

Horticulture Innovation Australia

Final Report

Plant health biosecurity, risk management and capacity building for the nursery industry

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The Department of Agriculture and Fisheries (DAF)

Project Number: NY11001

NY11001

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Contents

Summary	3
Keywords.....	4
Introduction	4
Methodology	5
Outputs	10
Outcomes	10
Evaluation and Discussion.....	17
Recommendations.....	19
Scientific Refereed Publications	19
IP/Commercialisation.....	19
Acknowledgements.....	20

Summary

Project NY11001 has been a four year funding partnership between the Australian nursery industry, the Queensland Department of Agriculture & Fisheries (DAF), and Horticulture Innovation Australia (HIA). The aim of the project was to provide support to the nursery industry in the area of plant health and biosecurity, 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.

Pest and disease diagnostics were conducted for the nursery industry under the umbrella of Grow Help Australia, a national diagnostic service operating out of DAF Queensland. This aspect of the project provided discounted diagnostics to all Australian nursery businesses for the duration of the project. The project team also conducted complimentary diagnostics for NIASA accredited businesses from around Australia, and provided plant virus indexing services to nursery producers.

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. A total of 31 workshops were delivered over the life of the project, with 853 participants in total (average of 27 participants per workshop). Post-workshop feedback indicated a high level of participant satisfaction.

The project has also produced a comprehensive portfolio of resource materials:

- Twenty-four fact sheets on common nursery pests and pathogens, as well as key biosecurity threats
- Four nursery papers on pest and disease management in production nurseries
- Detailed pest management plans for four key pest and disease groups
- Approximately 50 pest and disease descriptions as well as hundreds of high quality images for the Nursery Industry's Pest ID tool. 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
- Four pest specific contingency plans. 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

The resources produced by the project team, combined with the training and diagnostics undertaken over the course of the project, have given nursery producers the capacity to make more informed decisions regarding pest and disease identification, prevention and management. This will translate to reduced costs and increased profitability for nursery production businesses.

Given the success of this approach to date, and the capacity which has been developed as a result of this project, the industry will benefit from a continuation of this partnership. In light of the continuing threat of emergency plant pests, more emphasis on biosecurity preparedness is recommended.

Keywords

Production nurseries; Integrated Pest Management; biosecurity; plant health; diagnostics; fact sheets, pest contingency plans; emergency plant pests.

Introduction

The Australian nursery industry supports a number of production sectors including urban horticulture, fruit and vegetable cropping, forestry, land care and revegetation. The total GVP of nursery production in Australia was conservatively estimated at \$1.8 billion in 2008/09 (Market Monitor, 2009), but is likely to far exceed this figure (more accurate and recent figures are not available). Overall the industry underpins approximately \$14.5 billion in horticulture nationally, and there is also additional substantial added value further down the supply chain in the retail and services sector (Nursery Industry Biosecurity plan, 2013).

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.

Project NY11001 was developed with the aim of providing technical support to production nursery businesses and developing industry capacity in the four key areas of **diagnostics, training, information** and **biosecurity support**.

Accurate identification of causal agents through **diagnostics** forms the foundation of effective pest and disease management. One of the core objectives of NY11001 was to provide affordable, timely and professional pest and disease diagnostics to all nursery production businesses in Australia, utilizing Queensland DAF's existing diagnostic service, Grow Help Australia.

The project also aimed to offer regular **training** opportunities through the delivery of pest and disease identification and management workshops, specifically tailored to the needs of nursery businesses nationwide.

Ready access to practical and relevant technical **information** is essential for any nursery operating in a competitive business environment. NY11001 sought to develop a comprehensive portfolio of information resource material relating to key nursery pests and diseases (e.g. fact sheets, nursery papers, pest management plans and descriptions for industry's pest identification tool), and make this material freely available to industry, primarily through web-based resources.

