedule your production to factor this in
- Be mindful of how you apply the chemical

• Look at the concentration e.g. different application methods may have different concentrations e.g. spray versus drenching.

• Be mindful of spray drift e.g. from an ornamental crop to an edible crop

• Be aware of the rate of application this includes making sure that application equipment is calibrated i.e. delivers the right dose. Too much causes waste, costs money, causes possible phytotoxicity and elevated residues. Conversely, too little is not effective for the target pest.

• Be aware of where you have used pesticides in your production system. For example if pesticides are routinely incorporated into potting media this may pose a risk.

- Keep good records on your pesticide use. This will help to identify issues and will also be required from a compliance perspective.
- Ensure that any accidents are responded to appropriately e.g. if stock is inadvertently sprayed it is removed from sale.
- Consider using an Integrated Pest Management (IPM) System if you are not doing so already.

In addition to the above points, NGIA has recently released an updated Nursery Pesticide Application Best Practice Manual to assist nursery operators in identifying and understanding the range of pesticide application equipment available and the key issues related to the use of pesticides in the nursery environment. The APVMA and state DPI’s also have a great deal of information specific to your jurisdiction and situation.

Advanced herbs are an example of one product which may be readily consumable by customer

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Further information

Australian Pesticides and Veterinary Medicines Authority www.apvma.gov.au

Victorian Department of Environment & Primary Industries - Off label chemical use in Victoria

www.depi.vic.gov.au/agriculture-and-food/farm-management/chemical-use/agricultural-chemical-use/off-label-use/off-label-chemical-use-in-victoria

Biosecurity South Australia Movement of Nursery Stock & Plant Material to the Northern Territory (PMNT) Operational Procedure

www.pir.sa.gov.au/__data/assets/pdf_file/0007/43189/CA10_PMNT_PROCEDURE_15_5_2013.pdf

NGIA Nursery Pesticide Application Best Practice Manual www.ngia.com.au

For additional information, consult the following nursery papers which are all available electronically from www.ngia.com.au

Minor Use Pesticide Program. Issue Number 11. December 2012.

Abide by the directions of use and withholding periods of pesticides to ensure MRL’s are not exceeded.

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The importance of Suitable Sources of irrigation Water to nursery Businesses

Poor quality water can have potential impacts to plant health and product quality when used in the production, maintenance and detailing of plants for sale. A source of high quality irrigation water at an affordable price is critical to the successful production and maintenance of plants. Consideration should be given not only of the irrigation water applied directly to the plants, but also to the overall production and irrigation systems in place. In this month's Nursery Paper, NGINA Industry Development Officer, Michael Danelon seeks to raise awareness of the importance of identifying your water source and managing irrigation water, along with covering some simple testing parameters and information resources.

Water moves continually through a cycle of evaporation and transpiration (evapotranspiration), condensation, precipitation and runoff with the water then usually reaching the sea. In a nursery situation it is the exposure of water to nutrients, pesticides, soil and organic matter and how plants selectively remove elements/compounds from it before leachate passes through the plants rootzone modifying the net water quality for either reuse or disposal.

Not unlike the water cycle, production nurseries and Garden Centres obtain water from a range of different sources due to their location and accessibility to water (influenced by legal-licencing requirements or climatic conditions) where water may be generated from rainfall or extracted from local sources (creek, river, aquifer) or provided by a water authority such as the town supply.

Greater attention needs to be paid to

sustainable irrigation water quality in nurseries. Interpretive and remedial information to guide the owner/manager can be found in a few texts. Industry examples include “Managing Water in Plant Nurseries”(2), “Nursery Industry Water Management Best Practice Guidelines”(3) and the “Water Management Toolbox"(4).

As more businesses recycle or reuse their drainage water, actively sampling, recording and acting on analytical test results is an essential task, which will assist businesses in achieving good plant development in both the immediate and long term time frames.

Knowing the water quality limitations of your nursery is an essential first step in choosing an irrigation system and water management plan that best meets your water and plant health needs within budget constraints.

Commence by undertaking a comprehensive study (at least over 12 months) of the water quality in your nursery to determine its limitations. These may include pH, Electrical Conductivity/salinity (EC) water turbidity, slime growth and iron content.

Irrigation water comes from a diverse range of sources

By far the most suitable water for high quality nursery irrigation is water from a town supply, which has been treated to remove suspended solids, colour, odour and pathogenic bacteria – however in many instances it is uneconomic and can be unreliable during droughts and water restrictions.

Irrigation water can be obtained from a range of different sources: surface (i.e. creek, river, dams, and rainwater harvesting), groundwater (spring/aquifers) and reticulated (treated sewage effluent) which may contain impurities and substances derived from the natural environment and the wastes of human activity. The geology and location of the aquifer of underground water supplies will often greatly influence its quality.

Town water supplies

Although generally free from suspended

solids and treated to control plant pathogens,
it is generally expensive and usually restricted
during drought periods and likely to be a
growing cost to utilise.
The pH of town water can often be too high
for general plant production, > 7.5 and for
disinfestation via hypochlorous acid formed
from either sodium or calcium hypochlorite
chlorination addition(5). It may also be too
high when mixing certain pesticides where alkaline hydrolysis may occur.
Rivers and creeks
The quantity and type of impurities
in streams, creeks and rivers can vary
widely from the flowing watercourse depending on the size and condition
of the surrounding catchment. In many
locations there are conditions governing the
accessibility, entitlements, allocations and
trading of this water for extraction under
commercial use. Every nursery needs to be
Irrigation Water Quality Evolves
Subject to Input Sources
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aware of their legal requirements under the National Water Reform Process and Management of Water. For links to state legislations go to: http://www.water.gov.au/WaterAvailability/Watermanagement/index.aspx?Menu=Level1_3_4

There is no certainty of the water quality generated from adjoining properties where you have no control over the exposure of the water to certain chemicals and physical environments. In catchments with urban or other agricultural activity, streams may contain large quantities of organic and suspended matter which can promote biological issues in storage or the irrigation system if not removed by appropriate management and filtration.

During flooding or heavy rain, water courses are likely to contain large quantities of suspended clay. If the stream has a lot of algae, this may result in masses of algae mixing with the clay and remaining in suspension (turbid). In low flow conditions chemical pollutants may become concentrated making the water quality unsuitable for irrigation.

Storages – fresh and/or recycled systems

The quality of water in storages is influenced by the physical, chemical and biological characteristics of that storage. These characteristics are a function of how and what the water was exposed to before entering the storage so it is critical to review the environment the water is subjected to within your nursery and surrounding areas.

Collecting water off an adjoining open bare earth paddock may deposit significant soil/clay particles which can reduce the storage capacity through the deposition of soil particles. It may also introduce colloidal clay particles held in suspension fouling the irrigation system. The possible effectiveness of ultra violet water disinfestation is also impacted on, as this relies on water with a low total soluble solids (turbidity) reading (6).

The other issue to consider is, once a

contaminant enters the storage it may be difficult or impossible to remove it – especially if it is a herbicide.

Storages where water becomes both organically and nutrient enriched (eutrophication) are subject to seasonal changes, leading to increasing domination by aquatic weeds. In increasing light levels of spring and summer, the upper layer of the water can be heated reducing oxygen supplies to the water storage below. The extent of the heating and insulation capacity will vary subject to the water depth and climatic conditions causing layers of water with different temperature and oxygen supplies (stratification) and potential suspended clay particles or floating organic matter near the surface.

Where a water storage becomes stratified, the unmixed bottom water layer in a eutrophic storage may contain dissolved iron and manganese. Bacterial activity on the bottom of the storage uses oxygen resulting in iron and manganese present being dissolved and the production of hydrogen sulphide, which is often noted through its rotten egg gas smell.

It is not uncommon to have pH readings in the top half metre of 9 to 10. For water disinfestation, chlorine dioxide may not be affected up to pH levels > 10(6) but the alkaline pH may be unsuitable for acid loving crops if the water and rootzone environment is not managed.

Algal blooms often occur in the warmer, mixed surface layer, of fertile storages, in early spring and late summer. This is particularly exacerbated when storages are relatively small and shallow as the water surface can heat up and cool down rapidly with changing climatic conditions.

Normally the best quality water is found near the mid-depth between the top and bottom layers. However, as pumping and evaporation lower the storage, there may be a need

to pump both layers and deal with their
Technical
The potential effect of herbicides which inadvertently enter a water storage may take time to be seen in abnormal plant growth and longer to recover subject to the mode of action.
Consider how runoff generated within a nursery is dealt with. In this instance no clear drainage plan allows runoff to flow over roads and paths which is either lost due to evaporation and seepage or to collect sediment.
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corresponding impurities (hydrogen sulphide and algal blooms) via improving the aeration of the water source.

Recycled drainage water – most pertinent within a storage

How well a nursery collects their drainage water and what is collected in it is critical to the long term composition of the irrigation water contained in storages. High levels of carbonates and nitrates can produce stone-like precipitants and encourage algae and organic slimes to form in the water storage and irrigation systems.

Without appropriate removal of organic matter from the drainage water (screens/ sediment traps) this can contribute to oxygen depletion of the water creating an environment for bacterial, fungal and viral plant pathogenic microorganisms.

Recycled water from production areas will contain some or all of the following:

- surplus soluble nutrients
- degraded products of nutrients
- floating pine bark, sawdust, shavings and peat moss from potting mixes
- pesticides and fungicides
- humic acid
- leached material

These could affect water quality by:

- changing the pH
- increasing the hardness salts (principally calcium)
- adding organic matter and
- development of biological organisms (bacteria, green algae, aquatic crustacean larvae, small aquatic organisms, nymphs and adult water fleas and mites.

The effects of changed water quality are:

- scale formation in pumps, filters, valves, sprinklers and drippers
- clogging irrigation equipment

• biological growth of bacterial slimes
• growth and transmission of plant pathogens
• cross inoculation of bacteria, fungus and virus that may affect nursery staff.

Bores, wells and spear points

Water obtained from bores, wells and spear points is usually low in organic matter but may be contain fine sands.

High concentrations of iron and manganese are often present and these can become troublesome if not treated to remove from the irrigation water. Some bores which are poorly oxygenated may contain hydrogen sulphide, which may have high concentrations of sulphates and carbonates leading to possible blockages of irrigation.

Treated effluent

The use of effluent from sewerage treatment plants for nursery irrigation can provide a source of water; however it may cause severe operational problems with filters and emitters due to growth of microorganisms. The quality of water from effluent ponds varies greatly and at times the EC level may exceed limits of the plant material and potting mixes.

Water Testing

Good quality water for nursery production contains adequate but not excessive concentrations of inorganic ions and compounds in the correct ratios, while maintaining low levels of suspended solids and bacteria.

Whether fertigating or relying on fertilisers placed within or applied topically to the growing media, the nutritional program needs to be designed in conjunction with water analysis data and a long term focus.

It is difficult to establish how much each of the various substances in water contributes to the clogging of irrigation equipment. However, it can be generally stated that clogging problems due to the occurrence of impurities in irrigation water become more acute if the water is high in the following:

• Suspended particles of organic or inorganic matter

• Precipitate-forming elements, such as iron, manganese, calcium and magnesium
• Bacteria that secrete slime which causes the suspension to accumulate or which acts chemically and causes the accumulation of sulphides and insoluble compounds of heavy metals.

Plant growth and nutrient uptake will depend on the chemical cocktail that is available in the container, some of which will be supplied by the irrigation water.

Management of the recirculated water storage to restrict potential for weed growth is paramount to reducing organic matter and weed seeds which can deprive oxygen levels and facilitate production of hydrogen sulphide.

Crop pruning and surplus potting mix are not ideal additions to any water storage. Consider use of sediment traps and physical removal of plant pruning in the nursery.

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Water testing criteria

Biological - bacteria and algae

Physical - turbidity, light penetration, colour and suspended solids

Chemical - pH, Electrical conductivity, nutrients (nitrogen, potassium and phosphorous, inorganic ions and compounds and organic ions and compounds.

The number of criteria to test is determined in part on the water source, the product being grown and need for disinfestation.

If water is being recycled or liquid fertiliser is being used, more frequent chemical monitoring is required to maintain the correct nutrient balance and unclogged irrigation equipment.

An easy way to monitor basic water quality is to regularly measure the EC and pH on a monthly basis to look for trends and indications of possible chemical problems.

Assessing water quality criteria is necessary for any nursery that is or soon will be recycling or treating runoff water. For the others it is good practice to better understand the nursery's water quality.

Measuring EC is relatively easy and done using testing meters to determine the amount of dissolved salts present.

Plants vary in their salinity tolerance (type, age/stage of development, growing environment and growing media) so there is no definite reading which should be adhered to. Readers are directed to the NGIA Nursery Paper Water quality and nursery crop nutrition 2002/11(7).

pH is a measure of the water's acidity or alkalinity with the pH scale being

logarithmic which means that water of pH 5
is ten times more acidic than water of pH 6.
A reading of 7 is neutral, less than 7 is acid,
and more is alkaline.

Most water used for nursery irrigation should
be between 5.5 and 7. Water between these
levels will:

- maintain nutrient balance
- prevent scale formation in irrigation
equipment
- provide effective chemical disinfestation

pH is one factor to use when determining
potential clogging hazard of water.

If pH is:

- less than 7 it is a
MINOR HAZARD
- between 7 and 8 it is a
MODERATE HAZARD
- over 8 it is a
SEVERE HAZARD

The information above is a guide to raise the
awareness of the importance of identifying
your water source, some simple testing
parameters and managing your irrigation
water for long term benefits.

It should guide the reader to more specific
information referenced below and encourage

Portable pH and EC meters are a convenient way to monitor
basic chemical properties of irrigation water in the field
looking for changes in water quality.

Drainage works do not need to elaborate, just effective in
collecting runoff, retarding speed and removing sediments
before directing to a water storage (courteous Engalls Nursery)

industry participants to attend the industry specific “Waterwork” for containerised
nurseries which are delivered by the State and Territory Nursery and Garden Industry
Associations.

The water cycle is an evolving platform and the impact of how you manage the water
cycle in your business today can influence the profitability tomorrow!

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Growing media storage
With soilless growing media being integral to the success of greenlife and contributing to the sustainability of a business, regular monitoring and appropriate storage of media should be considered a critical component to your nursery's operation. In this month's Nursery Paper NGIV Industry Development Officer (IDO), David Reid outlines best practice storage requirements for both bulk and packaged soilless potting media.

Preventing soilless growing media's contact with potentially pathogen-infested materials such as discarded media, drainage/untreated surface water, plants, contaminated surfaces, used tools, soil and dust should be considered essential. Not only do contaminants need to be excluded from media, but any additives to growing media require monitoring if storing media for extended periods.

Soilless growing media can change over time, with draw-down of certain nutrients or the decreased effectiveness of a wetting agent due to a degradation through microorganisms in the growing media consuming them. Furthermore, microbes in the growing media can also utilise the fertiliser charge, especially iron and nitrogen. Some studies have also found that crops planted in aged growing media get off to a slower start or are liable to suffer a reduced overall vigour. Extended storage periods may also contribute to a mix that lacks sufficient moisture, thus increasing the difficulty of wetting. Extended storage can also cause chemical changes, such as an increase in pH and/or a decrease in soluble

salts and nitrogen levels.
These changes will occur at a higher rate during periods of higher temperatures than low.
While the soilless growing media a nursery uses may be of the highest quality, failure to adhere to some basic storage requirements, will see it transform into a vehicle that may spread contaminants through your nursery, carrying weed seeds, chemicals, insects or pathogens or will contribute to the degradation of its components and additives.
The following are a few guidelines for the proper storage of soilless growing media; bulk and packaged:
• Soilless growing media should preferably be stored in a dry, cool, low-light environment. In an ideal situation, growing media would be stored undercover (not a poly or greenhouse), in a concrete bay or on some other clean, sealed surface (See Fig.1). Alternative storage methods that are easy to clean and disinfest can include metal or plastic bins, trailers, trolleys or in bags on a sealed surface or racks under cover.
Growing media storage
Fig #1 – A concrete storage area is ideal, with a large concrete apron leading up to the bay(s). This nursery also employs the use of a dedicated bucket/shovel just for media, otherwise, they should be regularly disinfested. Clyde Plant Nursery

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• Concrete meets the storage surface requirement of easy cleaning and is most suited to disinfestation between media deliveries. Wooden sleepers are difficult to decontaminate, however scrubbing the surface thoroughly with an appropriate disinfestant (see references below) will reduce the risk. Concrete too has tiny pores that may hold contaminated media; however sealing the storage area with a suitable sealing paint again will reduce the risk even more so.

• Bulk media bays should be graded to remove water and should be constructed to prevent water from flowing into it and any water that enters the storage area should drain away freely (See Fig.2). Storing media on a raised area of land (height 10-12cm) will also prevent run-off water from entering the area (See Fig.3). Another option is to surround the media storage area with surface drains or diversion banks. If this cannot be easily achieved it may be necessary to surround the area with surface drains or diversion banks (See Fig.4).

• Exposure to heat and sunlight can accelerate degradation of nutrients and wetting agents in mixes. As most businesses do not have the capacity to store media indoors, bulk media stored outdoors for extended periods should be covered to prevent contamination and to protect it from sunlight and other contaminants (See Fig.5).

• When considering a potential media storage area at your facility it may be worthwhile thinking in terms of ‘dirty’ or ‘clean’ areas when choosing its location and other sites where inputs (plant material, containers, etc.) are received. With regards to media, it should be located close to the nursery entrance to reduce external vehicular movement through or onto the 'clean' areas of your site. The area leading up the media storage bay should be covered or sealed with gravel to minimise the movement of dust and soil particles. The location of throw-out, green-waste and contaminated media storage areas should also be carefully thought out and clearly separated from your clean media area to prevent cross contamination. Treated propagation media storage area/ systems need to be separated from untreated media storage area/systems to avoid cross contamination. Fortunately, studies have confirmed that the most common growing media materials such as peatmoss, perlite, vermiculite and properly composted pine barks prepared on clean surfaces, are often free of the most common pathogens occurring in propagating facilities, (Pythium spp., Rhizoctonia solani, Fusarium spp., Cylindrocladium scoparium, Phytophthora spp. and Botrytis cinerea). To keep them pathogen free best practice for storage should be followed. Source: NIASA

- When receiving media at your nursery designated employees should verify delivery specifications are met and ensure that potentially contaminated delivery vehicles do not enter the production 'clean' area. (Best practice procedures for receiving goods can be found in BioSecure documentation or from your state IDO)
- Packaged growing media should be kept shrink-wrapped, raised on pallets and covered appropriately until it is used. The elimination of direct sunlight, the provision of suitable circulation to prevent moisture build-up and the prevention of heat build-up should be the aim when storing media in this

form.

• Media should not be stored under or near chemicals such as insecticides, herbicides, disinfectants or even fertilisers. This is the case for packaged product too, as dry or liquid chemicals

drain
potting mix
drain drain
potting mix
potting mix
drain
potting mix
drain drain
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drain
potting mix
drain drain
potting mix
potting mix

Fig #2 – Potting media storage area designed to prevent water flowing onto or remaining on the pad.

Fig #3 – Potting media storage on a raised pad

Fig #4 - Diversion banks are another method to prevent water entering potting media storage may permeate packaging and affect contents. The handling and use of chemicals, both within your business and external to it, should also be done clear of media storage areas to prevent contamination. See your state IDO for details on chemical storage best practice

- Growing media and allied products should also be stored away from seed and seed products such as livestock feed or forage and pasture seeds, again to prevent contamination.
- Rodent populations should be controlled to prevent contaminants (i.e. weed seeds and droppings).
- Vegetation should be cleared from around storage areas to prevent leaf litter and seed contamination. Weeds around storage areas should be removed as part of a regular weed-monitoring program
- The storage area should be regularly cleaned between deliveries. Quaternary ammonium compounds (4,000ppm for 1 hour) such as Phytoclean or sodium hypochlorite solutions (4,000ppm for 1hour) are both effective treatments for disinfection, along with high-pressure steam. See references below for further, detailed, disinfestation methods.
- When transferring media, the equipment used such as front-end loader buckets, barrows, mobile bins, trolleys or plastic containers need to be regularly cleaned and disinfested between use and/or should be dedicated to a specific task. Cleaning such tools should be done according to the previously mentioned specifications; scrubbing first or pressure cleaning and then using a suitable disinfectant (see references below). Such cleaning should be carried out on a sealed area with appropriate drainage into a sump or a drain, located so as to minimise risk of

contamination of growing areas.

Fig #5 – If storing media for extended periods or if vegetation is overhead or close by, cover it. Dream-Time Wholesale Nursery

Fig #6 – If storing multiple loads, ensure that staff practice inventory rotation. Purtills Nursery

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• If you receive multiple loads or packaged product, ensure that inventory rotation is practiced. Different batches of media should be stored separately to avoid possible cross-contamination and to permit easy trace-back of any potential future growth issues (See Fig.6)

• Plug and propagation mixes should be used within the first six months of being manufactured. Peat-based media should be used within nine months of manufacturing date. Depending on the manufacturer and the specifics of the mix, bark based media should be used within 2-6 months. If the media does not contain controlled release fertilisers (CRF) it can be stored in large volumes and with heaps at heights of up to 2.5m in height, however it is important to keep the moisture levels at above 50% and to ensure the media is turned regularly to stop the product becoming anaerobic.

• Media stored for six months or longer should be tested to determine whether any chemical changes have occurred and to compensate for any changes as necessary. As mentioned earlier, wetting agents incorporated into the media may degrade over time, along with chemically altering the mix, such as a pH increase along with a decrease in soluble salt and nitrogen levels. It is advisable to test any product that has been stored for 6 months or longer to determine what changes have occurred and compensate for any change (see references below). Contact your supplier to gain an understanding of your media's 'best before' dates.

• The introduction of CRF, fungicides or other special additives brings with it extra elements to be aware of. Ideally bulk media should be turned over within 5 days if the product contains CRF and if the product is held for longer, by keeping it under approx. 60cm in height it will go some way to prevent the product heating up and causing the CRF to dump. Media containing a controlled-release fertiliser can typically be safely stored for one to two weeks prior to use, however soluble salt levels should be checked during extended storage periods. CRFs are not characteristically uniform and their manufacturers have particular media storage guidelines when added. The CRF product label or the manufacturer's recommendations should be referred to for specific instructions on longevity and usage of CRF incorporated into potting mixes.

• Packaged media has a general limit of 6 months storage, however if it contains CRF in it should not be stored outside during the warmer months, as it will increase the release rate.

• It is not advised that growing media is reused, but if it is it should be disinfested in an appropriate manner and prior to disinfestation, media to be reused must be stored on a site well separated from storage sites of new or treated media ingredients (see NIASA documentation or the IDO in your state).

Whilst you may receive a specification sheet upon delivery of your media, it is advised that you keep detailed records of shipments for future reference and that you perform some perfunctory pH or electrical conductivity testing on your media testing

upon receipt using the Australian Standard methods. NIASA accredited and growing-media manufacturers keep samples and records from each batch shipped to help identify or rule out any potential media related issues if they were ever to arise.
NIASA Accredited growing media manufacturers endeavour to supply a superior, closely monitored product, so if you have any questions about its quality, contact the manufacturer for assistance.
Appropriate storage will maximise both the shelf life of the growing media and minimise the potential for crop difficulties associated with product aging and contaminants. In order to ensure satisfaction, consider these suggestions and implement similar precautionary measures to help maintain the quality of the products you receive.

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Growing media manufacturers and component suppliers are required to:

- Adopt NIASA guidelines and adopt an internal audit system as described.
- Implement Australian Standard AS 3743 – 1996 and amendment 1 – 1998, ‘Potting Mixes’ as required.
- Implement Australian Standard AS 4454 – 1999, ‘Composts, soil conditioners and mulches’ for bark composting systems.
- Consent to independent site evaluations as described (external

audits).

- Provide a manufacturer procedure statement.
- Provide a producer’s product specification.
- Implement a satisfactory complaints resolution procedure.

Growing media storage basic rules:

- Dry
- Cool
- Clean
- Sealed surfaces
- Low-light environment (if holding for extended periods)

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a Systems approach to Managing Pests, Diseases & Weeds

BioSecure haccP

On Monday 21 October 2013 the testing of BioSecure HACCP to meet interstate market access requirements began with a trial between Queensland and Victoria. The BioSecure HACCP trial ran through until 21 April 2014 overseen by Nursery & Garden Industry Queensland, Nursery & Garden Industry Victoria, as well as the biosecurity agencies of Queensland and Victoria. This world leading holistic on-farm biosecurity program delivers a structured on-farm pest, disease and weed management system that has shown it can be used to support interstate market access. In this month's Nursery Paper John McDonald, Industry Development Manager Queensland, gives an account of the trial and records grower feedback on the value of the program.

Biosecurity is not just dealing with quarantine pests; it is the protection of a plant production system from the introduction of insects, diseases, weeds and other biological organisms that may adversely impact upon the cropping system. Producers (growers) are in constant battle to grow their crops with as little damage from plant pests as possible, achieving this through exclusion, eradication and/or management. With the integration of various strategies (e.g. protected structures, hygiene, use of beneficials, monitoring, chemical, etc) most producers get their crop(s) to market. However by structuring the entire process around standardised procedures, best management practice and skilled staff this integrated cropping system can benefit downstream from the farm gate through improved market access.

BioSecure HACCP is the industry specific biosecurity program designed to assist producers in their on-farm pest, disease and weed management through a systems approach supported by procedures and documentation. The program applies the 12 defining principles of Hazard Analysis Critical Control Point (HACCP) to the management of biosecurity risks at farm level (production nursery) providing a creditable risk identification and management process for growers. Having a clearly defined pest, disease and weed management system operating under best management practice guidelines, which is risk specific and supported by concise and accurate records, underpins the value of pest management and should be recognised by customers and regulators.

The trial was a national industry initiative supported by state, territory and national peak industry bodies as well as the biosecurity agencies across all Australian jurisdictions recognising the two businesses in both Queensland and Victoria which were testing on behalf of the industry. BioSecure HACCP is the first industry developed on-farm biosecurity program in Australia to be used as a legally approved market access instrument allowing the four production nurseries to trade with their clients during the trial phase. It is expected that at the completion of the trial audit report the other states and territories will phase in the adoption and recognition of BioSecure HACCP.

It has taken more than 5 years of interstate negotiations and industry program development to get to this point with industry R&D investment running at more than $400 000 to date. Costs

A Systems Approach to Managing Pests,

Diseases & Weeds, BioSecure HACCP

Pohlmans Nursery

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associated with interstate market access are constantly increasing with some businesses having annual bills above $100 000.

Added to the dynamic markets growers are operating within it is imperative that an interstate market access system is available which offers recognition of on-farm best management practice and grower skills, is flexible for growers, utilises technology and is cost effective.

The trial of BioSecure HACCP included two certified production nurseries from Queensland (Birdwood Nursery & Pohlmans Nursery) and two from Victoria (Mansfield's Propagation Nursery & Proteaflora Nursery) trading with their clients in the two respective states. Trial oversight was provided by the Project Control Board (PCB) that consisted of representatives from Plant Health Australia, Biosecurity Queensland, New South Wales Biosecurity, Victoria Plant Biosecurity & Product Integrity, Biosecurity South Australia and NGIA. Operational management was through NGIQ and NGIV with support from each biosecurity agency in the respective states (Qld & Vic) provided to ensure the trial met all legal requirements.

General Manager of Pohlmans Nursery Mr. Robert Pohlman said "Industry on-farm programs offer opportunities for self certification, under a biosecurity program like BioSecure HACCP, to assess plant stock and implement management programs to ensure crops are pest, disease and weed free and are maintained as per the intra and interstate movement and import regulations".

The BioSecure HACCP trial is based on the industry developed on-farm biosecurity program being tested to assess its ability to meet the interstate market access requirements for nursery stock of Queensland and Victoria. Each of the four production nurseries (two in each of two states) operated their interstate trade under robust on-farm plant pest, disease and weed management procedures. The on-farm BioSecure HACCP procedures are supported by pest specific Entry Condition Compliance Procedures (ECCP's) and, in an Australian first, a web based electronic biosecurity verification and certification system supervised by regulatory agencies in both jurisdictions.

Each business first had to gain BioSecure HACCP Certification available to NIASA Best Management Practice (BMP) Accredited businesses because many of the NIASA BMP activities underpin good biosecurity practice. Through the implementation and adoption of the procedures and record keeping in the BioSecure HACCP manual the growers developed their biosecurity program and incorporated it into the overall cropping system.

Key procedures implemented include:

Table 1. Examples of BioSecure HACCP Procedures
Each procedure is aligned to a relevant record and completion, access for audits and secure record storage are mandatory requirements under the BioSecure HACCP program. Some records are only completed once (e.g. Approved supplier register) and updated if the situation changes whereas other records are at least weekly (e.g. crop monitoring at no more than 7 day intervals) and are used to drive internal decision making plus demonstrate that an activity has occurred. Table 2 gives some examples of required records:

Table 2. Examples of BioSecure HACCP Records

Disinfesting plant
containers
Vehicle inspection Crop monitoring
Growing media
storage
Monitoring plant
growth
Site surveillance
Growing media
production
Cleaning &
Disinfestation
Despatch
inspection
Approved supplier
register
Register of Authorised
Inspection Person
Visitor record
Materials import
inspection
Materials despatch
inspection
Vehicle
inspection
Corrective action
report
Register of Certification
Signatory(s)
Crop monitoring
Birdwood Nursery
Proteaflora Nursery

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Mr. Rob Furniss, Proteaflora Nursery Production Manager, has said of BioSecure HACCP "The great thing about the BioSecure HACCP program is that it is not just about the quality measure at the end of the line, rather it is a program that when implemented will ensure that quality is achieved at each stage of the process. By identifying the critical control points in our plant production and implementing management strategies to mitigate issues before they arise we have further developed our production and reporting processes. In turn this has strengthened our already successful continuous improvement program as it has provided focus and a program that encapsulates all facets of quality control.

Throughout the trial and into May 2014 there have been a total of 79 BioSecure HACCP Biosecurity Certificates (BHBC) issued with 46 being from the two Queensland growers sending into Victoria and 33 from the two Victorian growers sending into Queensland. Each BHBC is an electronic document generated within each growers secure account in the web based biosecurity verification and certification system (Audit Management System (AMS)) specific to BioSecure HACCP Certified producers. Staff underwent specific training to meet the BioSecure HACCP requirements to be an "Authorised Person" under the approved ECCP. Initially the training was a face to face workshop delivered by the state NGI however during the trial this material was converted (NGIA) into a web based eLearning course with assessable criteria built into it and automatic notification making the process easy to access, very flexible in delivery and cost effective.

The electronic BioSecure HACCP Audit Management System (AMS) allows the certified production nurseries to manage their biosecurity processes in an efficient and practical manner with all relevant records being stored and retrieved electronically. The businesses complete paper based or electronic records such as monitoring, surveillance, inspection etc. during the normal course of activities across the production system. At nominated intervals (e.g. weekly, monthly, etc) the paper records are scanned and uploaded to the AMS. The AMS also provides the business with the capacity to store client details for automatic insertion into the BioSecure HACCP Biosecurity Certificate (BHBC) template which is the replacement to the government paper based plant health assurance certificate. The BHBC is saved automatically within the AMS and can be printed or emailed to clients or government regulators as required therefore avoiding the current national paper based system and the associated administration costs.

The benefits of an on-farm biosecurity program gaining legal status for interstate market access are multiple and across all stakeholders including government and industry alike. Producers benefit from a system developed for industry, by industry, that integrates all plant health issues into a farm management system that addresses both endemic and exotic plant pest threats and risk mitigation.

In April 2014 the national Sub-committee on Domestic Quarantine & Market Access (SDQMA) met in Brisbane to address a range of interstate market issues including BioSecure HACCP. On the 30th April, at the invitation of NGIQ and Robert Pohlman, the committee visited Pohlmans Nursery to gain firsthand experience on the application of an on-farm biosecurity program. Growing & Production Manager at Pohlmans Nursery, Mr. Chris Johnson, has been one of the leaders in the implementation of BioSecure HACCP across the production nursery and addressed the SDQMA informing them how he has found that even before using the system to trade interstate the program is delivering benefits on-farm.

Chris went on to explain to the SDQMA how the BioSecure HACCP system allows the business to proactively drill down and look at each step within the plant production process and critically assess how the crops in each of the five cropping systems are produced.

Having access to documented BioSecure HACCP procedures

Audit Management System (AMS)

Mansfield’s Propagation Nursery

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and integrating these into normal work instructions provides rigor around key activities such as crop monitoring, site surveillance, despatch inspections, etc. This enhances their effectiveness and traceability is provided through clear and concise record keeping.

Pohlmans Nursery has found strategic and organised pest and disease crop monitoring is delivering significant rewards to areas of the cropping system that traditionally face cyclic pest pressures that have historically required remedial pesticide management which is costly and labour intensive. The crop monitoring has seen pesticide applications drop by 90% as it becomes localised, target specific with less repetition due to low pest pressure. Crops are improving in quality, throw-out rates are reducing and turnover is increasing with one significant cropping system increasing turnover by more than 60% in 18 months.

In summing up the BioSecure HACCP program Rob Furniss of Proteaflora Nursery said “The implementation program appears to be a lot of work, but in essence it is a set of checks and balances and verification of processes that are happening, or if not should be happening, as a part of any efficient production system. The verification is important, not just to be recognised by external auditors, but for my own confidence as a nursery manager to know that what we plan to do, we do it and we do it well. We hope that when the program moves past it’s trial phase and is implemented nationally it will provide us with a system that will either improve or even increase market access, something that as a national brand and international supplier is critical to our growth."

The trial of BioSecure HACCP has shown there are major cost savings in labour, cropping inputs and efficiency gains in administration that support the value of the program. Government benefits through a greater engagement by and with industry in managing biosecurity threats, improved efficiency in technology adoption and auditing, real time information access and traceability of produce. The trial has been an overwhelming success with the next phase developing a full report on the trial being tabled at the next national Sub-committee on Domestic Quarantine & Market Access (SDQMA) meeting leading to national adoption.

Sub-committee on Domestic Quarantine & Market Access at Pohlmans Nursery 2014

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indoor heat Stress Mitigation with Urban Vegetation and Tree Shading

In this month's Nursery Paper, Zhengen Ren, Dong Chen, Guy Barnett and Xiaoming Wang from CSIRO's Land and Water Research Flagship,
report on levy funded research examining the potential that trees have to reduce the impact of heat waves on health and energy use.

SUMMARY

This study investigated the potential benefits of urban vegetation for regional greening and the provision of local tree shade around residential buildings to reduce the impact of heatwaves on occupant health and the energy required for cooling. It was undertaken by a research team from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and involved simulation of the thermal performance of a residential home under various urban greening and tree shade scenarios, using weather observations from the 2009 (Melbourne) and 2011 (Sydney) heatwaves. It was found that doubling the urban green coverage of the Central Business Districts (CBD) in Melbourne and Parramatta, together with proper tree shading around a residential home may reduce the total annual hours of 'severe' heat-related health risk by 14% and 44.6%, respectively. Whereas, covering 50% of the CBD building roof areas with green roofs as well as appropriate arrangement of tree shading around the house resulted in a reduction of the total annual hours of 'severe' heat-related health risk by 14.5% (Melbourne CBD) and 36.2% (Parramatta CBD). The impact on the energy required for space cooling, was similar between the locations for each of the scenarios investigated. The study confirms that urban vegetation and tree shading have a key role in managing impacts of heatwaves.

1. INTRODUCTION

With climate change, heatwaves in Australia are set to become more frequent and severe. Heatwaves, such as those that occurred in Melbourne in 2009 and Sydney in 2011, pose a significant and growing threat to public health as highlighted by the rise in heat-related illness and deaths. For instance, the 2009 heatwave in Victoria caused 374 excess deaths for the week of 26 January to 1

February 2009 (DHS, 2012). More recently in Sydney, there were significant increases in hospital admissions and ambulance call-outs during the heatwave (30 January to 6 February 2011) and 814 deaths compared with an average of 682 deaths for the same time period across previous years (Schaffer et al., 2012).

Health risk during heatwaves not only depends on extreme weather, but also the heat sensitivity of the population and the thermal performance of the housing in which people will retreat for protection. As reported by Cadot et al. (2007), the majority of excess deaths attributed to the 2003 heatwave in Paris occurred in the home. Therefore one important strategy for reducing heat-related health risks during heatwaves is to improve the thermal performance of residential buildings. Using computer modelling, Chen et al. (2014) assessed the potential impact of regional-scale urban vegetation schemes on the urban ambient environment of Melbourne and found that an increase in urban vegetation could reduce the average summer daily mean maximum temperature and as a consequence, the rate of heat-related excess mortality.

At the building scale, it has long been recognised that proper arrangement of trees and shrubs around residential buildings can reduce indoor temperatures during summer (Meier, 1990).

In this study, we build on this work by using computer modelling to predict the combined effect of regional-scale urban vegetation schemes to reduce ambient air temperatures and local tree planting to provide direct shade to residential buildings. The effectiveness of these strategies was assessed using a measure of heat-related health risk index and the energy required for space cooling. The geographic focus was Melbourne and Parramatta CBDs using weather from the 2009 and 2011 heatwaves, respectively.

Indoor Heat Stress
Mitigation with Urban
Vegetation and
Tree Shading

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2. METHDOLOGIES AND MODELLING RESULTS

2.1 Urban climate modelling and weather data preparation

An urban climate model UCM-TAPM (Thatcher and Hurley, 2012) was applied to predict the impact of different urban vegetation schemes on the local climate of Melbourne and Parramatta CBDs with regard to changes in mean monthly ambient temperature, mean monthly daily maximum temperature, mean monthly daily minimum temperature, and mean monthly relative humidity. Vegetation schemes that were investigated included doubling the CBD vegetation and covering 50% of the CBD buildings with green roofs. These were then compared with the existing CBD vegetation scheme. Tables 1 and 2 provide details of the urban vegetation schemes used for Melbourne and Parramatta, respectively.

To enable simulation of building thermal performance, hourly weather station data for Melbourne (1st July 2008 to 30th June 2009) and Parramatta (1st June 2010 to 31st May 2011) was modified to account for the simulated effects of the various urban vegetation schemes on the three mean monthly air temperatures and relative humidity. The methods for preparing the weather data for building simulation using the regional simulations from UCM-TAPM are described in Ren et al. (2014) and Chen et al. (2014).

2.2 Building thermal performance simulation

The space cooling energy requirement and thermal performance, including the indoor air temperature, relative humidity and Discomfort Index (DI), were estimated using the AccuRate software developed by CSIRO (Delsante, 2005). DI is a commonly used index for heat-related health risk (Epstein and Moran, 2006). For indoor conditions, it is calculated as the mean of the indoor dry-bulb and wet-bulb air temperatures. The risk of heat stress is considered to be ‘moderate’ for DI values in the range of 24–28°C and ‘severe’ for DI values above 28°C (Epstein and Moran, 2006). The higher the DI index the greater the heat-related health risk and potential for adverse health consequences for the occupants.

Simulations were performed on a typical residential house that was assumed to be of detached brick veneer construction and comprising four bedrooms. There was no insulation installed in the walls or ceilings as the aim was to represent older housing stock and to simulate the maximum exposure of building occupants to heat-related health risk. For the simulation of heat-related health risk, the house was assumed to operate without space heating and air-conditioning i.e. using natural ventilation and associated occupant behaviours. On the other hand, for the simulation of cooling energy requirement, the house was assumed to operate with space heating and air-conditioning, with common thermostat settings for the respective climate (i.e. Melbourne and Parramatta) and consistent occupant behaviours.

2.3 Analysis of indoor heat stress and space cooling load

Simulations were carried out for the CBD area of Melbourne from 1 July 2008 to 30 June 2009 and Parramatta from 1 June 2010 to 31 May 2011. The results are shown in Figures 1 and 2 for Melbourne and Parramatta, respectively. For tree shading, it was assumed that all the trees are 10m high and are planted along the northern and western walls with a distance of 3m between the trees and the building.

For the Melbourne CBD area (see Fig. 1), the total annual hours with DI above 28°C (severe heat stress threshold) for all the habitable spaces (four bedrooms, kitchen/family, dining/lounge, bathroom, laundry, entry hall, toilet, walk-in robe and ensuite) was predicted to be 311 for the existing CBD vegetation scheme with no tree shading. With tree shading alone, the energy required for space cooling (i.e. cooling load) and the total annual hours with DI above 28°C were both reduced by 6.8%. Doubling the CBD green coverage could reduce the total annual hours with DI above 28°C and the cooling load by 6.8% and 6%, respectively. Whereas 50% green roof coverage of the CBD area could reduce the total annual hours with the DI above 28°C by 7.4% and the cooling load by 7.9%. With a doubling of the CBD green cover and residential tree shading, the total annual hours with DI above 28°C and the cooling load are both reduced by 14%. Assuming a 50% green roof coverage of the CBD area combined with residential tree shading,

Urban Type	Vegetation coverage of entire land area (%)	Vegetation coverage fraction within vegetation area	Leaf Area Index	Green Roof Coverage of Building Roof Area (%)	Building Coverage over entire land area (%)	Building Height (m)	Irrigation
CBD	15	1.00	3	0	65	12.0	Yes
CBD(Double Vegetation)	33	1.00	3	0	62	12.0	Yes
CBD(50% Green Roof)	15	1.00	3 1.5 (GR)	50	65	12.0	Yes

Urban Type	Vegetation coverage of entire land area (%)	Vegetation coverage fraction within vegetation area	Leaf Area Index	Green Roof Coverage of Building Roof Area (%)	Building Coverage over entire land area (%)	Building Height (m)	Irrigation
CBD	18	1.00	3	0	46	9.0	Yes
CBD(Double Vegetation)	36	1.00	3	0	46	9.0	Yes
CBD(50% Green Roof)	18	1.00	3 1.5 (GR)	50	46	9.0	Yes

Table 1 The main characteristics of the urban vegetation schemes investigated for Melbourne CBD

Table 2 The main characteristics of the urban vegetation schemes investigated for Parramatta CBD the total annual hours with DI above 28°C is reduced by 14.5% and cooling load by 15%. These latter scenarios show the benefit of multiple levels of green strategies.

For the Parramatta CBD area (see Fig. 2), the total annual hours with DI above 28°C for all the rooms was predicted to be 686 for the existing CBD vegetation scheme with no tree shading. With tree shading alone, the total annual hours with DI above 28°C is reduced by 10.6% and the cooling load by 5.5%. Doubling the CBD green coverage alone could reduce the total annual hours with DI above 28°C by 37.1% and the cooling load by 8.7%. 50% green roof coverage of the CBD area could result in a reduction of the total annual hours with DI above 28°C by 27.6% and the cooling load by 1.7%. If we consider both doubling the CBD green coverage and residential tree shading, the total annual hours with DI above 28°C may be reduced by 44.6% and the cooling load by 13.4%. With both 50% green roof coverage of the CBD area and residential tree shading, the total annual hours with DI above 28°C could decrease by as much as 36.2% and the cooling load reduced by 7.0%. The results indicate that increasing green cover and/or the proportion of green roofs in the Parramatta CBD may result in a larger reduction in heat-related health risk than similar strategies in the Melbourne CBD, while the impact on energy requirements for space cooling are similar between the two locations.

Fig. 1. Predicted total hours with DI above 28°C and cooling load of the house in Melbourne CBD from 1st July 2008 to 30 June 2009.

Fig. 2. Predicted total hours with DI above 28°C and cooling load of the house in Parramatta CBD from 1st June 2010 to 31 May 2011.

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3. CONCLUSIONS

The potential of urban vegetation and tree shading around residential buildings in reducing indoor heat-related health risk and the energy required for space cooling were investigated for Melbourne and Parramatta CBDs, using weather data from 2009 and 2011, respectively. The results show that in the Melbourne CBD area, 50% green roof coverage and proper tree arrangement may reduce the total annual hours of 'severe' heat-related health risk (DI28°C) and the energy required for space

cooling by 14.5% and 15%, respectively. In the Parramatta CBD area, reductions in the total annual hours of ‘severe’ heat-related health risk (44.6%) and energy required for space cooling (13.4%) were greatest when doubling the CBD green coverage together with proper tree shading of the house.
This study confirms urban vegetation and tree shade are both important elements in mitigating heat wave impacts.

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American Study Tour 5-16 July 2014

"One must travel, to learn. Every day, now, old Scriptural phrases that never possessed any significance for me before,
take to themselves a meaning." Mark Twain 1869, The Innocents Abroad

In this month's Nursery Paper NGIA Policy & Technical Officer, Chris O'Connor reports on outcomes and some key highlights from the recent industry study tour to the United States.

Nursery and Garden Industry Australia (NGIA) recently conducted a study tour of America focusing on Green Infrastructure, Nursery Business Operations and the Cultivate Trade Show.

The tour which was partially funded through the Nursery Industry levy project NY13700 saw 10 people from the industry tour Los Angeles & San Francisco in California and Columbus, Ohio from 5-16 July 2014.

Green Infrastructure

A key element of the tour was to investigate the American take on Green Infrastructure, the utilisation of it, who the champions are and how they are promoting the concept to key influencers.