Biosecurity support was a major focus of NY11001, with the aim of assisting industry to meet its obligations under the Emergency Plant Pest Response Deed (EPPRD). This was to be achieved by providing technical support and information to industry as required during emergency plant pest incursions, and also by developing a number of pest specific contingency plans over the life of the

project.

In summary, NY11001 aimed to develop a productive and collaborative relationship with the Australian nursery industry, working towards a shared goal of developing industry capacity in the area of plant health and biosecurity preparedness.

Methodology

Plant pest and disease diagnostics

Pest and disease diagnostic work for the nursery industry was conducted by the NY11001 project team using the existing facilities and systems of Grow Help Australia, a diagnostic service provided by DAF Queensland for horticultural crops. To recognise the contribution of the Australian nursery industry in supporting this work, individual NIASA accredited businesses from around Australia were advised that they could receive up to three complimentary diagnostic samples per year, as well as one complimentary soil sample for Phytophthora testing per year. Furthermore, the project provided all Australian production nurseries, irrespective of status, membership or affiliation, discounted rates for diagnostic samples over the life of the project.



Grow Help Australia

Disease and pest diagnostics

Email: growhelp@daf.qld.gov.au
Telephone: 07 3255 4365

- Please contact us by phone or email prior to sending samples from outside Queensland.
- Refer to the website for sample delivery instructions.

For Couriers or direct delivery^{preferred}:
Ecosciences Precinct, DAFF
41 Boggo Rd
Loading dock - Basement 3
(off Joe Baker Street)
Dutton Park Qld 4102

Australia Post postal address:
Grow Help Australia
DAFF
GPO Box 267
Brisbane Qld 4001

Web: <http://www.daf.qld.gov.au/plants/health-pests-diseases/grow-help>



As part of the project, a new internal sample tracking database was created to more efficiently manage sample submissions, testing and reporting. In order to streamline these processes, a web-based sample submission form for clients was developed and added to the Grow Help website, which included a number of fields for sample submitters to provide background information which would aid in diagnosis of the problem. The website was also updated with detailed information on collecting, preparing and packaging diagnostic samples. The new database was designed with the capability to collate data relating to diagnostic activity; including sample numbers, sample origin, host species, pest/pathogen species and other parameters of interest.

Another aspect of the diagnostic work was to evaluate a group of currently available molecular diagnostic test kits for the detection of a range of key nursery pathogens. The "Pocket[®] Diagnostic" test kits are lateral flow devices that use a genus or species specific antisera/antibody to detect a particular pathogen. They are designed for in-field use, and are portable, rapid and cost-effective. In the first two years of the project, 8 test kits (5 viruses, 1 fungus, 1 oomycete and 1 bacterial pathogen) were evaluated on plant material known to be infected with each of the relevant pathogens. However, a decision was made by the Project Steering Committee to discontinue evaluation of the molecular test kits after the second year of the project, and to replace this activity with additional "Pest ID Tool" descriptions and images (see section on information resources).

Training in pest and disease identification, monitoring and management

A key objective of NY11001 was to provide pest and disease management training to nursery businesses in the form of face-to-face workshops. For each of the four years of the project, the aim was to deliver a workshop in each state/territory. The content to be presented in each workshop was first discussed with the IDO's in each state-based NGI to ensure that it would be relevant to the needs of industry members. The first round of workshops covered pest and disease management in the same workshop, but subsequent year's workshops specialized in either disease or insect identification and management, according to local preferences. Many workshops also included specific presentations on biosecurity issues, and in some instances, guest speakers from outside the project were invited to present topical subject areas likely to be of interest to workshop participants.



Prior to workshops, the project team collaborated with the state-based IDOs to produce a flyer for the workshops, which was distributed by the NGI's using their usual networks. The IDOs assembled a list of workshop registrants, organized an appropriate venue, and arranged catering for each event.

At the end of each workshop, participants were encouraged to complete workshop evaluation sheets. Participants were asked to rate various aspects of the workshop (including workshop facilities, content, and facilitators) on a 1-5 scale where 1=poor and 5=excellent. There was also the opportunity to provide specific comments.



Information resources relating to key nursery pests and pathogens

The preparation of resource material relating to pest and disease management in production nurseries was an integral component of this project. This material included fact sheets, nursery papers, pest management plans, descriptions and images for the nursery industry's Pest ID Tool, and images for the industry's web-based host-pathogen database. The topic for each of these was selected on the basis of industry's needs, and was agreed upon by the Project Steering Committee at the commencement of each project year (October).

Fact sheets and nursery papers included information on symptoms/damage, pest/pathogen biology (life cycle, spread), host range, distribution and pest/disease management (including cultural, biological and chemical). Fact sheets ranged in length from 4-16 pages, but most were 6-8 pages long. Nursery papers were all 4 pages in length. Some fact sheets dealt with key endemic pests and diseases of nursery crops, while others focused on biosecurity threats. Pest management plans had similar content to fact sheets and nursery papers, but provided much more detail on pest/disease management strategies and ranged from 12-22 pages in length. For each year of the project, 6 fact sheets, 1 nursery paper and 1 pest management plan were prepared.

The nursery industry has developed an electronic "Pest ID Tool" which assists producers in identifying and treating pest insects, diseases, disorders and weeds. It also includes information on beneficial insects as biocontrol treatments. As part of NY11001, the project team originally agreed to contribute 10 pests or diseases to the database annually. Each entry includes a one page description of the pest/pathogen (scientific/common name, symptoms, transmission, conditions favoring infection/infestation, host range and treatment options), as well as associated images. In the third year of the project, however, it was decided to increase the contribution of 10 pests/pathogens per year to 15 pests/pathogens per year. The decision to increase effort in this area of the project was made at a Project Steering Committee meeting, and was offset by a correspondingly reduction of work in the area of molecular diagnostics (pocket diagnostic test kits).

The nursery industry is also developing a database of photographic images of disease symptoms for an extensive range of host/pathogen combinations. During the course of the project, high quality images of ornamental, fruit and vegetable diseases were provided by the project team to the nursery industry for inclusion in the database.

A desktop audit of microbial products with potential application for the control of plant diseases and nematodes in nursery production was conducted as part of the project. This was done by conducting internet and scientific literature searches of microbial products (both locally available and overseas) containing bacterial and fungal antagonists with reported efficacy against horticultural pathogens. As part of this process, scientific evidence to support manufacturer's claims of efficacy was sought.

Biosecurity/industry support

Three areas relating to biosecurity support were included as project objectives: 1) assist and support industry during pest categorization processes under the EPPRD (Emergency Plant Pest Response Deed) as required; 2) assist industry during an emergency plant pest incursion by providing information on pest biology/host range, pest impacts, pest/disease management; and 3) develop emergency plant pest contingency plans as required by industry (1 per annum).

As there were no requests from industry for assistance with pest categorization during the life of the project, there were no activities completed under this objective. There were however several requests from industry for information and advice relating to a number of emergency plant pest incursions over the life of the project. This information was obtained from a number of sources including literature searches, liaison with relevant experts, and personal knowledge. Although specific pest details for these incursions cannot be given due to the confidential nature of such requests, a broad summary is given in the Outcomes Section.

Four pest contingency plans were produced over the life of the project. In each case, the project team obtained existing contingency plans that were available for the wider horticultural industry at the beginning of the process, to ensure complementarity between the two plans. The four nursery contingency plans were written using a template provided by the nursery industry, referring to the existing plans where appropriate. Experts with specialist knowledge of each pest or disease, as well as key industry representatives, were consulted during the preparation of the plans, and/or asked to provide comment on the final draft.