Three key advocate organisations were met with, these were; Sacramento Tree Foundation, Friends of the Urban Forest and Tree People. Each of these organisations has extensive involvement in urban forestry and a history extending back more than 30 years, but each has taken a different path in the expression of their advocacy.

Sacramento Tree Foundation has a close link to the Sacramento Municipal Utility District (SMUD) which provides trees to its customers for the purpose of shading homes. This program is backed by detailed instructions of where to plant trees for maximum benefit. The Sacramento Tree Foundation has undertaken a great amount of work in researching and lobbying government to increase and protect the Urban Forest.

Friends of the Urban Forest (FUF) have a more grass roots approach to campaign for the urban forest. Situated in San Francisco they provide trees to local residents through organised local tree planting days. Residents pay a fee for the tree, which is supplemented through grants. The tree is managed through a maintenance program for the first few years of its establishment. FUF has recently focused some of its energy towards campaigning for a San Francisco Urban Forest Plan.

Tree People likewise had a grass roots beginning but has since evolved into an sophisticated operation. Programs include public education, demonstrations of technology and urban forestry and managing tree planting through its citizen forester programs as well as advocacy and natural restoration programs.

A large focus of the American push towards green infrastructure has been due to the

American Study Tour 5-16 July 2014

The Cultivate 2014 trade show covered 7 acres

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benefits seen in managing water, and that was clearly seen in the tours meetings with Kristy Morris form the Council for Watershed Health and Raphael Garcia from the San Francisco Public Utilities Commission. A key aspect in San Francisco is the fact that sewerage systems and storm water systems are combined, so during large storm water events sewerage overflows can occur. Increased urban forest coverage is being embraced as a means to mitigate the impacts of these rainfall events.

The tour also visited Disneyland in Anaheim for a behind the scenes tour with the parks horticultural team. The horticultural support for the operation was impressive with work commencing at 2am every day before the park opens. Horticultural Manager Rhonda Wood highlighted operational aspects including the difficulties they have in accessing some plants in the park, some of which are accessed by using the jungle boat ride. Director of Disneyland Resort Horticulture Adam Schwerner provided a presentation covering amongst other items the focus they have on managing Disneyland's urban forest, expansion of the plant palette and training & development of the parks horticulture team.

The tour also met with Graham Ray from Deeproot, who are the manufacturers of the Silvacell. Graham discussed with the group some of the challenges that occur when trying to incorporate trees into an urban environment. During this discussion Graham went through some of the processes he undertook to ensure engagement of all involved parties at the local government level. He also provided some great insights into the tools and techniques available to overcome some of the engineering challenges posed when trying to get trees into urban areas. Some of these are essential for our industry to be aware of in order to increase our market opportunities.

Nursery Operations

Form a nursery perspective the tour visited four production nursery facilities in California. The first was a large family owned business Boething Treeland Farms. The operation covers 800 hectares over 3 sites in California. Production includes over 1200 plant varieties and supply of product is predominately to the landscape trade. Transport is conducted in house and the business has a fleet of trucks to achieve this. The scale of the operation was considerable however it was observed that there was limited mechanisation. This prompted a discussion on how mechanisation was something that the business was actively seeking due to rising labour costs. By way of information the minimum wage in California increased from $8/hour to $9/hour on the 1st of July 2014 so this was quite new during the tour. Within 18 months' time the minimum wage will rise again to $10/hour, placing more pressure on nursery operators.

Armstrong Growers was the next operation the tour visited. The company has three production sites and owns 31 Armstrong branded Garden Centres, as well as owning the controlling share of Pike Nurseries in Atlanta which operates 16 Garden Centres. The company has a vertically integrated structure whereby the production nurseries supply approximately 45% of the stock in the operations garden centres. The rest of the production material is supplied by other growers. Armstrong Growers also supplies plant material to other garden centres and landscapers as well as large resort operations.

The business has a number of partnerships for example they act as an agent for Monrovia and allow for consolidated freight deliveries through cross docking. The site at San Juan Capistrano also features a new landscaper's drive through service.

One aspect that was of note was that Armstrong Growers is an employee owned company whereby employees own a share of the business through an Employee Stock Ownership Plan (ESOP). Each year more than $2 million is put into the plan from the production business.

Altman Plants was the next nursery on the tour. The business established in 1975 encompasses some 880 acres across 3 states and supplies major chains such as Home Depot, Lowes and Walmart. The business produces a wide range of bedding plants, perennials, roses, and over 800,000 poinsettias. The site we visited at Vista covers 675 acres of production with 3 million square feet of greenhouse which is supported by 400 employees, 30 miles of roads and a 4 acre loading dock.

Drought has been a major issue for the Californians with the current drought being one of the severest recorded in the region. In keeping with this issue, General Manager Jim Hessler showed the tour the sites new dam and water recycling process. The total

The study tour group in front of the floral Mickey Mouse at Disneyland

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capacity is 37 acre feet which equates to approximately 45 million litres of water. Jim noted that they had just upgraded their sprinkler systems after gaining a grant from the local water authority and had seen a resulting reduction in water use.
One of the most interesting aspects of the Altman operation is the use of robotics. The site has 8 HV-100 robots from Harvest Automation which are used to space out plants. The robots are transported to various locations on site on a customised trailer and are managed by a “robot wrangler” who manages the robots and ensures they are functioning. These are partnered with a trike forklift which has specialised tines which allow for the bulk movement of potted plants. According to Jim Hessler the staff have quickly accepted the robots which have each been individually named. It allows Jim to free up labour to focus on more value adding / productive tasks and in light of the rising cost of labour this is essential.

The final nursery operation the tour visited was Valley Crest Tree Company. The Valley Crest Tree Company is one division in Valley Crest Landscape Companies, a business which includes Landscape Design, Installation and Maintenance as well as Tree Care and Golf Course Maintenance. In an release on the 1st of July 2014, the business announced that it had completed a merger with its largest competitor The Brickman Group. This new business entity has over 20,000 employees and has estimated that its turn over for the 14/15 financial year will be in excess of $2 billion dollars. To say that our tour was impressed by the scale, quality and professionalism of this operation is an understatement.

Our host at Valley Crest was Robert Crudup Jr. who is the president of the Valley Crest Tree Company. Robert stressed the central importance of business and production processes in his business. He noted that he had no problems with competitors visiting the site and seeing his production practices, because he knows they do not have the business disciplines in place to execute and do it right. Robert noted that they may emulate his practices for a month or two but could not sustain it. Robert also emphasised the importance of quality, an example he cited was during the Global Financial Crisis, Valley Crest put $5.7 million dollars of stock into the chipper because they were not able to be sold and their quality would suffer. This commitment to quality has also seen them work with key experts such as Ed Gillman and become contributors to quality standards. The business also has a number of ISA certified arborists on staff in a variety of roles including sales. This helps to solidify customer relationships and also helps Valley Crest to understand client needs.

The commitment to quality certainly pays dividends, Robert noted that his prices were at the premium end of the market but

Altman Plants Vista California operation cover 675 acres of production

Valley Crest Tree Company demonstration of modified pot in pot system including air pruning.

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the Valley Crest name and commitment to quality justifies this. Robert also noted how he undertook a lot of marketing upstream of the landscapers to those specifying the stock such as landscape architects. After seeing the quality of the stock and understanding the production process they are happy to partner with Valley Crest for their tree stock requirements.

Valley Crest Tree Company produces tree stock from 15 gallon pots through to large 72” timber boxes with their main market being 36” 48” and 60” boxes.

Dave Teuschler the Technical Services Manager walked the tour through their propagation process which is relatively new. The seed or cutting material is propagated directly into 65mm pioneer tube pots which are air pruned. They have found that by doing this they have limited root defects and have achieved great growth rates.

This tube stock is then potted up into 1 and then 5 gallon pioneer pots. These are again air pruned but are also placed into a modified pot in pot system using the solid walled pots. This limits the impact of wind desiccating the roots but provides the benefit of air pruning.

Production Manager Brad Bowers then gave a demonstration on formative pruning and their use of wire stakes instead of wooden stakes. The theory behind this is that the wire provides a high degree of flexibility to support the trees growth and development compared to the rigidity of a timber stake. The wire is also reusable and won’t rot.

Throughout the tour it was evident that savvy manufacturing principles were in place. The catch cry of “touch it one time” was heard numerous times and could be seen in the delivery of pots on site. Rather than having all pots in a central location the different size pots were located at the points where potting up was undertaken. This thinking is intrinsically linked to the ideal that each time a plant is touched it should provide some form of value add, for example potting up or pruning, rather than moving a plant.

Overall the Valley Crest Tree Company is an inspiring operation and one which the tour was privileged to have seen.

Cultivate 2014 Trade Show

The Cultivate trade show is an evolution of the previously well-known Ohio Short Course hosted by American Hort. The show which covers more than 7 acres provided the tour an excellent opportunity to see all that is new and exciting in the nursery production world. This ranged from new plant releases from the large breeders such as Proven Winners, Dummen group (Red Fox), Ball and Suntory through to new examples of mechanisation such as the Harvest Technologies HV-100 robots.

Cultivate also featured a number of education sessions and research extension sessions led by leading local academics. Some highlights of these sessions included;

• the use of Unmanned Aerial Vehicles (UAV’s) or drones to obtain accurate inventory counts of nursery stock
• Using RFID to manage stock in a tree production nursery
• The use of remote sensor technology to manage irrigation applications. Research in this area also included the use of irrigation control to manage plant growth without the use of PGR’s
• The use of LED light to provide supplemental lighting and to improve

plug growth rates.
The preceding synopsis of the tour has just scratched the surface of the opportunities that were seen in America and the contrasts both good and bad to our own industry.
The participants were all able to take something positive back to their respective businesses, so it was certainly a successful 10 days.
NGIA would like to extend our sincere thanks to our American hosts for their openness and warm hospitality during the tour. Thanks must also be extended to the tour participants for their enthusiasm, good humour and commitment to the tour and the industry.
The Harvest Industries HV-100 robot on display at Cultivate
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Barcodes – Beyond compliance

Barcodes are commonly used throughout the nursery industry to identify products in a retail setting, but what other opportunities do barcodes offer industry?

NGIA Policy and Technical Officer Chris O'Connor, takes a brief look at barcodes and the potential they have for the industry as well as what systems exist beyond barcodes.

The barcode has been in use in a retail setting for 40 years, having first been used on a packet of chewing gum in June 1974. Since this time the barcode has become integral in retail throughout the world and in fact the vast majority of retailers require suppliers to barcode their products.

But there are uses for barcodes beyond retail operations or complying with retailer's ranging requirements. In this nursery paper we will look at what growers can use barcodes for and how they can be used to identify improvement opportunities, increase profitability and assist in managing biosecurity responsibilities.

The GS1 System

One aspect which can be quite confusing is the broad range of terms and acronyms used in relation to barcodes. In the first part of this paper we will look at some of the various terms used with barcodes as well as some of the types of barcodes utilised as well as the wider context in which they are used.

A barcode is essentially a visual depiction of data which is machine readable; in essence it is a data carrier. But not all barcodes are the same; in fact there are a number of different types of barcode symbology. Different barcode symbology's

can carry different data types and are
used in different applications. This point is
essential as there is a difference between
the barcode (visual representation) and the
information that it carries.

Barcodes – Beyond compliance

Barcodes are a powerful tool which can be leveraged by both retailers and growers to reveal better data on a range of
aspects, "streamline tasks such as ordering and increase profitability."

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So before focusing on barcodes we have to consider the information that they contain first as this will dictate how we use the barcode and what barcode will be needed.

For data to be useful it needs to be understood and for it to be understood by many individuals there needs to be a system or a standard. This is where GS1 comes into play. GS1 is an international not for profit association with members organisations in over 100 countries. The role of GS1 is to administers and improve the system of standards which deal with supply chain information.

The standards which GS1 administers are built on three key areas of information management namely; identifying, capturing and sharing information.

Identify

For identification purposes the GS1 system uses a number of identification keys. The one which most growers and retailers would be familiar with is the Global Trade Item Number or GTIN. The GTIN is a unique number which provides a way to uniquely identify an item. This can then be used as a means of attributing information to a product such as pricing or production instructions and retrieving that information when used in conjunction with a database. The uniqueness of the GTIN becomes more important when the product moves out into the supply chain as products from multiple producers can be easily identified without duplication.

The GTIN's found in the nursery industry are 13 digit numbers which are comprised of 3 elements;

- A GS1 company prefix which is allocated to the company
- An Item Reference number allocated by the company
- And a Check Digit which is calculated

from the previous digits. This is a security feature which assists in ensuring that the code is read properly by the machine.

GS1 also has a number of other identification keys such as;

- Global Location Numbers (GLN) used to identify a physical location for example a business location, a propagation house or a shelf in a warehouse.
- Global Returnable Asset Identifier (GRAI) used to identify and track returnable assets for example pallets, trolleys or nursery trays.
- Serial Shipping Container Code (SSCC) used to track items throughout the supply chain, for example it could be applied to a trolley of mixed plants or a single box

Capture

Next we need a way in which we can capture that information for it to be useful. To do this GS1 administers a wide range of standards for data capture and encoding with perhaps the most recognisable being barcodes. The two barcode symbology's most common to the nursery industry are the EAN - 13 barcode and the GS1 – 128 barcode.

The EAN - 13 barcode symbology is used at the point of sale and it is the one which growers and retailers would be familiar with. Most major retailers require products to be barcoded with an EAN-13 and having a barcode is an essential criterion for having a product ranged. Having this barcode means a retailer can capture information; efficiently tracking sales, placing orders and speeding up the checkout process.

Barcodes can be used as an aid to traceability, not only in the production phase but through the entire supply chain

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The EAN -13 barcode does have its limitations, the data which it can carry is limited to a GTIN. In contrast the GS1-128 barcode can carry a lot more information. The GS1 -128 barcode cannot be used at the point of sale but it is powerful. It can cater for all identification keys (GTIN, GLN, GRAI, SSCC etc.) as well as additional information such as Batch/Lot Number, Production Date, Product Net Weight in Kg to name a few.

It does this by using Application Identifiers (AI) which acts as an indicator of what the data is when scanning. This enables other companies to also understand what the data is as well. The AI itself is a short 2 – 4 digit prefix which defines the meaning and format of the data.

Share

GS1 administers standards data synchronisation through its Global Data Synchronisation Network which allows trading partner’s access to the same up to date information on their products such as pricing information. This ability to synchronise data leads to a better trading environment with improved accuracy, reduced costs and increased speed.

GS1 also administers standards for Electronic Data Interchange (EDI) which essentially allows companies to send and interpret business messages including invoices and purchase orders.

Opportunities

So now that we have undertaken a quick overview of barcoding what are the opportunities available for production nursery business?

The first opportunity is through improved inventory management. Barcodes will facilitate the means to keep an accurate record of stock on the ground. This can be achieved in conjunction with the use of Global Location Numbers (GLN). Each location in the nursery can be given a location number. The locations will depend upon what level of detail is required by the business. As an example it could range from; Business – Site – Greenhouse - Bench.

At the operational level essentially as a product is moved into a location it is scanned in and as it leaves the location it is scanned out with both of these actions updating an inventory database. Apart from increasing recording accuracy this opens up the opportunity to have live inventory which is updated automatically as stock is moved. Live inventory will assist sales teams in knowing exactly what is available for sale without having to do a physical stock count. It also enables sales teams to sell to the last plant which in turn increases the profitability of the crop. This can be achieved through the facilitation of online stock availability which is accessible by your customers.

Live inventory can also be used to assist in identifying production quantity needs rapidly.

The next opportunity which barcoding offers production nurseries is through increased traceability. With increasing focus on biosecurity the ability to trace where your stock has come from and where it has gone to is becoming essential. For those businesses supplying the retail sector the ability to undertake a recall procedure is also becoming more important to limit risk and potential costs.

A business could use a GTIN to track product but this has its issues as there is no differentiation between product produced today, yesterday or even last year.

Traceability of product however can be enhanced through complimenting GTINs with a batch number. As noted previously this can be done using a GS1-128 barcode and an Application Identifier (AI). Incorporating batch numbers is a very useful tool as in the event of a recall one can limit the products being recalled to the batch rather than the entire product.

The ability to trace product using GTIN's and batch numbers also enhances the opportunity to track what has been done to the product during production. For example accurate data on watering, agrochemical applications (fertilisers, pesticides, and plant growth regulators) can be applied to a product batch. Likewise weather conditions and even which staff was involved in specific operations with the batch can be attributed and correlated.

This leads to two potent outcomes; firstly accurate production costs can be attributed to the batch and secondly causality can be determined.
Accurate production costs mean that you have an increased awareness of what the plant costs to produce. This in turn will guide decision making processes such as; how much do you need to sell the plant for? Which plants will give the best dollar return for the work needed to produce them? When the best time to dispose of excess stock is? Is it ok to pot up a plant when there is no market for it?
Determining causality can be greatly assisted with increased traceability. If there has been a good crop what caused it? Likewise if there was a crop failure what was the root cause? Increasing the level of information associated with production will help show the causes of success or failure. This focus on data is much better than relying on memory or anecdotal evidence. The information gathered can be incorporated into future operations contributing towards ongoing improvement

in production quality and speed along with improved profitability.

Each of the opportunities mentioned relate to the availability of better information and as commonly attributed to Peter Drucker “If you can’t measure it you can’t manage it”. The higher quality of information you have the more informed your business decisions will be. However for this information to be accurate it must be used in the context of a well-designed system and a disciplined approach.

The future

In many respects the future is already here. In the past few years there has been a tremendous advance in the computing power and adaptability of both hardware and software. Computing has gone mobile and tablets and smart phones are able to

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An example of an EAN-13 barcode encoding a GTIN

An example of a GS1-128 barcode with a GTIN and a batch number. Note the Application Identifiers in brackets.

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be used in many roles and applications which have in part been facilitated by the introduction of cloud computing. Conversely the price of this technology has decreased considerably and what was once the domain of big business only is now certainly available to smaller operations.

There are some new data carriers which have gained in prominence over the last few years and offer an alternative to EAN-1 or GS1-128 Barcodes.

GS1- Databar

The GS1 Databar was introduced at the start of 2014 and is designed for use at the point of sale. It has 4 configurations which allow for the barcode to be stacked. This means that the barcode can be compressed in size allowing it to go onto smaller products. Specific configurations of the GS1-databar barcode are also able carry additional information such as batch numbers. This would be a boon for the nursery industry in managing traceability further through the supply chain.

In Australia it has been recently used on fruit for sale in supermarkets however at this stage it has not been adopted widely for use in the retail hardware sector.

RFID

Radio Frequency Identification (RFID) technology has been available for a number of years and is now becoming more cost effective. RFID essentially allows the identification of items without a line of sight. So rather than having to scan a barcode a tagged item just needs to pass within the range of a receiver antenna to be identified. RFID is used in many situations but most readers will be familiar with RFID tags through their roadway etags or through their use in clothing tags for theft prevention at retail stores.

RFID tags contain a small microchip which allows for the programing of information usually an Electronic Product Code (EPC) similar to a GTIN and an antenna. The antenna enables the tag to both transmit the information stored on the chip and access power for the chip. The power for the chip is received from the antennas electromagnetic energy.

RFID has a number of benefits in automating stock control and inventory processes in production nurseries and a number of nursery businesses are already utilising this technology.

Barcoding has enormous potential for producers beyond compliance with retailer requirements. If you are not leveraging this technology to its full advantage you are missing out on opportunities to maximise profits and streamline your production.

Industry is working closely with GS1 Australia through the Hardware GS1 Action Group to ensure that industry has access to knowledge and is kept current with solutions to supply chain information management.

For more information on how you can better use barcodes in your business please contact GS1 www.gs1au.org or if you would like to engage a consultant from GS1 to assist your business in leveraging your GS1 membership please visit http://www.gs1au.org/services/professional_services/

Further Information

Dr. Tom Fernandez, Michigan State University 17909 Using RFID for Inventory Tracking in Container and Field Nursery
Operations, ASHS Conference Jul 2014 available from;
http://ashs.confex.com/ashs/2014/webprogram/Paper17909.html

Nursery Paper Issue 10 Nov 2009 Supply Chain Management holds the key to the viability of nursery enterprises available

from www.ngia.com.au

GS1 System: The Global Language of Business available from

http://www.gs1au.org/assets/documents/info/brochures/GS1_System_Brochure_all.pdf

An example of an RFID tag which has been used in a nursery environment

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Street tree diversity and canopy quality influences urban microclimate and pedestrian thermal comfort.

In this month’s Nursery Paper Ruzana Sanusi and Stephen Livesley from the University of Melbourne report on some ley funded research investigating the impact of street tree diversity and corresponding canopy quality have on pedestrian thermal comfort.

Summary

This study investigated the microclimate benefits of street trees with different canopy qualities in Melbourne, Australia. It also extends these microclimate measures to estimate the impact of tree canopy quality upon pedestrian thermal comfort below.

This study is collaboration between The University of Melbourne and NGIA. We measured under three street tree species that are commonly planted in Melbourne and other cities in the southern Australian states: Platanus x acerifolia (London Plane); Ulmus procera (European Elm) and Eucalyptus camaldulensis (River gum).

It was found that the higher the canopy quality, as indicated by plant canopy index, the cooler the midday microclimate conditions under that canopy in summer. Pedestrian thermal discomfort could be almost 20% better under canopies of high quality, as indicated by a reduction in physiological equivalent temperature (PET) from 43°C to <35°C. The changes in canopy quality largely influenced the amount of solar radiation transmitted below the canopy, and therefore pavement heat gain and pedestrian thermal comfort. These canopy shade benefits are dependent both on the tree species and the canopy quality of that tree. Below Eucalyptus camaldulensis canopies, PET conditions remained ‘very hot’ for pedestrians because of the smaller possible plant canopy index commonly associated with eucalypt canopy architecture and leaf orientation (pendulosity). This study suggests that both tree species and tree canopy quality are important factors to be considered for future urban tree selection and management.

1. Introduction

Effective management of trees in urban areas is important as the different tree species planted are diverse in themselves as well in the age, the health, the different architectural forms, canopy densities and leaf characteristics. Depending upon the urban landscape context, the users of that space, the exposure levels etc., it is important to identify the function of each tree species in the local landscape with regards to the benefits those trees can provide local residents. The urban forest, in its entirety, can contribute to reducing the urban heat island, but individual trees and street tree plantings can contribute to changing the urban microclimatic at the micro-scale; i.e. the street scale,. Many recent studies have highlighted the importance of urban trees for microclimate modification, a key benefit to the local urban residents and street pedestrians (Shashua-Bar et al., 2009, Georgi and Zafiriadis, 2006). Changes in microclimate can greatly benefit pedestrian in the urban landscape by improving the human thermal comfort (Shashua-Bar et al., 2011).

However for a single tree species, tree canopy characteristics, such as size, density, leaf clumping, are can vary according to management, environmental growth factors (soil volume, water, nutrients) and tree health (pests, pathogens). Canopies of different quality within a single species will provide different microclimatic benefits and ultimately may have different influence on the pedestrian thermal comfort. Obviously, canopies differ in quality amongst different tree species, so when comparing different tree species it is especially important to compare them across the range of canopy qualities that can be expected and found within an urban streetscape. This study investigated the midday microclimate benefits of three common, yet contrasting, urban tree species: Platanus x acerifolia (London Plane); Ulmus procera (European Elm) and Eucalyptus camaldulensis (River gum). A range of canopy qualities were selected for each tree species to provide an opportunity to investigate canopy quality influence on microclimate and pedestrian thermal comfort from a ‘within species’ and ‘inter-species’ perspective.

Street tree diversity and canopy quality influences urban microclimate and pedestrian thermal comfort.

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2. Methods applied

2.1 Canopy quality measurement

This study has been conducted in Melbourne, Australia in one to two storey residential streets with pedestrian pavements. Three street tree species used in this study were Platanus x acerifolia, Ulmus procera and Eucalyptus camaldulensis. A range of trees (n=9) with different canopy qualities was selected for each species. To determine the canopy quality for each tree, cover photography method from MacFarlene et al. (2007) was used to estimate a Plant Canopy Index (PCI) that includes an area estimate of both leaves and branches.

2.2 Microclimate measurement and pedestrian thermal comfort estimation

The microclimate parameters measured for this study were air temperature, relative humidity, wind speed, solar radiation and mean radiant temperature (Tmrt). Mobile climate stations (1.1 m above ground) were used to measure microclimate condition below tree canopy for a range of canopy qualities during mid-day period (Figure 1). All the measurements were made on three days during summer. All the climate stations were positioned below the tree canopy while control measurements were made away from the tree canopy and building shades. All these measured microclimate variables were then used as an input to the estimation the pedestrian thermal comfort by calculating the Physiological Equivalent Temperature (PET) using RayMan software (Matzakaris et al., 2007).

3. Results and discussion

The control measurements that were made in the open area were allocated a zero PCI value. The lower the PCI value indicates lower canopy quality for each tree. Figure 2 shows some examples of the tree canopies and their PCI value for each species. PCI for Platanus x acerifolia ranged from 0.641 to 5.079, Ulmus procera from 2.132 to 6.141 and Eucalyptus camaldulensis from 1.308 to 2.747. From the PCI range we could see that Eucalyptus camaldulensis had smaller range. The characteristic of the species such as inherent clumped canopy, thin open canopy and pendulous leaf characteristics explained why the species had lower PCI range. On the other

Figure 1: Portable weather station was used for microclimate measurements

Figure 2: Three street tree species of Platanus x acerifolia (Top), Ulmus Procera (Middle) and Eucalyptus camaldulensis (Bottom) with varying canopy quality measured as Plant Canopy Index (PCI). PCI value of 0 is for open space as control.

PCI: 5.079

PCI: 5.602

PCI: 2.738

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hand, Platanus x acerifolia is a large broadleaf tree with rounded to pyramidal canopy and Ulmus procera a small broadleaf tree with a dense and rounded canopy.

At the microclimatic scale, this study shows that different PCI values influence the microclimate below the tree canopy. Figure 3 shows that solar radiation below canopy for all three species was significantly reduced as the PCI increased. As high PCI relatively has denser canopy, theoretically there were less gaps exist within a given canopy. Therefore less solar radiation was transmitted below the canopy. However, at PCI values > 4 for Platanus x acerifolia and Ulmus procera, reduction in solar radiation transmittance was relatively small (Figure 3). The benefit of having lower solar radiation below a tree canopy is that greater shading and cooler ground surface temperatures can be achieved (Brown and Gillespie, 2005), Both of the shading and cooling benefits drive the reduction in Tmrt and therefore enhanced pedestrian thermal comfort (Shashua-Bar et al., 2011). Furthermore, Tmrt significantly correlates with PET (Figure 4) indicating that it highly determines pedestrian thermal comfort (Matzakaris et al., 1999).

PET decreased as PCI increased for all three tree species. As Platanus x acerifolia and Ulmus procera have larger range of PCI, it shows that higher canopy quality can helps in reducing thermal stress. For Platanus x acerifolia the difference in PET between PCI 0.64 and PCI 5.1 was 7.2°C that demonstrated the pedestrian thermal comfort changed from ‘slightly warm’ to ‘very hot’. However Eucalyptus camaldulensis that has a smaller range of PCI value due to its canopy architecture and leaf characteristics, PET demonstrates that below the tree canopy it remained ‘very hot’ for pedestrians. The increase in PET below the canopies as the solar radiation increased for all three tree species was the same as indicated by the similar slope in Figure 4. However, the PET value beneath a Eucalyptus camaldulensis canopy at any given ‘above-canopy’ solar radiation load, will be ~3°C greater as compared to the other two species (Figure 4), whereas, despite the differences between Platanus and Ulmus their thermal benefits are comparable for a given solar radiation load.

15
20
25
30
35
40

45
50
0 1 234567PET (°C)Plant Canopy Index
Platanus x acerifolia
Slightly Warm
Very Hot
Hot
0
200
400
600
800
1000
1200
0 123 4 5 6 7Solar Radiation (W/m2)Plant Canopy Index
0
200
400
600
800
1000
1200
0123 4567Solar Radiation (W/m2)Plant Canopy Index
0
200
400
600
800
1000
1200
0 1234567Solar Radiation (W/m2)Plant Canopy Index
15
20
25
30
35
40
45
50
0 1 2 3 4 5 6 7PET (°C)Plant Canopy Index
Ulmus procera
Slightly Warm
Hot
Very Hot
15

20
25
30
35
40
45
50
0 1 2 3 4 5 6 7PET (°C)Plant Canopy Index
Eucalyptus camaldulensis
Hot
Slightly Warm
Very Hot

Figure 3: Plant Canopy Index (PCI) and average solar radiation and Physiological Equivalent Temperature (PET) for three street
tree species. These results are the average of three day measurements during summer 2014 in Melbourne, Australia.

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This further indicates that reduction of solar radiation in cities is highly important to maintain pedestrian thermal comfort. Noteworthy, better cooling capacity from trees may reduces the chances of urban residents to get heat related illness such as heat stroke and heat stress during summertime which at certain high heat intensity level may lead to mortality.

4. Conclusions

The influence of different canopy quality from street trees was investigated in Melbourne, Australia to look at its effect on street microclimate especially for pedestrian thermal comfort estimation by using human thermal index, PET. In this study, it was clearly found that higher canopy quality (PCI) had modified the microclimatic condition below tree canopy in summer. Through these studies, reduction of solar radiation with higher canopy quality also highlights the importance of shading benefits that relatively cooling the surfaces below the canopy and improves PET. Noteworthy, selection of tree species that can provide better canopy quality or managing existing trees for better canopy quality is therefore needed during hot and dry summers as the reduction of heat load at street level is important for pedestrian thermal comfort. These findings can further assist the planners and managers for future species selection and the street tree canopy management in urban forest for the benefits of urban residents.

y = 1.4594x - 16.001

R^2 = 0.9824

y = 1.6598x - 22.86

R^2 = 0.9818

y = 1.6907x - 26.854R^2 = 0.9689

20

25

30

35

40

45

50

55

60

30 35 40 45 50Tmrt (ºC)Platanus x acerifolia

Ulmus Procera

Eucalyptus camaldulensis

Figure 4

y = 122.49x - 4301

R^2 = 0.8734

y = 140.31x - 4969

R^2 = 0.8953 y = 138.58x - 5335.7

R^2 = 0.8984

0

200

400

600

800

1000

1200

30 35 40 45 50Solar Radiation (W/m2)PET (ºC)

Figure 4: Relationship between mean radiant temperature (Tmrt) and solar radiation with Physiological Equivalent Temperature (PET) for three street tree species. This result is the average of all three days of measurement during summer 2014 in Melbourne, Australia.

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Design Issues and Beneficial Outcomes from Greening a Childcare Outdoor Space for Babies and Toddlers.

In this month's Nursery Paper Anne-Marie Morrissey, Caroline Scott and Llewellyn Wishart from Deakin University report on levy funded research focusing on the benefits of greenspace in childcare centres.

Introduction

The first five years of children's lives are crucial for their later life outcomes. Many young children spend significant amounts of their waking time in childcare and outdoor environments in these programs will be important influences on children's wellbeing, learning, and development. There is growing research evidence that well-designed, naturalised or green outdoor spaces benefit young children including: increasing the level and quality of physical movement (Cosco, Moore & Islam, 2010; Fjortoft, 2001; Greenfield, 2004); enhanced opportunities for play, increasing the sophistication of children's social and play skills (Herrington, 2007; Nedovic & Morrissey, 2013); providing a sense of calm and wellbeing (including for children with ADHD) (Nedovic & Morrissey, 2013; Wells & Evans, 2003); enhancing children's ability to concentrate (Waters & Maynard, 2010); and promoting children's understanding and appreciation of the natural world (Nedovic & Morrissey, 2013; Waters & Maynard, 2010).

Despite the growing evidence of the benefits of providing children with access to the natural world, it can be observed that many childcare centres have 'denatured' their outdoor spaces, and are providing the children in their care with limited experiences of green environments. This trend appears to be exacerbated by concerns to avoid litigation, leading to the elimination of 'risky' elements such as trees, rocks, etc. and their replacement by artificial soft-fall surfaces, plastic and low-challenge fixtures. The recent long-term drought has also encouraged management in some centres to remove vegetation, and install artificial surfaces. In addition, many childcare centres' lack of shade-providing vegetation such as trees, can mean that concerns about sun-exposure limits the times that children can spend engaging in healthy activity outdoors. This can increase the risk that children end up having too little exposure to sunlight, leading to conditions such as Vitamin D deficiency and depression (McCurdy, Winterbottom, Mehta & Roberts, 2010).

Perhaps the most important factors in this trend to increasingly artificial outdoor environments in childcare centres are a lack of awareness and appreciation of the value of green environments for children, and practical challenges faced by centres in establishing and maintaining green spaces. Despite the growing research on the value of naturalised outdoor spaces, there is only limited evidence on exactly how young children engage with green elements in childcare spaces. Research in Australian contexts is particularly limited, and there is a need for the acquisition of specialised knowledge in this area, that can form a basis for the development of viable and practical horticultural and landscaping ‘models’ and solutions for outdoor spaces in childcare centres. Without this specialised knowledge base, and the appreciation of the benefits of green spaces, it is difficult for childcare centre management and staff, and landscape designers and architects, to envisage and create outdoor garden spaces that maximise children’s beneficial engagement with a green environment, while also being sustainable within the constraints of a childcare context.

Design Issues and Beneficial Outcomes from Greening a Childcare Outdoor Space for Babies and Toddlers.

Looking to the north end of the yard pre-greening

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With funding from the NGIA and the Centre for Research in Educational Futures and Innovation at Deakin University, and in partnership with Fleming's Nursery, researchers from Deakin University investigated the effects on children's play and physical activity of greening an outdoor space for babies and toddlers (called 'The Babies Yard'), in an urban childcare centre run by a not-for-profit organisation.

The Research Project

The focus of the research was on observing children's physical and play activity and interactions with the environment pre- and post-greening. Physical and sensory interactions with their environment are crucial for babies and toddlers. At this age, children learn through their senses, activity and movement. This means that the opportunities provided for them in their physical environment, and the opportunities to move around in and act upon that environment, are critical factors in their development and learning.

The researchers used 'behaviour mapping' (Cosco, Moore & Islam, 2010) and tracking of individual children's activity in the space, to record the different types of play and physical movements that children engaged in, where these occurred, and how children used the different environmental features.

The researchers used Gibson's concept of affordances to help interpret their observations of children's responses to the space before and after greening. This concept is a way of conceptualizing environmental features (natural and man-made) in terms of the opportunities they provide for meaningful activities and experiences (Heft, 1988). Gibson views affordances as sitting between the environment and the observer, and affordances can hold a different meaning and potential for each individual based on factors such as knowledge, experience, strength, size, skills and preferences (Sandseter, 2009). In the same environment, children may perceive different affordances than adults would. Being able to understand what affordances children perceive in an environment is important, not only for reasons of avoiding potential hazards, but also as a basis for providing children with environments that offer a range of opportunities for positive experiences and interesting activities that promote wellbeing, learning and development.

The researchers were also interested in exploring the perspectives of Fleming's staff on the processes and requirements of designing a space for babies and toddlers in a childcare context. To this end, the designer/project manager at Flemings was interviewed on her perspectives on the project, including design goals, challenges and experiences of consultation and collaboration with researchers, staff and management.

The Space

Before Greening

The space had been inherited from the previous owners, a commercial chain of childcare providers. It was dark and dreary, with a wind tunnel effect, and the only natural elements a few struggling pot plants. The outlook from inside was dominated by a view of a grey concrete wall. A number of observers described the space as ‘like a prison yard’ or ‘a concrete cage’. Play resources consisted of brightly-coloured plastic, defined-use toys and equipment, often brought out from inside.

The Greening Process

The process of greening the Babies’ Yard was described by Fleming’s designer and project manager as ‘daunting’. Challenges included: the pre-dominance of concrete, including the possibility that it covered the whole space under the artificial surface; the lack of sunlight with a substantial area under a roofed veranda; the need to include an emergency exit wide enough for a cot to be pushed through, and the numerous building and safety regulations and requirements that had to be met.

Extensive consultations were held between Fleming’s and the childcare centre staff and management about how they worked in the outdoor space and their ideas for what could happen in the new greened space. The designer remarked that this was an important element of the design process, and that the eventual design would have looked very different without it. The researchers gave input on their preliminary observations of how children were using the space, as well as discussing existing research evidence on effective design and features for natural play spaces for babies and toddlers.

The eventual design had a number of objectives including:

- To introduce plantings and other natural elements into the space

The north end of the yard post-greening

The herb garden

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• To encourage greater use of the whole space such as by introducing points of interest at the ends of the space, and allowing pathways for activities such as riding bikes and running
• To include elements of challenge appropriate for toddlers while also accounting for the needs of the babies
• To respond where possible to staff suggestions and requests
• To expand the view from inside so as to bring in light and allow glimpses of greenery, sky, the weather, etc.

After Greening

Visually, the effect of Fleming's greening of the space was dramatic and the photographs show that the space now afforded children sensory experiences of trees, plants, sky, and natural materials such as sand, hay, stones, logs, and wooden features such as edgings and a bridge. The removal of a paling fence allowed sunlight to flood in, not only brightening the space and allowing plants to grow, but also introducing the play of sunlight and shade in contrast to the monotone of grey light that had dominated previously. The removal of the fence also allowed light and views of natural features from inside.

The new greened space also provided new opportunities for play and physical movement. Analysis of the behaviour mapping and child tracking data showed higher levels of physical activity, more movement across the space, and a greater range of types of movement after the greening. In particular, movements of walking and crawling up and down an incline, sliding, stepping, and balancing were not observed until after the 'greening' of space. Children were also now observed to be actively ranging across the space.

Balancing, Stepping & Inclines

Several new features in the greened space appeared to support this increase in level and variety of physical activity. Child engagement in balancing and stepping are interesting examples. While prior to greening, the space contained a plastic balance beam (see photo 5), balancing was not observed in this phase. After greening, children were observed spontaneously engaging in balancing activity as they used a wooden edging that crossed the space, (see photos 2, 3 & 4), usually as they were on the way to somewhere else. In some places there were steps in the edging and the children appeared to enjoy this feature, expressing delight and concentration when attempting to step up or down (see photo 5). Interestingly the researchers have observed this in other projects, where features such as edging, steps and slopes, embedded in an outdoor 'play landscape', have afforded children opportunities to engage in a range of physical movements not available in flat level spaces.

The wooden bridge was also a feature of the greening. The bridge appeared to provide opportunities for children to negotiate what was a steep incline for toddlers who had only recently learnt to walk, and the children appeared to relish the challenge, crossing the bridge over and over again. Photo 6 illustrates how children had to concentrate on placing their feet to negotiate the steep slope.

Engagement with Nature

Post greening, children also engaged more often with natural materials. Despite the availability of a sand tub pre-greening, observations showed the post-greening sand pit was used twice as often as the sand tub. A possible explanation for this might be due to the sandpit being more accessible for the children; they could climb up to it via the edging or garden bed and sit in the sand, whereas the sand tub had been raised off the ground (to at least child chest height) and children had to stand around and reach in to access it. The implication of this may be that the children found the sand pit more accessible, and a more comfortable and inviting place to sit and play.

The children were interested in engaging with nature, and often expressed surprise and delight at the way in which natural

A child's eye view looking towards the south end
post-greening

The plastic balance beam post-greening and wooden
edging post-greening

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affordances interacted with their senses in new and exciting ways. The stones set in concrete at the ends of the bridge afforded interesting feelings and sounds as children rode or pushed the bike wheels over them and as they walked over them (see photo 6). Children were observed stopping and squatting down to further investigate the stones with their hands. Loose parts such as leaves, bark and flowers were picked and thrown, sprinkled, squashed or sniffed in a way that the static, hard, plastic manipulatives in the pre-greening yard could not be. The designer and project manager

remarked that: “We wanted the kids to interact with the plants. Our plant selection was about choosing things that were robust enough to handle kids pulling bits off and tasting them…”. In some instances, children were observed peacefully observing a bee flying around the plants or branches swaying in the breeze, indicating that children were benefiting from the restorative nature of the green space in a way unavailable pre-greening.

Conclusions

In summary, the greening of the Babies Yard led to a significant increase in the level and variety of children’s physical activity. It also provided them with an environment that offered new challenges in their play, and positive experiences of the natural world. Visually the transformation was dramatic, providing children and staff with an attractive sunlit garden in which to spend their days, as opposed to the previous grey concrete ‘yard’. The findings showed that natural elements and carefully designed features provide affordances for young children that support their learning, development and wellbeing.

When asked if she had any advice for her colleagues in horticulture and landscaping on designing outdoor spaces for children, the designer responded:

I think I’d say take a step back from what is currently out there as a traditional play space and start exploring some of the more natural ways you can achieve the same thing. You know a climbing frame doesn’t have to be a plastic structure. It could be rocks, it could be hay bales, it could be logs. There’s so many different things that it could be and I think it’s about encouraging children to be creative. Don’t provide them with a set activity, provide them with components that could be any number of activities depending on the child.

Children walking over the wooden bridge post-greening

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Efficacy of Organic Amendments Used in Plant Production

In this month's Nursery Paper, consultant and Honorary Fellow at Melbourne Universities School of Land and Environment, Dr Sally Stewart-Wade reports on a comprehensive literature review undertaken for NGIA on the science behind whether organic amendments are useful in containerized plant production.

Organic amendments are a broad collection of products sourced from naturally occurring organic materials that can be added to growing media to improve plant growth. It is claimed that, amongst other benefits, they can provide nutrients to plants; stimulate growth and enhance flowering; control diseases and pests; and increase beneficial microbes. But there has been relatively little scientific scrutiny of these claims, particularly in containerized plant production.

While some can improve plant growth, the effects of organic amendments have been generally inconsistent. An organic amendment that improves plant production at one location, may not do so in other regions with different plant materials and cultural conditions, and they may even have negative effects. They need to be compatible with the containerized production system.

Synchronizing nutrient release from organic amendments with plant demand is a major challenge. Also, organic amendments can vary depending on season and source, and this can change the characteristics of the growing media. With the nursery, garden and horticultural production industries demanding a consistent, vigorous finished plant on a tight timetable, such variability must not interfere with the uniform rate of growth, plant nutrition or its form and aesthetics.

Some organic amendments can suppress soil-borne diseases; however, inconsistent results have hampered their widespread recommended use. Bonanomi et al. reviewed 2423 studies from 250 papers and found that organic amendments suppressed disease/pathogen populations in 45% of studies, had no effect in 35% of studies and increased disease/pathogen populations in 20% of studies. Furthermore, organic amendments were highly suppressive in only 12% of studies. Compost and organic wastes were most suppressive, each giving effective disease control in more than 50% of studies. The suppressive ability was pathogen-specific, i.e. an organic amendment that suppressed one pathogen, was ineffective or conducive to another. Noble and Coventry found that composts suppressed damping-off, root rots and wilts, and that this effect generally increased with application rate, with a minimum of 20% required, but suppression levels were variable. Factors such as the base substrate (e.g. peat), the feedstock, and the degree of compost decomposition (maturity) may influence suppression, and they recommended that biocontrol agent-fortified compost offer the best commercial opportunity (at about half the cost of a single fungicide drench).

A review examining 28 liquid organic amendments applied to field crops and pasture found no evidence that any of them improved crop yield. Though there was no reference to containerized studies, the author concluded that, when applied as recommended, there were inadequate amounts of nutrients, organic material or plant growth promoting compounds to enhance plant growth; though they may do so if applied at much higher rates. Perhaps this would be the case in containerized production.

Types of Organic Amendments

Locally sourced products that are waste products from other processes and industries would be ideal organic amendments.

It is important to get the proportions right17 to deliver plants of equivalent quality and productivity as conventional production methods, though there may be potential trade-offs, such as higher disease incidence. Amendments need to be optimized for individual production systems.

Composts

Compost is produced from the breakdown of organic matter (plant or animal) by microorganisms under aerobic conditions. The starter feedstock; production methods; level of maturity/stability; and the resulting chemical, physical and biological features of compost all affect its ability to improve plant growth and/or suppress disease and make it impossible to draw general conclusions about the positive or negative effects of compost. For example, the suppression of Verticillium wilt of eggplant varied among eleven compost amendments, with five composts suppressing disease, three having no effect, and three enhancing disease! Amending with compost, which is generally cheaper than other growth substrates, could make production more cost effective, as long as plant quality was not compromised. If the compost also suppressed disease, unsterilized media could be used and fungicide use could be reduced; and due to slow release of nutrients, fertilizer inputs could be reduced, further decreasing production costs.

Plant Residues

The most promising plant residues for compost production are cotton waste, grape marc, green wastes and spent mushroom waste. Media amended with cotton waste compost at 20-50% generally improved plant growth, though the effect was species-dependent. With Australia's large cotton industry generating ample cotton waste, there is plenty of opportunity to use this inexpensive feedstock. Grape marc, the solid remains of the grape after pressing, is a low cost, widely available, wine-making by-product. Plant species responded variably to different grape marc compost rates, which may be due to different grape cultivars and processing methods, and different composting conditions, but this amendment showed promise. Green waste compost can be produced from any wood and vegetable residues but the composition affects the compost's properties and efficacy. Generally amended at 25-50%, improvement of plant growth is species specific and suppression of disease is disease specific. Soluble salt levels, nitrogen drawdown rate, pH, ammonium concentration, and slumpage need to be monitored. Council collections of green waste provide plentiful feedstock, but the challenge is to produce a reliable, consistent product from such variable material. Spent mushroom compost is the composted organic substrate discarded after mushroom production is complete. Improving plant growth over a range of species, it is essential to optimize the rate to balance improved growth and disease suppression with acceptable levels of soluble salts, pH and media shrinkage. With mushroom growers and production nurseries often in close proximity, the regular turnover of spent mushroom compost could be put to good use.

Animal Manures

While animal manure composts have long been used in the field, their use in container production is less studied. Cattle dung and swine waste composts have improved growth and suppressed disease in some species, and the feedstocks are readily available and inexpensive.

Municipal and Industrial Waste Materials

The most promising municipal and industrial waste materials for compost production are municipal solid waste, sewage sludge and paper mill waste. Municipal solid waste (MSW) compost, made from the organic part of residential kitchen and domestic garden waste, amended at up to 50% has improved the growth of numerous plant species. Levels of soluble salts, pH, heavy metals, organic pollutants, pathogens, sharps (glass, metal, plastic) and odours, as well as the effects of the variable feedstock, need to be monitored. Different plant species can respond differently, so MSW compost should be tested in individual production systems. Australia currently has numerous facilities for the production of MSW compost and continuous feedstock. The cost of commercially produced MSW compost is ~$35-41/m3 plus transport costs (2006 prices). Sewage sludge compost (made from raw or treated sewage sludge) is rich in plant nutrientsbut the treatment procedure and particle size can influence efficacy. Levels of soluble salts and heavy metals, and manganese binding needs to be monitored, and the response of different species checked. The average cost of dry biosolids is $34 per tonne (2012 prices). Paper mill waste compost, made from the solid waste from effluent treatment from paper mill operations, has shown promise as an amendment but further work on more species is needed. Levels of heavy metals and organic contaminants need to be monitored.

Compost Teas

Compost tea is made by fermenting or ‘brewing’ compost in water, with or without aeration. Aerated compost tea ferments for only 12-24 hours, usually using an expensive ‘brewers’. Non-aerated compost tea usually ferments for 7-14 days, and is cheap to produce. Compost tea contains soluble nutrients and a variety of microorganisms, and aeration seems unnecessary. The effect of compost tea on plant growth and disease suppression depends on the compost feedstock/production; the tea production conditions, such as the ratio of compost to water, duration, temperature and pH; application decisions such as the dilution ratio, application rate, equipment, tank mixing with other inputs, timing, frequency, storage and adjuvants; and the environmental conditions during application and use. It is important to tailor compost tea products to specific production systems.

Meat Blood and Bone Meals

Products derived from animal slaughterhouse wastes are widely used in field applications, but reports of their use in containerized production are scarce. They contain useful nutrients to stimulate plant growth.

Fish Emulsions

Fish emulsions, prepared by modifying the excess liquid from processed fish, provide nutrients for plant growth and act as a nutrient base for plant growth promoting rhizobacteria. Treatment of basil plants with fish emulsion resulted in undesirable flavours, so it is likely that application to edible crops is not acceptable; but there is scope for application to ornamental species and different species should be tested. Emulsions sourced from different fish species should be tested. The cost (adjusted to current prices) is approximately $16-$26/L.

Seaweed Extracts

Seaweeds allegedly enhance germination, root growth, chlorophyll synthesis, general plant vigour, biomass and yield; reduce transplant shock; increase nutrient uptake and plant nutritional quality; induce early flowering and fruit ripening, fruit production and improve marketable qualities of fruit; suppress disease; increase pest resistance; and improve tolerance to salinity and frost. Some effects have been reported only anecdotally by commercial organizations and their value in field production has been questioned. Also, negative results are rarely reported, which creates a bias towards drawing the conclusion from the published scientific literature that they are effective. A liquid seaweed extract, marketed as Maxicrop in numerous formulations, has shown some positive effects on plant growth and pest/pathogen suppression in some studies, but no effect in others. The efficacy of all Maxicrop products was questioned in a legal case in New Zealand. After hearing evidence from more than 40 scientists, the High Court ruled that Maxicrop products did not promote plant growth and provided insufficient nutrients and low levels of plant hormones whose practical significance was doubtful. The judgement was that

Maxicrop (all formulations) 'cannot and does not work', supported by a lack of efficacy in more than 140 field trials. No glasshouse trials were specifically discussed, so there remains the possibility that Maxicrop may have some effect in certain situations. However, there is some evidence that some seaweed extracts improve growth of some plant species in containerized production, probably due to plant growth regulators. Rates; and application method, timing and frequency need to be optimized; and any seasonal differences monitored. The cost (adjusted to current prices) is approximately $11-$32/L.

Bioinoculants

Bioinoculants, particularly mycorrhizal fungi and plant growth promoting bacteria and fungi, can improve plant growth and suppress disease, but the plant response is species-specific. More work is needed on the effect of applying only a single species or consortia; single, dual or multiple applications; and the timing, method and rate of application. The cost (adjusted to current prices) is approximately $11-$80/L.

Biochar

The potential of biochar, charcoal that remains when biomass is heated rapidly without oxygen (pyrolysis), for horticultural field crops has been reviewed recently, and it may be useful in containerized production. Biochar may improve the physical and chemical structure of growing media; provide nutrients; increase fertilizer use efficiency; enhance root growth; and suppress certain diseases. It may also bring environmental, social and economic benefits to growers in terms of carbon trading. But it may decrease efficacy of some pesticides, immobilize nutrients, increase heavy metal content, become water repellent, and promote certain diseases. There have been few studies using biochar in containerized production, and further research is warranted on response of different plant species, different feedstocks and production conditions. However, with the cost of biochar presently at ~$2000-2500/tonne, its use is likely to be uneconomic.

Vermicomposts

Vermicomposts, formed by the breakdown of organic residues by earthworms, have excellent structure, porosity, aeration and drainage properties; good moisture holding capacity; and contain nutrients in plant-friendly form, but vary depending on the feedstock. Vermicompost at 10-40% improved plant growth. Vermicomposts produced from animal manures need to be monitored for pH and soluble salt levels, and human pathogens.

The cost of vermicomposts is highly variable depending on the feedstock, but they are (adjusted to current prices)3 approximately \$265-\$1050/t. Similarly, vermicompost liquid extracts (including tea) vary depending on the feedstock, so should be optimized for individual production systems.

Humic Substances

Commercial humic products are most commonly sourced from brown coals. The effect of humic products on plant growth is variable, so both the source and the rate of humic products should be assessed carefully and optimized for individual production systems.

Uncomposted Plant Parts

The most promising uncomposted plant parts are coir fibre/ dust, and pine tree substrate. Coir dust, already widely used in Australia mainly as a replacement for peat due to its excellent physical properties, needs to be monitored for high electrical conductivity, low cation exchange capacity and nitrogen immobilization. Pine tree substrates, though readily available from extensive pine plantations, need to be monitored for phytotoxicity, nitrogen immobilization, shrinkage, and irrigation and nutritional management strategies. In general, plant-based organic amendments should be mixed with growing media at least two weeks before sowing to prevent phytotoxicity and growth inhibition.

Amino Acids and Organic Acids

While there are many products that are based on amino acids and organic acids sold as liquid fertilizers, there are few scientific reports on their effect on plant growth, and even fewer in containerized production, so no recommendations can be given.

Conclusion

While a variety of organic amendments are available to enhance plant growth in containerized production, further research is required to evaluate their efficacy and optimal application rate for a wide range of crops in containerized production for which there is currently very limited information. Further research is needed to determine the optimal base level nutritional benchmarks for all nursery crops so that organic amendments can be identified that can supply, or partly supply, these nutrients. In addition, matching nutrient charting and responsive fertilizer applications to nutrient release from organic amendments to determine the precise application timing of organic amendment products for optimal efficacy is highly desirable. Investigation of the use of blends and sequential application of organic amendments matched to crop requirements for optimal plant production, and studies on the shelf life of organic amendments under normal storage conditions would be useful. This would allow the development of NIASA Best Practice Guidelines for the use of organic amendments in containerized production, promoting consistent quality management within the industry. This would ensure that nursery operators are best equipped to add only useful organic amendments and maximize their production systems.

Acknowledgements

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The full review is available online at www.ngia.com.au in addition to an expanded online version of this nursery paper incorporating a full reference list.

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Table 1. Organic amendments used in containerized production, their features (verified by scientific publications), estimated costs adapted from 3, application rate, potential drawbacks and practical relevance.

Organic Amendment Feature (verified by scientific publications) Approximate Costs 2013 Application Rate Potential Drawbacks Practical Relevancea

Composts Good nutrient source to plants Stimulates plant growth Suppresses disease Increases beneficial microbial biomass Increases flower and/or fruit set Increases root formation in cuttings Increases yield Improves media structure

Pelletised products: $105-$525/t Non-pelletised products: $7-$840/t

20-50% v/v but varies for different composts and plant species

• Can have detrimental effects on physical and chemical properties of media e.g. animal manures, green waste, MSW, spent mushroom, sewage sludge
• Can have variability in properties between batches e.g. green waste, MSW, sewage sludge
• Potential human health issues from pathogens and/or sharps e.g. animal manures, MSW
• Potential plant health issues e.g. MSW
• Unpleasant odours e.g. MSW
• Heavy metals/Organic contaminants e.g. MSW, sewage sludge, paper mill sludge
• Inconsistent efficacy
• Effect can be species-specific

Ease: Variable, generally easy-moderate Costs: Minimal

Compost Teas Stimulates plant growth Suppresses disease Cost of compost: $7-$840/t; Then depends on aeration: Non-aerated: negligible Aerated: $250-$2000

A 1:1 to a 1:9 dilution, apply equivalent to 50 L/ha every 14 days; but requires optimization

• Potential human health issues from pathogens e.g. particularly nutrient-amended
• Inconsistent efficacy
• Need to be made fresh
• Effect can be species-specific

Ease: Variable, generally easy-moderate Costs: Minimal-moderate

Meat, Blood and Bone Meal Good nutrient source to plants Stimulates plant growth

Liquids: $11-$32/L Solids: $840-$1260/t

Liquids: unknown Solids: 1-5% v/v • Unpleasant odours

• Potential human health issues from pathogens? (BSE overseas)

Ease: Easy Costs: Minimal

Fish Emulsions Good nutrient source to plants Stimulates plant growth Suppresses disease

$16-$26/L 0.5-2% v/v • Unpleasant odours Ease: Easy Costs: Minimal

Seaweed Extracts Stimulates plant growth (hormones) Suppresses disease Increases beneficial microbial biomass $11-$32/L 0.4-2% v/v (20% v/v for some species)

• Potential human health issues from pathogens e.g. composted seaweed

• Inconsistent efficacy

Ease: Easy Costs: Minimal

Increases flower and/or fruit set Increases root formation in cuttings Increases yield Reduces transplant shock Improves media structure

Bioinoculants Stimulates plant growth Suppresses disease Increases beneficial microbial biomass Increases flower and/or fruit set Increases yield Reduces transplant shock

$11-$80/L Varies; Liquid: 30-60 mL/ 7.6 L container Solid (experimental) - colonized host plant roots, spores, mycelia, substrate): e.g. 2 g/hole of 50 spore/g inocula)

• Effect may be neutral or negative

• Effect can be species-specific

Ease: Easy-moderate Costs: Minimal

Biochar Moderate nutrient source to plants Stimulates plant growth Suppresses disease Increases beneficial microbial biomass Increases tolerance to water stress Improves media structure

$2500/t 1-10% v/v • May decrease the efficacy of some pesticides

• May negatively affect the availability of nutrients

• May release bound toxicants such as heavy metals

• If allowed to dry out, can become water repellent

• Expensive due to lack of large scale production facilities

Ease: Difficult Costs: Minimal

Vermicomposts Good nutrient source to plants Stimulates plant growth Suppresses disease Suppresses pests Increases beneficial microbial biomass Increases flower and/or fruit set Increases root formation in cuttings Increases yield Improves media structure

Liquids: $1-$21/L Solids: $265-$1050/t

Liquids: A 1-10% solution, applied as drench or spray equivalent to 150-200 mL/25 cm pot every 7 days; but requires optimization Solids: 10-40% v/v but varies for different vermicomposts and plant species

• Can have detrimental effects on physical and chemical properties of media e.g. animal manures

Ease: Variable, generally easy-moderate Costs: Minimal-moderate

Table 1. Organic amendments used in containerized production, their features (verified by scientific publications), estimated costs adapted
from 3, application rate, potential drawbacks and practical relevance.

Practical relevance concerns issues such as Ease (Ease of sourcing product/materials/equipment) and Costs (Costs to retrofit and/or apply
the product)

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Waste management and disposal in the nursery industry

In this month's Nursery Paper David Hunt from Environmental and Horticultural Research Consultants, reports on levy funded work investigating waste management and disposal in the nursery industry.

Waste management and disposal have always been a part of business processes for Australian production nurseries. In recent times, the types of waste have changed and disposal costs have continued to increase. A greater use of product packaging has led to an increase in the amount of plastic and cardboard requiring disposal. The increasing cost to process these surplus resources, in addition to a community preference for resource recovery instead of landfill disposal, has led production nurseries to consider new ways to reduce waste management costs while also embracing environmental sustainability.

Waste comes in many forms and includes any material, effluent, surplus substance or item that does not function or is no longer required for production. It also encompasses the inefficient or inappropriate use of raw materials and resources or any actions that hinder production. Because of this broad definition, several waste analysts suggest that many businesses usually under-estimate the true cost of waste disposal, and in most circumstances the actual cost can be ten times more than shown in accounting records. The only way to determine the true cost of managing and disposing of waste is to ascertain where and why waste is generated. This will help to identify any alternative disposal methods and determine the best option to reduce costs.

Nursery & Garden Industry Australia (NGIA) commissioned a waste assessment project to identify the wastes generated by a production nursery and how changes in the waste disposal industry can be used to reduce costs for production nurseries. Responses to an online survey provided information about the type and quantity of waste being generated and the current disposal methods being used. A review of resource recovery principles, waste assessment procedures and waste companies were used to develop waste assessment guidelines to help managers identify the best waste disposal methods for their business.

Survey of production nurseries

In total 34 businesses provided waste management and disposal information for analysis. A detailed waste assessment was conducted at one large production nursery to provide a list of wastes and issues associated with production. The information from survey respondents varied in terms of yearly turnover, number of employees and the number of crops produced. Waste disposal costs were below one per cent of yearly turnover, ranging from $250 to $31,200 per year with staff hours allocated to waste management ranging from 1 to 40 hours per week.

Waste management and disposal in the nursery industry

Waste materials generated Tonnes
per year
% of total
waste General waste 535.93 39.345 Greenwaste and used media 408.64 29.999 Packaging card, paper and office paper 193.16 14.181
Plastic Containers 73.08 5.365 Pallets 66.04 4.848
Metals 25.04 1.838 Plastic wrap and packaging 22.50 1.652 Greenhouse film 10.83 0.795 Miscellaneous 7.90 0.580
Builders plastic and weed mat 7.31 0.537
General recycling 4.50 0.330 Batteries 1.77 0.130
Rubber, including tyres 1.66 0.122 E-waste (office and production) 1.34 0.098
Oil 0.72 0.053 Chemicals and fertiliser 0.47 0.035 Timber 0.42 0.031 Faulty equipment 0.25 0.019 Glass 0.22 0.016
Irrigation pipe 0.14 0.010 Irrigation fittings 0.11 0.008 Shadecloth 0.11 0.008 Total waste generated 1362.1

Table 1: List of waste types and quantities generated by 34 nursery production businesses

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The total estimated quantity of waste generated by the 34 surveyed businesses was 1362 tonnes per year. This potentially represents two per cent of the industry, suggesting that a minimum of 68,000 tonnes of waste is generated by the nursery and garden industry each year. There are five main waste categories: general waste (40%), greenwaste and used growing media (30%), cardboard and paper recycling (14%), plastics, including pots, packaging and pallet wrap (7%), and pallets (5%). The remaining 4 per cent is comprised of a variety of other production wastes and general recycling.

This ranking, shown in Table 1, was relatively consistent across all surveyed businesses, with each nursery generating slightly different waste types and quantities due to differences in production methods, input resources used and crop type.

Although there is a large quantity of greenwaste generated, only 21 per cent is sent to a commercial processing facility for mulching or composting. Fifteen per cent is still being sent to landfill via a general waste service and the remaining 64 per cent is dumped or composted onsite but no longer used for production. Eighty two per cent of survey respondents stated they recycle cardboard and paper, and sixty four per cent recycle plastic growing containers but less than 52 per cent recycle other plastics (chemical and fertiliser drums, packaging, pallet wrap and strapping). Several survey respondents stated they have halved their general waste disposal costs by recycling as many materials as possible. Several respondents expressed frustration associated with not being able to recycle certain wastes and the increasing quantity of plastic packaging that goes to general waste. A large proportion of recyclable materials are still being disposed as general waste, primarily due to the limited recycling infrastructure and services outside of city centres.

Waste management options and disposal costs

To reduce waste disposal costs in a production nursery requires an understanding of the types of waste generated, how much is generated, why it’s generated and how often it is generated. However another factor that should also be considered is the collection value of a waste material. The collection value will help to determine if separating and recycling a waste is more beneficial than general waste disposal. The collection value is dependent on several influencing factors such as, the type, quantity and frequency of waste generated, the contamination level, the price and demand for recycled materials, and the transport distance from point of collection to the processing facility. Large quantities of clean waste material that can be sold-on has a higher collection value and is more likely to be picked up than small quantities of mixed waste.

The first step to determining the most cost effective disposal option for your business is to carry out a waste assessment. An assessment can also help to identify any inefficient production processes which are generating more waste than expected or an increase in waste at one production area. Once the assessment has been completed and waste details are known, the next step is to determine the best option available to reduce waste disposal costs in the business. The waste minimisation hierarchy can be used to assist the decision process (Figure 1).

Avoiding or reducing waste is a better option than diverting waste as the initial costs are not incurred and the resources are not used. This involves reviewing production processes and purchasing

Figure 1: The waste minimisation hierarchy.

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practices to increase resource use efficiency and reduce waste generation. For example, a change in suppliers or an increase in production may have increased the volume of packaging needing disposal. In this case purchasing products in bulk to reduce the volume of packaging or reviewing the production process can improve resource use efficiency.

Reusing an item in its original form for the same purpose more than once will help to reduce costs and resource use. Simply washing or sterilising reusable items can be considerably cheaper when the combined purchase and disposal costs are considered. One large production nursery has embraced the reuse principle by installing a steaming system to sterilise growing containers and production equipment. A second hand diesel steam generator and cargo container was installed with a new control unit at a cost of $39,400. The system is run overnight for 12 hours to ensure all items are sterilised. The system has the potential to save more than $30,000 in growing containers, provide for a continuous supply of clean production equipment and will pay for itself in the second year of use.

Recycling involves the collecting and processing of an item to recover the raw material to remake the original item or a new item. For example, an increased volume of clean packaging could warrant separation from general waste for recycling. Collecting a sufficient quantity of clean packaging such as cardboard or plastic to increase the collection value can reduce disposal costs. If a large quantity is generated some collection companies may provide a compactor to assist in onsite collection. An added advantage of separating these materials from general waste could be to reduce your general waste disposal requirements allowing for a cheaper service.

Recovery involves the partial recovery of the base material or partial recovery of the energy expended in the material during production. For example, burning greenwaste or rubbish to power an electrical generator. This is less cost effective as only the energy component of the material is recovered but has provided a supplemental fuel source for one production nursery.

Disposal is the loss of all raw material and energy that has been expended in the item during production. It has a higher environmental cost due to the contamination and gas emissions given off during decay in landfill sites.

Which option is available to you will depend on the waste service in your area and the collection value of your waste materials. At the moment, the best option for a production nursery to reduce its waste disposal costs is to offer a waste collection company clean, sorted waste material that can be easily sold on. The larger the quantity that can be supplied, the greater the chance of having the material collected for free. Some companies will offer free use of collection bins or compactors if the collection value of the waste materials is high.

Due to the large variety and different volumes of wastes generated in a production nursery and the limited recycling services across Australia, it may not be possible to find a solution or service for all materials in all locations. However, recycling services are constantly growing and will be available in most areas for a cost. Remember, it is possible to reduce overall waste disposal costs by using separate general waste and recycling services or donating recyclables to an environmental or community group.

Also consider other businesses in the local area. Is there a neighbouring business that could use your discarded packaging or a landscaping business that might want your greenwaste for compost? Is there a neighbouring business that generates a similar waste that might agree to a bin-share arrangement, so you can increase the collection value of the combined waste materials?

Figure 2: Rejected plants and greenwaste dumped in onsite landfill

Figure 3: An increase in plastic packaging on inputs increasing disposal costs.

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Finding the best service for your needs may take some time and work, but using search services like the business recycling website (http://businessrecycling.com.au/info/), the recycling near you website (http://recyclingnearyou.com.au/) and other search services can help. Alternatively, contact any waste collection company and ask if they accept the material you want recycled. If they can't help you, ask if they can suggest a company that can.

No matter how the production waste in a nursery is currently being managed, it is certain that disposal costs will continue to increase. It is prudent business practice to implement waste minimisation and recycling practices to turn waste into a tradable commodity. For a sustainable future, the nursery industry needs to purchase products made from recycled materials and encourage the ongoing development of waste recycling services to change the way wastes are viewed.

The project has developed several documents to help managers with the waste assessment process. These can be obtained from
your local Nursery & Garden Industry representative and include - Nursery waste assessment form; Waste management cost
calculation worksheet; Steps to reduce waste management and disposal costs.

Further information:

Figure 5: : Disused or damaged equipment wanting to be recycled.

Figure 4: Containers being prepared for steaming or recycling.

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NURSERY PAPERS
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The importance of the greenhouse environment to the successful growing and merchandising of plants

Plants have optimum requirements for successful growth and development and minimizing the environment for pest and diseases. The goal of growers and plant managers should be to improve production and the health of the plants for long term success. To achieve this, a multitude knowledge and management skills are required to fulfil markets and the consumer expectations for healthy plants.

Ultimately, optimal management of the total environment can equate to long terms profits and customer satisfaction for potential repeat business.

In this month's Nursery Paper, NGINA Industry Development Officer, Michael Danelon seeks to raise awareness of the importance of identifying and managing your greenhouse environment to the successful production and merchandising of plants and minimising the environment for plant pest and disease.

The plant environment

Progressive growers seek to improve production by determining the optimum conditions for plant growth and providing these in the production facilities of the business. Those merchandising plants would be aware of the importance to manage the environment to maintain the optimal condition of the plants once they are received by the supplier, ie need for high light levels for seedlings and bedding plants or reduced humidity levels for plants subject to foliar diseases.

Plant production commences with some form of propagation, e.g. seed/germination, division, striking of cuttings, layering, tissue culture etc. The growing on of a newly produced plant, e.g. seedling, tubestock, tissue culture into a larger container will differ to the environment in the propagation phase as will a larger more mature plant will again differ in its environmental conditions to the prior phase of growth and development.

The greenhouse environment

Growers need to consider the options available to them and provide a suitable greenhouse environment whilst managing the technology available but at a cost effective solution. Merchandisers need to strike a balance between a suitable environment for the plants they are managing and a comfortable environment for the buyer/shopper. Note – throughout this nursery paper, reference to greenhouse also implies glasshouse.

The challenge for growers and managers are:

- Which equipment and strategies should be used to achieve best crops from the greenhouse and environment the local climatic conditions
- What level of investment should be used in the greenhouse to achieve the best long term benefit with the least outlay and operational cost.

The key driver here is that the plant will be the product of the environment it has been subjected to. Growing and merchandising plants with different environmental requirements in the same conditions and management will ultimately mean a compromise and loss in quality and performance of the plants in the immediate and long term.

An example here is to consider the needs of a propagation greenhouse (temperature and relative humidity control and suitable light levels) to that of a display greenhouse for a retail garden centre which protects buyers and plants from rain and direct heat from sunlight.

The greenhouse

An examination of the greenhouse and

climate is required to determine the
potential and actual plant environment.
Readers are directed to the NGIA Nursery
Paper “Greenhouse Design” 2005, February
Issue 1 (1) for more detail regarding the
type of greenhouse technology, structure,
cladding and features referred to as low,
medium and high technology greenhouses.
The Governing factors of the greenhouse
design relating to performance and the
greenhouse environment are:

- size (height and surface/area)
- shape (gable roof, sawtooth, arched)
- style (covering and ventilation – sides and or roof, multispan)
- location (orientation, exterior shading, potential internal shading and slope).

The increasing trend in the nursery industry
is to invest in high technology greenhouses
(1) with computerised automation and
the ability to manipulate the greenhouse
environment to suit the plant requirements
through ventilation, heating, cooling,
internal screens, modification of light levels,
irrigation and rolling benches to optimise
the whole of the greenhouse.
Low technology greenhouses have
limitations in their ability to modify the
greenhouse environment for optimum
production limiting their suitability

for propagation where a higher level of management of the environmental conditions is required.

Not all greenhouses and plant situations can justify large investments to manipulate the greenhouse environment so planning is critical to get the best long term outcome for the grower and plant merchandiser.

In the greenhouse, the way irrigation is delivered (overhead – fogging/mist/droplets/drippers/hand watering, sub-irrigation – capillary, ebb and flow/flood floor) and moves within and out of the greenhouse, plant density, light levels and air movement within and out of the greenhouse will influence the plant environment.

Critical greenhouse factors

Within the greenhouse the key factors to influence how the plant will perform are:

- Light (visible light, photosynthetically active radiation [PAR] and thermal radiation)
- Air and root temperature (human comfort is different to the plant)
- Relative humidity (driving transpiration and disease potential)
- Concentrations of oxygen/carbon dioxide for fundamental plant process.

Understanding the greenhouse and plant environment requires measurement and monitoring to be conducted. Basic measurement of temperature and at least on an annual basis assessment of the light quality within the greenhouse to determine if the greenhouse cladding either requires cleaning (glass) or replacement due to deterioration of the material through aging. All too often a greenhouse roof covering if it fails from weather rather than optimised before light levels supplied to the plants are compromised.

With this information of the greenhouse conditions, adjustments to the greenhouse can be implemented which provide the basis of producing healthy and profitable crops.

Light – essential but be aware of too much of a good thing

Light is electromagnetic radiation within a certain portion of the electromagnetic spectrum. Humans refer to visible light (light) as electromagnetic radiation within a certain portion of the electromagnetic spectrum having a wavelength of 380 to 770 nanometers between the infrared and ultraviolet wavelength. For plants, the PAR is known to be 400 to 700 nanometers (2) with claimed peak of 435 to 675 nanometers.

The main source of light on Earth is the sun. Sunlight provides the energy that green plants use for photosynthesis. With the invention of electricity, electric lighting and advances in technology, artificial lighting has been used in greenhouse for many decades to either supplement or replace sunlight.

Manipulation of the colour spectrum (red, orange, yellow, green, blue, indigo, violet (ROYGBIV) have been claimed to allow photomorphogenesis (light mediated development) with new technology crop covers to improve stem length and produce larger leaves and phototropism (growth toward the light source) claimed to increase shoot tops and length of plant stems.

The quality and amount of light (photoperiod) and darkness is a critical factor for plants and needs to be considered for the type of plant. An example here is the mechanism for flower induction of Chrysanthemum by the duration of darkness required or elevated light duration to maintain vegetative growth.

Light is received as quanta/photons with photosynthetic photon flux density measured as watts per square metre (w/m2). On a bright sunny day peak light

levels will be around 1000 w/m2 (3) and
around 125 w/m2 in an overcast day, whilst
in comparison a bright winter day will be
around 500 w/m2 and an overcast day
around 75 w/m2.

The type of greenhouse covering (glass/
polyethylene) will influence the type
and amount of light which enters the

A specific greenhouse for orchid production which allows control
over the light and temperatures through external and internal screening and
forced ventilation for air exchange and cooling.

In the right climatic conditions, a
simple low technology greenhouse
can be used for propagation needs
(bottom heat, relative humidity
and light) until external factors limits
its effectiveness.

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structure. Glass is known to have the highest transmission around 90% whilst polyethylene cladding manufacturers claim up to 87% transmission with a diffused light offering a softer more appealing light for plant growth.

The orientation of the greenhouse (north/ south or east west), the type of structure (height and roof type) and cladding will influence how much light enters the greenhouse. Always design the greenhouse for the worst case climatic conditions to provide sufficient natural light for successful production.

It is critical to optimize light levels in greenhouses for seedlings – particularly where the temperature threshold for growth has been achieved to avoid soft and “leggy” seedlings. Seedlings require exposure to the leaf layers and surface area of the growing media to optimize photosynthetic activity.

In propagation greenhouses which strike cuttings, light is important for photosynthesis (at least , however too much light without sufficient ventilation can cause temperatures to rise well beyond 25 degrees celcius (oC) and above the optimum basal rootzone temperatures of 22-24oC to exacerbate moisture loss of unrooted cuttings causing plant stress before roots are initiated and produced. The Cutting needs to be encouraged to put its limited energy into producing roots rather than more leaves so leaf temperature should a little lower than the root zone temperature - this is easier to do in winter, but not in summer in most parts of Australia.

Mature plants have higher surface leaf area index and can intercept light more easily than seedlings. However, it is only the upper leaves which are exposed to the light with lower leaves potentially receiving 50% and the bottom leaves of larger trees and shrubs being 10% of the available light – yes it is critical to look at plant density to avoid losing lower light. It is also important to consider the needs of outdoor plants, those that grow in the rainforest understory and indoor plants.

Do not just assume a 30% shade cloth material equates to a reduction of 30% of the sunlight. Without an actual measurement of the light/photon you are potentially compromising crop health and productivity. Also consider the colour of the shade cloth/crop cover whereby darker materials are more able to absorb and retain the thermal radiation in comparison to white coverings which can deflect heat.

The plant response is the critical element within the greenhouse and the light saturation or that above the plant needs where a surplus can lead to higher greenhouse temperatures. Excess sunlight causes leaves to heat up potentially increasing water demand. Surfaces absorb the thermal energy (pots, benches, floors, steel) and are released as convection to heat the greenhouse environment. As the air heats up and if plants cannot transpire the relative humidity may drop and induce stress.

Air and root temperature

Without good ventilation of the greenhouse (<2m high sidewalls and little to no roof ventilation) in high sunlight levels and ambient temperatures, the greenhouse can well exceed the outside temperatures to reduce plant growth or cause stress to the point damage occurs.

Modern greenhouses can perform well in hot summer conditions, provided ventilation (roof and sidewall) supports air exchange and the crop management applied meets the plant needs - NIASA accredited Howlong Nursery.

A modern greenhouse with high side walls, roof

ventilation, internal screens and the ability to deliver good
light levels for plant growth - NIASA accredited Alstonville
Palms, NSW
Internal screens used to reduce light
and thermal energy (day) to
modify the greenhouse environment
and retracted at night for heat
retention. NIASA accredited Alstonville
Palms NSW.
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Irrigation can be used for evaporative cooling in certain situations, however it is important to provide passive ventilation and aiming to prevent the rise in temperature rather than dealing with high temperatures where the crop is. Irrigation is also used for plant cooling by transpiration, however if relative humidity is too high the ability of the plant to transpire may be compromised to allow for cooling.

External shading is an option if it can be removed when sunlight is limited or pulled across the greenhouse to reduce the thermal radiation when sunlight it adequate for crop needs. Some businesses apply a coating on the roof to reduce light levels, however this will compromise light when overcast conditions exist.

Subtle changes in the temperature are ideal to allow a more stable environment for the plants and not disrupt water uptake and transpiration. In addition, a rapid change in temperature changes the relative humidity (see below) and hence concentration of water within the air.

Relative humidity

Relative humidity is the ratio of the partial pressure of water vapour to the equilibrium vapour pressure of water at the same temperature. The relative humidity depends on temperature and the pressure of the system and is expressed as a percentage measure of the water vapour held in the air at a set temperature.

Plants will have an optimum relative humidity depending on the stage of

development (propagation, transplant and mature) climate, and plant type, ie tropical, subtropical, temperature where they have adapted to certain climate zones.
Too high a relative humidity can result in reduced transpiration and poor water with reduced nutrient uptake and plant cooling. For cutting propagation a general guide is 70 to 85% relative humidity to reduce transpiration loss from leaves which cannot be replaced until roots are present of cuttings. Similar applies to early stages for germination until roots are able to access water in the rootzone of the container.
To help manage relative humidity, air movement within the greenhouse and the consistency of the air movement is critical. Natural ventilation (typically through cross flow side ventilation and/or up to 25% of floor area as ventilation) with or without forced air ventilation may be required to have air movement within the greenhouse and throughout the plants. Subtle movement of air is the aim with 2 to 4km/hr to avoid condensation and a mixing of the greenhouse atmosphere.
Timing of irrigation can influence the immediate and short term relative humidity by charging the greenhouse with water which can add to the water vapour pressure. In general, aim to limit the amount of free water in the greenhouse when relative is >70% (unless propagation) and temperatures are declining toward the end of the day as relative humidity will increase as the temperature drops unless artificial heat (pipe heating) is supplied to dry the air whereas using natural or liquefied petroleum gas will produce water vapour as a byproduct.
Greenhouse drainage is critical to allow water movement and a residual bank of moisture which can elevate the water vapour. Having both floor drainage and drainage on benches to displace water out

of the greenhouse are encouraged to allow a greater level of control.

To raise relative humidity, crude systems such as wetting the floor, plants and greenhouse surfaces have been used. For optimal control computer systems which deliver fog with relative humidity sensors reflective of the crop environment are recommended.

It is generally easier to increase relative humidity, however it can be difficult to remove if the ambient conditions have high relative humidity and high temperatures.

Think about progressively opening the greenhouse in stages to help lower rising temperatures and maintain humidity as ambient temperatures rise and closing the greenhouse progressively as ambient temperatures decline at the end of the day to help manage relative humidity levels to limit disease pressure and improve water uptake.

Concentrations of oxygen and carbon dioxide

Carbon dioxide is an essential plant food found within the earth's atmosphere. With evidence of global warming, so to is there evidence of increasing levels of carbon dioxide in the atmosphere.

The background level of carbon dioxide in 2015 has been measured at 400 parts per million (ppm) (4) whereas in the 1970's this was in the range of 330-340ppm.

In a well-sealed greenhouse fully occupied with plants where air exchange is restricted, the limiting factor to plant growth may be the carbon dioxide level. It is important to allow air exchange to introduce fresh supplies of carbon dioxide whilst allow potential manipulation of the temperature and relative humidity.

What can you do?

The information above endeavours to provide guidance and raise awareness of the importance of identifying plant needs and offering some simple tips for long term benefits to the grower and plant manager.

Assessing the existing performance of the greenhouse to suit your needs via a suitably well qualified greenhouse expert is often the first step. Air flow, peak temperatures, relative humidity and fit for purpose will drive any changes within your budget allow greater outlay subject to the plants and potential returns.

It should guide the reader to more specific information and encourage industry participants to review their management.

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Plant photosynthetic growth and photomorphogenesis under LED light

In this month's Nursery Paper Industry Development Officer David Reid shines a light on LED use in production nurseries.

Light is undeniably one of the most influential, complex and particularly challenging factors to control in plant development. To meet the demands of peak sales a majority of production will occur in late winter to early spring, however natural light levels or the photosynthetic daily light integral (DLI) is understandably low at this time of year. Fortunately, the level required to produce quality material can be supplemented with additional lighting. The use of artificial light is technology worth exploration in Australian nurseries, in order to increase production and quality. This is supported by recent studies suggesting that growers can benefit from supplementary lighting such as light emitting diodes (LEDs), high-pressure sodium lights (HPS) and numerous other alternatives.

DLI or the Daily Light Integral is the number of light particles or photons received during one day in the photosynthetically active radiation (PAR) region of 400-700nm, over an area of 1 square metre. The DLI has a significant effect on growth habit, flower number, shoot growth, root development and stem thickness and as a rule, quality usually increases as DLI increases. In addition to the DLI, plants also react to quality, intensity, duration and the direction of light. DLI is measured in mol/m2/day. The DLI needed to grow high-quality plants should hover around a 10-12mol/m2/day target. Shade crops are generally exceptions with African violets and Phalaenopsis orchids preferring a DLI of 4-6 mol/m2/day.

LEDs in particular, whilst still a relatively new technology, have the potential to offer greater efficiencies, longer lifetimes and wavelength specificity, over conventional lighting sources. They are also appropriate for different horticultural sectors, such as tissue culture, cut flower, plug and tube production and other protected cropping situations. Tissue culture in particular has seen the largest uptake

of LEDs.
LEDs should be investigated, as current research has found they can give growers greater control over various anatomical, morphological and physiological characteristics. Greater uniformity, reduced production time, healthier rooted cuttings, increased control over rhizogenesis, axillary shoot formation, shoot elongation, leaf anatomy, colour variability and somatic embryo induction are just some characteristics found to be governed by specific wavelengths. It is this ability to select a specific wavelength for a targeted plant response that illustrates LEDs potential application in horticulture’s future.

Plants and the electromagnetic spectrum

The effect of light on plant responses is illustrated in many aspects of their growth and development. Light energy initiates photosynthesis, when chlorophyll and carotenoid pigments absorb specific light wavelengths, utilising CO2 and H2O, and then converting it to chemical energy for metabolism and growth.
Gene expression manipulation in plants is initiated by light intensity and quality, which in turn prompts a cascade of particular photoreceptors which control varied plant responses.
People see the visible part of the electromagnetic spectrum as white light; however plant photoreceptors are excited by specific colours (wavelengths) in the spectrum (See fig 1). Phytochromes for example are sensitive to the ratio of red and far-red-absorbing light and act as an environ¬mental sensor to measure day length and control several aspects of seedling phenology, such as seed germination and bud set.. The part of the electromagnetic spectrum that is considered to enable the highest photosynthetic rates is the PAR between 400-700nm (nanometers) and is generally considered to be found in two bands; red and blue wavelengths.
Plants respond to visible light by two general mechanisms that are keyed to specific wavelengths: photosynthesis that has a higher-energy requirement and photomor¬phogenesis that has a lower-
Plant photosynthetic growth and photomorphogenesis under LED light

Fig 1. Electromagnetic Spectrum

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energy requirement. Plants using wavelengths outside of PAR are generally undergoing photomorphogenesis, which is light regulated changes in development, biochemistry, morphology and cell structure and function e.g.: far-red light is critical for the flowering of many plants.

Photosynthetic growth rates are able to increase with supplementary lighting within the 400-70nm range, but only up to a particular point and this can also vary between species. You will find that shade-loving plants reach their maximum photosynthetic rate significantly earlier than shade intolerant plants.

LED lights

The only way to increase the DLI in a protected cropping situation is to use supplemental lighting. Light sources such as, high-pressure sodium (HPS), metal-halide, incandescent and fluorescent lamps have been available for use in plant production for decades, however, these lights will only increase photosynthetic rates to a point. Traditional lighting systems are inefficient in delivery as they contain unnecessary wavelengths located outside the PAR spectrum.

LEDs are a solid-state device that is more closely related to a computer chip than a light bulb (see Fig 2). During an LEDs operation, electricity will pass through a junction made of a particular semi-conductor material found in the device, with the semiconductor materials' properties determining the lights' wavelength (or colour). LEDs can have peak emission wavelengths from UV-C (~250 nm) to infrared (~1000 nm) and it is the first light source to have the capability of spectral control, allowing wavelengths to be matched to plant photoreceptors.

The units themselves are approx 0.2-.05mm in size, can be set up in linear arrays or standard fixtures and are protected in a casing (see Fig 3). Compared to conventional light sources, LED lighting systems have several unique advantages.

• Long operating lifetimes, - LEDs last up to 2-3 times longer than fluorescent and 50 times longer than a typical incandescent lamp. A key difference to traditional lighting alternatives is that LEDs do not burn out, although intensity will reduce over time. It is recommended that once they reduce to 70% of original strength they should be replaced, with typical lifetimes ranging from 25,000 to 100,000 hours.

• Wavelength specificity - As LEDs can produce light in such specific wavelengths, they will generate only the most useful wavelengths (colours) in the visible spectrum for each targeted species and can even be combined to create 'white light'.

• Minimal heat radiance - As LEDs generate a minimal level of radiant heat they can be positioned deep within the canopy to reach leaves that would ordinarily be sheltered, without burning (See Fig 4).
• Energy efficient - Energy efficiency is usually calculated as useful output divided by energy input. When compared to a traditional supplementary lighting, LEDs exceed any competitors and continue to increase their efficiency with every new generation. LED efficiency, in general, is projected to increase considerably, for example it is predicted, that the photosynthetic efficacy of red LEDs will be double HPS lamps by the year 2020 (Pinho et al. 2012).
• Versatile - Small LED size allows flexible design of the lighting unit and as they are solid-state devices, LEDs are easily integrated into digital control systems (Morrow, 2008). This facilitates complex lighting programs that control for intensity or spectral composition over the course of photoperiod or during plant developmental stages (Yeh & Chung, 2009).
• Safer to use in a nursery -. There is no fragile glass cover to break, no extreme temperatures and they contain no hazardous materials, such as mercury.

Disadvantages

• A potential disadvantage to using LEDs as a light source is the relative financial viability when compared to traditional lighting methods, although there is an argument for cost neutrality when you consider the electricity savings. However with advancement in LED technology and growth in demand, the cost of LEDs will decrease.
• LEDs are limited in the light coverage they can provide; the light intensity will rapidly decrease as the distance to the plants increases and placing the lights lower to compensate may interfere with irrigation. Before switching to LEDs, be sure that light coverage is adequate and confirmed with a light meter at crop level.
• When used as a sole source for photosynthetic, photomorphogenic and/or photoperiod lighting, LEDs must be chosen and installed carefully to obtain desired plant responses. Developing the ideal mix of LED light wavelengths can be difficult and success may only be achieved after extensive trials.

Despite these obstacles, with improvements being made all the time with regards to efficiencies and decreasing costs, growers should be aware of future developments with this technology.

Fig 2. LED schematic

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Plant reactions to LED lighting

Light reaching plant surfaces can evoke different photomorphogenetic and photosynthetic responses and can vary amongst different plant species. These responses are of practical importance to production technologies, since LEDs wavelengths can be tailored, enabling growers to control plant growth, development and nutritional quality.

• Photosynthetic rates - HPS and metal halide lamps, have been used in protected environments to supplement natural light however, due to the significant energy required to power a growth house full of lamps, supplementary lighting can be impractical. With the advent of LEDs a change can now be considered. As not all wavelengths are equally effective for pho¬tosynthesis, artificial lighting should be high in the PAR wavelengths bands; blue (460 nm) and red (680 nm) wavelengths.

• Increasing photoperiod - When day length becomes shorter, photoperiodic lighting might be more appropriate than photosynthetic lighting. A variety of different lighting arrangements have been effective in keeping plants actively growing when natural day length is limited. Light levels only need to be low in order for daylight extension, with most artificial lighting methods generating enough light to be effective because they all emit light in the red wavelength. Research trials have determined photoperiodic lighting intensity should be at least “8 mol/s/m2 and should be increased to 16 mol/s/m2 when the crop has a greater light requirement” (Landis, et.al. 2013).

Increasing the germination rate or the growth rate of a plant and potentially increasing crop turns, is not the only characteristic of a plant that affects salability. In addition to photosynthetic rate, flowering, leaf and flower colour, habit, shape, taste, smell and root development all help to improve plant quality.

Red wavelength effects (640- 690nm)

Red light is generally the base component in the lighting spectrum and has proven sufficient to be the sole lighting source for normal plant growth and photosynthesis. Low intensity LEDs emitting red wavelengths are as useful as traditional supplementary lighting will use less energy and last longer

• Biomass yield increased on particular vegetable crops when the wavelength of red LED emitted light increased from 660 to 690 nm (Goins et. al., 2001)

• 660 nm LED light, applied as sole light source in the controlled environment, stimulated anthocyanin accumulation in red leaf cabbages and 640 nm LEDs resulted in enhanced lutein and glucosinolate sinigrin accumulation (Mizuno et al. 2011)

• Germination in three species of Pinus was positively affected by application of red wavelengths (Merkle et al. 2005)

• The elongation of stem and internode length of Chrysanthemum (Kim et al. 2004) and grape (Puspa et al. 2008) were greatest under red LED light.

• 658 nm red light in combination with cool white fluorescent lamps resulted in 6% higher phenolics concentration in baby leaf lettuce (Li & Kubota, 2009).

Combination red & blue

Plant photoreceptors are most efficient in the blue and red area of the spectrum, and combinations of red and blue LED lights have been proven to have the greatest impact on plant growth compared to a monochromatic system.

• Increase fresh and dry weights of Lilium (Lian et al. 2002), banana (Duong et al. 2003), strawberry (Nhut et al. 2003) and Chrysanthemum plantlets (Kim et al. 2004c).