A minor objective of the project was to identify new pesticide registrations or uses in horticulture that could be added to the nursery industry Minor Use Program (six per year). These were generally identified during the course of project activities, usually as a result of research associated with the preparation of fact sheets/pest management plans or diagnostic reports, by discussions with other scientists or industry specialists, or through attendance at specialist seminars and workshops.

Project Steering Committee

A Project Steering Committee (PSC) was formed at the commencement of NY11001 to ensure that project deliverables were scheduled appropriately and to discuss issues surrounding priorities and communication. The committee initially comprised the following members: Mr Robert Prince (CEO NGIA), Dr Anthony Kachenko (Policy Manager NGIA), Mr John McDonald (Development Manager NGIQ), Mr Garry Fullelove (Science Leader DAF), and Dr Lindy Coates (Project Leader DAF). Ms Vicki Lane (Director DAF) replaced Mr Garry Fullelove as a PSC member in April 2013, Dr Anthony Kachenko resigned from NGIA in August 2014, Mr Robert Prince resigned from NGIA in June 2015, and Mr Peter Vaughan commenced as CEO of NGIA in July 2015.

The PSC was scheduled to meet quarterly (by phone or face to face), with the PSC Minutes to be attached to each six monthly milestone report. A mid-term project review was also scheduled to be conducted by the PSC in the second year of the project.



Outputs

Over the life of the project, a range of outputs have been delivered in the four key areas of diagnostics, training, information and biosecurity support. Outputs are listed below, and details are provided in the Outcomes section.

Diagnostics

- A total of 546 nursery plant samples were processed through Grow Help over the course of the project, including 260 NIASA samples. Clients submitting NIASA samples were not charged for samples, and those submitting non-NIASA nursery samples received discounted rates.
- A total of 8 pocket diagnostic test kits were evaluated in the first two years of the project against a range of key nursery pathogens.

Training

- Thirty-one training workshops on pest and disease identification and management were delivered nationwide over the duration of the project, with a total of 853 industry participants.

Information

- Twenty-four fact sheets, four nursery papers and four pest management plans were produced for key nursery pests and pathogens.
- Fifty pest and disease descriptions and associated images were provided for the nursery industry's electronic Pest ID tool.
- Over 500 high quality images of ornamental diseases in approximately 100 host species were provided, as well as 588 images of vegetable diseases and 536 images of fruit diseases.
- A desktop audit of microbial products with potential application for the control of plant diseases and nematodes in nursery production was produced.

Biosecurity/industry support

- Four pest specific contingency plans were developed over the course of the project.
- Technical advice was provided to industry in relation to 18 emergency plant pest incursions over the course of the project (14 insect/mite pests and 4 pathogens).
- A total of 24 insecticides and fungicides were provided as suggestions for inclusion in the nursery industry's Minor Use Program.

Outcomes

Diagnostics

Table 1 summarizes pest and disease diagnostics conducted by the project team over the duration of the project (November 2011 – December 2015). The total number of nursery samples processed through Grow Help increased significantly over the life of the project, with over 3 times as many nursery samples processed in 2015 (210 samples) compared to 2012 (61 samples). There was a similar increase in the number of NIASA nursery samples between 2012 (31 samples) and 2015 (103 samples). A considerable number of virus indexing samples were also conducted, a process which enables nursery stock to be certified as virus-free.

The progressive increases seen in the number of nursery diagnostic samples received through Grow Help over the course of NY11001 indicate the value of this service to industry. Improved sample submission, tracking and reporting procedures implemented as a result of this project have most likely contributed to the increased demand.

Table 1: Number of diagnostic samples processed over the duration of NY11001

Year	Total no. of Grow Help samples ¹	Total no. of nursery samples ²	Total no. of NIASA samples	Total no. of virus indexing samples
2011 (Nov/Dec only)	16	6	1	-
2012	122	61	31	-
2013	245	92	54	-
2014	450	177	71	2,310
2015	464	210 ³	103	3,326
TOTAL	1,297	546	260	5,636

1 Excludes virus indexing samples; includes non-nursery (e.g. field grown fruit and vegetable crops, forestry species) and nursery samples.