• Promote shoot organogenesis in Anthurium, by exposure to higher percentages of red than blue illumination, however, the number of shoots was more when exposed to higher percentages of blue than red LEDs (Budiarto, 2010).

• End of production lighting with red and blue LEDs increases purple pigmentation of red leaf lettuce and Pennisetum 'Rubrum' (Randall & Lopez, 2014)

There is no clear relationship between red and blue light ratios when manipulating plant growth and photomorphogenesis, with some studies showing growth to be higher under 10 % blue LEDs, with others increasing under 30% blue LEDs in a blue and red combination (Nhut & Nam, 2010).

Green light (505- 535 nm)

• Enhances vegetative biomass accumulation and affects chlorophyll and carotenoid synthesis, improving leaf colour.

• Promotes lettuce growth (Kim et al. 2004)

• Affects nutritional quality of different baby leaf lettuce varieties (Samuolien et al. 2012, Li & Kubota 2009).

Fig 3. LED interlighting Source: Phillips Australia

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Blue light - (450- 470 nm)

Blue light is critical to morphological development, par¬ticularly with regard to shoot strength and branching and is particularly favourable for growth, especially in leafy greens.

• Important for phototropism and chlorophyll formation (Blaauw & Blaauw-Jansen, 1970; cited in Massa, 2008)
• Promtes stomatal opening and inhibits stem and leaf cell elongation (Schwartz & Zeiger, 1984; cited in Massa, 2008);
• Inhibits seedling growth on emergence from a growing media (Thomas & Dickinson, 1979).
• Controls factors such as circadian rhythms and de-etiolation in plants (Devlin et al., 2007).
• Increases stem length in marigold (Heo et al. (2002)
• Inhibits Chrysanthemum in vitro culture plantlet extension and increases dry matter content and photosynthetic pigments (Kurilcik et al. 2008).
• Stimulates antioxidant status in green vegetables, increasing polyphenol (Johkan et al. 2010), vitamin C (Li et al. 2012), carotenoid (Lefsrud et al. 2008, Li and Kubota 2009) and anthocyanin contents (Stutte et al. 2009)
• Increases photosynthetic capacity and plant biomass in tomato, cucumber plants and pepper (Samuoliene et al. 2012c).
• Decreases elongation growth) and leaf area expansion in tomato and cucumber transplants (Nanya et al. 2012.

Far red light (720, 740nm)

• Results in tomato hypocotyl elongation (Brown et al. 1995, Kubota et al. 2012);
• Stimulates flowering of long-day plants (Deitzer et al., 1979, Downs, 1956; cited in Massa, 2008)
• Promotes internode elongation (Morgan & Smith, 1979; cited in Massa, 2008).
• Can be necessary for normal photomorphogenetic processes in plants (Kubota et al. 2012).

Another potential trend in LED usage is the possibility to reduce disease, pest and pathogen loads in particular crops (Massa et al. 2008). The thought of managing pest and disease with reduced chemicals is an attractive one, however, the initial studies point to it being cultivar or species specific.

- Massa (2008) showed that certain wavelengths could be used to minimise or even eliminate fungal proliferation. This study also suggested that LEDs could interfere with insects attempting to navigate to host species and reproduce. This was proven by (Vanninen et al. 2012) who showed that wavelength effects on insect phototactic behavior interfered with the ability of pests to successfully locate host plants
- The changes that some wavelengths could have on primary or secondary plant metabolites (defence mechanisms) could interrupt disease development and interactions with pests (Vänninen et al. 2012).
- Cucumber plants, grown under red LED light were more resistant to powdery mildew. (Shuerger & Brown, 1997).
- Blue-light on some species limited the efficacy of gray mold (Botrytis cinerea), most likely closely associated with the increase of antioxidant capacity as well as the development of compact morphology (Kook et al. 2013).

At present the majority of studies with LED lighting were performed in controlled environment growth chambers, where the primary environmental parameters can be controlled independently of external influences. This does not necessarily indicate that the same results will occur in a protected cropping situation (Pinho et al. 2007).

Conclusion

Research into LED lighting for supplementary or as the sole light source has been advancing for decades, however there are still many unanswered questions. What particular wavelength is required for what species; will a crop do better with a combination or a monochromatic approach; is there a critical time in a plants growth to apply supplementary lighting? The answers to these questions could be as numerous as there are plant species.

Furthermore, the interactions between light and plant photosynthesis and photomorphogenesis are complex and still being slowly unraveled at a molecular level, however, with the ability to focus on individual or combination of wavelengths, the attention that LEDs attract is warranted. The accumulation of evidence showing their ability to enhance desired features in plants' appearance, productivity or other responses will see a greater uptake of LED technology, but only after extensive successful (and unsuccessful) trials.

Thank you to Matt Mansfield @ Mansfields Propagation Nursery and Tony Bundock @ Powerplants for images and advice.

Fig 4. LEDs maximising space with multilayering Source: Phillips Australia

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The use of gas in nursery management

In this month's Nursery Paper NGISA CEO, Grant Dalwood, reviews the use of gas within nursery production.

The various types of environments encountered within the nursery sector vary greatly from full sun outdoor to climatically controlled indoor environments. Subsequently the need to control all types of factors within the range of applications will also vary. Gasses in various forms have been used for many years to control, treat and fumigate all types of problems occurring. This paper is aimed at updating knowledge within the industry and perhaps opening aspects of control that have been over looked for many years and due to new pest and insect incursions.

Gas is one of the four fundamental states of matter (the others being solid, liquid, and plasma). What distinguishes a gas from liquids and solids is the vast separation of the individual gas particles. This separation usually makes a colourless gas invisible to the human observer.

Because most gases are difficult to observe directly, they are described through the use of four characteristics: pressure, volume, number of particles and temperature. Pressure and temperature influence the particles within a certain volume. Gas particles spread apart or diffuse in order to homogeneously distribute themselves throughout any container.

Natural gas

Natural Gas in Australia is well known as an efficient form of energy with widespread availability. The two main types of distribution of gas for use as a nursery energy system are tank (including bottle) and mains supply. As many nursery production facilities are in peri urban areas often a continuous permanent mains supply is not available and subsequently tanks are required to store the liquefied natural gas product that is used. It is always advisable to thoroughly research and compare the various costing differentials between the energy resources available in your local area. The costs of running tank fed machinery can be very high if controls are not put into place at setup.

All gas tanks require a licence from the local authority in order to store product on site as well as ensuring sufficient segregation from other structures. Registration of a tank is reliably conducted through the supplier and recharging of bottles and tanks is generally conducted through the supplier as well.

With ever changing cost structures and tariff rates the Nursery industry operator needs to regularly look at their onsite needs. This may result in the usage of a number of forms of energy sources such as electricity, gas, wind and solar, as the availability and costs of these sources develop and the needs of the business operator change. For example the use of electrically powered under bench heater cables may become inefficient and subsequently obsolete if gas can be efficiently used to heat water that can be channelled to a number of parts of a facility effectively to do the same job.

The use of Methyl Bromide gas as a soil fumigant was widespread in Australia for many years and has now been systematically abolished under the 2005 Montreal Protocol, due to its effects on the critical ozone layer of the earth’s atmosphere. Alternatives to this very

effective but environmentally damaging
gas have been developed but many do not
have the same breadth of efficacy, i.e. they
are effective on some but not all vectors
that Methyl Bromide controls, as it is a soil
steriliser as well as a controller of insects
including nematodes.

Australian Standards for potting media,
composts and soils have influenced
the quality of media in the industry
and subsequently the need for media
sterilisation is minimal. Indeed in Nursery
best practice, one area that still utilises
Methyl Bromide is for Strawberry runner
production.

There is scope within the NIASA program
to recycle potting media as long as it
is sterilised, this process if required is

The use of gas in nursery management

A sulphur diffuser hung at the correct height and aided with fan dispersal over a
gerbera crop

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often carried out by the use of steam generated by various forms of energy. Steam sterilisation is extremely effective and relatively safe given good quality units and a regular maintenance program. Work, Health and Safety considerations along with good training are mandatory when using all types of steam sterilisers. The age of steam sterilisers certainly can impact upon their safety and effectiveness. Likewise all due care must be taken with properly conducted in accordance with state regulations.

Sulphur dispersers are a commonly used method of control for a range of greenhouse or glass house problems. These units consist of sulphur powder contained in an aluminium pot under an electrical element enclosed within a stainless steel cover. The sulphur vaporisers to create a gas vapour that spreads with the aid of fans to protect crops from fungal diseases such as Mildew, Botrytis and Black Spot. The usage of these effective and efficient diffusers is widespread within a number of scenarios as fungal spores cannot spread in the sulphurous atmosphere. The units also inhibit the spread of greenhouse pests such as spider mite.

One of the problems with these dispersers is the need to ensure that the consistent heat generated (temperature regulation at about 150 degrees Celsius) by the diffuser does not burn the sulphur and produce oxides but creates a vapour that is dispersed over the crop and throughout the growing house. Also the location of the vapouriser in relation to the height of the crop is often a variable due to overhead watering causing water to settle in the sulphur pan and altering the effectiveness of the diffusion. Aligned to this is when diffusers are put too close to the plastic cover of a poly tunnel then burning of the plastic lining occurs and a rapid breaking down of the poly skin. Coverage of sulphur units is regulated by airflow distribution and through the natural funnel effect created by the shape of the lower pan. Each diffuser is capable of treating at least $100m^2$ depending on the size of the house, severity of fungal problems and airflow.

Micro climates within various growing structures can vary, the levels of light, temperature, water, air movement, humidity and air quality are all factors that affect plant growth. One of the factors that can be controlled by augmenting gases and has been used for a number of years within the industry across the globe is the addition of Carbon Dioxide (CO_2). The theory behind the process is that the CO_2 when raised from ambient sea level (app 340ppm) to a level of around 1000 to 1300 ppm in the airspace of a growing house will aid photosynthesis. Photosynthesis is a process which uses light energy to convert CO_2 and water into sugars. Many crops have shown that for any given level of increasing the CO_2 level to 1,000 ppm plus will increase the photosynthesis by about 50% over ambient CO_2 levels. Light levels are also an important factor in the equation of adding CO_2 to ambient air, to achieve best results the addition of CO_2 is only effective during light hours. Growers could regard CO_2 as a nutrient similar to fertilisers and water. Another factor to consider in the design of a growing house is that it is important not to let the ambient level of CO_2 in the air drop below the 340ppm level as this will have a detrimental effect. It is therefore essential to have good natural air flow within enclosed structures.

Measuring equipment for CO_2 levels are readily available to incorporate into a basic recording program for nursery production systems. There are a number of providers who can assist in developing a recording system for greenhouse growing and they should be consulted in any system investment.

Fogging systems can vary depending on the volume, number of particles, pressure and temperature involved in the process of dispersal of a liquid through the fogger nozzles. They are an often forgotten aid in creating not only a better growing atmosphere but also the effective method of dispersal of an array of materials in order to achieve a desired result. A limitation of fogging will be the final particle size that can be squeezed through the nozzle at pressure. This very process means that the liquids being used to carry the supplements being dispersed will need to have no impurities that will clog up nozzles. Water treatment will often be required as well as storage and collection through a dedicated line system devoid of contaminants.

Fogging systems and misting systems are often confused with each other as they are substantially the same, the difference being in the size of the droplet they produce.

Misting systems typically operate between

A sulphur diffuser hung at an incorrect height and aided with fan dispersal but destroying the plastic covering above as it is too close.

A Co2 Generator – often attached to fluting for better distribution through a house (Source - Ontario MAFR)

Portable fogging machines can be utilised with various propellants to disperse fungicides and insecticides in green houses

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100psi and 250psi, with droplet sizes of around 200 microns in size. High pressure fogging on the other hand, produce a droplet around 10 microns, (i.e. 10-20 times smaller than a misting system). Droplets from a high pressure fogging system are so fine that they are able to remain suspended in the air until they evaporate. Increased droplet size leads to poor evaporation, reduced greenhouse cooling effectiveness and increased wetness in the greenhouse .This wetness can cause increased disease, crop damage and pose a safety risk to greenhouse staff. Permanently installed foggers require high quality pipes and fittings to accept the pressure and give solid performance over many years, so don't scrimp on the setup costs.

In essence high pressure fogging, which operates at over 700psi, gives optimal greenhouse cooling and temperature control. Droplets flash evaporate, eliminating the chance for excess wetness to occur, as this process is happening in the area where the heat is, the cool air travels down to the crop level, to be replaced by the hot air rising. The convection air currents ensure even temperature distribution throughout the crop without the need for fans to stir and distribute the cooler air, thus saving energy. Because droplets fully evaporate high pressure fogging is often referred to as dry fog. One of the advantages of high pressure fogging is that it can be applied directly where the hot air is located.

Ideally humidity should be between 50% and 70% for optimum growing conditions, however much higher levels are achievable if required, such as in propagation areas. An effective inline fogging system to control humidity in a propagation area

with misters (hanging) at Native Plant
Wholesale Nsry (BioSecure HACCP)
A steam sterilising unit at Great Southern IT – WA (NIASA Accredited)
Bottle gas refilling station at Bio Gro SA (Biosecure HACCP)
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When heat levels rise, humidity levels drop, the plants under stress face double trouble, and it can be a deadly combination. High pressure fogging can provide almost immediate humidification, overcoming a potential huge loss in greenhouse stock. Accurate humidity and temperature control is essential throughout the stages of production, media should be moist, but without wetness. System Design Considerations must ensure that humidity levels do not drop below 30%. If more humidity is needed, the greenhouse's ventilation system can be turned off. Determining how often foggers should be on, as well as the amount of time between fogging events, depends on the desired level of relative humidity. In general, systems used to increase humidity run for a very short amount of time, with the duration of fogging ideally lasting 1 to 3 seconds. Fogging systems, be they portable or permanent are reducing in cost and they can be utilised in other very effective ways also to distribute fungicides and pesticides. Dust is also a problem that can be controlled by high pressure fogging. The small droplets, produced make it effective in encapsulating dust particles, and bring these to ground without causing wetness. Liquefied gases are a very important method for control in the pest and food industry where complete extermination of pests, rodents and insects are essential. Perhaps we can learn from them within the nursery sector and in alliance with our existing IPM (Integrated Pest Management) programs gas generated products could be used to augment the ever increasing resistance within nurseries of common flying insects that cause great product value decrease. One of the great beauties of the product is that when sprayed selectively it can be used outside directly onto crops on a calm day to eradicate many insects that are resistant, inside use is extremely effective for sheds and houses of all sizes. Although seasonally variable, within any nursery there is often a need to control flying insects at the growing point as well as the despatch point.

Liquefied gas based pesticides can be used in this situation and are readily available, clean and easy to use. They are available in a range of options which can ensure effective control in a short space of time and with limited safety risk if used correctly. The chosen gas product will disperse over a large volume through a simple hand held gun attached to small easily mobile cylinders; application is simple and fast and can be carried out in some cases with people in a close proximity or with a vacancy period for other products. Like all pesticides, always read the product specifications and Safety Data Sheets (SDS). and one of the beauties of this type of product is it is regularly used in Food processing and storage warehouses, Domestic and commercial premises, hotels, restaurants and hospitals, Mushroom farms, Dairy product processing, Food storage and cut flowers throughout the world already so is well tried and tested.

Further Information

Nursery paper 2001 Vol 5 Water fogging and misting systems are they a risk to human health?

Ontario Ministry of Agriculture Food and Rural Affairs Carbon Dioxide In Greenhouses Available online at http://www.omafra.gov.on.ca/english/crops/facts/00-077.htm

Another use of gas is demonstrated in the use of a compressed air bench lifter to assist with the rotation of stock in a glass house (Jong’s Nursery South Australia)

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Nursery Production Pest Monitoring, Inspection and Surveillance Methodology

In 2013 NGIA commissioned a project to investigate statistically valid systems and protocols for on-farm monitoring, inspection and surveillance for pests of biosecurity concern within production nurseries. The project, completed in 2014,
has investigated national and international information and systems and has developed recommended monitoring, inspection and surveillance protocols that have the highest probability of success. NGIQ Industry Development Manager
John McDonald provides details in this Nursery Paper on the key project outcomes for use within production nurseries.

What is the key issue?

Despite numerous monitoring, inspection and surveillance protocols and systems developed both in Australia and abroad that provide guidance on implementing these programs, few investigate and provide an evaluation of the efficacy of what is proposed in a quantitative sense. This is understandable due to the complex and varied nature of the problem based on the thousands of cultivars grown across varied cropping systems (e.g. seedlings, small containers, advanced trees, etc.) and the exposure to a vast array of plant pests and diseases.

Nursery production is both unique and diverse, as are the numerous pests and diseases that can impact on the quality and economic return gained from the thousands of plant cultivars produced. Production can also be both intensive and extensive ranging from the production of plugs and seedlings to advanced tree stock and in-ground plant production.

In Australia, quantitative sampling systems that do exist fall primarily within the realm of inspection, treatment and certification for intra and interstate movement of plants that are hosts of specific and regulated plant pests and diseases. For example, approved inspection protocols for the movement of plants known to be hosts of melon thrips between infested and non-infested jurisdictions.

For visibly detectable pests and disease symptoms, the development, approval and agreement on inspection systems directed at meeting interstate movement regulations is generally consistent with systems used by national quarantine authorities. These systems are applied to host material to provide assurance that imported plant products are free of pests and diseases of concern to Australia. The team undertaking this nursery project have ensured the protocols recommend are quantitative in nature as this form of analysis is the basis for on-farm structured and knowledge based decision making that will deliver the best return on investment.

Nursery Production Pest Monitoring,
Inspection and Surveillance Methodology

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For the purpose of this Nursery Paper, ‘monitoring’ means the regular ongoing examination of a population of plants (e.g. crop monitoring) to determine changes in presence, incidence and or prevalence of pest populations. This can include ongoing physical examination of the plant and/or other methods such as trapping or regular diagnostic testing. ‘Inspection’ means the visual examination of a plant or group of plants to determine if a pest or disease symptom is present at one point in time e.g. consignment despatch inspection. ‘Surveillance’ means the process of looking for potential plant pests across the whole production site, excluding the crop, such as areas of native or exotic vegetation, waterways, drainage lines and water storage areas, car parks, waste disposal areas, etc.

Why monitor, inspect and survey for plant pests?

There are three primary reasons why producers may monitor, inspect and survey for pests:

• To estimate pest population density, in order to make optimal pest management decisions, such as when to manage and what management measures to use (e.g. release beneficial’s or treat with a pesticide). This includes decision making regarding management for optimal productivity and control for optimal quality for the market

• To provide assurance that general biosecurity obligations have been addressed and/or to facilitate market access for freedom of pests of quarantine concern

• To detect high risk exotic biosecurity pests (Emergency Plant Pests – EPP’s) in order to respond effectively in accordance with legal reporting and industry obligations aimed at eradication

Visual monitoring, inspection and surveillance

Visual observation is a fundamental inspection, monitoring & surveillance method that should be used as a minimum and in combination with other detection methods, such as trapping or testing. In other words, other monitoring methods should always be supplemented/supported by visual inspection for pests, weeds and disease symptoms in a structured detection program.

Whole crop visual scanning may be undertaken initially to observe and map areas of uneven plant growth, colour/damage or obvious disorders such as wilting, etc. Individual plant observation is then conducted to explain any differences observed, that is take a sample and inspect/test to determine the causal agent.   Finally if no obvious issues are observed at the time of crop scanning random sampling and inspection is undertaken to detect infestations not apparent through initial whole crop observation.

Many to most insect species can be visually detected on the external surfaces of plants including stems, foliage, buds/ flowers, and plant roots. Smaller invertebrate species may require magnification with a hand lens or microscope such as eriophyid mites. Disease symptoms, and some pathogen life stages (e.g. rust spore pustules), may be distinctive and after sampling may require sensitive testing, such as ELISA and/or PCR, or laboratory based isolation and culturing of the pathogen to provide confirmation of a specific infestation.

The sensitivity of visual inspection for identifying infestations can be poor if it is done carelessly, is rushed or by someone without experience. Approaching this task methodically (a structured and planned procedure) can increase its sensitivity (effectiveness) greatly. Methodical improvements can be made at different scales including the whole crop, individual plants, and parts of individual plants such as flowers and buds, leaves, stems and roots. Experience and plant protection knowledge will lead to improved sensitivity, but often even experienced staff could improve their detection sensitivity if they are methodical.

The approach for examining plants depends on the pests being sought. It may involve dislodging and capturing insect pests by beating onto trays, or inspecting insects more carefully in their feeding location if they are firmly attached or fly away readily, or inspecting leaves for symptoms, or taking leaf samples for analysis, or examining the roots for pests or symptoms.

Table 1. Inspection type and population to sample

Import and despatch inspection

For import and despatch plant inspection the report recommends that a default 50% sensitivity of detection be used. It is believed that this default sensitivity of detection is likely an underestimate of the true sensitivity of detection of pests (including their symptoms) plus it equates with the existing national quarantine protocol of ‘inspect 600 units’ irrespective of population size.

For import and despatch plant inspections the report has recommended that, at a minimum, an inspection be conducted to detect pest infestation, prevalence, at a maximum of 1% within the imported/despatched consignment. Therefore a maximum of 600 units will be sampled for import and despatch inspections with a minimum of 520 units sampled in smaller consignments.

Table 2 contains the minimum sampling rates applicable to import/

despatch inspections.

Table 2. Import & despatch inspection sampling rate

Monitoring inspections

The report recommends when conducting a monitoring program across a production nursery for multiple pests and diseases (as is typically the case) the lowest actual estimated sensitivity of detection across all pests being surveyed should be used as the default – assuming an acceptable level of training is provided in the identification of pests and disease symptoms. For inspection regimes to be used within the scope of a monitoring program the report recommends an inspection cycle be undertaken to achieve a maximum design prevalence of 5% at the end of the cycle.

Designing a survey where we use the lowest realistic estimate of sensitivity is a conservative, risk-averse, approach. In this case the estimate of the likely lowest estimate of sensitivity of detection of target pests is 70%. The estimated sensitivity for the detection of common insects and disease symptoms are listed in Table 3 below plus results comparing end point inspection (1 inspection) and crop monitoring (12 crop monitoring activities).

The information in Table 3 is generated via a statistical modelling program which demonstrates that through the use of a methodical (structured) crop monitoring program over 12 weeks inspecting 35 plants per monitoring activity, out of a population of 10 000, the sensitivity is equal to an end point despatch inspection of 421 plants. The above example reflects the current national and state end point inspection protocol of 600 units for inspections.

Further analysis of the above data shows that after 1 inspection (aphids) the maximum prevalence of target pests if not detected initially, is 0.70% however after 12 weekly inspections the maximum pest prevalence, if not detected over the 12 inspections, is 0.05%. When the monitoring and end point inspections are combined the maximum number of potentially infested plants is 2 or 0.02%, well below our target prevalence figures of 1% for inspections and 5% for monitoring.

Monitoring frequency

Survey frequency for monitoring purposes should be governed by the life cycle of the target pest and for practicality. For example, pests with short life cycles that can grow and expand populations rapidly should be inspected more frequently because if they are missed during one inspection, and there is a long lag time until the next inspection, a significant amount of damage could have been done to the crop. However, surveying too frequently (e.g. daily) is costly, impractical and potentially unnecessary if a structured system is employed.

For practical purposes the report recommends weekly monitoring by allocating a set day during the week which is easily scheduled and should be considered as a routine task with results recorded. Inspecting every 7 days also fits into the shortest lifecycle periods under ideal circumstances by problem pests in most cropping systems.

Monitoring sample unit

When surveying (inspecting) the crop a systematic approach to selecting sample units from the population for inspection is essential. If the survey program (crop monitoring) will run over a period of time (i.e. the nursery stock will be in the production nursery for many weeks and monitoring will take place weekly) the starting point for each weekly inspection should vary. For example, on the first monitoring week every 10th unit may be sampled starting from the 3rd plant in row 1, and on the second monitoring week every 10th unit may be sampled starting from the 5th plant in row 1, and so on. This ensures the same plants are not monitored

Note: Survey interval is one week –

12 surveys = 12 x weekly monitoring activities

Table 3. Likely maximum prevalence of infested plants when the survey population is 10 000 plants and 600 plants are inspected at 95% confidence using estimated sensitivity of detection.

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across each week and underpins the detection system sensitivity.

The report has determined for crop monitoring within a production nursery the most statistically valid rate based on the recommended sensitivity and prevalence parameters is to inspect 30 plants within the monitored population. If 30 or less plants are in the monitored population, inspect all plants. Table 4 gives indicative numbers of plants to sample based on various crop populations.

Table 4. An indicative proportion of plants/rows to sample in a monitoring activity

The above recommended sampling numbers/frequencies are the minimum values recommended by the report. If sampling numbers/frequencies are increased, where more plants are inspected and/or inspection frequency is increased, then the greater the sensitivity of the process resulting in higher crop quality at the end of the cropping cycle and/or earlier detection of possible problem pests which will reduce the cost of corrective action.

Through the use of on-farm skill sets in pest, disease and weed identification and the use of knowledge support tools, such as pest identification resources (see www.pestid.com.au), production nurseries can reduce the risk associated with pest infestations through inspection, monitoring and surveillance of the crop and production system.

References

Telford, G.A. & Potts J.M. (2014) A review and analysis of nursery production pest monitoring, inspection and surveillance methods.
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How efficacious are chlorine, chlorine dioxide and ultraviolet radiation as disinfectants against waterborne pathogens in irrigation water?

In this month's Nursery paper NSW Industry Development Officer Michael Danelon reviews some recently conducted levy funded research investigating the efficacy of some popular water disinfestation methods.

Abstract

A number of disinfection treatments are available to reduce the risk of certain plant diseases in various water sources used for irrigation. Limited published studies have compared the efficacy of disinfection treatments specific to the nursery and garden industry (NGI) on a range of various life stages (propagules) of plant pathogen species and their sensitivity in different water qualities.

This nursery paper aims to summarise a levy funded study conducted by NSW Department of Primary Industries to address industry concerns about gaps in the knowledge about the efficacy of disinfection of irrigation water treatments used by the Australian Nursery Industry. Propagules of eight significant plant pathogens were exposed to chlorine (sodium hypochlorite), chlorine dioxide and ultraviolet radiation (UV-C) disinfestation treatments at a range of application rates and exposure times in deionized water and dam water.

Introduction

Plant pathogens found in irrigation water may originate from a number of sources. These source include natural occurrences in water storage reservoirs (rain water surface fed dam, creek or river), or in surrounding soil or plants, with pathogens then being washed into the nursery runoff and drainage water storage following rainfall and irrigation events. Alternatively pathogens may be introduced to the production system via externally-sourced infected propagation material, growing media or materials or workers, visitors and equipment brought onto the production site.

The reuse or recycling of nursery runoff water as an irrigation source may potentially provide a vector for pathogens. This can elevate inoculum pressure and the risk associated with infection; disease incidence and production losses. Hence effective disinfection of recycled water for irrigation is beneficial as a phytosanitary measure to reduce the risk of plant disease development.

Under the Nursery Production Farm Management System (NPFMS), all water used for irrigation from either surface supplies and nursery runoff must be disinfested with an approved treatment method as outlined in the current Nursery Industry Accreditation Scheme Australia (NIASA) Best Management Practice (BMP) Guidelines.

When considering the required effectiveness of disinfestation treatment

How efficacious are chlorine, chlorine dioxide and ultraviolet radiation as disinfectants against waterborne pathogens in irrigation water?

Chlorine dioxide generator

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of water, the log reduction of colony forming units (CFU) of the viable (potential to be infectious) pathogen propagules present prior to, and post exposure to the disinfestation technique, ie typically >99% (log 2) reduction or >99.9% (log 3) reduction post treatment is the industry measurement.

Chlorine as either sodium hypochlorite or calcium hypochlorite is commonly used to treat irrigation water, as it is easy to apply and relatively persistent. Residual concentrations can be monitored to ensure suitable germicidal dose whilst being relatively inexpensive to install. When chlorine is introduced to water, (subject to the pH), it reacts to form free chlorine species of hypochlorous acid (HOCl) pH<7 and hypochlorite (OCl^-) ions pH >7 which oxidise organic materials and pathogens if present in the water. The more organic matter present in the water, the greater the rate of deactivation of free chlorine species and lower residual.

Chlorine dioxide (ClO_2) also acts by oxidising organic matter and pathogens. Chlorine dioxide exists as a dissolved gas in water and has a greater oxidising strength than hypochlorite salts. It is claimed to be at least 1.2 times more effective than sodium hypochlorite as a disinfectant. Chlorine dioxide is affected by the presence of organic matter in water, but it is effective across a wider pH range (4-10) and has the potential to offer residual post disinfestation treatment like chlorine.

Ultraviolet radiation (UV) is applied at a wavelength of 254 nm (UV-C) at a certain germicidal dose to disinfect pathogens in irrigation water. Energy discharged from the UV light reacts with the DNA and RNA of surrounding microorganisms present. This essentially eliminates the ability of vulnerable fungi, bacteria and viruses to be

infectious. Effective disinfection depends on duration and intensity of UV exposure to water flow and water UV transmission (UVT) and presence of organic matter. Turbidity is measured as nephelometric turbidity units (NTU) with <2 NTU considered optimum.
The most widely used measure of water quality in relation to UV-C efficacy is UVT. Water with a UVT <50% may be disinfested with UV radiation, however, the dose needed increases greatly as UVT falls. Where plant pathogens are harboured inside organic matter or mucilage suspended in water, they may be protected from exposure to the UV and other disinfectants, highlighting the advantage of filtration prior to treatment with disinfectants.

Materials and Methods

The efficacy of the three disinfectant treatments (refer Table 1) were tested against the 22 pathogen propagules according to application/dosage rates and exposure times listed in Tables 2 and 3. Deionised water (laboratory control – pH 6.5 and 0.32 NTU) and dam water (field) were used in the experiments. The pH of the dam water ranged between 7.8 and 8.0 which are considered suboptimal for chlorine (HOCl) disinfestation. The turbidity of the dam water ranged between 20 and 87 NTU, with a pH between 7.8 and 8.0 at the different sampling times. Dam water was diluted with deionised water to achieve 50% UVT prior to use in the UV tests, whilst the dam water used in the chlorine and chlorine dioxide tests had a turbidity of 20 NTU and was not adjusted to 50% UVT.
To determine the effectiveness of exposure to each disinfestation treatment on propagule survival, the propagule suspension was sampled at required times (Table 2) or post UV treatment (Table

3). Propagules were then cultured and the number of viable propagules (CFU) determined by comparing the number of growing colonies from treated samples with those in the untreated (control) samples.

Results

The disinfestation efficacy (>99% kill of CFU) of the three disinfection treatments tested varied between pathogens and propagules types with application rate/dosage, time and water quality characteristics (pH and turbidity, likely organic matter load) – refer Tables 2 and 3. Of the disinfection treatments tested in this study, chlorine dioxide applied at 5ppm for 10 minutes (residual 2.7 ppm) was the only effective disinfectant in dam water against all pathogen propagules in this study. In Fliltering water pre treatment is essential

New UV generator bening installed

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deionised water, chlorine dioxide applied at 5ppm for 4 minutes was required for effective disinfestation of all pathogen propagules.

Chlorine applied at 5ppm for 30 minutes (residual 4.6 ppm) was the only effective disinfectant in deionised water against all pathogen propagules in this study. Chlorine was ineffective against all pathogen propagules in dam water.

In this study, residual chlorine dioxide rates were only measured after the 10 minute treatment rates, whilst chlorine residuals were only measured after 30 minute treatments – refer Appendix II of the full report.

UV was effective against all pathogen propagules except Calnectria pauciramosa (Cylindrocladium spp.) chlamydospores in deionised water. In dam water, UV was ineffective against all propagules of: Alternaria alternata, Calnectria pauciramosa and Fusarium oxysporum but effective against all pathogen propagules.

Discussion

Water quality is one of the factors affecting the efficacy of water disinfection treatments and longer exposure times or higher exposure rates/dosage were generally required to kill propagules in dam water compared with deionised water, however in some instances the highest rates were ineffective against certain pathogens and propagules – refer Table 2 and 3.

These results highlight the importance of ensuring the disinfection treatment and “dosage” selected is suitable for the water quality available and the importance of achieving a minimum residual chlorine and chlorine dioxide concentration for complete exposure for the contact time where these treatments are applied.

Therefore, both pH and turbidity may have affected the efficacy of the chlorine treatments tested, and turbidity of the dam water reduced the efficacy of the UV treatment for some propagules, such that higher rates or exposure times were required to kill many of the pathogen propagules, when compared with those required for deionised water.

Table 2. Calculated minimum application rate and residual rate (where measured) and exposure time required to kill >99% CFU of propagules tested following exposure to chlorine and chlorine dioxide. A '–' indicates that propagules were not killed at the rates tested.

Pathogen	Propagule	Chlorine (NaClO)				Chlorine dioxide			
		DI		Dam		DI		Dam	
		Rate/Residual (ppm)	Time (min)	Rate/Residual (ppm)	Time (min)	Rate/Residual (ppm)	Time (min)	Rate/Residual (ppm)	Time (min)
Clavibacter michiganensis	Bacterial cells	1	10	1	10	1	4	1	4
Alternaria alternata	Conidia	5	20	-	-	5	4	5	4
	Mycelium	5	20	5/3.8	30	3	4	5	4
Chalara elegans	Chlamydospores	2	20	5	20	3	4	5	4
	Endoconidia	5/4.6	30	-	-	5	4	1/0.5	10
	Mycelium	5/4.3	30	-	-	5	4	3	8
Colletotrichum gloeosporioides	Conidia	1	10	5	10	1	4	1	4
	Mycelium	5	10	-	-	1	4	3	4
Calnectria pauciramosa	Conidia	2	20	5/2.5	30	1	4	3/1.3	10
	Chlamydospores	2	20	5/3.1	30	3	4	5/2.7	10
	Mycelium	1/0.4	30	5/3.2	30	3	4	3/1.6	10

Fusarium oxysporum

Conidia 1 10 5 10 1 4 1 4

Chlamydospores 5 20 - - 1 4 5 4

Mycelium 5 10 - - 1 4 3 4

Phytophthora cinnamomi

Zoospores 1 10 1 10 1 4 1 4

Cysts 1 10 1 10 1 4 1 4

Oospores 2 10 1/0.4 30 3 4 3 4

Sporangia 2 10 1 20 3 4 3 4

Mycelium 5 10 2/1.4 30 3 4 3 4

Zoospores 1 10 5 10 1 4 3 4

Chlamydospores 5 20 - - 1 4 3 4

Mycelium 5 20 - - 1 4 3 4

Table 1. Exposure times and residual application rates for the disinfection treatments tested

Treatment Time (min) DOSAGE Rate/Concentration

Chlorine (sodium hypochlorite) 0, 10, 20, 30 0, 1, 2, 5 ppm

Chlorine dioxide 0, 4, 8, 10 0, 1, 3, 5 ppm

UV-C transmission (254 nm) - 0, 113, 250 mJ/cm2

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To use high concentrations (5 ppm initial/free) of chlorine and chlorine dioxide treatments to effectively disinfest irrigation water, further work is required to investigate potential phytotoxicity associated with residual concentrations in irrigation water and the effect of residuals on beneficial microbial organisms in the plant rhizosphere. A critical aspect which must be considered with water disinfesting treatments which leave residuals, is the original dosage rates and the residual concentration post the effective treatment duration (where known) and the potential phytotoxicity with residuals of 2.7 ppm post 10 minutes (chlorine dioxide) and 4.6 ppm post 30 minutes (chlorine) in the treated irrigation water to effectively disinfest the water – which in most instances of this study were unknown.

Recommendations

Selecting the appropriate disinfection system will depend on:

• current hygiene practices in the nursery
• water quality
• plant species grown in the nursery
• pathogens present and
• the resources available to the nursery.

Based on the outcomes from this study and the full reports literature references:

• Good nursery hygiene practices will

reduce the risk of pathogens and disease being introduced and establishing

• Use initial water free of plant pathogens and prevent pathogen entry into the water source and the nursery

• When selecting a disinfection method for irrigation water, the water quality and pathogens present in the water and nursery must be carefully considered and done with a level of independent technical support to achieve best outcome

• Chlorine dioxide (with residuals) and UV were the most effective of the three treatments tested

• Where water quality can be maintained at a consistently high level with low organic matter and turbidity, UV provides good disinfection against most pathogen propagules tested

• Where water quality is lower or pH is likely to be variable, chlorine dioxide provides good disinfection against most pathogens tested

• Particulate matter can influence the efficacy of the disinfection treatment and

• Pathogens with pigmented or melanised cell walls are less likely to be susceptible to UV treatment.

Conclusion

This study has begun to address the gaps that exist in the available data for the effectiveness of disinfection treatments on different life stages, or propagules of a given pathogen, and the role of water quality characteristics.

Ultimately, the selection of a disinfection system for any given situation will depend on a number of factors including; current hygiene practices in the nursery, water quality, plant species grown, pathogens present, targeted pathogens and their propagules and the cost to treat and resources available to the nursery.

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Roots, Hormones and in-between - Back to Fundamentals

In this month's Nursery Paper NSW Industry Development Officer, Des Boorman presents a fundamentals review of the important aspects of a propagation system conducive to high quality plants with particular emphasis on root quality.

Health Status

With few exceptions, high health status is generally under-appreciated in ornamental horticulture, while in production horticulture it is widely recognised as being critical to crop performance.

Industry schemes such as the strawberry clean runner, banana, potato, citrus, grape and passionfruit focus on supplying high health, disease free material to maximise the opportunity for long term crop success - not just in the propagation and container production stages.

Certain pathogen issues are obvious in a range of clonally propagated ornamentals yet are often poorly acknowledged or addressed. Daphne odorata is an example where viruses, latent or expressed prevented clonal propagation. Once material was "cleaned-up" through a process of re-culturing and heat treatment to destroy the virus it contained Daphne became readily available in commercial quantities.

Both root production and quality could be directly influenced by both latent and expressed pathogens. Additionally poor propagation and production tool hygiene and material selection may perpetuate or exacerbate such issues in commercial situations (Hygiene in plant Propagation, Nursery Papers December 2004, Issue no. 11).

One NIASA accredited grower imports fresh tissue culture stock each year of a range of plants with these being grown to be used as stock plants for that seasons cutting requirements. At the end of the season these stock plants are disposed of and the process repeated to reduce the risk of pathogens and disease transfer to production stock. Production at this nursery is some of the most uniform over a range that I have ever seen and is in some part attributed to the health status of the stock material used for propagating cuttings.

With the release of the Australian Standard - Tree Stock for Landscape Use, AS 2303:2015 (April 2015), The knowledge and competency of tree growers in either sourcing and/or producing quality propagated material to grow on and/or sell is particularly important for immediate and long term compliance and the production of quality trees.

For production of quality plants and particularly trees, it is critical to focus on the root quality of both seed grown and clonal plant lines during propagation phases.

Why do we need to focus on roots so much?

GREAT ROOTS and root systems underpin the health and performance of plants and the integrity of the Nursery and Garden Industry (NGI). The move towards container-less growing media propagation systems such as Preforma®, Ellepot® and Oasis® from community seed/cutting trays and rigid containers containing growing media offers a positive step to achieving great root systems. Container-less propagation systems promote some air pruning of roots via the surrounding sides of the propagation cell being exposed to air.

The adoption of a convenient production

system which may comprise quality should
never be an option to the NGI. Rather the
NGI needs to focus more on what makes a
quality plant; i.e. GREAT ROOTS.

Roots, Hormones and in-between - Back to Fundamentals

Image 1 : Jagera sapling showing a full trunk s-bend and obvious root issues after germinating on a rock ledge. In nature, trees such as this don’t always fail, however this conformation is unacceptable in commercial practice

Other systems such as Jiffy pots® require growing media but are a “free standing” propagation cell, so when prepared correctly can produce excellent root systems.
Correct wetting up and irrigation of the Jiffy® and growing media is essential during the propagation phase to prevent the Jiffy® drying out and possibly causing root restriction by this product.
How do we address Plant Propagation Quality Issues?
Propagation environment
The level of environmental control and adequacy of propagation facilities and the range of crops grown in Australia’s generalist production nurseries tend to be the major impediments for all round great propagation. Typically propagation environments are one size fits all, where depending on volume and frequency, often 3 or 4 specific environmental controls (bottom heat, light, relative humidity, air temperature, mist / fog) and propagation media/substrate combinations would deliver better results for the range of plants being propagated. Propagators should not focus on ‘cost and convenience’, but determine and adopt what is technically a good growing media and environmental combination for the propagation of their specific plants.
Propagation growing media
The choice of propagation growing media options are numerous and there is often a cross-over where the propagation cell contains the growing media, such as with Ellepots®, Oasis®, Jiffy® and Preforma® systems. Apart from Jiffy®, these systems negate preparation and filling propagation cells with growing media.
The expectation now is the application of a universal propagation growing medium, container and environment which typically yields mixed results as such systems don’t

fit all propagation requirements. Some growers have gravitated towards whatever propagation growing media is cheapest rather than specifying or understanding the physical properties and interactions required within the propagation root zone to achieve optimum results. Other growers have implemented the newer unitised systems forgoing the “cost” per unit for the efficiency and ease of use. Reader Note – if ever there is a justification in the considerable investment and return from growing media, plant containers, propagation facility and environmental control being made, then it is the propagaton phase of production to establish the foundation for future quality plant production.

While cuttings prior to root initiation may require moisture to satisfy transpiration requirements and turgidity, the growing media doesn’t need to be overly wet. A well maintained humid environment will help address transpiration loss with occasional top up watering to the growing media to satisfy water uptake through cut basal end of the cutting/stem.

The initiation of roots and their development require oxygen, and it is important to maintain uniform air exchange within the growing media to promote sufficient root numbers rather than just one or few roots. The air exchange within and through the growing media and propagation is usually supported by water entry and drainage (top to bottom) and by the surrounding air around all sides of the exposed growing media, i.e. from the top and bottom of community tray or exposed growing media in container-less propagation systems.

In larger and shallow community trays, air diffusion is much lower and the interface and variation in the sides and centre of the community trays from air/water retained is

much less uniform across the tray than that
in individual propagation cells without rigid
containers.

Air filled porosity (AFP) is a term that
doesn’t get discussed nearly enough and
a lot of specialist propagation knowledge
has also been lost or fails to be adequately
communicated to where it’s needed.

Image 2: While propagated in a
suitable non-restrictive growing
medium, this cutting has been held
too long in the supporting tray,
resulting in poor root structure.

Image 3: Jiffy® cells showing root penetration through the wall.

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Propagation containers

The type of container used has a great effect on both root quality and air exchange to the propagation growing media, where root restriction could possibly lead to structural root issues later in the production cycle.

Traditional 50mm plastic tubes, either round or square, with or without root trainers all have the potential to either direct roots downwards or around when contacting the rigid container wall.

Inserting cuttings at the edge of the tube is likely to exacerbate this problem.

This early formative root training leads to root systems not inclined to spread laterally when subsequently potted-on or planted out. Without proper pre-pot preparation this could lead to root issues later in the production cycle as well as end use structural issues. Either way, a 90° root bend near the base of any seed or cutting grown dicotyledon is undesirable. Physical remediation of these formative root systems at each potting stage by manually teasing out the roots is beneficial, however it is costly, time consuming and may cause significant plant set-back so should be avoided if possible.

Ideally the propagation systems used by the NGI should allow roots to radiate outwards from the inserted section of the cutting during propagation and then facilitate air pruning or unrestricted root extension.

Such a system is more likely to produce a high quality root system. These containers usually allow greater air exchange at the base of the cutting which seems to promote better root development and numbers.

Ideally a cutting should produce numerous radial roots around the inserted section that allow for quicker establishment, increased stability and performance of the plant throughout the production cycle.

When cuttings produce poor or non-uniform root systems it is often difficult to get early plant stability and as a result staking has to be utilised. Compared with 20 years ago, staking is now common and is a significant cost in the production cycle. Staking may impact the long term plant stability and potentially yield false economies of a faster and taller plant at the expense of more robust and qaulity plants.

Plant propagation hormones

Artificial phytohormones used in propagation are designed to initiate adventitious roots on cuttings. Adventitious roots are those that have arisen from other than from the seedling root system, that is inducing stem and leaf tissue to form roots. In dicotyledons, there is a meristem responsible for bark production and also the vascular meristem immediately below this region. Roots can initiate from the base of a cutting or up the stem where a hormone response is achieved, and typically callus (Scar tissue) can be seen swelling under the bark and forcing it off the stem at the basal cut and roots may subsequently initiate from this area.

In the case of callus production, excessive miss-shaped lumps on the cutting base can inhibit root production or a few roots may develop from these cuttings, however these tend to be not of good quality. Excess callus can also be a result of excess hormone concentration or cutting material selection and usually results in low or poor strike rates.

Personal experience propagating Tibouchina heteromalla ‘Jules’ revealed that using a basal dip of 1000ppm IBA also caused callus formation on the leaf surfaces along the veins within days of treatment and then soon after leaf abscission, usually resulting in cutting death. At 1000ppm, the IBA had a phytotoxic effect on the cuttings. Once concentrations were reduced to 150-200 ppm IBA, the cuttings reliably produced healthy roots without the detrimental effects observed at the higher concentration.

The two artificially manufactured hormones commonly used for root initiation of cuttings are;

Image 4: Root trainers in a 50mm square tube have directed these roots down however 90° kinks close to the stem are likely to cause stability issues in later production stages.

Image 5 : While older than ideal, this cutting in an Oasis® cube demonstrates the radial development of roots around the cutting base.

Image 6: Poor root development will likely cause stability issues with this plant

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Further reading

Hartmann & Kesters Plant Propagation: Principles and Practices 8th edition by Hartmann, Kester, Davies and Geneve

Hygiene in plant propagation, Nursery Papers December 2004, Issue no. 11

Indole-3-YL-Butyric Acid (IBA) &
Naphthylacetic Acid (NAA)

The ability for most nurseries to obtain and effectively use IBA and NAA hormones as actives makes the proprietary off the shelf products appealing for use. Three commercial available formulations are based solely on IBA and one contains both IBA and NAA.

As with any chemicals it is essential to understand risk factors involved with use and exposure so refer to specific product labels and Safety Data Sheets (SDS) for use conditions. Heat and UV light may cause degradation of certain hormone formulations so it is advisable to store them under refrigeration, however as with all other chemicals they should never be stored with foodstuffs.

Hormone formulations

Powder

Talcum powder is used as a filler to dilute the undissolved crystalline IBA concentration. At neutral pH, IBA is a relatively insoluble compound where only small amounts are likely to dissolve on the cutting base in sap or water to be available to initiate roots.

Alcohol

Rootex-L® consists of IBA dissolved in an ethanol base at 4000ppm. This can then be diluted with water to achieve the desired concentration. This product does work well and for some material it is a good option and where a convenient best fit solution is desired.

Gels

Clonex® is a potassium based gel formulation being available in various concentrations of 1000, 4000 and 8000 ppm IBA whilst being combined with some other ingredients such as vitamins and nutrients. Unlike alcohol based formulations, sensitive cutting material does not burn and being a gel there is improved potential for retention of the product and hormone on the base of the cutting after the cuttings are treated and stuck in the growing media. Gels can offer advantages over both the talc and alcohol based formulations and are extremely useful in the various concentrations available.

Detergent

Esi-root® is a detergent based liquid that can be used for dunking or soaking applications. The latter method of application has numerous benefits and few disadvantages. Compared to other hormones applied to the base of cuttings, application rates are significantly lower and often by more than a factor of 100.

Esi-root® is a mix of both IBA and NAA. The inclusion of NAA notable as it is a strong root promoting hormone and works at low concentrations, noting that required concentrations vary depending upon cutting type. Cuttings soaked in this solution will take up NAA and IBA through all plant surfaces and be translocated to the base of the cutting. If cuttings are not fully turgid they may be reinvigorated once left in the solution.

Excess field heat may be removed from the material once soaked in the solution and this will aid early cutting survival and ultimately success.

Large numbers of cuttings can be prepared using the soaking method as cuttings are not deteriorating once prepared, allowing for more systematic propagation activities. Due to fully turgid material and sticking into well-watered propagation media, cuttings don't need to be watered in once stuck and placed in the propagation environment, allowing for more absorption of the hormones from the wet cutting surfaces.

Drawbacks of soaking cuttings in a hormone/hydrating solution

Any latent pathogens on the cuttings are more likely to be spread to other cuttings so selection of high health status material is essential.

Some plant material doesn't respond to being either saturated or in NAA and leaves will go glassy and shed from cuttings even when soaked for short periods of time. By example Allamanda cathartica 'Sunee' is one such plant, while cuttings of Gardenia jasminoides 'Radicans' and Ixora compacta 'Sunkist' have been left soak in Esi-root® solutions overnight with no observed deleterious effects.

Conclusion

There are numerous options and combinations for clonal propagation. To achieve excellent results it is essential to trial the range of options available to gain an understanding of the complex interactions between plant material, hormones, growing media and the propagation environment. While this may seem onerous it will ensure efficient space utilisation, optimum crop performance and ultimately it is an investment in long term profitability.

The ultimate goal is to produce cuttings with excellent roots that radiate unrestricted from the cutting to provide lateral support for the plant and faster, healthier more robust crops to be supplied to customers. Many other factors also affect cutting strike rate such as stock plant health, stage of growth and juvenility. These factors also need to be determined but have not been discussed here.

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In this month's Nursery Paper, NGIA Policy and Technical Officer, Chris O'Connor examines the recently released Australian Standard AS2303:2015 Tree stock for landscape use.

After many years of discussion, debate and development, AS2303:2015 Australian Standard Tree stock for landscape use was introduced in April 2015. This paper will cover the need for a standard, some of the background in developing the standard, some of the key aspects of the standard and future developments for the standard.

The Need for a Standard

Standards are not new to the industry and most of industry would be aware of AS4454:2012 Composts, soils conditioners and mulches and AS3743:2003 Potting mixes, but let's look first at what a standard is. A standard is a document which sets specifications and/or procedures to ensure products, services or systems are safe, reliable and consistent. Standards also establish a common language for defining quality.

The industry should see the following outcomes from the implementation of the Australian Standard for tree stock for landscape use.

- Improved tree stock quality overall.
- Recognition for growers of high quality tree stock and a market driver for those growers.
- Consistent and nationally recognised specifications for growers, specifiers and purchasers of landscape tree stock.
- Increased support for the investment into and likelihood of success of green infrastructure projects.

It must also be noted that AS2303:2015 Tree stock for landscape use is NOT mandatory and is a voluntary standard.

The Development of the Standard

The drivers and benefits of a standard for treestock have been long recognised, however it has taken a number of years to successfully establish a standard. The first attempt in creating a standard started in 2006 however failed by 2010 due to a lack of support and consensus. The second attempt in developing a standard was initiated in 2012 and this was successfully implemented in April of

2015.

The standard development was guided through consultation with the Standards EVO18 committee, as well as through public and industry consultation. The EVO18 committee saw representation from a wide range of stakeholders including;

- Arboriculture Australia
- Australian Institute of Horticulture
- Australian Institute of Landscape Architects
- Australian Local Government Association
- Institute of Australian Consulting Arboriculturists
- Local Government Tree Resources Association
- Nursery & Garden Industry Australia
- Parks and Leisure Australia
- TAFE NSW
- The University of Melbourne

Much of the standard has been based upon the previous work "Specifying Trees: A Guide to Assessment of Tree Quality" authored by Ross Clark and published by NATSPEC. This publication was and is still used by many in the industry as a method to evaluate tree quality and as a de-facto standard since its first edition was published some two decades ago in 1996. Readers who are familiar with this publication will no doubt see much commonality with the standard.

Terminology

For those not familiar with Australian Standards there are some key consistent terminologies used which readers must be familiar with.

The first term is "shall", which is used to state a requirement which must be strictly followed in order to conform to a Standard. When this term is used there can be no deviation from that requirement, unless there is a specified tolerance. When standards are applied in legislation the term "must" is considered an equivalent.

The second term is "should" which introduces a suggestion or recommendation which is not a requirement, so it is not necessary to be followed in order to comply with the Standard. Likewise 'should not' and 'may not' are only suggestions and are not required to be complied with.Root circling is a tree stock defect which the standard addresses.

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The third term “mandatory” is a term used to describe a provision of a Standard to which it is necessary to comply with so as to be able to claim compliance with the Standard. Examples of mandatory requirements include test requirements to be met or records to be kept.

The fourth term is “Normative” and this term describes an element of a Standard which must be conformed to in order to comply with a Standard. So it is similar to “mandatory” but applies to a whole element (part, section or appendix) which may demand multiple requirements, whereas mandatory applies to an individual requirement (a sentence or paragraph, a clause or a table).

The last term “informative” is a term used to describe an element (clause, note or appendix) of a Standard that gives additional information, recommendations and/or guidelines which is not mandatory. The information in an informative seeks to explain & clarify mandatory elements and provide assistance in complying with the standard.

The Standard in Detail

The Standard consists of 34 pages in total divided into four sections as well as a foreword and appendices.

i. Foreword

ii. Section 1 - Scope and General

iii. Section 2 - Criteria for Tree Stock Assessment

a. Above ground assessment

b. Below ground assessment

iv. Section 3 - Tree Stock Balance Assessment

v. Section 4 - Testing

vi. Appendices A - E

Stem bark ridges shall be convex

Staking is permissible and may be necessary in production, however stock in 45L pots or greater must be self supporting on dispatch

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Foreword

The foreword contains a preamble which highlights the intent of the standard and provides some background to tree stock production and aspects of tree quality. It is noted in the foreword that the term tree covers a broad range of species which are highly variable and influenced by many factors. Bearing this in mind, the standard provides for a sound method of determining tree stock quality which is flexible in its application.

Section 1 - Scope and General

The first section of the standard covers the scope of the standard noting that it specifies criteria to assess above and below ground characteristics of tree stock supplied for landscape use. Also noted is that the standard applies to all methods of production systems covering container grown, containerised bare rooted and ex ground tree stock. Noted exceptions to the standard include palms and tree stock grown for topiary, espalier, bonsai, pollarding or coppicing, as well as tree stock transplanted from the landscape to place other than a production nursery.

The first section also covers the application of the standard and a detailed list of terms and definitions specific to this standard.

Section 2 - Criteria for tree stock assessment

The second section specifies the criteria for the above ground and below ground assessment of tree stock which are used in determining quality tree stock for landscape use. For the above ground assessment of tree stock a number of criteria are covered, some of which are noted below.

Firstly the tree or batch should be labelled with the correct botanical nomenclature (true to type) and the height and calliper of the tree recorded.

The tree should display good health considering the time of year, location and stage of growth. Considering these aspects, tree health can be demonstrated through crown cover, form and density, as well as leaf colour and size and the absence of epicormics shoots and dieback. The tree should also be free from significant injury and wounds apart from pruning conducted in accordance with AS 4373.

Crown Symmetry is considered, noting that differences in tree crown distribution on opposite sides of the stem axis are no greater than 20%.

Apart from atypical species, the stem calliper at any given point is less than the stem calliper at any lower point, in other words the

stem tapers to the apex of the tree.
Moving onto stem structure, at any branch union the stem diameter above the branch union is greater that the diameter of the branch at the point of attachment. In tree stock with a defined central leader an apical bud must be intact and the stem doesn't deviate more than 15O from the vertical axis. For branch dominant tree stock the terminal buds must be intact and any unions are sound.
Although support through staking may be required during production, at the time of dispatch treestock in containers 45L or greater need to be self-supporting, for containers less than 45L the tree stock should be self-supporting.
The standard notes that included bark (concave) shall not be present and stem or branch bark ridge unions are outwardly turned (convex). Included bark is where bark grows between the branches inside a branch union usually where two or more branches are growing closely together. Branch unions with included bark are more prone to failure than convex unions. Albeit some species may display included bark as a characteristic this should not detract from the aim to eliminate included bark from tree stock.
In grafted tree stock, the scion and rootstock must be compatible for the entire graft perimeter and the graft union sound.
Additionally excluding bark and cleft grafts, the scion diameter immediately above the graft is within 20% of the rootstock diameter immediately below the graft.
The second major component of section two focuses on the below ground assessment requirements of tree stock. Some aspects of the below ground assessment are discussed in the following paragraphs.
Firstly the rootball must meet specific requirements for depth and diameter; for instance rootballs of containers 45L or greater should have a diameter greater than their depth, conversely however rootballs of tube and cell stock shall have a depth exceeding their diameter.
In relation to rootball occupancy, when removed from the container, 90% of the growing media volume needs to remain intact around the rootball. This can be assisted by the requirement that treestock in containers 45L or less have undergone primary root division at least once and that tree stock in larger containers must have undergone primary root division at multiple intervals.
The tree on the left demonstrates a symmetrical crown, whilst the tree on the right demonstrates an asymmetrical crown with more than 20% difference in distribution.
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References and further reading

Standards Australia 2015, AS 2303:2015 Tree stock for landscape use available from www.standards.org.au
Standards Australia 2014, Standards Development SG 003: Standards and other publications available from www.standards.org.au
Clark, R. Specifying Trees: A Guide to Assessment of Tree Quality NATSPEC/Construction Information, 2003
Draper, D. & Richards, P. Dictionary for Managing Trees in Urban Environments CSIRO Publishing, 2009
NGIA 2013, National Plant Labelling Guidelines www.ngia.com.au
NGIA 2013, Nursery Industry Accreditation Scheme Australia Best Management Practice Guidelines 5th Edition www.ngia.com.au

Roots need have grown in an outward and downwards direction and there is to be no evidence of circling roots, girdle roots kinked roots or j-roots. Roots must also not display signs of suckering at the time of dispatch.

Finally for both above and below ground assessments the tree should show no evidence of active pests or diseases or weeds. weeds. It is noted that the Nursery Production Farm Management System contains information on the management of pests and diseases.

Section 3 - Tree stock balance assessment

The third section of the standard relates to the tree stock balance assessment. The tree stock balance assessment is a guide to assess tree stock grown in containers of greater than 20L or ex-ground treestock. It is a way of describing the proportional relationship between the above and below ground aspects of the tree stock factoring in tree height and stem calliper (size index) as well as the rootball volume.

The size index of tree stock is a good indicator of the self-supporting nature of trees and likewise a sufficient rootball volume also contributes to the trees ability to support itself in the landscape.

To determine the tree stock balance, firstly the ratio of height to calliper or size index needs to be calculated by multiplying the height of the tree in metres by the calliper in millimetres. The resulting size index figure is then applied to a table in appendix E which gives a nominal container size appropriate for the tree stock based upon a size index range.

It is noted in the standard that tree stock are living products and hence species, production processes and climatic conditions can influence the height/calliper ratio. Hence it is important to understand that the tree stock balance assessment should not be used in isolation and rather it should inform a part of a holistic assessment of tree quality.

Section 4 - Testing

The fourth section covers testing methods to demonstrate compliance with the standard and the retention of documentation. The three listed methods of compliance demonstration include; testing at dispatch, internal nursery production systems which ensure compliance with the standard and as part of an audited quality assurance (QA) program.

Appendices

The standard contains 5 appendices, with A & B being normative and appendices C, D & E being informative.

Appendix A covers sampling strategies based upon AS 1199.1 suggesting the number of trees to sample based upon the size of the production batch. The testing process for treestock analysis is also covered by this appendix. Moving on Appendix B details the procedures and test report requirements for assessing rootball occupancy and root division and direction at the time of dispatch.

Appendix C provides two examples of treestock inspection forms which may be used or modified for recording inspection data.

Appendix D is an informative appendix which provides guidance on treestock height and calliper measurements and expected rootball diameters. Three categories are presented for tall slender species, general species and stockier thick stemmed species.

Appendix E is an informative table used in conjunction with section 3 to offer advice on the nominal container sizes for specific size index ranges.

The standard moving forward

The major area of contention during the formation of the standard, centred on the tree stock balance concept and its calculation as it applies to varying production regions and across various species.

As noted in the standard, NGIA committed to undertake research to evaluate the tree stock balance parameters across all climatic regions of Australia. This research has been successfully tendered by Horticulture Innovation Australia and will be conducted by Western Sydney University through a levy funded research project. The project is expected to conclude in March 2017 and the results will be used to guide a future update of the standard.

AS 2303:2015 Tree stock for landscape use is available for purchase from the SAI Global store online at http://infostore.saiglobal.com/store/Details.aspx?ProductID=1796682 and it is highly recommended that tree growers purchase this standard for use in their business.

For further information on Australian Standards please refer to the standards website www.standards.org.au

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National Plant Health and Biosecurity Project delivers benefits for Australian production nurseries

In this month's nursery paper Dr Andrew Manners and Dr Lindy Coates of the Queensland Department of Agriculture & Fisheries provide an update on a levy funded project which has delivered some excellent support for the industries capacity in the areas of plant health and biosecurity.

Pests and diseases, both endemic and exotic, represent a major threat to the health, productivity and profitability of Australian nursery production businesses, as well as the industries they support. The nursery industry is particularly vulnerable compared to other horticultural and forestry industries, mainly due to the great diversity of plant species (> 10 000 cultivars) involved, and the multitude of pathogens and pests associated with these hosts. Furthermore, the extensive domestic and international movement of nursery stock through commercial trade creates significant plant health and biosecurity challenges. As nursery production businesses face pest and disease issues on a daily basis, it is imperative that industry has access to the support needed to both manage their current pest and disease problems and protect against potential new pest and disease incursions.

The Nursery Production Plant Health & Biosecurity Project has been a four year (2011-2015) funding partnership between the Australian nursery industry, Queensland Department of Agriculture & Fisheries, and Horticulture Innovation Australia (HIA).

The aim of the project has been to provide support to the nursery industry in a number of areas, including the identification and management of plant diseases and pests through professional diagnostics, skill enhancement of industry through training workshops and the development of various resources for on-farm biosecurity management. Over the life of the project, a range of outputs have been delivered in the four key areas of diagnostics, training, information and industry support. These outputs are summarised in this article, while full details will be provided in the HIA Final Report for Project NY11001, which will be available in 2016 from HIA.

Diagnostics

Pest and disease diagnostics have been conducted for the nursery industry under the umbrella of Grow Help Australia, a national diagnostic service operating out of Queensland Department of Agriculture & Fisheries. As part of the project, NIASA accredited businesses from around Australia have been entitled to three complimentary diagnostic samples and one complimentary soil test (Phytophthora) per year. The project also provided discounted diagnostics to all Australian nursery businesses, irrespective of status, membership or affiliation.

Table 1 summarises pest and disease diagnostics conducted by the project team over the period November 2011 – August 2015. The total number of nursery, NIASA and virus indexing samples processed through Grow Help Australia increased significantly over the life of the project. The project team handled a total of 316 different plant hosts and 180 different plant pathogens over this period (data not shown). Fungi and viruses were the predominant pathogens reported, with Fusarium, Pythium, Colletotrichum and Rhizoctonia species being the most common fungal pathogens isolated from samples.

National Plant Health and Biosecurity Project delivers benefits for Australian production nurseries
Ongoing capacity development in areas around plant health and biosecurity is essential for the nursery industry
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Table 1: Summary of samples processed through Grow Help Australia1 over the life of the Plant Health & Biosecurity Project

1 https://www.daf.qld.gov.au/plants/health-pests-diseases/plant-pest-diagnostic-services/grow-help

2 Excludes virus indexing samples, includes non-nursery (e.g. field grown fruit and vegetable crops, forestry species) and nursery samples.

3 Includes NIASA samples.

4 This equates to receiving about 3-4 nursery samples every week.

Phytophthora lupin baits indicating that the sample above is healthy and the sample below infected.

Training

A series of training workshops on the recognition of key pest and pathogen groups affecting production nurseries, as well as integrated pest management strategies, were conducted in each state/territory. In most cases, one workshop per year was delivered in each state/territory. Attendance numbers and feedback from workshop participants are summarised in Table 2.

Healthy Azalea (left) and growing tip with broad mites (right)

(1 1

State/Territory	workshops	participants	workshop	benefit
WA	4	105	26.0	4.4
SA	4	122	30.5	4.4
VIC	4	136	34.0	4.4
TAS	3	62	20.7	4.7
NSW/ACT	4	118	29.5	4.6
QLD	82	235	29.4	4.6
NT	4	75	18.8	4.5
TOTAL	31	853	27.5	4.5

Table 2: Attendance numbers and participant feedback for workshops conducted between 2011 and 2015 for the Plant Health & Biosecurity Project.

1 Workshop participants evaluated overall benefit of each workshop using a 1-5 scale where 1=poor and 5=excellent. Results averaged over all workshops conducted in each state.

2 Three of the eight QLD workshops were additional workshops funded directly by NGIQ, and one of the eight workshops was conducted as part of the NGIA National Conference at the Gold Coast in 2012.

Information

Factsheets

A series of 24 factsheets on common nursery pests and pathogens, as well as key biosecurity threats, were

produced over the life of the
project (Table 3). These are available from the NGIA website1. However, the last six factsheets listed in Table 3 will
be made available in
early 2016.
Year
Samples2 3
2011
2012
2013
2014
2015 –
16
122
245
450
300
6
61
92
1774
136
1
31
54
71
63
2,310
3,165
TOTAL 1,133 472 220 5,475
Year
Samples2 3
2011
2012
2013
2014
2015 –
16
122
245
450
300
6
61
92
1774

136
1
31
54
71
63
2,310
3,165
TOTAL 1,133 472 220 5,475
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Title of factsheet
Alternaria diseases in production nurseries
Asiatic citrus psyllid – a biosecurity threat
Bacterial diseases in production nurseries
Bacterial leaf scorch – a nursery industry biosecurity threat (Pierce's disease)
Fire blight: a biosecurity threat to the Australian nursery industry
Fusarium: a formidable nursery pathogen
Glassy winged sharpshooter – a nursery industry biosecurity threat
Huanglongbing – a nursery industry biosecurity threat
Managing green peach aphid in production nurseries
Managing silverleaf whitefly in production nurseries
Managing two-spotted mite in production nurseries
Managing Western flower thrips in production nurseries
Phytophthora diseases – problematic in the nursery and beyond
Phytopthora ramorum: a biosecurity threat to the Australian nursery industry
Protect your nursery from virus diseases
Pythium species: a constant threat to nursery production
Rhizoctonia: a variable and versatile nursery pathogen
The biology and management of Colletotrichum diseases in production nurseries
Scale insects – a hard problem that can be managed
Mealy bugs – a pest of a different scale
Cycad blue butterfly – a pretty name for an ugly problem
Root and leaf nematodes – microscopic worms with major consequences
Powdery mildew – a myriad of nursery pathogens
Downy mildew – early management is critical
Leaf spot caused by the fungus, Pseudocercospora, on leatherleaf fern.1 Available at:
https://www.ngia.com.au/Category?Action=View&Category_id=682
Nursery papers
Four nursery papers were produced on pest and disease management during the project (Table 4).
These are available from the NGIA website1.
Table 4: Nursery papers produced over the life of the Plant Health & Biosecurity Project
Issue
1 Available at: http://www.ngia.com.au/Section?Action=View&Section_id=46
Pest management plans
Detailed pest management plans were produced for three key pest groups (fungus gnats, whiteflies and mites) as well as for soilborne
diseases of nursery crops (Table 5). These are available from the NGIA website1.
Table 5: Pest management plans produced over the life of the Plant Health & Biosecurity Project
1 Available at: https://www.ngia.com.au/Category?Action=View&Category_id=689
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TECHNICAL
NURSERY PAPERS
TECHNICAL
November 2015 Issue no.10

Published by NGIA, PO Box 7129 Baulkham Hills BC NSW 2153
Compiled and edited by Chris O'Connor NGIA Technical and Policy Officer; banner photography by Anthony Tesselaar.

Pest ID tool

Approximately 50 pest and disease descriptions as well as hundreds of high quality images were provided for the Nursery Industry's Pest ID tool1 over the course of the project (Table 6). This web-based information package is designed to assist nursery producers in identifying and managing pests, diseases, disorders and weeds. It also includes information on beneficial insects as biocontrol treatments. The Pest ID tool can be used on any device that has web-browsing capabilities.

Close-up of glasshouse whitefly on avocado. The upper most individual has not emerged as an adult, the other individuals have already emerged.

Table 6: Pest and pathogen descriptions and images2 provided for the nursery industry's electronic pest ID tool

Phytophthora
Pythium
Rhizoctonia
Cylindrocladium
Fusarium
Colletotrichum
Alternaria
Botrytis
Chalara
Phoma
Gliocladium
Bipolaris
rus
Red
beetle
Phytopht

1 Available at: https://pestid.com.au/. State-based NGI members receive 40% discount

2 Many additional images without associated descriptions were also provided.Industry support

Pest contingency plans

Four pest specific contingency plans were developed during the course of the project (Table 7). These provide background information on pest biology and available control measures to assist production nurseries with preparedness for an incursion into Australia, as well as guidelines and options for steps to be undertaken and considered when developing a Response Plan. Copies of these plans can be obtained by contacting NGIA. Huanglongbing and fire blight contingency plans are also currently available on the Plant Health Australia website.

Table 7: Pest specific contingency plans developed for the nursery industry as part of the Plant Health & Biosecurity Project

1 Currently available at:
http://www.planthealthaustralia.com.au/wp-content/uploads/2014/11/Huanglongbing-CP-NG-2013.pdf

2 Currently available at: http://www.planthealthaustralia.com.au/wp-content/uploads/2014/11/Fire-blight-CP-2014.pdf

EPPRD (Emergency Plant Pest Response Deed) support

The project team has also provided technical support to industry in relation to 18 EPP (emergency plant pest) incursions over the life of the project, particularly in relation to supplying information on pest biology, host range and management.

Project Team

Department of Agriculture & Fisheries (DAF) Queensland: Andrew Manners, Lindy Coates, Tony Cooke, John Duff, Jan Dean,
Ken Pegg and Leif Forsberg (November 2011 – September 2013).
NGIQ: John McDonald; NGIA: Anthony Kachenko, Chris O'Connor (August 2014 - present)
Further information on this project is available from Lindy.Coates@daf.qld.gov.au

Acknowledgements
All photos in this nursery paper were taken by the DAF members of the project team except where noted.

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NY12011 Nursery & Garden Industry Communications 2013-2015
Appendix 2

Policy Positions Developed

Australian Nursery
& Garden Industry
Environmental
Sustainability
Position
Version 2   February 2014

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• Newspoll commissioned by NGIA in 2011.
ACKNOWLEDGEMENTS:
The development of this document would not have been possible without input from the State and Territory Nursery & Garden Industry Associations.
First published in September 2009.

Foreword

The sustainable development of Australia's nursery and garden industry is a principal concern for Nursery & Garden Industry Australia (NGIA). In recent times, the importance of environmental stewardship has been brought into sharp focus through issues such as drought, climate change and natural resource management. These issues have required careful consideration and management by NGIA to ensure sound environmental outcomes are achieved.

This Position Document 'Australian Nursery & Garden Industry Environmental Sustainability Position' provides the public and other key stakeholder groups with a summary of NGIA's views on key environmental issues. This document captures the many environmental achievements of industry and reaffirms that NGIA is committed to achieving on-going improvements in its environmental performance and is well positioned to act positively in improving our environment.

The publication of this Position Document firmly cements Australia's nursery and garden industry as a true, green industry that has long been concerned about working in harmony with the environment for a sustainable future.

This Position Document has been finalised by NGIA following feedback from State and Territory Nursery & Garden Industry Associations as well as members. NGIA gratefully acknowledges this assistance.

I highly recommend this Position Document for your reading.

Dr Anthony Kachenko
Research and Market Development Manager
Nursery & Garden Industry Australia
February 2014

Table of contents

1 Introduction

Environmental Sustainability Position 5

Nursery & Garden Industry Australia (NGIA) is the peak national industry body representing producers, retailers and allied traders involved in the production of plants across all states and territories of Australia. In partnership with state and territory peak industry bodies, NGIA is responsible for overseeing the national development of the Australian nursery industry.

The nursery and garden industry provides significant economic, cultural, social and environmental benefits to the Australian community. Nationally, production nurseries support a diverse array of end users through the provision of green-life as starter crops or finished products. End users include retail outlets, landscapers, cut flower growers, orchardists, vegetable growers, interiorscapers, sustainable forestry and revegetation enterprises. Production areas are well established with some having been in existence and having industry representation for over 100 years. Along the supply chain, allied traders provide products and services that support the production, sale and health of green-life and include growing media and fertiliser manufacturers.

Owing to the diverse nature of nursery production, and its customer base, nurseries typically occur in urban, peri-urban and regional localities across Australia. As such, industry is confronted with a variety of environmental and natural resource impediments that require careful consideration and management to ensure sound environmental outcomes are achieved.

NGIA recognises that maintaining a healthy environment is critical for a viable and thriving industry and is mindful that preserving the environment in a rapidly changing landscape is a necessity that shouldn't be overlooked. Government policy can also impact on the sustainability of industry and therefore it is imperative that industry is prepared for the challenges and opportunities that may arise through this process.

The Australian nursery industry has had a long history of embracing change and managing key environmental issues through investment in research, development and extension programs via the nursery products levy. The purpose of this Environmental Sustainability Position is to demonstrate that the industry remains committed to safeguarding the environment and minimising any adverse environmental impacts of its operations. To this end, the industry is committed to working with government, research organisations, the community and other stakeholders to address and manage key environmental issues.

This document covers environmental issues across all sectors of the supply chain from cradle to grave, including issues pertinent to the gardening public and the broader community.

By responding to and undertaking activities in relation to key environmental issues such as climate change and natural resource management, the industry aims to ensure that these issues are addressed through a triple bottom line approach. This will inevitably result in the sustainable development of the Australian nursery and garden industry.

2 Mission Statement

Position the Australian nursery and garden industry as the community's leader on relevant environmental issues

3 A sustainable future begins here

In response to the issue of sustainability and environmental responsibility, NGIA has developed this Environmental Sustainability Position. This document demonstrates NGIA's commitment to environmental sustainability, the appropriate management of the association and its operations, the engagement of businesses in principles and applications of sustainability and the engagement of and collaboration with the broader community.

The industry recognises that sustainability of the environment directly affects the sustainability of businesses. NGIA is engaged in helping to build a sustainable future and has developed several initiatives to ensure the use of environmentally sound practices across the full supply chain. These initiatives cover a wide range of environmental issues, framed to encourage and not discourage the industry. NGIA is committed to promoting and encouraging environmentally sound business practices and is dedicated to assisting industry in working towards this goal.

NGIA is committed to maintaining an Environment & Technical Committee for the ongoing improvement of this Environmental Sustainability Position. This national committee will review this document biennially and make necessary revisions as/where required. An environmental risk assessment matrix, developed by the Environment & Technical Committee, underpins this document. This matrix depicts key environmental issues that have the potential to impact on the sustainability of industry and is reviewed every six months by the Environment & Technical Committee.

4 Environmental Best Practice Programs

4.1 Nursery Production Farm Management System (FMS)

The Australian nursery industry operates a tiered suite of internationally sought-after best management practice (BMP) programs nested under the Nursery Production Farm Management System (FMS).

These programs include:

- Nursery Industry Accreditation Scheme Australia (NIASA) BMP.
- EcoHort - environmental stewardship and natural resource management.
- BioSecure HACCP – biosecurity management.

These programs are available in separate streams, to production nurseries, growing media manufacturers and greenlife markets.

4.2 Nursery Industry Accreditation Scheme Australia (NIASA)

NGIA encourages production nurseries, growing media manufacturers and greenlife markets to gain NIASA accreditation and operate in accordance with national Best Management Practices (BMP). These guidelines detail industry BMP for crop hygiene, crop management practices, water management and general site management and have been developed over two decades by respected industry representatives and researchers. They are reviewed annually by the National Accreditation and Certification Committee to ensure they cover relevant and current production and environmental issues. This national, third party audited scheme, developed in 1994, aims to enhance business professionalism, profitability and encourage continuous improvement whilst being mindful of the environment. The program can also be used as a reference guide to assist in the setup and establishment of new businesses. NIASA also serves as a base level of certification which must be achieved prior to EcoHort and BioSecure HACCP.

4.3 Environmental Management System – EcoHort

NGIA advocates the adoption of EcoHort across all production nurseries, growing media manufacturers and greenlife markets. EcoHort is an industry specific Environmental Management System (EMS) that provides businesses with a systematic approach to assess their environmental and natural resource management responsibilities, as part of their daily business management.

This program addresses the following key areas:

- Efficient irrigation
- Wastewater management
- Nutrient management
- Managing biodiversity
- Efficient energy use
- Waste minimisation
- Land and soil management
- Pest & weed management, and
- Recycling of waste products

The EcoHort guidelines provide businesses with the tools to ensure they can demonstrate to industry, government and the community, their sound environmental and natural resource stewardship and compliance with the diverse range of environmental legislation. This national third party audited EMS offers businesses with a risk assessment-based pathway to continuously improve their management systems.

Businesses engaged with EcoHort must first achieve NIASA accreditation.

4.4 BioSecure HACCP – Guidelines for Managing Biosecurity

BioSecure HACCP is an industry-specific biosecurity program for production nurseries, growing media manufacturers and greenlife markets. This third party audited program provides businesses with a systematic approach to assess on-farm biosecurity hazards and responsibilities and it details how to best manage these identified risks. These guidelines have been developed following HACCP, which is the world recognised standard in risk management processes.

BioSecure HACCP guides businesses in:

- Assessing their current and future pest and disease risks
- The implementation of management strategies at critical control points
- Identifying internal and external threats to the integrity of a business biosecurity preparedness
- The establishment of an effective internal quarantine process for both imported and exported plant material
- The conduct of internal audits and self-improvement systems

Businesses engaged with BioSecure HACCP must first achieve NIASA accreditation.

4.5 Environmental Best Practice for Garden Centres

4.5.1 Australian Garden Centre Accreditation Scheme

The Australian Garden Centre Accreditation Scheme (AGCAS) is a national third party audited industry managed scheme, designed to raise retail standards, encourage business improvement and promote excellence in garden retailing. NGIA encourages engagement in this scheme across all garden centres throughout Australia. Embedded in this scheme are four environmental modules to provide businesses with a high level of environmental awareness. These modules provide industry standard guidelines on water, weeds, chemicals and waste management to ensure businesses reduce their environmental footprint. A key component of this program is to position AGCAS businesses as a trusted and reputable source of information for the general public.

5 Biosecurity preparedness

One of the biggest threats to the Australian environment is the introduction of exotic pests. Owing to Australia's geographic isolation, it has remained relatively free from many exotic pests such as Sudden Oak Death (Phytophthora ramorum), that have significantly affected other parts of the world. To ensure Australia remains proactive in managing biosecurity, a 'whole of community' approach, involving State and Federal Governments, industry and the wider public is required.

NGIA acknowledges that it plays a vital role in the biosecurity continuum, and as such, maintains a policy position on biosecurity referred to as 'Reducing the Pest Risk' and is actively engaged in several biosecurity initiatives across Australia. NGIA is also a member of Plant Health Australia (PHA) further demonstrating its willingness to participate in this arena.

NGIA has developed a number of supporting tools and documents to assist industry in its biosecurity responsibilities. Resources include:

- Biosecurity Manual for the Nursery Production Industry
- Pest Fact Sheets
- Best Practice Videos
- Pest Management Plans
- Farm Biosecurity Signage

5.1 Industry Biosecurity Plan for the Nursery Industry

Developed in 2005 the Industry Biosecurity Plan for the Nursery Industry provides a blueprint for the exclusion, eradication and control of key pests relevant to the Australian nursery industry. This plan is a living document and undergoes review by the Industry Biosecurity Group annually to embrace changes to industry biosecurity. Reviews to the document saw a version released in 2008 and another in May 2013.

This plan is vital to ensure industry has the capacity to better prepare for and respond to, incursions of pests ensuring the future sustainability and viability of the industry. As part of the Industry Biosecurity Plan for the Nursery Industry, NGIA has developed contingency plans for key pests which provide background information on the pest biology and available control measures to assist with preparedness in the event of an incursion. Each contingency plan provides guidelines to assist in developing a pest specific Response Plan.

5.2 Emergency Plant Pest Response Deed

In 2005, NGIA became a signatory to the Emergency Plant Pest Response Deed (EPPRD). As a signatory to the EPPRD, NGIA is at the forefront of developments in biosecurity. The EPPRD is a progressive partnership arrangement that sees Australian industries and Governments cooperating as equal parties in the management of emergency plant pests (EPPs).

An EPP can be defined as a:

- Known exotic plant pest
- Variant form of a plant pest already established in Australia
- New serious plant pest
- Plant pest that is being officially controlled in Australia but requiring a significant emergency response to ensure that there is not a large scale epidemic of regional or national significance

As part of this deed, NGIA is directly involved in categorising the EPPs based on their likely environmental, human health, trade, economic and industry impacts. In the event of an incursion, NGIA is also directly involved in decision making about mounting and managing EPPs relevant to industry. In 2013 the nursery and garden industry agreed to establish a biosecurity levy, to be enacted during an EPP Incursion thereby meeting its funding obligations under the EPPRD.

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6 Climate change and variability

Australian horticultural industries (which include nursery production) fall under the umbrella of Agriculture, which is responsible for approximately 16% of Australia’s greenhouse gas emissions. Of this 16%, Australia’s combined horticultural emissions account for approximately 1.2%. The Australian nursery and garden industry has the capacity through the production of living products to make a significant contribution to reducing greenhouse gas emissions and may also play an integral role in mitigating climate change and variability.

Historically, the industry has shown to be resilient and adaptive in response to environmental pressures; no more noticeable than the ongoing drought which continues to impact across large expanses of Australia. In light of this adversity, the industry has the capacity to cope with climate change and remain viable in a highly variable climate. In February 2011, the Australian nursery and garden industry released a policy position on climate change and variability in order to further cement its position on this issue.

NGIA has developed a carbon foot printing tool to estimate emissions from production nurseries. This tool can provide full lifecycle and cost/ benefit analysis to measure the environmental impacts of specific nursery lines from cradle to grave. This model will benchmark the carbon footprint of production nurseries, identify areas of improvement and prioritise potential actions for mitigation through offsets or emission reductions. Emission benchmarking, based on nursery ‘best practice’ emissions, will be reviewed and updated as technology improves.

NGIA recognises that greater adoption of renewable energy technologies is a sound approach in reducing the demand on non-renewable energy, hence reducing emissions. NGIA has developed a Renewable Energy Calculator for growers to evaluate energy co-generation, namely solar and wind power for the generation of electricity onsite. Utilising renewable technologies in lieu of non-renewable energy may present opportunities for growers to also potentially reduce economic burdens. Fact sheets have also been developed to guide industry on renewable technologies.

6.1 Urban forestry

Urban forestry - encompassing the planning, design, establishment and management of trees and forest stands in public or private areas - has become widely accepted both locally and internationally as an essential element in the built environment. In addition to the amenity value, the urban forest provides a multitude of environmental, human health and wellbeing benefits including:

• Improved air quality through interception of pollutants and oxygen production
• Reducing the impact of the Urban Heat Island Effect
• Improving human mental and physical health
• Provision of habitat for plants and animals
• Consumption of C02 through photosynthesis
• Maintaining ground water hydrology and reducing the load of rainfall on stormwater infrastructure
• Production of food for humans
• Stabilisation of climate
• Maintaining soil organic matter
• Enhancing soil nitrogen and recycling of nutrients
• Provide a sense of place and enhanced community
• Improved aesthetics

NGIA urges greater recognition of the benefits associated with urban forests and the role they play mitigating climate change and variability. In 2009, NGIA hosted the inaugural Urban GreenScapes Symposium to position green-life and plants as an integral part of the solution to climate change by presenting the research and the reasoning in the areas of environment, health/wellbeing and planning to support this.

Since the 2009 Urban Greenscape Symposium, NGIA has actively supported and funded research focused on the benefits of the urban forest with leading researchers from around the country including the Commonwealth Scientific and Industrial Research Organisation (CSIRO). NGIA has also invested in the development of Australian data for use in the iTree suite of software tools that allow for urban forest analysis and an assessment of the benefits provided by the urban forest. This peer reviewed tool is free to use and allows urban forest managers to quantify the urban forest as a community asset.

In 2011, NGIA became a founding partner of the National Urban Forest Alliance (NUFA) which is an alliance of key stakeholders such as Arborists and councils, who have a focus on the promotion and investment into Australia’s Urban Forest. The vision of NUFA is to promote a thriving, sustainable and diverse Australian urban forest that supports healthy ecosystems which are valued and cared for by all Australians as an essential environmental, economic,

and community asset for future generations.
Environmental Sustainability Position 12

7 Managing water

Water is considered a finite resource, and one that industry is dependent upon for the production and care of plants. Industry recognises that managing water efficiently is a key driver to sound environmental performance and is committed to achieving improvements in water use efficiency across whole of industry. In recent years, industry has developed several initiatives that demonstrate the Australian nursery and garden industry is an efficient and responsible water user.

Given the significant importance water has to the nursery and garden industry, NGIA maintains a policy position on water.

7.1.1 Nursery Industry Water Management Best Practice Guidelines

Developed in 1997, with the third edition published in 2010, these guidelines promote best practice water management in production nurseries. These guidelines highlight five key areas to achieve sustainable water use:

1. Efficient water use to minimise water demand
2. Increased reuse of waste water to minimise water demand
3. Efficient management of sediment and litter
4. Maximum retention of nutrients to improve efficiency of production and maintain water quality
5. Environmentally responsible use of plant protection products to promote quality plants

7.1.2 Smart Approved Water Mark

NGIA in cooperation with Water Services Association of Australia, Australian Water Association and Irrigation Australia developed the Smart Approved Water Mark program. This independent program is Australia's national labelling scheme for outdoor water efficient products and services and is supported by the National Water Initiative, and the Water Smart Australia program. Both NIASA and EcoHort programs have been Smart Approved WaterMark certified as approved services since 2010.

7.1.3 Water Management Toolbox

NGIA is committed to ensuring production nurseries are equipped with the most up-to-date irrigation system delivering optimum water use efficiencies. To achieve this, The Water Management Toolbox (www.watertoolbox.ngi.org.au) has been developed to assist production nurseries in on-farm water management.

This resource comprises of simple calculators for growers to manage nursery irrigation and drainage water to support sustainable and responsible use of water resources as well as the industry accreditation, certification and training programs. The calculators are derived from:

- The popular industry book titled ‘Managing Water in Plant Nurseries’
- The industry training program Waterwork
- Existing industry programs and Nursery and Garden Industry Queensland Environmental Sustainability Position 14

7.1.4 Managing nutrients in production nurseries

NGIA supports the pragmatic use of fertilisers to minimise nutrient leaching from potting media during irrigation of containerised plants. Research by NGIA into experimental reed beds, as a mechanism to filter nutrient laden run-off water from nurseries, resulted in a 90% reduction of nitrate and 96% of the phosphate present in nursery run-off. These reed beds can also eliminate Phytophthora.

Where feasible, NGIA encourages the uptake of this technology as a viable mechanism to efficiently remove nutrients and organic matter from nursery run-off.

8 Invasive plants

Industry is committed towards lessening the impact of invasive plants on the natural environment and halting the spread of garden escapes. The nursery and garden industry is responsibly working towards eliminating known invasive plants from sale to ensure a sustainable future for generations to come. To achieve this, industry consults scientific literature to identify potentially invasive plants. In recent years, NGIA has taken significant steps forward in tackling the spread of invasive plants and maintains a policy position on invasive plants since 2009.

8.1 Grow Me Instead

The national Grow Me Instead (GMI) educational program is the largest and most important initiative undertaken by NGIA to reduce the spread of potentially invasive plants. This program has been designed to educate stakeholders including landscapers, government, industry, gardeners and the wider public about potentially invasive plants and the impact they may have on the environment.

For each state/territory, a GMI booklet has been developed that identifies potentially invasive garden plants and suggests superior, non-invasive alternative plants. The GMI program has also been developed into a rich online resource (www.growmeinstead.com.au) with an interactive database. Through this program, NGIA is committed to educating the public about making responsible plant choices and managing potentially invasive plants they may already have.

8.2 Plant Risk Assessment Tool

In conjunction with a number of key Botanical Gardens, Regulatory Agencies and Researchers, NGIA has developed an online weed risk assessment tool (www.plantrisktool.com.au) based on peer reviewed science. This database can be used by growers, retailers and consumers to determine the weed risk potential of specific plants based on regional climatic data.

8.3 National Plant Labelling Guidelines

NGIA recognises the importance of correct naming and labelling of plants, including the use of full species names. In collaboration with plant nomenclature experts, industry stakeholders and horticulturists, NGIA has developed national plant labelling guidelines, which were updated in January 2013. These guidelines provide direction on how to correctly label plants and include:

- Correct botanical names – nomenclature
- Intellectual property – Plant Breeders Rights and Trademarks
- Plant growth requirements and characteristics
- Potentially harmful plants – health and environment

8.4 Plant Safely

The Plant Safely website (www.plantsafely.com.au) aims to highlight some of the potentially hazardous gardening items, organisms and activities commonly found in gardens and provide useful information, resources and links to help reduce the risks that they may pose.

Topics covered by the Plant Safely website include invasive plants, poisonous plants as well as general information on the safe use of garden chemicals. This website is the only comprehensive garden safety site on the web and provides easy links to organisations that are subject matter experts on issues of gardening safety.

9 Managing waste

NGIA promotes the reduction in waste materials entering landfill. The industry is committed to minimising waste and maximising efficiencies by reducing, re-using, recycling and donating waste where appropriate.

This is demonstrated by the industry's use of bark and coconut fibre (coir), waste by-products of timber and coconut harvesting, as a component of the raw ingredients that constitute a professional growing media and waste minimisation programs incorporated in EcoHort.

10 Education initiatives

NGIA recognises that educating staff and business owners about key environmental issues is vital to ensure industry is adequately equipped with the knowledge and skills to competently tackle these issues head on. A skilled industry will cultivate innovation and a responsiveness to change that will enable it to command the knowledge required to excel as the community's leader on relevant environmental issues. To achieve this goal, industry has developed multiple training packages including:

- EcoHort – An introduction to EMS for production nurseries
- BioSecure HACCP – Guidelines for managing biosecurity in nursery production
- Environmental Management for Retail Garden Centres – How to implement EMS in retail garden centres
- Waterwork series – Water treatment, irrigation, recycling and fertigation options for production nurseries and retail garden centres
- Recognising and Monitoring Pests and Diseases
- Control & Management of Pests
- Implementing Integrated Pest Management
- Growing Media – Handling and physico-chemical properties of growing media in the context of industry Best Practice

These training packages are offered through face to face workshops and field days as well as online via the NGIA eLearning portal (www.ngia.talentlms.com).

10.1 Best Practice Manual for Pesticide Application in the Nursery and Garden Industry

The nursery and garden industry recognises that safe pesticide use is vital to protect individuals and the environment and promotes best practices for handling, storage and disposal of pesticides. NGIA has developed BMP for pesticide application to assist production nurseries identify and understand the range of pesticide application equipment available and the key issues relating to the use of pesticides in the nursery environment. An industry tailored pesticide management diary to record pesticide application events has also been developed to further assist in BMP.

11 Environmental extension

11.1 Industry Development Officer network

Extension of nursery and garden industry research and development is paramount to improve the environmental standing of industry. The Industry Development Officer (IDO) network, established in the early 1990s, is the primary conduit for the extension of industry research and development to businesses. This valuable resource of qualified and experienced professionals provides the skills and expertise required by business to ensure they operate in an efficient, productive and sustainable manner.

The IDO network is also responsible for:

- Developing research and development projects
- Managing and/or facilitating training
- Representing industry on environmental
- Delivering industry developed environmental BMP to businesses

11.2 Environmental communication

NGIA publish monthly Nursery Papers which provide information to the whole of industry on key issues that impact industry. The Nursery Papers report on research and development outcomes, emerging environmental issues and business sustainability. The information presented is clear, concise and includes actionable conclusions to assist in greater uptake.

NGIA also provides targeted environmental communications through social media including the Your Levy at Work Blog, Facebook, Twitter and YouTube pages as well as the NGIA website.

12 Participating in the broader environmental debate

Industry believes that increasing public awareness about key environmental and sustainability issues is paramount to achieve behavioural change and is committed to being a community leader on relevant issues. Likewise industry also believe that there is scope for those in positions of influence such as politicians and regulators to effect positive change at the macro level by developing favourable policies and processes to incorporate greenlife as an essential component to urban design.

Many Australians are keen to make change at a grass roots level, by making a difference in their own backyard. Indeed, 89% of Australians want more trees and green space in their local environment. In order to achieve this, retail garden centres are well positioned with experience and an understanding of local environmental issues. Furthermore, they are seen by the community as a credible source of information on key environmental issues.

12.1 202020Vision

202020 Vision is the latest marketing campaign facilitated by the Australian nursery industry with the objective to increase urban greenspace by 20% by the year 2020. This will be achieved through influencing the influencers namely government at Local, State and Federal levels, major developers, town planner's and landscape architects. The campaign provides a collaborative platform of information and facilitates the exchange of ideas between key communities in order to understand, recognise and establish urban green space co-benefits.

202020 Vision is supported by the body of research conducted both locally and internationally of the benefits of the urban forest.

Further details on the campaign can be found at www.202020vision.com.au

13 Research & development

Key environmental issues such as climate change and variability, biosecurity, water availability and invasive plants will continue to impact on the long term health and sustainability of the nursery and garden industry. These key environmental issues, where they are managed well, can present our industry with opportunities for growth.

In order for Industry to identify these opportunities and enhance industry’s capacity for innovation, the nursery and garden industry is committed to investing in research and development. NGIA’s research and development program aims to lessen the impact of industry on key components of the environment and conserve and enhance Australia natural resources.

By linking with national research institutions and external stakeholders, the nursery and garden industry will minimise duplication and maximise transfer of knowledge to industry through greater research and development outputs. All completed levy funded research and development reports can be accessed on the NGIA website via a searchable database.

Research and development will enhance industry capacity for innovation, expertise and knowledge to promote a sustainable future & position the industry as an environmental steward and leader.

14 Further information

If you would like more information about the NGIA Environmental Sustainability Position, contact NGIA on:

(02) 8861 5100

or info@ngia.com.au;

or visit www.ngia.com.au

This Policy Position has been funded by Horticulture Australia Limited using the Nursery Industry Levy and matched funds from the Australian Government.

National

Plant

Labelling

Guidelines

Version 2 January 2013

GUIDELINES FOR LABELLING OF PLANTS

Introduction:

These guidelines for labelling plants have been developed by the Australian nursery industry in conjunction with the Tree & Shrub Growers Victoria, the wider industry and a legal team with a specialist interest in intellectual property within the nursery industry. They are recommended for adoption by all plant producers, suppliers of plant material, plant retailers and label manufacturers.

These guidelines have been developed to reduce confusion and provide clear guidance in relation to the content of labels used on plants, and how plant information is conveyed to the market. These guidelines also support the efforts of regulators to address market access, invasive plant and potentially harmful plant issues.

Objectives of the Guidelines:

Provide a standard of acceptable and recommended guidelines for the nursery industry to adopt in preparation of labels and marketing material.

In these guidelines the definition of a label is any tag, brand, mark or statement in writing or any representation or design or descriptive matter on or attached to or used in connection with or accompanying any plant or plant material. This covers labels attached to plants, barcodes, sleeves, bulb cards, seed packets, planting guides; plant lists catalogues, printed plant pots and electronic representation.

To assist in understanding the obligations of providing clear, unambiguous and accurate information on labels and to avoid the public or others in the plant trade from being misled and deceived.

It is not the aim of these guidelines to include everything that should be on every label produced. It is to provide guidance on how to correctly deal with issues including:

1. Correct botanical names – nomenclature
2. Intellectual property – Plant Breeders Rights and Trademarks
3. Potentially harmful plants – health and environment

Definitions:

1. Botanical Names - A botanical name is the actual scientific name for the plant. It is the only internationally unique identifier for the plant.

1.1. Species: A wild or natural species is the smallest population which is, in human terms, distinct and distinguishable from all others. It is the primary taxonomic unit, and gene exchange within the species occurs freely, while exchange between species via hybridization is usually restricted or even impossible.

The name of a species is always identified by a botanical name comprising two words; the genus name and a specific epithet or species name (e.g. Grevillea rosmarinifolia). A botanical name must be latinized, and validly published in a recognised international journal in order to be legitimate.

1.2. Hybrids: If natural hybrids do occur, the name of a hybrid can be given as the two species names separated by a multiplication sign e.g. Calystegia sepium x Calystegia silvatica, or if an author wishes, a latinized binary name linked by the multiplication sign e.g. Calystegiax lucana (the same taxon as the last example)

1.3. [Botanical] Variety: 'Variety' used in a taxonomic sense describes members of a species that differ from others of the same species, in a naturally occurring population, in minor but heritable characteristics. A variety is often a local or ecological race or ecotype.

The botanical variety name must be published and is latinized. It is used in conjunction with the name of the genus and species with the added abbreviation 'var'. e.g. Ceanothus gloriosus var. exaltatus.

Note. The recognition of a distinct variety also automatically means that there is a typical variety of the species i.e. Ceanothus gloriosus var. gloriosus. Using the name Ceanothus gloriosus does not imply the typical form and the user of the name may be unaware of the existence of varieties.

1.4. Cultivated plants: When a naturally occurring species is domesticated and 'bred' to change its characteristics, new 'cultivars' are developed. The term cultivar and botanical variety cannot be used interchangeably (see above). Cultivars are of diverse nature e.g. clones, self-fertilized lines or lines of hybrid origin developed in cultivation. In Plant Breeder's Rights terms, a 'plant variety' or a 'variety' is the same as a 'cultivar'.

Cultivar names can be associated with a genus name, a species name or a hybrid. They are not latinized, are written with an initial capital letter and in single quotation marks e.g. Rubus idaeus ‘Malling Wonder’, Viburnum x bodnantense ‘Dawn’, Rosa ‘Crimson Glory’.

2. Intellectual Property: -Intellectual property represents the property of your mind or intellect. In business terms, this also means your proprietary knowledge.

2.1. Plant Breeders Rights: Plant Breeder's Rights (PBR) are time-limited exclusive commercial rights, granted by IP Australia for a plant variety that has been bred (i.e. a cultivated plant), is new, distinct from all other know varieties, uniform and stable. In PBR terms, a ‘plant variety’ or a ‘variety’ is generally the same as a ‘cultivar’, not to be confused with the botanical variety described above. The rights are a form of intellectual property, like patents, trade marks and copyright, and are administered under the Plant Breeder's Rights Act 1994.

2.2. Trade marks: A trade mark is used to distinguish the goods and services of one trader from those of another. A trade mark is a sign, for example a word or logo, which is used to indicate that a plant has been grown by a particular grower. The use of trade mark is implying that the owner of the trade mark has control over trade in relation to that plant. The owner of a trade mark can license others to use the mark. This use can be subject to conditions which could be in relation to quality and origin of the end product and the class of product to ensure that the integrity of the trade mark is maintained. This would apply to plants grown under licence that are grown to a particular standard. Trade marks should not be used on plants if the trade mark owner has no control over the way it is used in relation to a product.

2.3. Copyright: Copyright protects the original expression of ideas, not the ideas themselves. It is free and automatically safeguards your original works of art and literature, music, films, sound recording, broadcasts and computer programs from copying and certain other uses. Copyright is not registered in Australia but arises automatically when the work is created. Copyright can apply to labels, manuals, brochures, videos, photographs and other such works developed by a business.

2.4 Plant Patents: ‘A patent is a right that is granted for any device, substance, method or process that is new, inventive, and useful’ (IP Australia web site). Plant related patents may be obtained over a plant variety, a process for producing a plant variety or biological information (e.g. a DNA sequence). In Australia new plant varieties can be patented if they meet the criteria, but this should not be confused with a ‘plant patent’ granted in the United States. The latter is granted under a special section of the patent law (designed to meet UPOV requirements) which applies specifically to asexually reproduced plant varieties. In the USA, the Plant Variety Protection Act only covers sexually reproduced plants. Sexually and asexually reproduced plant varieties can also be the subject of a normal US utility patent if they meet the relevant patent criteria, as in Australia.

3. Potentially harmful plants:

Consumer Health – A potentially harmful plant is a plant that causes:

• Poisoning: that is a toxic reaction when put into the mouth or ingested, or
• A skin reaction, that is a rash, swelling, dermatitis, allergy, pain or infection when handled or when skin comes into contact with a plant part, or
• Respiratory problems as a result of exposure to pollen, perfume or sawdust.

Environment – An environmentally harmful plant is one that:

• Has been identified to have sufficient weed impacts as to warrant publication of national specific control recommendations.
• Is undergoing assessment for potential invasiveness utilising National Guidelines to variety or cultivar level and may need increased awareness re management, or disposal.
• An invasive plant has the ability to thrive and spread aggressively outside its natural range. A naturally aggressive plant may be especially invasive when it is introduced to a new habitat. An invasive species that colonizes a new area may gain an ecological edge since the insects, diseases, and foraging animals that naturally keep its growth in check in its native range are not present in its new habitat.

The Guidelines

It is recommended that a label be:

• in the English language,
• legible and prominent in distinct contrast to the background,
• indelible - must not fade or be able to be rubbed off under normal conditions, and
• true and correct regarding information (i.e. not false or misleading).

Required Information:

a. The botanical name of the plant is always written in italics with the first word or genus name having a capital letter and the species written in lowercase e.g. Grevillea rosmarinifolia. The name of a validly published natural variety is also written in italics and separated from the species name by the abbreviation var., e.g. Ceanothus gloriosus var exaltatus (compare with cultivated variety below).

b. A cultivar name (cultivated variety) is always written with a capital letter, single quotation marks and is not italicised e.g. Grevillea rosmarinifolia 'Nana'. If the cultivar name (referred to as the plant variety name in PBR terms) is subject to protection under the Plant Breeders Rights Act the PBR symbol can be used beside the cultivar name, e.g. Grevillea rosmarinifolia 'Nana'. Then somewhere on the label the full PBR text should be included.

Appendix 2 contains a copy of the PBR Industry Guidelines for the use of the PBR symbol and letters.

c. The common name for the plant (when this differs from the botanical name). This is not required to be written in any particular way and preferably must not be depicted in italics or in quotation marks or in any way to confuse it with the botanic or cultivar name.

d. Plant cultural notes. These provide guidance on the requirements for the plant to be successfully grown and should cover:

• Brief description
• Desirable characteristics
• Preferred aspect
• Preferred soil type
• Likely height and width at maturity
• Special uses (e.g. bird attraction, suitable for coastal conditions)
• Any necessary cautions (e.g. potentially harmful plants [health and environment], invasive tendencies or disposal guidelines).

This information may be provided by text or pictogram but must be easy to understand and accurate.

If a grower uses a trade mark as a commercial designator to identify the plant as originating from that grower the trade mark should also appear on the labels.

a. The trade mark is not to be used as the botanical or cultivar name of the plant or as a substitute for the botanical or cultivar name of the plant.

b. If a trade mark is used on the label it should be consistently used in the same way on all labels which bear that trade mark. Preferably it should be depicted in capital letters, fancy script, in bold print or a colour all of which are different to the way in which the botanical and cultivar names are depicted.

c. If the trade mark is registered the ® can be used in close proximity to the trade mark. If the trade mark is awaiting registration or is an unregistered trade mark the letters TM can be used in close proximity to the trade mark until registration is achieved. The TM is normally in capital letters and ‘raised’ above the name/expression it is associated with. This is also the case with the ® symbol.

d. The trade mark should be followed with a noun or the botanical name, the cultivar name or the common name, e.g. EVERGREEN CASCADE ® Weeping Alder Alnus jorullenesis 'Pendula'. It is recommended that the botanical name be in a font size that is in proportion with the general label font and is legible.

License Names or Trade Marks:

a. Where a grower uses a cultivar name which is the subject of protection under the Plant Breeders Rights Act and the use of that name is licensed to the grower by the PBR owner, the grower should indicate that he/she is the licensee of the PBR protected variety. The label should be in accordance with this guide and any terms of use in the licence agreement.

b. Where a grower uses a trade mark under license from another party the grower should use the trade mark in accordance with this guide and also in accordance with the licence agreement with the other party. It is recommended that the grower indicates that the trade mark is used under license e.g. EVERGREEN CASCADE ® Weeping Alder Alnusjorullenesis 'Pendula' used under licence.

Other Notices:

a. Some growers may wish to include a "passing off" notice on their plant labels. Such a notice is appropriate and can be used when the grower has adopted a trade mark to identify the commercial origin for a plant and the trade mark has been used to such an extent (either as a registered or an unregistered trade mark) for a reputation to have developed in that trade mark. [e.g. This plant has been promoted by XYZ Nursery in the course of their business. ANY PERSON PASSING OFF a plant or plants as being those of XYZ Nursery or their authorised distributor by using the name XXYYZZ or imitating this label will be liable to civil action.] A "passing off" notice is not to be directed to the botanical name, cultivar name or common name of the plant. To date, many uses of the “passing off” notice have not been used in conjunction with the correct use of a trade mark. Growers must be careful in the correct use of any “passing off” notice(s).

A copyright notice may appear on the label if the grower is the owner of copyright in the artistic material or photographs appearing on the label, e.g. © Copyright 2005 – (XYZ Nursery).

b. It is recommended that the grower seeks legal advice to determine ownership of copyright.

Potentially Harmful Plants - Consumer Health

1. Introduction:

Australians are fortunate in having access to a wealth of plant species. Most of these are harmless. However, there is a level of public concern regarding the potential harm from some plants in the house and garden. These guidelines for labelling will ensure that the public is informed of potentially harmful plants.

Plants that are known to be harmless do not require a warning.

A list of potentially harmful plants that are harmful if eaten can be found in Appendix 1.

This list has been established as a guide only by Nursery and Garden Industry Australia (NGIA). It was developed from a combination of reputable international and local sources and contains the list of plants known to be potentially harmful. The list will be regularly reviewed and updated by the NGIA Board and relevant subcommittee(s) with input from external expertise. This list is restricted to potentially harmful plants that are commonly cultivated for sale, and excludes weeds of national significance e.g. Lantana camara.

The list of potentially harmful plants posted on the NGIA website will be considered to be the most up-to-date list.

Disclaimer:

While every effort has been made in preparing this list, Nursery and Garden Industry Australia, accepts no responsibility for any errors, omissions or inaccuracies. NGIA accepts no responsibility to persons who may rely on this document, in whole or in part, for whatever purpose. As new species are continually being discovered and commercialised they need to be verified by authoritative institutions such as State Herbariums.

2. Need for Referencing on the Label

The required wording for each potentially harmful plant is as per Appendix 1 and must be presented in such a way as to not be confused with the general text of that label (as per the definition of a plant label).

Potentially Harmful Plants - Environment

The Nursery and Garden Industry is an active participant in processes relating to invasive plant management. The correct identification of plants by their botanical name will ensure accuracy in plant identification. The diversity of plant lists and regional focus of plant producers make it essential that there is an agreed scientific process for risk assessment that is valid to variety or cultivar level. With this in mind, the Australian nursery industry has recently developed an invasive plant risk assessment tool which can ascertain the degree of invasive risk associated with plants. This can be accessed by visiting the NGIA website.

Plant producers are urged to adhere to the following recommendations:

• Be aware of the legislation relevant to plant production and trade in their area. All plants on the WONS list are banned from production, sale or trade in all jurisdictions in Australia. Details of the WONS list can be found by clicking HERE.

• Do not produce plants for sale if they are on the National Environmental Alert List and Noxious Weeds List. This list is jurisdiction specific and will impact on what may be sold in various regions. The label should state any restrictions to where the plant is grown.

• Review the degree of invasive risk associated with plants available for sale using the Australian nursery industry invasive plant risk assessment tool.

• Provide cultural guidelines re plant management if a plant MAY show invasive characteristics e.g. Remove seed heads after flowering, dispose of plant or fruit via burial or approved composting facility.

General Requirement for Industry:

A grower must take all reasonable steps to avoid using labels for ornamental plants which are misleading or deceptive or likely to mislead or deceive. To mislead someone may include leading them to a wrong conclusion, creating a false impression or making false and inaccurate claims.

Designing and printing labels can be a difficult, detailed and expensive operation if done incorrectly. NGIA would recommend that you seek independent legal advice in this area to check your labels for accuracy and compliance before printing. You should also ensure your label supplier is providing labels that conform to the guidelines.

If barcodes are used on labels then they should comply with standards set by GS1. A copy of these can be found on the GS1 Australia website.

Questions or Issues:

Any questions or complaints about the content of plant labels can be directed to the Nursery & Garden Industry Australia, 7129 Baulkham Hills BC NSW 2153 or your state or territory nursery industry association. The version of these guidelines located on the NGIA website is the latest and current version. The Guidelines will be reviewed every 3 years by the NGIA Board and relevant subcommittee(s).

References and Links:

Botanical Names database: www.ars-grin.gov/~sbmljw/istaintrod.html accessed October 2012.

Code of Recommended Retail Practice Relating to the Labelling and Display of Potentially Harmful Plants - Published for its members by The Horticultural Trades Association December 2005

Frohne, D. and Pfänder H. J. (2005). Poisonous Plants: A Handbook for Doctors, Pharmacists, Toxicologists, Biologists and Veterinarians. Manson Publishing, UK.

IP Australia (for PBR, Trademark and Patent information) www.ipaustralia.gov.au accessed October 2012.

McKenzie, R. (2012). Australia's Poisonous Plants, Fungi and Cyanobacteria, A Guide to Species of Medical and Veterinary Importance. CSIRO Publishing, Australia.

Noxious Weeds List by State Jurisdiction: www.weeds.org.au/noxious.htm
accessed October 2012.

Plants and fungi poisonous to people in Queensland: Queensland Government Booklet 2005 – Queensland Health and Environmental protection Agency.

Primefact 359 – Garden Plants poisonous to people. NSW DPI: November 2006

The Plant List: http://www.theplantlist.org/ accessed October 2012.

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Griffith University, Queensland

SUMMARY AND EXAMPLES

The examples below indicate how these guidelines should be put into practice.

We have identified eight different kinds of names that now appear quite frequently on retail plant labels and here we show how the words “spring splendour” can be presented in different ways to indicate different kinds of names.

Botanical Name:

• The botanical name is the single unique identifier for the plant and should be placed somewhere on the label. It may be put on the back of the label when the front is used for strong promotion. Botanically this is the species name consisting of the genus and specific epithet.

Grevillea rosmarinifolia

• If the plant is a botanical variety of this species it would be written:

Grevillea rosmarinifolia var exaltatus

• If the plant is a cultivar of this species it would be written:

Grevillea rosmarinifolia ‘Spring Splendour’

• In the above botanical name the words ‘Spring Splendour’ in single quotes are known botanically as the cultivar epithet and this kind of botanical name is often referred to as the cultivar name. As presented here the cultivar has no legal protection.

• Note: the terms ‘cultivar’ and ‘botanical variety’ refer to very different things and must not be used interchangeably. In Plant Breeder’s Rights terms, a ‘plant variety’ or a ‘variety’ is the same as a ‘cultivar’.

Synonym:

• Alternative or old names are placed in brackets after the botanical name.

Corymbia citriodora (syn. Eucalyptus citriodora). In Plant Breeder’s Rights terms, a synonym is generally an alternative plant variety name that is included in the application for PBR.

- The synonym is placed immediately after or under the botanical name.

Trade Marks

• These are generally placed on the front of labels as promotional brand names.

• An unregistered common law trade mark:

SPRING SPLENDOUR TM Grevillea rosmarinifolia

• In this example the TM would indicate an unregistered trade mark, and that Spring Splendour is a brand of Grevillea rosmarinifolia.

• A registered trade mark:

SPRING SPLENDOUR® Grevillea rosmarinifolia

• In this example the ® would indicate a registered trade mark and that Spring Splendour is a brand of Grevillea rosmarinifolia.

• The trade mark cannot be used as the botanical or cultivar name of the plant or as a substitute for those names.

• There are no absolute rules on writing trade marks. However, in general a plant trader's trade mark is given the letters ™ written beside it when it is found on packaging and advertising. The symbol™ is generally taken to indicate a pending registration or common usage, while the symbol ® indicates a registered trade mark with full legal protection. We recommend this usage even though it is not legally required.

• It is recommended that the trade mark be written in capital letters or possibly a fancy script or bold colour that is different from the botanical or cultivar names. If the trade mark is a logo, make sure that it is written in the form that it is registered.

• A particular trade mark should be used consistently in the same way on all labels

• Somewhere on the label the trade mark should be followed by the botanical and/or cultivar and/or common name, for example:

EVERGREENEDGER® Buxus sempervirens 'Rotundifolia', Round-leaf Box

• Where a trade mark is used under licence from another party it should be used in accordance with the licence agreement and it is recommended that licensing be indicated on the label, for example:

EVERGREEN EDGER® Buxus sempervirens ‘Rotundifolia’, Round-leaf Box, trade mark used under licence.

• Sometimes a copyright notice may appear on the label to protect the literary, artistic material or photographs appearing on the label, for example:

© Copyright 2005 – GreenGills Nursery

• Avoid genercising the trade mark, this is where the product becomes generic or commonly known by. Trade marks should be used as an adjective not a noun or a verb for example;

SPRING SPLENDOURTM grows to 2 metres is incorrect
SPRING SPLENDOURTM Grevillea rosmarinifolia grows to 2 metres tall is correct

Plant Breeder’s Rights:

• A true cultivar name protected by PBR:

Grevillea rosmarinifolia ‘Spring Splendour’

• A plant protected by PBR under a PBR variety name:
Grevillea rosmarinifolia ‘SPRSPLEN’

• Where a PBR protected plant is used under licene from another party it should be used in accordance with the licence agreement and it is recommended that licensing be indicated on the label, for example:
Grevillea rosmarinifolia ‘Spring Splendour’ is under licence

Note, it is advisable (but not mandatory) for all names protected under PBR legislation to carry the PBR symbol or the letters "PBR".

The PBR symbol or letters should not be applied to trade marks, only varieties can bear the PBR logo or letters.
Also, note that plant material sold for test marketing before the lodgement of an application for a PBR should be labelled to establish an intention and time frame for an application for PBR. The following words should be used:
"Eligibility of this plant as a registrable plant variety under Section 43(6) of the

Plant Breeder's Rights Act 1994 will expire on <insert date>."

Note: The date nominated must not exceed 12 months from the date of first sale in Australia and not more than four years from the date of first sale overseas (or six years in the case of overseas sales of tree and vine varieties).

Common Names:

• Common names are “generic” and therefore cannot be used as trademarks or cultivar names: they are written without quotes or any other embellishment or symbol.

Potentially Harmful Plant Wording

If this plant was known to be potentially harmful we would recommend the following wording:

Amaryllis belladonna - CAUTION Harmful if eaten

Potentially Environmentally Harmful Plant Wording

If the plant is known to be a declared weed in another state we would recommend the following wording on the label:

Lavandula stoechas - This plant is a declared noxious weed in Victoria and Western Australia

Hedera helix - English Ivy is a declared weed in ACT and considered highly invasive. Ensure the plant is controlled if planted and dispose of appropriately.

Appendix – 1. Potentially Harmful Plants: Health

Potentially harmful plant
genus - includes all
species unless specified
Potentially harmful plant
common name/s Required warning
Abrus precatorius
Coral Pea, Crab's Eyes, Paternoster
Beans CAUTION Harmful if eaten
Acalypha
Red Hot Cat-Tail, Copperleaf, Chenille
Plant
CAUTION Harmful if eaten/skin & eye
irritant
Acokanthera
Dune Poison Bush, Wintersweet CAUTION Harmful if eaten/skin & eye
irritant
Aconitum napellus Badger's Bane, Monkshood, Wolfsbane CAUTION Harmful if eaten/skin irritant
Actaea
Doll's Eyes, White or Red Banberry,
Snake Berry CAUTION Harmful if eaten/skin irritant
Adenium Desert Rose, Impala Lily, Sabi Star CAUTION Harmful if eaten
Aesculus hippocastanum Buckeye, Horse Chestnut CAUTION Harmful if eaten
Aglaonema
Aglaonema, Painted Drop-Tongue CAUTION Harmful if eaten/skin & eye
irritant
Agapanthus praecox
ssp.orientalis
African Lily, Lily-of-the-Nile CAUTION Harmful if eaten/skin & eye
irritant
Agrostemma githago Common Corncockle CAUTION Harmful if eaten
Ailanthus Tree of Heaven CAUTION Skin & eye irritant
Allamanda
Allamanda, Golden Trumpet CAUTION Harmful if eaten/skin & eye
irritant
Alocasia
Taro, Chinese Taro, Giant Taro, Cunjevoi,
Spoon lily, Elephant's ear
CAUTION Harmful if eaten/skin & eye
irritant
Alstromeria Lily of the Incas, Peruvian Lily CAUTION Skin irritant

Amaryllis belladonna
Belladonna Lily, Jersey Lily, Marach Lily,
Naked Ladies CAUTION Harmful if eaten
Anthurium Anthurium, Flamingo Flower CAUTION Harmful if eaten/skin & eye

irritant
Apocynum cannabinum Dogbane CAUTION Harmful if eaten
Argemone Mexican Poppies CAUTION Harmful if eaten
Arisaema
Arisaema, Dragonroot, Green Dragon,
Cobra Lily, Indian Turnip, Jack-in-the-
Pulpit
CAUTION Harmful if eaten/skin & eye
irritant
Arum
Lily CAUTION Harmful if eaten/skin & eye
irritant
Atropa belladonna Belladonna, Log Fern, CAUTION Harmful if eaten
Aucuba japonica Japanese laurel, Spotted laurel CAUTION Harmful if eaten
Baptisia False indigos CAUTION Harmful if eaten
Borago officinalis Borage CAUTION Harmful if eaten
Bowenia Zamia 'fern', Byfield 'fern' CAUTION Harmful if eaten
Brugmansia
Angel's Trumpet CAUTION Harmful if eaten/respiratory
irritant
Brunfelsia
Lady of the Night, Francisia, Yesterday-
today-and-tomorrow CAUTION Harmful if eaten
Caesalpinia
Brazilian Ironwood, Leopard Tree, Bird-of-
Paradise Shrub, Barbados Pride,
Peacock Flower CAUTION Harmful if eaten
Caladium
Angel Wings, Elephant Ears CAUTION Harmful if eaten/skin & eye
irritant
Calla
Water Arum CAUTION Harmful if eaten/skin & eye
irritant
Calophyllum inophyllum
Beauty leaf, Alexandrian laurel CAUTION Harmful if eaten/skin & eye
irritant
Capsicum annum
(ornamental cultivars)
Pepper, Capsicum, Bell Pepper CAUTION Harmful if eaten/skin & eye
irritant
Caryota
Fish-tail palm CAUTION Harmful if eaten/skin & eye
irritant

Cascabela
Lucky nut CAUTION Harmful if eaten/skin & eye irritant

Cassia fistula Golden shower tree CAUTION Harmful if eaten
Castanospermum australe
Black Bean, Moreton Bay Chestnut CAUTION Harmful if eaten/skin, eye &
respiratory irritant
Catharanthus roseus
Madagascar periwinkle, Cayenne
jasmine CAUTION Harmful if eaten
Cestrum
Night Shade, Orange cestrum, Green
cestrum, Night-scented jessamine,
CAUTION Harmful if eaten/skin, eye &
respiratory irritant
Chelidonium majus
Greater Celandine CAUTION Harmful if eaten/skin & eye
irritant
Clivia Bush lily CAUTION Harmful if eaten
Codiaeum variegatum
Croton CAUTION Harmful if eaten/skin & eye
irritant
Colchicum
Autumn Crocus, Meadow Saffron,
Naked Ladies CAUTION Harmful if eaten
Colocasia esculenta
Cocoyam, Dasheen, Taro CAUTION Harmful if eaten/skin & eye
irritant
Convallaria majalis Lily of the Valley CAUTION Harmful if eaten
Corchorus olitorius Jute CAUTION Harmful if eaten
Coriaria Coriara CAUTION Harmful if eaten
Cotinus coggygria Smoke bush, Venetian sumac, Wig tree CAUTION Skin irritant
Cotoneaster Cotoneaster CAUTION Harmful if eaten
Cycas Cycas CAUTION Harmful if eaten.
Cyclamen
Cyclamen, Alpine Violet, Persian Violet,
Sowbread CAUTION Harmful if eaten
Daphne Daphne CAUTION Harmful if eaten/skin irritant
Datura Angel's Trumpet CAUTION Harmful if eaten
Delphinium Larkspur CAUTION Harmful if eaten
Dianella Dianella CAUTION Harmful if eaten
Dicentra spectabilis
Lady's locket, Dutchman's breeches,
Bleeding heart
CAUTION Harmful if eaten/skin & eye
irritant

Dictamnus albus Burning Bush, Dittany CAUTION Skin irritant

Dieffenbachia
Dumb Cane, Mother-in-Law's Tongue,
Tuftroot
CAUTION Harmful if eaten /skin & eye
irritant
Digitalis Foxglove CAUTION Harmful if eaten
Dracunculus
Black Arum, Dragon Arum, Voodoo Lily,
Snake Lily
CAUTION Harmful if eaten/skin & eye
irritant
Duranta
Duranta, Golden Bead Tree, Golden
Dew Drop, Pigeon Berry, Brazilian Sky
Flower
CAUTION Harmful if eaten/skin & eye
irritant
Echium
Echium, Paterson's Curse, Purple Viper's
Bugloss, Blue Weed, Pride of Madeira CAUTION Harmful if eaten/skin irritant
Epipremnum (E. aureum)
(SynScindapsusaureus)
Centipede Tongavine CAUTION Harmful if eaten/skin & eye
irritant
Eriobotrya japonica
Loquat, Japanese medlar, Nispero,
Japanese plum CAUTION Harmful if eaten
Erythrina Coral Tree CAUTION Harmful if eaten
Erythrophleum
chlorostachys
Ironwood CAUTION Harmful if eaten
Euonymus europaeus
Burning Bush, Corkbush, Winged Spindle
Tree, Strawberry Bush, Wintercreeper, CAUTION Harmful if eaten
Euphorbia (except E.
pulcherrima)
Euphorbia, Wood spurge CAUTION Harmful if eaten/skin & eye
irritant
Fatsia japonica
Formosan rice tree, Japanese fatsia CAUTION Harmful if eaten/ skin & eye
irritant
Gelsemium sempervirens Carolina Jasmine, Yellow Jessamine CAUTION Harmful if eaten
Ginkgo biloba Maiden-hair tree CAUTION Harmful if eaten/skin irritant

Grevillea Grevillea CAUTION Skin irritant
Hedera Ivy CAUTION Harmful if eaten/skin irritant
Heliotropium CAUTION Harmful if eaten
Helleborous Lenten Rose, Winter Rose CAUTION Harmful if eaten/skin irritant
Hemerocallis Day lily CAUTION Harmful if eaten
Hippeastrum Amaryllis, Knight’s Star Lily CAUTION Harmful if eaten/skin & eye

irritant
Homeria (syn. Moraea) Cape Tulip, Puerto Rico yellowseed CAUTION Harmful if eaten
Hyacinthoides Bluebells CAUTION Harmful if eaten
Hyacinthus Hyacinth CAUTION Harmful if eaten/skin irritant
Hydrangea
Hydrangea CAUTION Harmful if eaten/skin & eye
irritant
Hyoscyamus Henbane CAUTION Harmful if eaten
Hypericum perforatum St John's wort CAUTION Harmful if eaten
Ilex Holly CAUTION Harmful if eaten
Ipomoea tricolor
Belle de Nuit, Moonflower, Cardinal
Creeper
Morning Glory, Spanish Flag CAUTION Harmful if eaten
Iris Iris CAUTION Harmful if eaten
Jatropha
Peregrina, Coral Plant, Physic Nut, Spicy
Jatropha, Gout Plant
CAUTION Harmful if eaten/skin & eye
irritant
Kalmia
Sheep Laurel, Calico Bush, Mountain
Laurel
Eastern Bog Laurel, Swamp Laurel CAUTION Harmful if eaten
Laburnum anagyroides Laburnum, Golden Chain Tree CAUTION Harmful if eaten
Lagenaria siceraria Gourd CAUTION Harmful if eaten
Lathyrus Sweet Pea, Vetchling, Wild Pea CAUTION Harmful if eaten
Lepidozamia Wunu, Scaly Zamia CAUTION Harmful if eaten
Leucaena leucocephala CAUTION Harmful if eaten
Ligustrum Privet CAUTION Harmful if eaten
Lobelia (except L. erinus) Lobelia CAUTION Harmful if eaten
Lonicera
Honeysuckle CAUTION Harmful if eaten/skin & eye
irritant
Lupinus Russell lupin, Lupine CAUTION Harmful if eaten
Macrozamia Burrawang CAUTION Harmful if eaten
Mandevilla Chilean jasmine CAUTION Harmful if eaten

Mandragora Mandrake CAUTION Harmful if eaten
Manihot esculenta Cassava CAUTION Harmful if eaten
Melia Persian Lilac, White Cedar CAUTION Harmful if eaten
Mirabilis
Four O'Clock Flower, Marvel of Peru,
Vieruurtjie CAUTION Harmful if eaten/skin irritant
Monstera deliciosa
Fruit Salad Plant, Swiss Cheese Plant,
Mexican Breadfruit
CAUTION Harmful if eaten/skin & eye
irritant
Moraea Cape tulip CAUTION Harmful if eaten
Muscari Grape hyacinth CAUTION Harmful if eaten
Narcissus Daffodil, Jonquil CAUTION Harmful if eaten/skin irritant
Nerine Spider lily CAUTION Harmful if eaten
Nerium
Oleander CAUTION Harmful if eaten/skin &
respiratory irritant
Nicotiana Tobacco CAUTION Harmful if eaten
Ornithogalum Chincherinchee, Star of Bethlehem CAUTION Harmful if eaten
Papaver Opium Poppy CAUTION Harmful if eaten
Parthenocissus Virginia creeper CAUTION Harmful if eaten
Pedilanthus
Devil's Backbone, Zig-zag plant, Slipper
flower
CAUTION Harmful if eaten/skin & eye
irritant
Phaleriaclerodendron Rosy Apple CAUTION Harmful if eaten
Philodendron
Philodendron, CAUTION Harmful if eaten/skin & eye
irritant
Phytolacca
Poke, Pokeberry, Pokeweed, Bella
Sombra Tree CAUTION Harmful if eaten
Physalis alkekengi Chinese lantern, Winter cherry CAUTION Harmful if eaten
Pimelea CAUTION Harmful if eaten
Plumeria
Pagoda Tree, White Frangipani,
Frangipani CAUTION Skin & eye irritant
Podophyllum May Apple CAUTION Harmful if eaten
Polygonatum Solomon's seal CAUTION Harmful if eaten
Polyscias Aralia, Malaysian Aralia, Geranium CAUTION Harmful if eaten/skin irritant

Aralia, Ming Aralia
Primulaobconica German Primrose, Poison Primrose CAUTION Skin irritant
Prunus
laurocerasus&lusitanica
Cherry Laurel, Laurel Cherry
Portugal Laurel, Portuguese Laurel CAUTION Harmful if eaten
Rhamnus
Italian Buckthorn, Coffeeberry, Redberry
Common Buckthorn, South African
Dogwood CAUTION Harmful if eaten
Rhus
Rhus Tree CAUTION Harmful if eaten/skin & eye
irritant
Ricinus communis
Castor Bean Plant, Castor Oil Plant CAUTION Harmful if eaten/eye &
respiratory irritant.
Robinia psuedoacacia Black Locust, False Acacia CAUTION Harmful if eaten
Ruta graveolens Common Rue, Herb of Grace, Rue CAUTION Skin & eye irritant
Sambucus Elder, Elderberry CAUTION Harmful if eaten
Schefflera Umbrella Plant CAUTION Skin irritant
Scilla Bluebell, Squill CAUTION Harmful if eaten
Scindapsus
CAUTION Harmful if eaten/skin & eye
irritant
Solandra maxima Chalice Vine CAUTION Harmful if eaten
Solanum Solanum CAUTION Harmful if eaten
Sorbus aucuparia Rowan, Mountain ash CAUTION Harmful if eaten
Spathiphyllum
Peace Lily CAUTION Harmful if eaten/skin & eye
irritant
Symphytum Comfrey, Knitbone CAUTION Harmful if eaten
Synadenium grantii
African Milkbush, Grant’s Milkbush CAUTION Harmful if eaten/skin & eye
irritant
Syngonium
Syngonium, Arrowhead Vine, Five
Fingers vine
CAUTION Harmful if eaten/skin & eye
irritant
Tabernaemontana
Crape Gardenia, Crape Jasmine,
Pinwheel Flower, Milkwood CAUTION Harmful if eaten
Taxus Yew CAUTION Harmful if eaten

Templetonia retusa Cockie's tongue, Bullock bush CAUTION Harmful if eaten
Thevetia (syn.
Cascabelathevetia)
Lucky Nut, Yellow Oleander
CAUTION Harmful if eaten /skin irritant
Toxicodendron
Californian Poison Oak, Western Poison
Oak
CAUTION Harmful if eaten/skin & eye
irritant
Triunia Spice Bush CAUTION Harmful if eaten
Tulipa Tulip CAUTION Harmful if eaten /skin irritant
Veratrum False Hellebore CAUTION Harmful if eaten
Wisteria Wisteria CAUTION Harmful if eaten
Xanthosoma
Yautia, Tannia, Blue taro CAUTION Harmful if eaten/skin & eye
irritant
Zamioculcas zamiifolia
Zanzibar gem, Zee zee, ZZ plant, Money
tree, Arum 'fern', Eternity plant
CAUTION Harmful if eaten/skin & eye
irritant
Zantedeschia
Arum Lily, Calla Lily CAUTION Harmful if eaten/skin & eye
irritant
Zephyranthes Wind flower, Fairy lily, Rain lily CAUTION Harmful if eaten
Zigadenus Death Camas, Zygadene CAUTION Harmful if eaten

Appendix – 2. Industry guidelines for PBR labelling (from the IP Australia website)

Varieties covered by provisional or full protection under the Plant Breeder's Rights Act 1994 should use the accepted form of the logo and warning as illustrated.
If several varieties of the same species under a brand name are listed, the PBR symbol should be displayed next to the protected varieties.
Note: It is no longer necessary to display application or grant numbers.
Labelling Seed Bags

This version of the logo prints either solid PMS 562 or Black onto seed bag packaging. The warning should appear immediately under the logo but must not encroach into the blank space required around the logo.
The minimum amount of blank space to surround the logo is indicated by the dotted line.

Dotted line does NOT print

NB: Delete keyline from artwork
Unauthorised commercial propagation or any sale, conditioning, export, import or stocking of propagating material of this variety is an infringement under the Plant Breeder's Rights Act 1994.

Application of Logo to Variety Name
Space between name and the logo =
the width of a character “c”
Cap height of box =
height of
section of
logo

Labelling Plants

Use of the logo on ‘tie-on’ or ‘push-in’ labels.

Seed and plant categories

Right holders should use the PBR symbol to denote varieties under protection of Plant Breeder’s Rights in catalogues offering for sale.

ESSENTIAL
FOR GROWTH
The Australian Nursery
& Garden Industry's
Policy Position on Water
July 2015

Essential For Growth

The Australian Nursery & Garden Industry's Policy Position on Water

The viability of the Australian Nursery and Garden Industry is intrinsically linked to the availability and affordability of suitable quality water for the production and ongoing care of plants.

The impact of water availability in the wider community plays an important part through influencing the profitability and strength of markets in which the Nursery and Garden Industry (NGI) operates. These markets consist primarily of the retail market, landscape sector, and farming and forestry markets.

Given this, it is clear to see how water is essential for growth in the NGI in more ways than one. Likewise, based upon its reliance on water, the nursery industry acknowledges that it has a lead role to play in the wider water debate in Australia.

Since the mid-2000's the industry has undergone much change as wide spread drought resulted in water restrictions being placed upon businesses, the public and environment. These restrictions caused massive impacts to nursery industry markets and certainly had a detrimental impact upon industry profitability. Since then however, there has been a greater understanding develop within the industry and the wider community of the value of water, along with a number of cultural shifts in the use of water.

Focus at the consumer level has been directed upon smart water practices, conservation methods, such as alternate irrigation methods (drip irrigation) cultural practices (appropriate plant selection, mulching and the prudent use of allied products) and alternative water sources such as grey water, recycled water and rain water.

At the industry level more growers have adopted improved water conservation methods, updated irrigation infrastructure and adopted a more prudent approach to water budgeting, management and stewardship.

Water regulators have also taken a more considered approach to water restrictions and have indeed shifted their focus beyond water being a commodity to that of an enabling resource.

However we now operate in an era where the effects of climate change and variability expressed through increasingly frequent extreme weather events are being more strongly felt. Drought still remains an issue and is likely to remain so into the future. Storms and large scale floods have the potential to pollute our water environment and these events have been seen numerous times in recent years. This level of climate uncertainty therefore drives the NGI to continue undertaking a proactive approach to water policy.

The Australian NGI faces a number of intrinsically linked challenges in relation to water, which can be broadly summarised into the areas of climate uncertainty and the influence of government policy on water.

First and foremost of these are the ongoing impacts of drought and climate variability. The past decade has seen some of the most extreme weather conditions reflected in recorded Australian weather data. This high degree of climate impact places stresses upon the industry, indeed unlike other horticultural industries the Australian NGI is affected on both sides of supply and demand through weather events.

Rising water costs are another issue which poses challenges to the industry, as water is a key production input. Cost pressures on water supply directly influence the cost of production and these costs are by necessity passed onto the markets which influence sales volumes. Likewise rising water costs also influence the market directly as user markets need to supply water to maintain the product post farm gate. Water quality must also be factored into consideration when discussing water costs as in production nursery systems high quality water is essential for producing quality plant material. There are costs associated with establishing and operating recycled water schemes and this may result in a price discrepancy between recycled and mains water.1 These pricing discrepancies limit adoption rates of recycled water products and leave industry and the markets more vulnerable to the impact of water restrictions and conservation measures if and when introduced in peak demand/limited supply periods.

Noted with water restrictions and enforced conservation measures are the influence that policy decisions have upon the Australian NGI. Policy decisions and how they are implemented directly impact the industry. Evidence of this was certainly seen beforehand with the introduction of widespread water restrictions in the middle of the previous decade.

Flowing on from the impact of policy and its implementation is the influence of general public opinion. There has been a considerable shift in the public's attitude to water in Australia in the past decades and this has certainly impacted upon sales 2 and indeed the product demographics of the industry, with focus certainly in the height of drought to low water use plants and increasing use of xeriscaping (low water use landscaping).

Issues facing the Australian Nursery and Garden Industry

1 Water recycling; What to consider before setting up a recycled water scheme Sydney Water, 2013 http://www.sydneywater.com.au/web/groups/publicwebcontent/documents/document/zgrf/mdu3/~edisp/dd_057020.pdf

2 Queensland lifestyle horticulture industry survey report
Queensland Department of Employment, Economic
Development and Innovation, July 2011

The variation in markets has also been demonstrated in the changing of urban demographics. Populations in urban areas are increasing, as is population density in these areas. The flow on effects from this will influence the debate around urban water in the coming years and will certainly impact upon the Australian NGI.

With the high degree of volatility surrounding weather impacts and the increasing pressures on urban water, comes the need for the Australian NGI to take proactive steps. This will ensure it and its markets have the ability to access sufficient water in a sustainable and economical manner, maintaining the viability of both the industry and urban green infrastructure which will enhance the livability of cities.

Responding to these challenges, six central strategies have been formulated with industry consultation:

1. Leadership in policy development and investment in the area of water.
Recognising the impact of policy decisions and investment on businesses and their customers, and the need for consultation.

2. Investment in on-farm support to address water management.
The realignment of investment and a commitment by governments to support on-farm practices, innovation and incentives to adapt, manage and respond to water issues.

3. Building upon established industry best management practice.
Recognising and supporting the Nursery Production Farm Management System (NPFMS) as a key water management strategy for the industry and investment in research development and extension.

4. Water security and assurance of access.
Without water and a future for water management both at the industry and community level then the industry will suffer and decline.

5. Recognition of water as an enabling resource.
This recognises the capacity that water has to enable jobs, economic development as well as the impact it has on the livability of our cities.

6. Support and acknowledgment for industry initiatives in water management by government and water regulators.

1. Leadership in policy development and investment in the area of water

Recognising the impact of policy decisions and investment on businesses and their customers, and the need for consultation.

Policy development by state, territory and federal governments has significant implications for the Australian NGI. Rapid policy development that is poorly designed and orchestrated may lead to greater impact on the industry than current water management arrangements across Australia.

Changes in water policy, especially urban water policy have significant impact upon the sustainability of the Australian NGI. Therefore, the opportunity to provide input into strategies and decisions made by Commonwealth, State and Territory Governments or authorities will always be required.

Proposed changes to water policy must be based upon sound science, credible and accurate data and demonstrated improvements to water conservation.

Policy impact statements must be undertaken with any proposed changes to water policy to identify and consider all impacts and benefits including social environmental and economic aspects before implementation.

Water policy must be based upon principles of fairness and equitability and conservation measures must be applied in a transparent, consistent and predictable manner complimented with industry consultation.

The Australian NGI requests that they be consulted and given adequate time and mechanisms to respond to issues regarding current and future changes to water management arrangements. This will ensure the industry has the best opportunity to contribute meaningfully in these discussions, take ownership of decisions made and assist in producing policy of substance.

Water policy must also be subjected to ongoing review and improvement processes. This will ensure an adaptive approach to the changing needs of industry, community and government and will see the continual incorporation of new knowledge and best practice into policy.

The Australian NGI is in principle supportive of national coordinated water policy approaches.

Likewise the Australian NGI is supportive of the ongoing development of water market and pricing mechanisms to support water conservation efforts, provided that such pricing mechanisms are fair and equitable across the water use spectrum and the development of water markets do not unduly disadvantage the Australian NGI and are based upon sound information on water use needs.

2. Investment in on-farm support to address water management

The realignment of investment and a commitment by governments to support on-farm practices, innovation and incentives to adapt, manage and respond to water issues.

The production of quality plants requires access to reliable water supplies of appropriate quality. As a result the Australian NGI has valued water as the foundation on which industry growth and productivity is based. As such the Australian NGI support government policy which encourages on-farm practices, innovations and incentives to manage water use and improve efficiencies.

This importance of water has led to the development of innovative approaches to water management and use and has driven continued improvements in water use efficiency.

In the past years a great deal of investment has been directed into water use efficiency. Much of this investment has been in partnership with the Federal Government and Horticulture Innovation Australia Limited (previously Horticulture Australia Limited) through the Nursery Industry levy.

Some examples of this investment include;

Nursery Industry Water Management Best Practice Guidelines 3 - first produced in 1997 it was incorporated into the Nursery Production Farm Management System (FMS) in 2005 and subsequently updated in 2010. These guidelines focus upon 6 goals including; efficient water use, irrigation management tools, reuse of waste water, management of sediment, nutrient retention, and the environmentally responsible use of plant protection products.

Waterworks industry workshop series is a suite of workshops designed to assist growers in better understanding and improving on-farm water management practices through practical workshop delivered information. Delivery of these workshops is primarily conducted through the industry extension network, which deliver and facilitate on farm extension outcomes.

Water Management Tool Box for Nursery Production 4 is a group of excel based calculators designed to support growers with water budgeting and managing irrigation and drainage water. This assists in the sustainable and responsible use of water on farm.

These examples constitute some of the change management tools which deliver results at the industry coal face and result in direct positive outcomes for industry water management. They also constitute a great method for delivering R&D outcomes through the industry extension network. It is also cognisant to consider that behavioural change in water management will be fundamental in ensuring long term water security.

Given the success of these initiatives it is of no doubt that further investment into this area will continue to see positive returns, as growers adopt these basic processes into their business practices and continue to translate new information into on farm practice and better water

management outcomes.
3 Water Management Best Practice Guidelines
http://www.ngia.com.au/Section?Action=View&Section_id=556
4 Water Management Tool Box for Nursery Production
http://www.watertoolbox.ngi.org.au/

3. Building upon established industry best management practice

Recognising and supporting the Nursery Production Farm Management System (NPFMS) as a key water management strategy for the industry and investment in research development and extension.

The Australian NGI seeks recognition and support of the Nursery Production Farm Management System (FMS) by all levels of government as a key water management tool for the local industry. This industry driven best management practice (BMP) program provides production nurseries, growing media suppliers and greenlife markets with a framework for sound on farm risk management in relation to water amongst other key areas. 5

The Nursery Production FMS incorporates three key programs

• Nursery Industry Accreditation Scheme Australia – Best Management Practice (NIASA-BMP),
• EcoHort® - which promotes best management practices in environmental and natural resource management and;
• BioSecure HACCP- which promotes best practice in pest and disease management and biosecurity risk assessment and management

Both the EcoHort® and BioSecure HACCP programs play key roles in managing the impact of nursery use on water in areas such as nutrient loads and pathogen control.

It is essential that the NPFMS utilise the best available science and are regularly updated as research evolves and new findings on innovative practices to manage water become available. Investment in R&D into these best practice programs is vital to ensure these programs are relevant and in line with innovation and technological advancements in areas such as water scheduling, application methods, recycling and treatment.

Ongoing investment is also required to ensure the resources are available to deliver this valuable program to whole of industry through an extension network. Extension activities will ensure businesses can apply the outcomes of the Nursery Production FMS, as well as provide businesses with the outcomes of other government and industry research and development programs to directly address water management and water use efficiency.

5 Nursery Production Farm Management System
http://www.ngia.com.au/Category?Action=View&Category_id=524

4. Water security and assurance of access

Without water and a future for water management both at the industry and community level then the industry will suffer and decline.

This policy position acknowledges that the availability of reliable and appropriate quality water supply is integral to the sustainability of the Australian nursery and garden industry at both the industry level and at an individual business level.

The Australian NGI acknowledges that water is a finite resource and is committed to sustainable water use. The industry is an efficient and responsible water user, and has demonstrated a commitment to addressing water issues and making ongoing performance improvements.

The availability of water extends to the markets that the Australian NGI services namely, the retail sector, landscape sector, farming and forestry sectors. Without access to water these markets will suffer which will directly influence the profitability of the Australian NGI. In addition water availability will impact upon urban greenspace quality and viability.

Complementing the need for industry water security and assurance of access, urban water use supply must be considered in a broader context addressing the whole of water cycle. Such considerations include the disposal, capture, treatment and reuse of water, as well as the incorporation of storm water, wastewater and treated effluent into the commonly available suite of water resources.

The Australian NGI strongly supports a move away from reliance on potable water sources in both production nurseries and in the urban forest setting and actively encourages moves to on site recycling and improved access to reclaimed storm water or treated effluent fit for use where available. Indeed the Australian NGI supports moves to optimise the use of all available water resources.

This will ensure that our water sources are diverse and will drive resilience to the impacts of climate change and variability.

With the importance of water to the industry clearly seen the Australian NGI will seek to develop a greater understanding of the risks to long term water availability and seek to develop strategies to manage these risks.

5. Recognition of water as an enabling resource

This recognises the capacity that water has to enable jobs, economic development as well as the impact it has on the livability of our cities.

The Australian nursery and garden industry is a significant sector of the Australian horticultural industry with an estimated value in excess of $1.5 billion annually.[6]

It is important to note that the breadth of the industry is quite diverse with end user markets being supported in nurseries, forestry, revegetation, fruit and vegetable farming, cut flower markets and other specialised arenas.

Central to supporting this industry is water, without it the economic impacts would be significant. This has been demonstrated in the past, in the wake of the 2004 drought and the introduction of stringent water restrictions at business, consumer and public levels, which led to job losses and reduced turnover.

Transitioning beyond the direct economic impacts to the NGI, it is prudent to consider the impact of water as an enabling resource on the urban green infrastructure of our cities, towns and suburbs.

Improving our urban green infrastructure is increasingly being seen as an essential component to managing some of the key negative products of the urban environment.[7] A good level of tree canopy coverage has positive benefits to ameliorate the urban heat island effect which has flow on effects to the levels of human mortality rates due to heat injury. Another important flow on effect of a good tree canopy cover is the positive influences on power consumption for heating and cooling. By shading our suburbs and reducing wind velocities with trees, peak energy use demands can be reduced. This can reduce load requirements on energy infrastructure.

Further to this good tree canopy coverage will reduce the impact of rainfall events, especially through reducing peak load pressures upon existing water management infrastructure. This is especially important as urban population densities increase and the base load on waste water management systems is placed under strain.

Likewise it has been documented through numerous peer reviewed studies that a good level of urban green infrastructure plays an invaluable role in improving human mental health and physical wellbeing in the urban environment. Biodiversity is also improved through increasing the levels of urban green infrastructure.

However without the support of water these benefits would cease or would be at the very least severely impacted upon. It is therefore vitally important that the extended green infrastructure of our cities, towns and suburbs be incorporated into water policy and that the enabling ability of water is recognised in this arena.

6 IBISWorld Industry report A0111 Plant Nurseries in Australia

7 Green Infrastructure: Life support for human habitats Ely M. and Pitman S. 2014 http://www.environment.sa.gov.au/files/1a6b24e1-d957-4da7-bb86-a12d0114fccd/bg-gen-Green_

Infrastructure_Evidence_Base_December_2012.pdf

6. Support and acknowledgment for industry initiatives in water management by government and water regulators

Over the past 20 years the Australian NGI has undertaken a number of initiatives designed to promote and improve water management both within the industry and the wider community. Indeed the Australian NGI is both well positioned and committed to educate consumers on water management within the urban environment. Likewise Nursery & Garden Industry Australia (NGIA) is, and will continue to be, committed to improving industry water management through promoting best practice supported by sound science and the delivery of innovation and implementation of new technologies.

Some of the current initiatives that the industry has developed and support are detailed;

Smart Approved Water Mark[8]; A collaborative effort between NGIA, Water Services Association of Australia, Australian Water Authority and Irrigators association of Australia developed the Smart Approved Water Mark scheme. This scheme provides a channel to inform consumers about the outdoor products and services they can use to save water.

Best Management Practice (BMP); as previously acknowledged in this policy the Nursery Production Farm Management System (NPFMS), incorporating Nursery Industry Accreditation Scheme, Australia (NIASA), EcoHort and BioSecure HACCP, is a suite of best management practice programs (BMP) which are designed to facilitate incremental improvements and assist in a systematic management of processes in production nursery businesses. A key aspect of this is the integration of water management into each of the NPFMS programs.

202020 Vision[9]; An initiative of the Nursery & Garden Industry Australia in conjunction with Horticulture Innovation Australia, the 202020 Vision is a national campaign with the goal of increasing urban green space in Australia by 20 percent by 2020. Complimenting this vision is a significant body of research supportive of the need for increasing urban green space and infrastructure. Aspects of this research relate directly to water management in the urban environment through the use of trees and plants to intercept rainfall and control run off, thereby reducing load on waste water systems and limiting the impact of erosion.

These initiatives demonstrate the determination of the Australian NGI in relation to being a leader in pertinent water issues. It also clearly demonstrate the ability of the Australian NGI to act as an educator of the public in water conservation and conduit of water conservation information.

8 Smart Approved Water Mark www.smartwatermark.info

9 202020 Vision www.202020vision.com.au

Further Information

If you would like further information about the Australian Nursery & Garden Industry’s Policy Position on Water please contact:

Nursery and Garden Industry Australia
Unit 58, 5 Gladstone Road
Castle Hill, NSW, 2154
Mailing Address
PO Box 7129
Baulkham Hills BC
NSW 2153
Phone: 02 8861 5100
Email: info@ngia.com.au
Web: www.ngia.com.au

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Nursery &
Garden
Industry
Australia
Communication
Policy & Procedure
2015

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For further information contact;
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Phone (02) 8861 5100 Email chris.oconnor@ngia.com.au

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Background

Nursery & Garden Industry Australia (NGIA) is the national peak industry body for the nursery and garden industry (NGI). It delivers on a broad range of activities which directly impact upon the viability and success of the nursery and garden industry.

NGIA works in an environment which poses a number of challenges and uncertainty and as such must leverage the work it does with its available resources.

NGIA undertakes regular communication with members, levy payers, the State/Territory NGI's, the public, as well as a wide range of other influencers such as government, research bodies and other industry groups. As the industry representative body, NGIA has a key role to play in communicating issues of importance to its members, levy payers and the wider community.

All communication needs to be relevant, accurate, clear, concise, targeted, well delivered and understood by the recipient. The quality of communication content can also dramatically impact upon NGIA credibility and its ability to influence and leverage stakeholders.

The delivery of communication has changed dramatically over the past decade as various print communication mediums have declined or gained in significance. Social media has rapidly gained mainstream acceptance and importance. The delivery of information in rich multimedia, multi-channel, streams is now a norm. Communications infrastructure improvements such as the NBN are increasing the wide uptake and capacity of online media and digital communication means.

NGIA has embraced the opportunities that online media offer however the external communication approach of NGIA is not always consistent and there are some gaps in the delivery of information.

However, communication still remains a fundamental component of NGIA's core business regardless of the form it takes. Likewise, communication is essential for the success of the NGIA and the wider industry.

Why do we need a communication policy and procedure document?

- To ensure the consistent and effective delivery of key industry messages
- To maintain and improve current communication mediums and develop future communication mediums
- To increase stakeholder engagement
- To assist in identifying gaps in delivery
- To protect the integrity and longevity of our communication mediums
- To maintain effective administration and efficiency
- To keep pace with emerging communication trends and help establish the benchmark for industry.

Policy

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Objective

Communication is central to the work undertaken by NGIA. This document will assist in the continuing development and refinement of communication between NGIA and its stakeholders. This will result in a more coordinated approach to NGIA communication through the provision of a set of common communication principles. These principals are aligned with the objectives 2 and 3 of the NGIA Industry Strategic Plan 2010-2015 and NGIA Industry Strategic Investment Plan 2012-2016.

• Objective 2 of the SIP is to "Enhance the capacity and efficiency of the industry's resources through upgrading industry skills, knowledge and practice (internal)" • Objective 3 of the SIP is to "Build industry support through shaping government, public and related industry understanding of the industry's benefits, and enhance these benefits through communications related to industry activities and benefits (external)."

This policy document aims to;

Analyse and document stakeholder groups

Audit and record current communication mediums

Identify and define the process for ensuring;

o The right message

o The target audience

o The best suited communication medium

o Corporate consistency

Establish a review process cycle to identify weakness and opportunities.

Identify targets for communication levels

Establish protocol for external communication

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Stakeholder Identification
Identifying the communication stakeholders is vital in ensuring a robust communication plan. As such NGIA has identified three broad key stakeholder sectors for external communication;

- Industry (NGI's members, levy payers and ancillary stakeholders),
- Public and;
- External Influencers

Each of these stakeholder sectors are integral to the success of the Australian NGI, however each audience sector has different motivations, information needs and communication medium preferences. Compounding this situation, each sector has a number of subsectors again with their own needs and preferences.
A degree of overlap exists in each of these audience sectors, whereby the same information streams, motivations or information needs can be applicable to multiple audience sectors. Figure 1 is a visual depiction of the stakeholder sectors, subsectors and their interaction.

Figure 1 - Audience sectors Australian Nursery & Garden Industry
PUBLIC INDUSTRY
EXTERNAL INFLUENCERS
Demographic
Subsectors
- Gen X
- Gen Y
- Baby boomers
- School age
- Mothers

Growers

Nursery Allied
Industry

Retailers
- Supply Chain

Educators

Issue Motivated
Groups

Aligned Industry Groups
Hort PIB's
AIH, AILA etc.

Media

Researchers

Government

International
vs. National
vs. State
vs. Local

Breeders

Horticulture
Innovation
Australia

State NGI

NGI members

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Present communication environment

NGIA has a number of different mediums at present covering a range of audience sectors. Figure 2 depicts a current audit of what communication mediums are present and what audience sectors they service.

Figure 2 Current communication mediums of NGIA
White circles represent websites and orange squares represent written material which may or may not be replicated online. The “Flora for Fauna” and “Life is a garden” websites are now both defunct; however a presence of material is still available online. Social media connected with websites is indicated via social media icons. Yellow websites are operated by external groups on behalf of NGIA.

Flora for
Fauna
Life is a
Garden
Greenlife
Careers
Plant Life
Balance
Your Levy
at Work
Blog
NGI/AMS
AuditingP
ortals
NGIA
Awards
Website &
Portal
Targeted
editorial
content
NGIA
Website
Hort
Journal
Nursery
Papers

Policy &
Annual
Report
Trade
Register
Targeted
mail
Plant
Safely
202020
Vision
Grow
Me
Instead
Plant
Risk Tool
IAC Annual Report

End state communication medium Landscape of NGIA

NGIA has a number of communication vehicles in use and a number of potential new vehicles/delivery mechanisms for further evaluation. These are depicted in Figure 3 and the key elements summarised below.

Web sites

NGIA operates two core websites. The “NGIA” website is aimed at industry with a minor focus on external influencers. “Plant Life Balance” targets the consumer/public demographic. These websites facilitate a central digital hub for the industry and act as repository of information and provide direction to services and other communication mediums.

Consultation

Consultation is essential for NGIA as it provides opportunity to impart information to, and obtain feedback from stakeholders. Consultation is achieved through a variety of means. At the formal level this includes; consultation meetings, AGMs, committee meetings (National Accreditation and Certification Committee (NACC), Environment & Technical Committee) and Adhoc surveys. NGIA also engages in consultation with government through various committees, written submissions and responses to policy. Consultations may be facilitated through face-to-face meetings, teleconferencing, webinars or other digital means. Consultation also occurs at the informal level through one on one discussion.

Social Media

Current and developing social media communication tools offer considerable scope for NGIA to enhance its message delivery. This can be achieved firstly through a greater breadth and depth of message penetration. Currently 81% of all Australians own a smartphone device with more than half of Australians updating or check social media daily.

Secondly social media also offers the opportunity to engage in two way communication with audience participants, as opposed to the primarily one sided communication of static media. This two way communication can be used to enhance service delivery and engagement with NGIA members and service users as well as the public and influencer sectors.

Scope for greater utilisation of existing social media communication tools exists through the development of materials and systems to ensure regularity of content posting and quality of posting.

NGIA currently uses Twitter Facebook and LinkedIn as its social media channels. Usage statistics1 as of April 2015 indicate the follow rates.

Facebook – 14,000,000 users

LinkedIn – 3,500,000

Twitter – 2,791,300 Active Australian Users

1 Social Media News - www.socialmedianews.com.au/social-media-statistics-australia-april-2015/

NGIA maintains two Facebook sites; an Industry NGIA page and the Public Plant Life Balance page. As noted in the statistics previously given Facebook has the highest social media uptake in Australia and an NGIA presence in this sector is beneficial given the potential reach of communication to both internal and external audiences.

Facebook was also critical in the 2011 launch of the Improve your Plant/Life Balance industry marketing campaign.

LinkedIn is a social media tool with a strong professional focus on networking and discourse. This platform provides mechanism for the industry to leverage the extended network of industry to promote industry messages. LinkedIn is also becoming a preferred medium for jobseekers. The NGIA presence includes the NGIA company page and two specific forums - Nursery & Garden Industry Business Improvement and Australian Nursery Industry Statistics. The 202020 Vision also maintains a LinkedIn forum which is linked from the NGIA company page. The forums provide a mechanism for growers to clarify technical questions and to connect directly with researchers in the arena.

Twitter is another mainstream social media tool which facilitates real-time micro-blogging. Twitter is also effective as a repeater channel of industry communications, extending the reach and support of aligned industry messages to a broader audience.

Whilst YouTube is used by industry, at this stage it is primarily used as a media hosting facility rather than as a social media channel. Content is readily adaptable to other digital assets as well as being shared socially. YouTube has potential to develop into an audio-visual library to support both consumer and industry knowledge.

Conferences and Field Days

Conferences and field days provide opportunity for face to face meeting and knowledge transfer through presentation, practical demonstration and participation in industry R&D. Conferences and field days also offer a social aspect to the industry fostering an environment conducive to informal knowledge transfer.

Portals

Portals are online hosted tools which provide submission facilities and act as a controlled repository of information. They are security managed with individuals accessing their own materials.

eLearning

eLearning presents an opportunity to convey knowledge transfer through targeted training messages applicable to specific audience sectors and subsectors. Cost effectiveness and a high degree of flexibility are inherent attributes to eLearning. Whilst not superseding face to face learning completely, eLearning provides a complementary means of delivery. The NGIA eLearning portal used is hosted by American based Talent LMS which is accessible via smartphone, tablet and PC. Opportunities for communication and improvement identification can be facilitated via surveys which can be embedded into the end of each course.

Farm Management System (FMS) Portal

The FMS portal is a custom designed management system to retain information on audits conducted as part of the Farm Management System.

Awards

The awards portal is an externally hosted mechanism for conducting online delivery of the National awards program. Entrants to the awards are able to respond to criteria and support this with multimedia assets such as video, images, documents. Judging is also easily facilitated via this platform.

Digital Magazines

Readymag represents a relatively new medium which allows for the publication of a wide variety of digital assets and packages them into a magazine style format for PC, tablet devices and smartphones. This has the advantage of incorporating multimedia assets including videos and interactive forms into a publication.

Multiple editors can submit items to be included and these can be vetted by a chief editor prior to inclusion in the magazine. Articles selected can be from NGIA source or from other sources of interest to NGIA members and the wider industry. Likewise NGIA authored content may be incorporated into NGIA members own Readymag publications providing opportunity for member benefit, furthering the reach of industry messages.

In comparison to traditional print mediums digital magazines offer a cost effective and adaptable solution.

Trade Register

The NGIA Trade register is a national publication detailing member businesses. The publication is available in both an online format as well as a printed version.

Webinars

Webinars offer an opportunity for presentation of an issue and provide a mechanism for audience participation. Webinars can also be recorded for later review and contribute further to our online industry knowledgebase. There are some drawbacks to webinars; as numbers of participants increase free discussion can be limited. As with all other technological based mediums access to IT and the degree of familiarity with IT can limit the numbers of users. However, webinars are becoming seen as an alternative to traditional conferences and field days due to their cost effectiveness and time convenience. Likewise webinars also offer advantages in eLearning knowledge transfer.

Electronic Direct Mail (EDM)

EDM provides a targeted distribution method across various market segments through email. Current EDM campaigns administered by NGIA include the monthly Your Levy at Work and direct NGIA mail outs. These are delivered via platforms that provide detailed analytics for each mail out. EDM has been utilised by NGIA for a number of years.

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Printed Collateral

NGIA, where required, produces a range of printed collateral. This includes information on industry programs for distribution at events such as conferences, trade expos and consumer events. Key documents include NGIA policy positions, FMS information and Plant/Life Balance/202020 Vision marketing materials and Annual Reports.

Plant Life
Balance
Website
202020
Vision
Website
 Greenlife Careers
 Plant Safely
 Flora for Fauna
 PlantRisk tool
 Grow Me Instead
 Kidsgrow
Two Way
Communications
 Annual Survey
 Polls
 Vox Pops
 Your Questions
CONSULTATION
MEETINGS
Committees
 NACC
 Env & Tech
 Ad Hoc
 Greenlife Careers
NGIA
Website Event Calendar
PORTALS
 FMS
 Awards
 eLearning
Technical Library Biosecurity
Water
Growing Media
Business
Green Cities

Advocacy Agripolitical
Presidents Thoughts
Policy
Industry Submissions
Committee Representation
Board
 Backgrounds
 Portfolios
 Selection process
Committee Members
 Backgrounds
 Portfolios
 Selection Process
Staff
 Backgrounds
 Portfolios
 EDM/BLOG
-National Nursery News
/Your Levy @ Work
 Pod/web casts
Industry
Ready Mag Consumer
ReadyMag
Trade
register
Crisis
Management
Media
Releases
Figure 3 - Desired communication landscape
 Conference
& Field Days
Webinars
Board

Review process for communication

NGIA should undertake an annual review of its communication policy. This is to ensure that focus is given to the choice of communication mediums being utilised, identify any gaps and to determine if NGIA can service its stakeholders with better communication tools and processes.

As part of this review attention should be given to any available metrics associated with communication uptake. Examples include Facebook engagement, email campaign opens, and website analytics. There is also an imperative to build into communication programs a mechanism to provide feedback on the effectiveness of those communication programs. For example the eLearning modules incorporate a survey at the end of each course for participants to provide feedback and shape further course improvements.

Reviews should also be guided by consultation with members to determine their engagement, uptake and perceived value of NGIA communications. This could be facilitated through targeted surveys (survey monkey) or as part of ongoing evaluation through interactive forms embedded in communications.

Given that communication via electronic mediums is progressing rapidly consideration should also be given to emerging communication mediums. This rapid progress of technology also demands that existing mediums are reviewed and if needed dated forms renewed to current standards; for example upgrading websites to reactive format.

Consideration should be given to ensuring the cost effectiveness of communications. This includes reviewing costs of print publications and mail house services, website hosting, teleconferencing/webcasting/webinar/ePortal/etc.

Procedures

NGIA Use Only – NOT FOR EXTERNAL DISTRIBUTION

Considerations for ensuring content quality and relevance

The fundamental question that must be asked in any communication is; what is the purpose of the communication? It is a call to action, is a response required or is it to inform only. The purpose of the communication will influence;

the importance of the message to both NGIA and the recipient,

the relevance to audience subsectors,

the choice of communication medium.

The message content needs be tailored with consideration to the following

a brief synopsis of what the issue is,

what are the implications to intended recipient,

does the intended recipient need to take action and if so what action,

where can more information be found.

Prior to release of any communication a vetting and editing process should be undertaken to ensure the accuracy of the message content, presentation and to ensure the absence of grammatical and typographical errors.

Considerations for selecting the best communication medium

The process of selecting an appropriate communication medium is of high importance to ensure successful communication outcomes.

The selection of appropriate communication mediums is dependent upon a number of factors. First and foremost amongst these factors is that the appropriate messages are conveyed to and understood by the intended audiences.

To ensure that the message is successfully conveyed to the target audience, thought must be given to the most suited medium. Considerations here are;

convenience for the recipient

number of engaged participants in a medium

the technological savviness of the recipients

The choice of communication medium will be influenced by the speed at which it must be disseminated and the formality of the message. Official letters may be required to be printed for example.

The cost effectiveness of a medium must also be scrutinised. Electronic mediums such as direct emailing, social media and the use of pdf publications offer a cost effective alternative to print publications and traditional mailouts. However this must be balanced against the uptake by the audience, which can be influenced by factors

perceived message importance (i.e. what’s in it for me)
volume of electronic communications received by the individual
levels of IT skill and access to the internet
Another consideration is the ability for sharing information once it has been released. Electronic mediums and social media in particular easily facilitate the sharing of information, which can have both desirable and undesirable consequences.
Desirable consequences include the transfer of information to parties not engaged but relevant to NGIA such as levy payers, allied industries or other green industry players.
Undesirable consequences could include the transfer of information to parties not intended to view the information, or for sensitive information to make its way into the hands of persons or parties which may utilise it to cause damage to NGIA and industry reputation.

Protocol for External Communication Standards

Employees and representatives of NGIA including office holders such as Board Directors or committee representatives should be aware that their communications reflect upon NGIA. They should therefore conduct any communications related to their NGIA role in a professional manner; this includes email, other written communications, during committee representation and on social media.
In all communications the following rules and guides apply;
Care should be taken to maintain the confidentiality of sensitive information.
No material is to be sent via communication media (including social media) which is; offensive, discriminatory, threatening, malicious, demeaning or harassing in nature.
Communications should not cause intentional damage to the reputation of NGIA, to its members, the wider industry and the public.
Intellectual property rights must be observed for all content.
Sources should be clearly referenced.
Be aware that personal use of social media may still occur in the public forum. You should be aware that your actions here can still affect NGIA’s reputation.
Editing should take place on all communications and important communications should be reviewed by another person prior to release.
All communications must comply with relevant legislation such as Spam Act 2003; Privacy Act.
Be aware of communication protocols and norms;
Avoid sending courtesy copies (CC) to multiple persons or replying all if it is not required.
Do not use emoticons and be aware of the limits in tone that are transmitted via email or other electronic communications.
Avoid the use of capitalised words.
Profanity and/or unsuitable content sharing.

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Corporate brand identity

NGIA maintains a corporate brand identity. To ensure consistency the use of NGIA logo, typeface and colour palette is directed through a usage guide available on the common drive: I:\PHOTOS & IMAGES\7.3 Logos\Nursery & Garden Industry

Specific programs including; Plant/Life Balance, the Nursery Production Farm Management System and 202020 Vision also have specific logo usage guidelines which can be found on the common drive.

202020 Vision I:\MARKETING\202020 Vision 2013-2015\Vision 202020\202020 Vision Material\Asset pack\Guide

Plant/Life Balance
I:\MARKETING\Plant Life Balance\Logos and images

Nursery Production Farm Management System
I:\ACTIVITIES & PROJECTS\Farm Management System\FMS Artwork & Logos

Acknowledgement of funding - Horticulture Innovation Australia (HIA) and the Nursery Industry Levy

Where required, acknowledgement for levy funds used in projects and outputs of those projects must be stated. Approval of acknowledgment statements must also be sought from HIA prior to publication.

Information on the process and wording of acknowledgement statements can be found at the HIA website located here;
http://www.horticulture.com.au/wp-content/uploads/2014/12/HIA-Interim-Publications-Guide.pdf

NOTE - This publication is an interim publication and may change. Please check the HIA website for updates.

Passwords and login administration

Passwords and login details must be recorded and details provided to Ms Heather Henderson NGIA Reception and Administration Manager.

Where possible an alternate staff member should also have administration rights on websites, social media communication tools and other forms of electronic media. This is to prevent any administrative issues arising if the key staff member is unable to access the tool due to leave, illness or on departure from NGIA.

Where possible the linked email address to accounts should be info@ngia.com.au rather than personal email addresses. Again this is to facilitate easier administration of the tool.

Crisis management and communication

As part of its preparation for dealing with potential crises NGIA maintains an industry crisis management guideline. The current version of the guidelines is available on the NGIA common drive.
I:\ACTIVITIES & PROJECTS\Crisis Management Plan\2015 version Crisis Management Guidelines
NGIA staff should be familiar with the plan and actions they should take in a crisis situation.
NGIA staff should also be aware of their responsibilities if dealing with media requests or requests from industry, government or the general public.
Identified examples of potential crisis for the industry include pesticide poisoning or contamination, illness or death from legionella in potting media, biosecurity incursion.
The key point of contact for the Industry will be the NGIA CEO in conjunction with the Board President of NGIA.

Media

NGIA staff and representatives may in the course of their duties be exposed to the media, both mainstream and industry. In all dealings with the media NGIA staff and representatives must at all times conduct themselves in a professional manner. Prior to commenting to media NGIA staff should seek permission to do so from the NGIA CEO or President.
NGIA staff who are funded through levy funded projects are reminded to refrain from commenting on agripolitical matters.
For considerations when dealing with the media in a crisis situation refer to NGIA Crisis Management Guidelines.
An NGIA template exists for a media release which is located at;
I:\MEDIA RELATIONS\Media Releases\TEMPLATE
Completed media release should be sent to Mr Matthew Carroll NGIA Communications Officer for distribution through media channels.

Appendices

Appendix 1 Summary of NGIA digital communication assets

Name Location Objective of medium Delivery Frequency Target

Nursery and Garden

Industry Australia website www.ngia.com.au Landing point for industry communications and information repository Ad Hoc news feed. Website is

reviewed each month

- NGIA Facebook https://www.facebook.com/nurseryandgardenindustry Communicate Industry events news and personalities Weekly post minimum
- NGIA Twitter https://twitter.com/NGI_NEWS Communicate Industry events news and personalities Weekly post minimum
- NGIA YouTube http://www.youtube.com/user/ausngi Communicate Industry events news and personalities, business improvement Adhoc

Nursery Papers http://www.hortjournal.com.au/

www.ngia.com.au Business Improvement and build Industry Capacity Monthly

Policy Statements http://www.ngia.com.au/Category?Action=View&Category_id=139 Communicate the position of Industry on pertinent issues As required

Your Levy At Work http://yourlevyatwork.com.au/ Communicate to Industry on Levy related activities Minimum of 4 per month

Plant Life Balance http://www.plantlifebalance.com.au/

Communicate to Public Industry and Influencers the PLB campaigns - more trees

please & put a plant on your desk Ad Hoc reviewed monthly

- PLB Facebook https://www.facebook.com/plantlifebalance

Communicate to Public Industry and Influencers the PLB campaigns - more trees

please & put a plant on your desk Weekly post minimum

- PLB Twitter http://twitter.com/improveyourPLB

Communicate to Public Industry and Influencers the PLB campaigns - more trees

please & put a plant on your desk Weekly post minimum

- PLB YouTube http://www.youtube.com/user/plantlifebalance

Communicate to Public Industry and Influencers the PLB campaigns - more trees

please & put a plant on your desk As required

National Audit Portal https://www.ngi.org.au/ Facilitate the recording and reviewing of FMS audit results As required

FMS Online Manuals http://fmsmanuals.ngia.com.au/login Online store for FMS Manuals As required

LinkedIn http://www.linkedin.com/company/nursery-&-garden-industry-of-australia?trk=hb_tab_compy_id_2897257

Promote professional connectivity and networks to the Nursery Industry

Stimulate professional discussion on topics pertinent to industry

Company page static needs quarterly

review. Posts from this site should be

as required

- Nursery & Garden

Industry Business

Improvement
http://www.linkedin.com/groups?home=&gid=5121115&trk=anet_ug_
hm
Forum designed for the promotion of business improvement within the Australian
Nursery industry   Weekly min postings
 - Australian Nursery
Industry Statistics
http://www.linkedin.com/groups?home=&gid=4846649&trk=anet_ug_
hm
Targeted focus group engaged with the need for Industry Statistics   Ad Hoc reviewed monthly
NGIA Awards portal http://www.ngiaevents.com.au/awards2014/ Submissions and management of judging for
awards As required

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Plant Safely Website www.plantsafely.com.au
Increase awareness of risks in gardening to the public
Repository of information
Static site - Review on 3 monthly
basis
E Learning Portal www.ngia.talentlms.com
Facilitate delivery of industry specific training and business improvement to
Industry Email as new courses released
Vision 202020 http://202020vision.com.au Landing page for Influencers and Public for Vision202020 program HIA / Republic of Everyone - Targeted
focus
Grow Me Instead www.growmeinstead.com.au Increase awareness of invasive plants to the public
Static site
Invasive Plant Risk
Assessment Tool www.plantrisktool.com.au Increase awareness of invasive plants to the public Static site

Appendix 2 Summary of NGIA paper based communication assets

Name Location Objective of medium Delivery Frequency Target
Nursery Papers
Appear in HortJournal and on NGIA website (currently open searchable
database) and back issues on the Hort Journal website Increase awareness of technical, business and marketing issues that
impact whole of industry. Linked to levy funding. Monthly to Hort Journal readership
Trade Register Mailed to NGIA membership and online via
http://traderegister.ngia.com.au/ Directory of NGIA members, products and services. Annually to NGIA membership
Targeted editorial content
Hort Journal, Greenworld and Horticulture Media Association News as
well as related industry publications such as The Bark/Landscape
Contractor Magazine. Non-industry publications also included.
Increase awareness of technical, business and marketing issues that
impact whole of industry. Linked to levy funding. Adhoc
NGIA Annual Report Mailed to NGIA membership is required. Appears on NGIA website. Comprehensive report on NGIAs activities throughout the preceding year. Annually prior to NGIA AGM as required
HAL Industry Annual Report Mailed to Levy Payers and on NGIA and HAL website. Comprehensive report on levy investment program. NIL -retained for reference post HAL/HIA
transition

NY12011 Nursery & Garden Industry Communications 2013-2015
Appendix 3

NGIA Digital Assets

Figure 1 NGIA website www.ngia.com.au

Figure 2 - Your Levy At Work www.yourlevyatwork.com.au

Figure 3 NGIA Twitter account NGIA@NGI_NEWS

Figure 4 - NGIA Facebook Page www.facebook.com/nurseryandgardenindustry

Figure 5 - LinkedIn forum Nursery & Garden Industry - Business Improvement

NY12011 Nursery & Garden Industry Communications 2013-2015
Appendix 4

NGIA Website Metrics

NY12011 Nursery & Garden Industry Communications 2013-2015

Note: The period Aug 14 - Mar 15 is lacking data due to the tracking code for google analytics not being properly installed during website upgrading.

NY12011 Nursery & Garden Industry Communications 2013-2015
Appendix 5

Your Levy At Work Metrics April 2013 - November 2015

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/04/2013
Click rate
6.6%
Open rate
28.6%
33.4%
List average
479
Opened
143
Clicked
29
Bounced
29.9%
212
5/11/13 2:33PM
0
1,196
19/2/15 7:52PM
0
1,436 98.0%Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/4/13 4:00AMYLAW Monthly RSS
Overview
1,465 Recipients
Delivered: Mon, 01 Apr 2013 04:00 am
10.0%
List average
3
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/4/13 4:00AMYLAW Monthly RSS

Country	Opens	Percent
Australia	967	96.6%
USA	17	1.7%
New Zealand	13	1.3%
Costa Rica	2	0.2%
Thailand	1	0.1%
United Kingdom	1	0.1%

Opens by location

Opens Clicks24-hour performance
89http://yourlevyatwork.com.au/update-on-the-proposed-australian-standard-for-grow
ing-trees/
47http://yourlevyatwork.com.au/new-federal-post-entry-quarantine-facility/
39http://yourlevyatwork.com.au/more-trees-please-for-our-communitys-health-and-we
llbeing/
32http://yourlevyatwork.com.au/post-entry-plant-industry-consultative-committee-pepi
cc-meeting/
4http://yourlevyatwork.com.au/
Sent 1/4/13 4:00AMYLAW Monthly RSS
Subscriber activity
Top links clicked
4:00AM 8:00AM 12:00PM 4:00PM 8:00PM 12:00AM
0
10
20
30
40
50
60

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/05/2013
Click rate
6.6%
Open rate
28.6%
32.6%
List average
463
Opened
155
Clicked
42
Bounced
33.5%
233
9/8/13 10:28AM
0
1,105
12/12/14 2:27PM
0
1,420 97.1%Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/5/13 4:00AMYLAW Monthly RSS
Overview
1,462 Recipients
Delivered: Wed, 01 May 2013 04:00 am
10.9%
List average
2
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/5/13 4:00AMYLAW Monthly RSS

Country	Opens	Percent
Australia	869	95.5%
USA	18	2.0%
New Zealand	13	1.4%
Singapore	7	0.8%
Turkey	1	0.1%
Germany	1	0.1%
Thailand	1	0.1%

Opens by location

Opens Clicks24-hour performance
100http://yourlevyatwork.com.au/new-pest-fact-sheets-available/
64http://yourlevyatwork.com.au/nursery-industry-and-e-learning/
37http://yourlevyatwork.com.au/farm-management-system-fms-manuals-online/
28http://yourlevyatwork.com.au/sydney-university-research-facilities-tour/
3http://yourlevyatwork.com.au/
40info@yvn.com.au
Sent 1/5/13 4:00AMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
4:00AM 8:00AM 12:00PM 4:00PM 8:00PM 12:00AM
0
20
40
60
80
100
120

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/06/2013
Click rate
6.6%
Open rate
28.6%
32.9%
List average
463
Opened
122
Clicked
42
Bounced
26.3%
190
15/8/13 12:10PM
0
1,075
19/8/15 4:01PM
0
1,407 97.1%Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/6/13 4:00AMYLAW Monthly RSS
Overview
1,449 Recipients
Delivered: Sat, 01 Jun 2013 04:00 am
8.7%
List average
9
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/6/13 4:00AMYLAW Monthly RSS

Country	Opens	Percent
Australia	789	91.3%
New Zealand	48	5.6%
USA	9	1.0%
France	5	0.6%
Singapore	3	0.3%
Indonesia	2	0.2%
United Kingdom	2	0.2%
Germany	1	0.1%
South Africa	1	0.1%
Italy	1	0.1%

Opens by location

Opens Clicks24-hour performance
70http://yourlevyatwork.com.au/2014-nursery-garden-industry-awards/
51http://yourlevyatwork.com.au/free-fms-information-pack-valued-at-over-50/
39http://yourlevyatwork.com.au/national-young-leader-awarded/
27http://yourlevyatwork.com.au/launch-of-the-updated-industry-biosecurity-plan-for-t
he-nursery-industry/
2http://yourlevyatwork.com.au/
Sent 1/6/13 4:00AMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
4:00AM 8:00AM 12:00PM 4:00PM 8:00PM 12:00AM
0
10
20
30
40
50

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/07/2013
Click rate
6.6%
Open rate
28.6%
35.2%
List average
501
Opened
159
Clicked
43
Bounced
31.7%
251
13/8/13 3:23PM
0
1,378
19/8/15 4:06PM
0
1,423 97.1%Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/7/13 4:00AMYLAW Monthly RSS
Overview
1,466 Recipients
Delivered: Mon, 01 Jul 2013 04:00 am
11.2%
List average
1
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/7/13 4:00AMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,050	95.1%
USA	17	1.5%
New Zealand	13	1.2%
Japan	7	0.6%
United Kingdom	3	0.3%
Singapore	3	0.3%
Canada	2	0.2%
Spain	2	0.2%
France	2	0.2%
Thailand	1	0.1%

Opens by location

Opens Clicks24-hour performance
77http://yourlevyatwork.com.au/horticulture-the-next-generation/
61http://yourlevyatwork.com.au/new-import-conditions-for-phytophthora-ramorum-sudden-oak-death-host-species/
48http://yourlevyatwork.com.au/nursery-industry-biosecurity-levy-approved-by-government/
34http://yourlevyatwork.com.au/get-involved-national-tree-day-2013/
30http://yourlevyatwork.com.au/entries-now-open-for-the-2014-nursery-garden-industry-awards/
Sent 1/7/13 4:00AMYLAW Monthly RSS
Subscriber activity
Top links clicked
4:00AM 8:00AM 12:00PM 4:00PM 8:00PM 12:00AM
0
20
40
60
80
100

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/08/2013
Click rate
6.6%
Open rate
28.6%
31.6%
List average
468
Opened
89
Clicked
50
Bounced
19.0%
122
13/8/13 4:33PM
0
1,251
23/7/15 10:05AM
0
1,483 96.7%Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/8/13 4:01AMYLAW Monthly RSS
Overview
1,533 Recipients
Delivered: Thu, 01 Aug 2013 04:01 am
6.0%
List average
4
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/8/13 4:01AMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,078	91.0%
Japan	46	3.9%
USA	25	2.1%
New Zealand	24	2.0%
	6	0.5%
Italy	2	0.2%
Germany	1	0.1%
Croatia	1	0.1%
Portugal	1	0.1%

Opens by location

Opens Clicks24-hour performance
51http://yourlevyatwork.com.au/greening-childcare-spaces-calling-for-expressions-of-i
nterest/
45http://yourlevyatwork.com.au/supply-chain-week-with-gs1/
22http://yourlevyatwork.com.au/industry-represented-on-australian-government-expor
t-consultative-committee/
4http://yourlevyatwork.com.au/
0http://us4.campaign-archive2.com/?u=433117ed1d8edb1fad307c98f&id=cf2bac463
3&fblike=fblike-c980bac1&e=[UNIQID]&socialproxy=http%3A%2F%2Fus4.campaig
n-archive2.com%2Fsocial-proxy%2Ffacebook-like%3Fu%3D433117ed1d8edb1fad
307c98f%26id%3Dcf2bac4633%26url%3Dhttp%253A%252F%252Fyourlevyatwor
Sent 1/8/13 4:01AMYLAW Monthly RSS
Subscriber activity
Top links clicked
4:00AM 8:00AM 12:00PM 4:00PM 8:00PM 12:00AM
0
20
40
60
80
100

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/09/2013
Click rate
6.6%
Open rate
28.6%
31.8%
List average
469
Opened
107
Clicked
45
Bounced
22.8%
203
21/2/14 10:40AM
0
1,389
1/7/15 11:49AM
0
1,476 97.0%Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/9/13 4:00AMYLAW Monthly RSS
Overview
1,521 Recipients
Delivered: Sun, 01 Sep 2013 04:00 am
7.2%
List average
5
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/9/13 4:00AMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,157	90.1%
Japan	73	5.7%
New Zealand	22	1.7%
USA	17	1.3%
France	5	0.4%
Italy	4	0.3%
	3	0.2%
Germany	1	0.1%
India	1	0.1%
Singapore	1	0.1%

Opens by location

Opens Clicks24-hour performance
58http://yourlevyatwork.com.au/introducing-the-202020-vision/
39http://yourlevyatwork.com.au/national-code-of-practice-for-chemicals-of-security-re
leased/
39http://yourlevyatwork.com.au/changes-to-quarantine-approved-premises-qaps-for-o
pen-quarantine-areas-for-approved-bulbs/
38http://yourlevyatwork.com.au/update-on-nursery-industry-access-to-minor-use-per
mits/
26http://yourlevyatwork.com.au/industry-partners-with-collaborative-research-into-urb
an-micro-climates-in-sydney-melbourne-and-adelaide/
Sent 1/9/13 4:00AMYLAW Monthly RSS
Subscriber activity
Top links clicked
4:00AM 8:00AM 12:00PM 4:00PM 8:00PM 12:00AM
0
10
20
30
40

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/10/2013
Click rate
6.6%
Open rate
28.6%
32.0%
List average
469
Opened
90
Clicked
43
Bounced
19.2%
181
6/12/13 11:36AM
1
1,355
24/8/15 10:35AM
0
1,464 97.1%Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/10/13 4:01AMYLAW Monthly RSS
Overview
1,507 Recipients
Delivered: Tue, 01 Oct 2013 04:01 am
6.1%
List average
3
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/10/13 4:01AMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,081	89.1%
Japan	84	6.9%
USA	24	2.0%
New Zealand	15	1.2%
France	2	0.2%
	2	0.2%
Chile	1	0.1%
Germany	1	0.1%
Spain	1	0.1%
Qatar	1	0.1%

Opens by location

Opens Clicks24-hour performance
54http://yourlevyatwork.com.au/public-comment-now-open-on-proposed-australian-st
andard-as-2303-tree-stock-for-landscape-use/
44http://yourlevyatwork.com.au/national-conference-2014-registrations-open/
32http://yourlevyatwork.com.au/register-to-attend-an-i-tree-eco-australia-workshop/
26http://yourlevyatwork.com.au/plant-safely-website/
22http://yourlevyatwork.com.au/treenet-symposium/
Sent 1/10/13 4:01AMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
4:00AM 8:00AM 12:00PM 4:00PM 8:00PM 12:00AM
0
20
40
60
80
100

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/11/2013
Click rate
6.6%
Open rate
28.6%
28.7%
List average
418
Opened
68
Clicked
39
Bounced
16.3%
106
29/11/13 6:59PM
0
1,055
1/7/15 11:50AM
0
1,454 97.4%Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/11/13 11:00AMYLAW Monthly RSS
Overview
1,493 Recipients
Delivered: Fri, 01 Nov 2013 11:00 am
4.7%
List average
6
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/11/13 11:00AMYLAW Monthly RSS

Country	Opens	Percent
Australia	891	90.7%
Japan	49	5.0%
USA	20	2.0%
New Zealand	18	1.8%
Chile	1	0.1%
Germany	1	0.1%
	1	0.1%
Netherlands	1	0.1%

Opens by location

Opens Clicks24-hour performance
47http://yourlevyatwork.com.au/national-conference-early-bird-registrations-ending-so
on/
21http://yourlevyatwork.com.au/public-comment-on-draft-australian-standard-as-2303
-tree-stock-for-landscape-use-closes-18-november-2013/
16http://yourlevyatwork.com.au/licencing-the-nursery-production-farm-management-s
ystem-to-the-new-zealand-production-nursery-industry/
12http://yourlevyatwork.com.au/industry-sharing-the-biosecurity-responsibility/
9http://yourlevyatwork.com.au/annual-general-meeting/
Sent 1/11/13 11:00AMYLAW Monthly RSS
Subscriber activity
Top links clicked
11:00AM 3:00PM 7:00PM 11:00PM 3:00AM 7:00AM
0
10
20
30
40
50

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
03/12/2013
Click rate
6.6%
Open rate
28.6%
28.4%
List average
410
Opened
64
Clicked
37
Bounced
15.6%
104
5/5/14 3:47PM
0
935
28/4/15 3:57PM
0
1,442 97.5%Successful deliveries
Total opens
Last opened
Forwarded
Sent 3/12/13 11:01AMYLAW Monthly RSS
Overview
1,479 Recipients
Delivered: Tue, 03 Dec 2013 11:01 am
4.4%
List average
1
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 3/12/13 11:01AMYLAW Monthly RSS

Country	Opens	Percent
Australia	786	90.8%
Japan	41	4.7%
USA	20	2.3%
New Zealand	12	1.4%
Germany	1	0.1%
	1	0.1%
Hong Kong	1	0.1%
Indonesia	1	0.1%
Macau	1	0.1%
Netherlands	1	0.1%

Opens by location

Opens Clicks24-hour performance
29http://yourlevyatwork.com.au/202020-launch/
25http://yourlevyatwork.com.au/dr-anthony-kachenko-wins-kendle-wilkinson-horticult
ure-award-2/
21http://yourlevyatwork.com.au/industry-builds-closer-ties-with-university-of-queensla
nd-following-recent-visit/
20http://yourlevyatwork.com.au/call-for-research-posters-at-ngia-national-conference-
2014/
8http://yourlevyatwork.com.au/national-conference-early-bird-extended-until-13th-de
c-2013/
Sent 3/12/13 11:01AMYLAW Monthly RSS
Subscriber activity
Top links clicked
11:00AM 3:00PM 7:00PM 11:00PM 3:00AM 7:00AM
0
10
20
30
40
50
60
70

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
04/02/2014
Click rate
6.6%
Open rate
28.6%
31.3%
List average
447
Opened
108
Clicked
43
Bounced
24.2%
182
4/3/14 8:39AM
0
1,343
19/8/15 4:07PM
0
1,430 97.1%Successful deliveries
Total opens
Last opened
Forwarded
Sent 4/2/14 11:00AMYLAW Monthly RSS
Overview
1,473 Recipients
Delivered: Tue, 04 Feb 2014 11:00 am
7.6%
List average
3
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 4/2/14 11:00AMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,129	89.4%
Japan	63	5.0%
USA	47	3.7%
New Zealand	14	1.1%
India	3	0.2%
Belgium	1	0.1%
Czech Republic	1	0.1%
Germany	1	0.1%
	1	0.1%
Indonesia	1	0.1%

Opens by location

Opens Clicks24-hour performance
56http://yourlevyatwork.com.au/update-on-the-development-of-the-national-tree-stoc
k-standard-as2303/
41http://yourlevyatwork.com.au/ngia-conference-2014-update/
32http://yourlevyatwork.com.au/ngia-2014-conference-update/
29http://yourlevyatwork.com.au/915/
23http://yourlevyatwork.com.au/nursery-levy-payers-meeting/
Sent 4/2/14 11:00AMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
11:00AM 3:00PM 7:00PM 11:00PM 3:00AM 7:00AM
0
20
40
60
80
100

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
04/03/2014
Click rate
6.6%
Open rate
28.6%
30.1%
List average
427
Opened
74
Clicked
39
Bounced
17.3%
94
14/8/14 5:38PM
0
949
1/7/15 11:50AM
0
1,420 97.3%Successful deliveries
Total opens
Last opened
Forwarded
Sent 4/3/14 4:00PMYLAW Monthly RSS
Overview
1,459 Recipients
Delivered: Tue, 04 Mar 2014 04:00 pm
5.2%
List average
2
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 4/3/14 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	780	84.6%
Japan	72	7.8%
USA	51	5.5%
New Zealand	12	1.3%
France	3	0.3%
Portugal	2	0.2%
Germany	1	0.1%
Netherlands	1	0.1%

Opens by location

Opens Clicks24-hour performance
37http://yourlevyatwork.com.au/new-project-managing-myrtle-rust-and-its-impacts-in-australia/
29http://yourlevyatwork.com.au/industry-development-officer-ido-undergo-lead-auditor-training/
9http://yourlevyatwork.com.au/conference-only-1-week-away/
9http://yourlevyatwork.com.au/202020-vision-update/
8http://yourlevyatwork.com.au/hal-review-submission-deadlines/
Sent 4/3/14 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50
60
70

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
04/04/2014
Click rate
6.6%
Open rate
28.6%
30.3%
List average
429
Opened
82
Clicked
34
Bounced
19.1%
148
14/8/14 4:08PM
0
1,014
1/7/15 11:50AM
0
1,417 97.7%Successful deliveries
Total opens
Last opened
Forwarded
Sent 4/4/14 4:00PMYLAW Monthly RSS
Overview
1,451 Recipients
Delivered: Fri, 04 Apr 2014 04:00 pm
5.8%
List average
3
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 4/4/14 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	839	84.5%
Japan	65	6.5%
USA	60	6.0%
New Zealand	20	2.0%
United Arab Emirates	6	0.6%
Spain	1	0.1%
Netherlands	1	0.1%
Portugal	1	0.1%

Opens by location

Opens Clicks24-hour performance
47http://yourlevyatwork.com.au/are-you-a-business-leader-within-the-australian-hortic
ulture-industry/
36http://yourlevyatwork.com.au/expressions-of-interest-sought-for-usa-green-infrastru
ctureproduction-study-tour-3/
24http://yourlevyatwork.com.au/australian-nursery-garden-industry-environmental-sust
ainability-position/
19http://yourlevyatwork.com.au/202020-vision-2nd-special-report-by-the-australian-
nancial-review/
17http://yourlevyatwork.com.au/nursery-industry-iac-annual-report/
Sent 4/4/14 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
04/05/2014
Click rate
6.6%
Open rate
28.6%
31.9%
List average
451
Opened
132
Clicked
33
Bounced
29.3%
200
7/8/15 1:39PM
0
1,302
7/8/15 1:39PM
0
1,413 97.7%Successful deliveries
Total opens
Last opened
Forwarded
Sent 4/5/14 4:00PMYLAW Monthly RSS
Overview
1,446 Recipients
Delivered: Sun, 04 May 2014 04:00 pm
9.3%
List average
1
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 4/5/14 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,138	87.5%
Japan	103	7.9%
USA	29	2.2%
New Zealand	10	0.8%
Germany	8	0.6%
Hong Kong	5	0.4%
France	3	0.2%
Portugal	2	0.2%
Spain	1	0.1%
	1	0.1%

Opens by location

Opens Clicks24-hour performance
159http://yourlevyatwork.com.au/new-portable-pest-identication-tool-for-the-nursery-industry/
36http://yourlevyatwork.com.au/ngia-makes-submission-to-agricultural-competitiveness-white-paper/
5http://yourlevyatwork.com.au/
0http://yourlevyatwork.com.au
0http://us4.campaign-archive2.com/?u=433117ed1d8edb1fad307c98f&id=539ddfd6c2&fblike=fblike-fdf83e23&e=[UNIQID]&socialproxy=http%3A%2F%2Fus4.campaign-archive1.com%2Fsocial-proxy%2Ffacebook-like%3Fu%3D433117ed1d8edb1fad307c98f%26id%3D539ddfd6c2%26url%3Dhttp%253A%252F%252Fyourlevyatwork.
Sent 4/5/14 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50
60

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
04/06/2014
Click rate
6.6%
Open rate
28.6%
31.6%
List average
446
Opened
121
Clicked
37
Bounced
27.1%
205
4/12/14 11:52AM
0
1,287
10/8/15 3:37PM
0
1,411 97.4%Successful deliveries
Total opens
Last opened
Forwarded
Sent 4/6/14 4:00PMYLAW Monthly RSS
Overview
1,448 Recipients
Delivered: Wed, 04 Jun 2014 04:00 pm
8.6%
List average
3
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 4/6/14 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,038	80.9%
USA	153	11.9%
Japan	68	5.3%
New Zealand	14	1.1%
Netherlands	4	0.3%
	2	0.2%
Germany	1	0.1%
Spain	1	0.1%
Fiji	1	0.1%
France	1	0.1%

Opens by location

Opens Clicks24-hour performance
86http://yourlevyatwork.com.au/2015-nursery-garden-awards/
39http://yourlevyatwork.com.au/future-post-entry-quarantine-peq-facility-update/
30http://yourlevyatwork.com.au/update-on-the-review-of-horticulture-australia-limited-hal/
24http://yourlevyatwork.com.au/202020-vision-features-at-international-green-city-conference-london/
22http://yourlevyatwork.com.au/usa-study-tour/
Sent 4/6/14 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50
60
70

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
04/07/2014
Click rate
6.6%
Open rate
28.6%
30.8%
List average
436
Opened
75
Clicked
41
Bounced
17.2%
110
26/5/15 11:47AM
0
1,157
19/8/15 4:04PM
0
1,415 97.2%Successful deliveries
Total opens
Last opened
Forwarded
Sent 4/7/14 4:00PMYLAW Monthly RSS
Overview
1,456 Recipients
Delivered: Fri, 04 Jul 2014 04:00 pm
5.3%
List average
2
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 4/7/14 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,038	89.8%
USA	57	4.9%
Japan	43	3.7%
New Zealand	11	1.0%
	2	0.2%
Netherlands	2	0.2%
Canada	1	0.1%
Fiji	1	0.1%
Cambodia	1	0.1%

Opens by location

Opens Clicks24-hour performance
51http://yourlevyatwork.com.au/future-of-the-australian-standard-as2303-national-tree
-stock-for-landscape-use/
29http://yourlevyatwork.com.au/fee-increases-for-import-services/
20http://yourlevyatwork.com.au/ngia-to-partner-with-university-of-melbourne-on-new-
urban-forest-research/
8http://yourlevyatwork.com.au/cut-off-dates-to-import-plant-propagative-material-int
o-eastern-creek-peq-facility/
2http://yourlevyatwork.com.au/
Sent 4/7/14 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50
60

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
04/08/2014
Click rate
6.6%
Open rate
28.6%
31.4%
List average
446
Opened
72
Clicked
31
Bounced
16.1%
102
19/8/14 9:40AM
0
1,106
19/8/15 4:04PM
0
1,422 97.9%Successful deliveries
Total opens
Last opened
Forwarded
Sent 4/8/14 4:00PMYLAW Monthly RSS
Overview
1,453 Recipients
Delivered: Mon, 04 Aug 2014 04:00 pm
5.1%
List average
1
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 4/8/14 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	969	87.7%
Japan	61	5.5%
USA	55	5.0%
New Zealand	10	0.9%
	3	0.3%
France	2	0.2%
Thailand	2	0.2%
Macau	1	0.1%
Netherlands	1	0.1%
Singapore	1	0.1%

Opens by location

Opens Clicks24-hour performance
39http://yourlevyatwork.com.au/new-quarantine-alert-for-sudden-oak-death-and-xylell
a-host-nursery-stock/
26http://yourlevyatwork.com.au/australian-government-assistance-for-small-exporters/
23http://yourlevyatwork.com.au/hal-nursery-levy-tender-unravelling-the-green-supply-
chain-now-open/
13http://yourlevyatwork.com.au/viii-international-symposium-on-new-ornamental-crop
s-xii-international-protea-research-symposium-and-xvii-international-protea-associa
tion-conference/
1http://yourlevyatwork.com.au/
Sent 4/8/14 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50
60

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
04/09/2014
Click rate
6.6%
Open rate
28.6%
30.0%
List average
430
Opened
45
Clicked
25
Bounced
10.5%
68
28/9/14 8:31AM
0
1,004
12/8/15 5:27PM
0
1,432 98.3%Successful deliveries
Total opens
Last opened
Forwarded
Sent 4/9/14 4:00PMYLAW Monthly RSS
Overview
1,457 Recipients
Delivered: Thu, 04 Sep 2014 04:00 pm
3.1%
List average
6
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 4/9/14 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	868	86.6%
USA	59	5.9%
Japan	45	4.5%
New Zealand	11	1.1%
	7	0.7%
Singapore	5	0.5%
Hong Kong	2	0.2%
Netherlands	2	0.2%
Germany	1	0.1%
Italy	1	0.1%

Opens by location

Opens Clicks24-hour performance
25http://yourlevyatwork.com.au/calling-all-plant-breeders/
16http://yourlevyatwork.com.au/industry-accreditation-surprise/
12http://yourlevyatwork.com.au/allied-products-please-take-the-stage/
8http://yourlevyatwork.com.au/the-new-challenge-for-business-of-the-year-entrants/
7http://yourlevyatwork.com.au/1500-prize-for-the-winner-of-the-heather-rumsey-youn
g-leader-award/
Sent 4/9/14 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50
60

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
04/11/2014
Click rate
6.6%
Open rate
28.6%
30.9%
List average
441
Opened
105
Clicked
28
Bounced
23.8%
184
8/12/14 3:38PM
0
1,214
12/8/15 5:38PM
0
1,427 98.1%Successful deliveries
Total opens
Last opened
Forwarded
Sent 4/11/14 4:00PMYLAW Monthly RSS
Overview
1,455 Recipients
Delivered: Tue, 04 Nov 2014 04:00 pm
7.4%
List average
2
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 4/11/14 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,098	90.5%
Japan	46	3.8%
USA	36	3.0%
New Zealand	27	2.2%
	2	0.2%
Portugal	2	0.2%
Germany	1	0.1%
India	1	0.1%

Opens by location

Opens Clicks24-hour performance
108http://yourlevyatwork.com.au/free-business-training-for-horticulture-growers/
50http://yourlevyatwork.com.au/the-new-hal/
23http://yourlevyatwork.com.au/national-tour-to-tackle-our-cities-declining-green-spaces/
2http://yourlevyatwork.com.au/
1http://us4.campaign-archive1.com/?u=433117ed1d8edb1fad307c98f&id=e80b51e5b4&fblike=fblike-abf22906&e=[UNIQID]&socialproxy=http%3A%2F%2Fus4.campaign-archive1.com%2Fsocial-proxy%2Ffacebook-like%3Fu%3D433117ed1d8edb1fad307c98f%26id%3De80b51e5b4%26url%3Dhttp%253A%252F%252Fyourlevyatwork.com.au%252Ffree-business-training-for-horticulture-growers%252F%26title%3D
Sent 4/11/14 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50
60

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
09/12/2014
Click rate
6.6%
Open rate
28.6%
32.9%
List average
494
Opened
169
Clicked
66
Bounced
34.2%
326
7/8/15 1:37PM
0
1,274
20/8/15 2:32PM
0
1,501 95.8%Successful deliveries
Total opens
Last opened
Forwarded
Sent 9/12/14 4:00PMYLAW Monthly RSS
Overview
1,567 Recipients
Delivered: Tue, 09 Dec 2014 04:00 pm
11.3%
List average
1
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 9/12/14 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,128	88.7%
USA	63	5.0%
Japan	46	3.6%
New Zealand	28	2.2%
	2	0.2%
Germany	1	0.1%
India	1	0.1%
Portugal	1	0.1%
Qatar	1	0.1%
Thailand	1	0.1%

Opens by location

Opens Clicks24-hour performance
98http://yourlevyatwork.com.au/national-nalists-announced-for-the-2015-nursery-gar
den-awards/
68http://yourlevyatwork.com.au/nursery-and-garden-industry-australia-announces-resi
gnation-of-ceo-robert-prince/
63http://yourlevyatwork.com.au/free-business-training-for-horticulture-growers-2/
47http://yourlevyatwork.com.au/new-board-elected-at-ngia-annual-general-meeting/
43http://yourlevyatwork.com.au/horticulture-innovation-australia/
Sent 9/12/14 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50
60
70

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
03/03/2015
Click rate
6.6%
Open rate
28.6%
32.3%
List average
492
Opened
135
Clicked
52
Bounced
27.4%
217
10/7/15 11:51AM
0
1,323
30/7/15 4:38PM
0
1,522 96.7%Successful deliveries
Total opens
Last opened
Forwarded
Sent 3/3/15 4:00PMYLAW Monthly RSS
Overview
1,574 Recipients
Delivered: Tue, 03 Mar 2015 04:00 pm
8.9%
List average
4
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 3/3/15 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,172	88.7%
Japan	71	5.4%
USA	58	4.4%
New Zealand	15	1.1%
China	1	0.1%
France	1	0.1%
	1	0.1%
India	1	0.1%
Netherlands	1	0.1%
Singapore	1	0.1%

Opens by location

Opens Clicks24-hour performance
63http://yourlevyatwork.com.au/south-australia-is-gearing-up-for-proposed-new-plant
-declarations/
44http://yourlevyatwork.com.au/2015-nursery-garden-awards-gala-dinner-24-march-2
015/
42http://yourlevyatwork.com.au/horticulture-innovation-australia-consultation-paper/
38http://yourlevyatwork.com.au/survey-on-automated-irrigation-controllers/
23http://yourlevyatwork.com.au/new-minor-use-permit/
Sent 3/3/15 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50
60
70

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
03/04/2015
Click rate
6.6%
Open rate
28.6%
33.7%
List average
512
Opened
109
Clicked
50
Bounced
21.3%
180
6/7/15 4:06PM
1
1,391
21/8/15 7:18PM
0
1,521 96.8%Successful deliveries
Total opens
Last opened
Forwarded
Sent 3/4/15 4:00PMYLAW Monthly RSS
Overview
1,571 Recipients
Delivered: Fri, 03 Apr 2015 04:00 pm
7.2%
List average
2
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 3/4/15 4:00PMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,260	90.9%
Japan	55	4.0%
USA	44	3.2%
New Zealand	24	1.7%
	1	0.1%
India	1	0.1%
Thailand	1	0.1%

Opens by location

Opens Clicks24-hour performance
82http://yourlevyatwork.com.au/as-23032015-tree-stock-for-landscape-use-release-da
te/
39http://yourlevyatwork.com.au/draft-review-of-policy-importation-of-phytophthora-ra
morum-host-propagative-material-into-australia/
39http://yourlevyatwork.com.au/excercise-yellow-dragon/
9http://yourlevyatwork.com.au/
2http://twitter.com/share?url=http%3A%2F%2Fyourlevyatwork.com.au%2Fdraft-revi
ew-of-policy-importation-of-phytophthora-ramorum-host-propagative-material-into-
australia%2F&text=Draft+review+of+policy%3A+importation+of+Phytophthora+ram
orum+host+propagative+material+into+Australia&count=none
Sent 3/4/15 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/06/2015
Click rate
6.2%
Open rate
28.8%
32.6%
List average
493
Opened
103
Clicked
55
Bounced
20.9%
139
29/9/15 9:53AM
0
1,511 96.5%
1,189
25/11/15 3:27PM
0
Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/6/15 10:00AMYLAW Monthly RSS
Overview
1,566 Recipients
Delivered: Mon, 01 Jun 2015 10:00 am
6.8%
List average
2
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/6/15 10:00AMYLAW Monthly RSS
Country Opens Percent
Australia 1,043 88.5%
USA 56 4.7%
Japan 54 4.6%
New Zealand 12 1.0%
Singapore 4 0.3%
Slovenia 3 0.3%
Turkey 2 0.2%
1 0.1%
Hong Kong 1 0.1%
Indonesia 1 0.1%
Opens by location

Opens Clicks24-hour performance

39http://yourlevyatwork.com.au/linkedin-industry-forums/

33http://yourlevyatwork.com.au/new-minor-use-permit-3/

24http://yourlevyatwork.com.au/the-202020-vision-plan/

23http://yourlevyatwork.com.au/bicon-update/

18http://yourlevyatwork.com.au/vegetable-leafminer-liriomyza-sativae-incursion-in-the-cape-york-peninsula/

29info@yvn.com.au

Sent 1/6/15 10:00AMYLAW Monthly RSS

Subscriber activity

Top links clicked

Subscribers with most opens

10:00AM 2:00PM 6:00PM 10:00PM 2:00AM 6:00AM

0

20

40

60

80

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/07/2015
Click rate
6.6%
Open rate
28.6%
32.1%
List average
512
Opened
77
Clicked
51
Bounced
15.0%
155
21/8/15 8:14AM
0
1,294
24/8/15 10:17PM
0
1,594 96.9%Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/7/15 10:00AMYLAW Monthly RSS
Overview
1,645 Recipients
Delivered: Wed, 01 Jul 2015 10:00 am
4.8%
List average
7
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/7/15 10:00AMYLAW Monthly RSS

Country Opens Percent

Australia 1,099 85.5%

Japan 74 5.8%

USA 50 3.9%

New Zealand 41 3.2%

6 0.5%

Thailand 4 0.3%

Croatia 3 0.2%

Canada 2 0.2%

Indonesia 2 0.2%

Philippines 1 0.1%

Opens by location

Opens Clicks24-hour performance
50http://yourlevyatwork.com.au/202020-vision-how-to-grow-and-urban-forest/
43http://yourlevyatwork.com.au/expressions-of-interest/
28http://yourlevyatwork.com.au/nursery-industry-levy-funded-research/
16http://yourlevyatwork.com.au/20vupdate/
8http://yourlevyatwork.com.au/
82jane.cleary@ngiwa.com.au
42emontibeler@universalmagazines.com.au
Sent 1/7/15 10:00AMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
10:00AM 2:00PM 6:00PM 10:00PM 2:00AM 6:00AM
0
20
40
60
80
100

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/08/2015
Click rate
6.6%
Open rate
28.6%
36.1%
List average
561
Opened
122
Clicked
74
Bounced
21.7%
263
26/8/15 9:36PM
0
1,522
26/8/15 9:34PM
0
1,552 95.4%Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/8/15 10:00AMYLAW Monthly RSS
Overview
1,626 Recipients
Delivered: Sat, 01 Aug 2015 10:00 am
7.9%
List average
3
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/8/15 10:00AMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,339	88.8%
Japan	73	4.8%
USA	73	4.8%
New Zealand	17	1.1%
	3	0.2%
Germany	1	0.1%
Fiji	1	0.1%
Portugal	1	0.1%

Opens by location

Opens Clicks24-hour performance
75http://yourlevyatwork.com.au/research-report-on-water-disinfestation-treatment-effi
cacy/
70http://yourlevyatwork.com.au/2419/
42http://yourlevyatwork.com.au/2016-national-conference/
35http://yourlevyatwork.com.au/new-minor-use-permit-4/
34http://yourlevyatwork.com.au/ngia-water-policy/
62brendan.haar@haarsnursery.com.au
Sent 1/8/15 10:00AMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
10:00AM 2:00PM 6:00PM 10:00PM 2:00AM 6:00AM
0
10
20
30
40
50
60

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
01/09/2015
Click rate
6.2%
Open rate
28.8%
30.2%
List average
479
Opened
49
Clicked
33
Bounced
10.2%
79
27/9/15 7:31PM
0
1,587 98.0%
1,204
26/11/15 4:23PM
0
Successful deliveries
Total opens
Last opened
Forwarded
Sent 1/9/15 10:00AMYLAW Monthly RSS
Overview
1,620 Recipients
Delivered: Tue, 01 Sep 2015 10:00 am
3.1%
List average
1
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 1/9/15 10:00AMYLAW Monthly RSS

Country	Opens	Percent
Australia	1,058	89.2%
Japan	63	5.3%
USA	39	3.3%
New Zealand	16	1.3%
	4	0.3%
Indonesia	2	0.2%
Poland	2	0.2%
France	1	0.1%
Thailand	1	0.1%

Opens by location

Opens Clicks24-hour performance
51http://yourlevyatwork.com.au/new-minor-use-permit-5/
26http://yourlevyatwork.com.au/department-of-agriculture-cost-recovery-reforms-f
or-import-and-export/
2http://yourlevyatwork.com.au/
0http://yourlevyatwork.com.au
0http://us4.campaign-archive2.com/?u=433117ed1d8edb1fad307c98f&id=da3a3ff
fad&fblike=fblike-d0ab142f&e=[UNIQID]&socialproxy=http%3A%2F%2Fus4.camp
aign-archive1.com%2Fsocial-proxy%2Ffacebook-like%3Fu%3D433117ed1d8edb1f
ad307c98f%26id%3Dda3a3fffad%26url%3Dhttp%253A%252F%252Fyourlevyatwo
rk.com.au%252Fdepartment-of-agriculture-cost-recovery-reforms-for-import-and
-export%252F%26title%3DDepartment%2520of%2520Agriculture%2520%25E2%2
580%2593%2520Cost%2520Recov..
Sent 1/9/15 10:00AMYLAW Monthly RSS
Subscriber activity
Top links clicked
10:00AM 2:00PM 6:00PM 10:00PM 2:00AM 6:00AM
0
10
20
30
40
50
60
70

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
10/07/2015
Click rate
6.2%
Open rate
28.8%
31.6%
List average
502
Opened
98
Clicked
27
Bounced
19.5%
159
2/11/15 8:47PM
0
1,588 98.3%
1,247
26/11/15 8:49PM
0
Successful deliveries
Total opens
Last opened
Forwarded
Sent 7/10/15 5:00PMYLAW Monthly RSS
Overview
1,615 Recipients
Delivered: Wed, 07 Oct 2015 05:00 pm
6.2%
List average
4
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 7/10/15 5:00PMYLAW Monthly RSS

Country Opens Percent

Australia 1,090 88.0%

USA 65 5.3%

Japan 44 3.6%

New Zealand 28 2.3%

France 6 0.5%

Qatar 2 0.2%

Singapore 2 0.2%

1 0.1%

Opens by location

Opens Clicks24-hour performance

73http://yourlevyatwork.com.au/ngia-raises-concerns-with-horticulture-innovation-around-my-park-rules/

35http://yourlevyatwork.com.au/ngi-national-conference-exhibition-2016/

29http://yourlevyatwork.com.au/plantlife-balance-for-mental-health-week/

11http://yourlevyatwork.com.au/national-gala-dinner-and-award-announcement-adelaide-february-2016/

10http://yourlevyatwork.com.au/67th-aiph-annual-congress-20th-23rd-october-2015-stresa-italy/

Sent 7/10/15 5:00PMYLAW Monthly RSS

Subscriber activity

Top links clicked

Subscribers with most opens

5:00PM 9:00PM 1:00AM 5:00AM 9:00AM 1:00PM

0

10

20

30

40

50

60

List: Your Levy at Work
Subject: Posts from Your Levy at Work for
11/13/2015
Click rate
6.2%
Open rate
28.8%
31.6%
List average
503
Opened
71
Clicked
30
Bounced
14.1%
88
19/11/15 12:31PM
0
1,590 98.1%
1,054
26/11/15 4:59PM
0
Successful deliveries
Total opens
Last opened
Forwarded
Sent 13/11/15 4:00PMYLAW Monthly RSS
Overview
1,620 Recipients
Delivered: Fri, 13 Nov 2015 04:00 pm
4.5%
List average
5
Unsubscribed
Clicks per unique opens
Total clicks
Last clicked
Abuse reports

Sent 13/11/15 4:00PMYLAW Monthly RSS

Country Opens Percent

Australia 934 90.5%

USA 54 5.2%

Japan 30 2.9%

New Zealand 11 1.1%

2 0.2%

Taiwan 1 0.1%

Opens by location

Opens Clicks24-hour performance
37http://yourlevyatwork.com.au/new-minor-use-permit-6/
16http://yourlevyatwork.com.au/nursery-industry-levy-funded-research-to-support-australian-standard-for-landscape-tree-stock/
15http://yourlevyatwork.com.au/2016-conference-registration-open/
11http://yourlevyatwork.com.au/community-and-consumer-engagement-project-for-the-202020-vision/
7http://yourlevyatwork.com.au/media-release-14-10-15-my-park-rules/
18sales@colourwise.com
Sent 13/11/15 4:00PMYLAW Monthly RSS
Subscriber activity
Top links clicked
Subscribers with most opens
4:00PM 8:00PM 12:00AM 4:00AM 8:00AM 12:00PM
0
10
20
30
40
50
60
70

NY12011 Nursery & Garden Industry Communications 2013-2015
Appendix 6

Facebook Metrics - Audience size Dec 2013 - November 2015

NY12011 Nursery & Garden Industry Communications 2013-2015

Figure 1 - Facebook Total page likes Dec 2103 - Nov 2015

NY12011 Nursery & Garden Industry Communications 2013-2015
Appendix 7

Nursery Paper Downloads via ngia.com.au April 2013 - November 2015

Item Total: Apr 2013
Oct 2015
Total: Since June
2009
Total Nursery Paper downloads ex www.ngia.com.au 29,106 85,731
Supporting and Advancing Australian Plant Breeding 1,040 3,975
Ornamental Plant Breeding in Australia 1,276 4,646
Working towards greener cities 819 3,593
Assessment of hand watering in production and retail nurseries 931 4,071
A generic economic decision model for the nursery industry to assess proposed changes to a business 796 3,584
Upgrading an irrigation system can improve water uniformity and reduce your operating expenses 977 3,960
Do soil moisture sensors have a role in containerised nursery production? 986 3,982
Smart Approved WaterMark: Helping consumers make waterwise choices 851 3,627
A taster of innovative technologies for the nursery & garden industry 986 3,782
Changing perceptions for a stronger future 756 3,455
Promoting the green credentials of the nursery & garden industry to the consumer through World Environment Day 793 3,475
What is NIASA and how can it benefit you?1,660 5,906
Nursery Paper March 2008 1,461 5,719
Plant Breeders Rights An Australian Nursery & Garden Industry Perspective 1,057 3,902
The art of strategic merchandising 1,623 4,836
Transforming a dead spot into a hot spot: how to make the most of your retail space 923 3,704
Avoiding the Discount Addiction 1,017 3,778
Taking control of your future business succession planning 913 3,702
Reducing the water weed risk How government and industry can contribute to a safer trade 810 3,516
Plant Intellectual Property 815 3,501
Managing emergency plant pest incursions the Emergency Plant Pest Response Deed (EPPRD) and the nursery in dustry 1,138 4,497
Future options moving on from retailing or growing 867 3,542
Water management in retail nurseries and garden centres 949 3,943
Water use in the nursery and garden industry results of the 2006 Water Use Survey 918 3,784
EcoHortâ„¢ the environmental management system for Australian nursery production 1,470 4,719
Weeds and the nursery industry 946 3,739
Nonornamentals: the forgotten members of our industry 847 3,451
Future options: new directions for a profitable future 1,136 3,841
Scheduling irrigation to maximise efficiency 1,181 4,233
Home is where the heart is 838 3,363
Get the recognition you deserve the Certified Nursery Professional Program 808 3,408
How efficient is your business water management?935 3,657
Gardening: A modernday oasis?858 3,501
How do the new water rules affect your business?859 3,484
Nursery and Garden Industry Strategic Plan 200608 825 3,493
Protecting your business against fire 773 3,371
The cultural experience of retail 918 3,526
Adding value to your product, your service and your customers experience 893 3,701

Threes a crowd, the three generation workplace.820 3,541
Advising, Allocating and Approving the role of the IAC 791 3,367
Achieving a profitable business 1,124 4,014
Understanding population and social trends 1,034 3,882
Professional strategies for profitable products and businesses 839 3,470
Development Officers Build Better Businesses 815 3,431
Greenhouse design 2,655 7,475
Hygiene in plant propagation 2,832 7,754
Marketing programs: ideas from garden centres 1,359 4,227
Using pot plants to clean indoor air 1,104 4,449
Managing Western Flower Thrips using Integrated Pest Management (IPM) 1,047 4,090
Water restriction effects on gardeners, and how to respond 864 3,483
Simple integrated pest management (IPM) techniques 1,371 4,819
Tapping into the growing landscaper market 862 3,510
What is your core product?860 3,512
Pest & disease prevention is better than cure 1,036 4,160
Landscaping, the growth opportunity for retailers 799 3,420
New report shows latest trends in the Australian garden market (Feb 2004 Issue no. 13) 835 3,654
Spotted anything Unusual 907 3,584
Understanding and managing nursery weeds 1,442 4,471
Your Development Officers 831 3,393
Understanding gardeners and garden owners 835 3,454
Ensuring safety in your nursery 1,091 3,901
Designing a nursery reed bed 1,150 4,169
Improving efficiencies within the nursery industry 820 3,550
Reed beds clean up nursery runoff water 947 3,734
Getting waterwise messages to your customers 841 3,430
Nutrient Charting 904 3,572
Growth of the nursery and garden industry 892 3,550
The benefits of being professional accreditation 1,254 4,348
Importing plants its not that hard 1,690 4,439
Managing and marketing new plants 884 3,511
Biological controls for diseases of nursery plants 901 3,555

Item Total: Apr 2013
Oct 2015
Total: Since June
2009
Total Nursery Paper downloads ex www.ngia.com.au 29,106 85,731
Supplying crop nutrition through controlled release fertilisers 888 3,619
Supplying crop nutrition through fertigation 922 3,685
Water quality and nursery crop nutrition 1,004 3,749
Market research information for your business 831 3,448
Making the internet work for you 790 3,364
The Australian garden market monitor 839 3,493
Water retention efficiency of potting mixes 1,034 3,779
Pesticide Management Diary CD launched 1,098 4,185
Disease awareness in the nursery and garden industry 858 3,490
Horticultural industries working together through AusHort 817 3,345
Fire Ants and the nursery and garden industry 836 3,564
The Industry Advisory Committee what does it do?857 3,485
How the nursery and garden industry benefit from Plant Health Australia 810 3,362
The facts on hazardous plants 1,003 3,876
Understanding your customers 841 3,465
Discovering alternatives to garden escapes 797 3,415
Flora for fauna plants for birds, bees, butterflies and profitability 813 3,538
Knowing your business costs 848 3,505
How big is your slice?814 3,473
Understanding distribution channels and product categories 1,032 3,976
Chalara (black root rot), can you recognise it?859 3,464
Business information the key to meeting present and future challenges 894 3,558
Water fogging and misting systems are they a risk to human health?919 3,834
The environment, your nursery & its management 961 3,820
Computer software for the nursery industry 941 3,805
Potplants really do clean indoor air 910 3,525
The expanding overseas market for Australian nursery product 866 3,471
Childs play... Kids in The Nursery 798 3,357
Fungus gnats common and damaging!2,784 7,080
Invasive plants not wanted in public or private gardens identified 807 3,430
Sprinkler layout and selection for igloos and poly houses 1,011 4,056
Sprinkler layout and selection for outdoor production areas 886 3,629
Greenlife Buyers Survey quality and service worth $798 3,372
Pricing for retail nurseries with that new tax 790 3,352
Maximising profits by building displays to link into promotions 910 3,471
Plant pricing and the GST for growers 1,270 3,972
Hygiene in the nursery Disinfecting production surfaces; cement, gravel, capillary mats and sand beds 1,579 5,993
Reducing the labour costs of potting 883 3,607
Hygiene and sanitation of working surfaces in the nursery 1,243 5,123
Potinpot container culture 939 3,905

WFT insecticide management 944 3,766
Creating instore events to maximise retail sales 784 3,378
Beware of Chalara elegans black root rot 1,112 3,945
Grower success stories on the path to industry development 901 3,592
Windbreaks, an investment in quality and profitability 1,021 4,116
The southern red mite, another new pest!952 3,598
WARNING! Industry chemicals under review 876 3,699
International interfirm comparisons yield interesting results 810 3,419
Ash Whitefly a new pest 815 3,473
Funding Research and Development for the Australian Nursery Industry 765 3,334
More lies, damned lies and statistics 818 3,501
New flowering pot plants from Western NSW flora 789 3,360
Slow flow sand filtration (SSF) for water treatment in nurseries and greenhouses 1,008 3,839
Advising gardeners about controlling pests, diseases and weeds 820 3,482
Greenhouse insect screens making the right selection 917 3,699
Lies, damned lies and statistics!808 3,442
Your NIDO NetworkThe national approach to industry development that works for you! 774 3,343
Handle potting mix safely 912 3,693
GrowSearch Australia 1,011 3,858
Garden centres benchmark financial performance 895 3,594
Getting to know gardeners as consumers 748 3,373
Preventing the introduction of potential weeds as ornamental plants 882 3,569
Financial benchmarking provides real life indicators for business improvement 817 3,536
Performance of controlled release fertilisers at high temperatures 790 3,412
Biological control of insect pests, now and tomorrow 852 3,778
Measure and improve your environmental performance 868 3,611
Are trace elements a waste of money?1,088 3,805
Accreditation for business success 888 3,507
Tools to help with decisions on capital expenditure 773 3,395
Getting control of weevil borers and leaf beetles in palms 806 3,581
Garden centres make better business decisions with better information 799 3,381

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Managing Western flower thrips 821 3,447
Grubs in your pots? Are they weevils and what can you do about it?836 3,506
New hygiene protocols will reduce disease and save on control costs!874 3,595
Silverleaf whitefly: management of a new nursery pest 919 3,811
Water disinfestation Chlorobromination and ozone systems get the thumbs up! 840 3,458
Keeping pests out with screening 735 3,271
Controlling Botrytis (grey mould) in nurseries 914 3,689
A stepwise programme for practising IPM 917 3,871
Increasing efficiency in nursery dispatch 778 3,439
Chasing consistent disease suppression in potting media 861 3,654
Testing your potting media is being kind to your wallet 953 3,664
Benchmark study highlights labour and management shortfalls 793 3,370
Rid seeds of disease give them a sauna!863 3,478
Controlling downy mildew in nursery seedlings 797 3,428
Improving nitrogen management in woodwaste based potting mixes 918 3,650
Waterwork is working!795 3,392
Reducing nutrient leaching from pots 952 3,830
Biological control of thrips, mites and other insects 951 4,081
Dynamic Pulse a new method of propagating difficult cuttings 775 3,425
Year round production of Australian daisies as flowering pot plants 970 3,653
Using ultra violet radiation and chlorine dioxide to control fungal plant pathogens in water 867 3,576
Monitoring and managing recycled water quality in nurseries 848 3,489
Savings in nursery dispatch 831 3,436
Plants face the heat on the way to market 844 3,414
Let's Do Our Own Research and make the most sense of it.829 3,429
Grow Me Instead How the nursery industry is addressing the spread of invasive plants 838 3,713
Insurance in the nursery & garden industry 1,123 3,961
Training, Careers & Employment in Horticulture 897 3,865
Plant health in Australia 935 3,896
Electronic Pest, Disease, Beneficial & Weed Identification Tool 1,094 4,193
Supply Chain Management holds the key to the viability of nusery enterprises 964 3,783
Plant Patents An alternative for the Nursery Industry 782 3,223
The 2010 Nursery & Garden Industry State Young Leaders 835 3,119
Infield rapid, portable & costeffective plant disease diagnostics 915 3,257
Mitigating Frost Damage in Nursery Production 988 3,502
The Basics of Plant Tissue Culture 3,468 6,711
Plant labelling the first point of contact in knowing about the plant 993 3,096
The positive effects of office plants 1,642 3,973
Nursery Footprint a carbon footprinting tool 1,005 2,812
Will any growing media suffice to grow the best plants possible?1,049 3,159

Garden Centre benchmarking (phase one)1,204 3,162
Nursery & Garden Industry Strategic Plan 20102015 1,048 3,024
National Invasive Plants Survey 877 2,442
NGIA Nursery Paper February 2011 880 2,464
NGIA Nursery Paper March 2011 847 2,374
NGIA Nursery Paper April 2011 996 2,538
NGIA Nursery Paper May 2011 886 2,330
NGIA Nursery Paper June 2011 947 2,400
NGIA Nursery Paper August 2011 887 2,112
NGIA Nursery Paper September 2011 993 2,120
NGIA Nursery Paper October 2011 944 2,057
NGIA Nursery Paper November 2011 1,017 2,066
NGIA Nursery Paper December 2011 879 1,919
NGIA Nursery Paper February 2012 973 1,737
NGIA Nursery Paper March 2012 963 1,673
NGIA Nursery Paper April 2012 1,018 1,760
NGIA Nursery Paper May 2012 964 1,574
NGIA Nursery Paper June 2012 972 1,638
NGIA Nursery Paper July 2012 1,006 1,446
NGIA Nursery Paper August 2012 939 1,402
NGIA Nursery Paper September 2012 914 1,278
NGIA Nursery Paper October 2012 933 1,170
NGIA Nursery Paper November 2012 878 1,075
NGIA Nursery Paper December 2012 880 1,078
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NGIA Nursery Paper June 2013 923 923
NGIA Nursery Paper July 2013 764 764
Nursery Paper August 2013 695 695

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Appendix 8

Policy page monthly views via www.ngia.com.au April 2013 to November 2015

Table 1 - Policy page views per month via NGIA website Apr 2013 - Nov 2015

Page views - NGIA policy

Month	2013	2014	2015
Jan		413	341
Feb		569	304
Mar		697	420
Apr	382	675	346
May	425	439	288
Jun	415	282	297
Jul	501	327	286
Aug	530	286	484
Sep	384	397	275
Oct	383	513	349
Nov	421	315	239
Dec	329	294	
Total	3770	5207	3629

Project Total 12606