2 Includes NIASA samples.

3 This equates to receiving about 4 nursery samples every week.

Although the overwhelming majority of both NIASA and non-NIASA nursery samples were received from Queensland producers, there were also a number of samples received from Western Australia, New South Wales/ACT, Victoria, South Australia and Tasmania (Table 2). No samples were received from the Northern Territory.

Table 2: Number of nursery diagnostic samples processed from different states over the duration of NY11001

STATE	2011 (Nov-)		2012		2013		2014		2015		TOTAL	
	Not NIASA	NIASA	Not NIASA	NIASA	Not NIASA	NIASA	Not NIASA	NIASA	Not NIASA	NIASA	Not NIASA	NIASA
NSW/ACT	0	0	4	0	0	5	2	10	3	11	9	26
NT	0	0	0	0	0	0	0	0	0	0	0	0
QLD	5	1	26	31	38	42	101	35	104	51	274	160
SA	0	0	0	0	0	0	3	1	0	1	3	2
TAS	0	0	0	0	0	4	0	0	0	0	0	4
VIC	0	0	0	0	0	3	0	22	0	4	0	29
WA	0	0	0	0	0	0	0	3	0	36	0	39
TOTAL	5	1	30	31	38	54	106	71	107	103	286	260

Over the duration of NY11001, the project team handled over 300 host plant species and over 150 different plant pathogens or pests. Fungi and viruses were the predominant pathogens reported, with *Fusarium*, *Pythium*, *Colletotrichum*, *Phytophthora* and *Rhizoctonia* species being the most common

pathogens isolated from samples.

Over the course of the project, the following pocket diagnostic test kits were evaluated in relation to standard diagnostic procedures: *Pythium* spp., *Botrytis* spp., *Ralstonia* spp., tomato yellow leaf curl virus (TYLCV), tomato spotted wilt virus (TSWV), tomato mosaic virus (ToMV), potato virus Y (PVY) and cucumber mosaic virus (CMV). Diagnostic samples known to be infected with the following pathogens gave a correct positive result using the appropriate test kit: *Pythium*, *Botrytis*, *Ralstonia*, TSWV, ToMV and PVY. CMV-infected plant material was unable to be sourced during the course of the year. Kits were tested using freeze-dried CMV-infected tomato tissue, but did not test positive for CMV. Results for the TYLCV test kit was inconclusive, and therefore at this stage could not be recommended for testing of critical samples.



Training

Table 3 summarizes participant attendance numbers and feedback for pest and disease management workshops conducted as part of NY11001. In all states except Tasmania and Queensland, a total of 4 workshops were conducted over the life of the project (1 workshop per year). Only 3 workshops were held in Tasmania at the request of NGIT. A total of 8 workshops were held in Queensland, which included: 4 standard workshops (as per project milestone criteria), 3 additional workshops funded separately by NGIQ so that additional localities (e.g. North Queensland) could be serviced, and 1 workshop delivered at the NGIA National Conference in March 2012.



There were a total of 853 industry participants at these workshops, with an average of approximately 27 participants attending each workshop. This is considered to be a high participant rate for this type of workshop involving hands-on training, and the fact that these rates were achieved consistently over the 4 years of the project suggests that participants were gaining considerable benefit from their involvement. Certainly the ratings for mean "overall benefit" listed in Table 3 support this finding.

Table 3: Attendance numbers and participant feedback for workshops conducted between 2011 and 2015 for the Plant Health & Biosecurity Project.

State/Territory	No. of workshops	Total no. of participants	Average no. of participants per workshop	Mean overall benefit (1-5 scale) ¹
NT	4	75	18.8	4.5
QLD	8 ²	235	29.4	4.6
NSW/ACT	4	118	29.5	4.6
VIC	4	136	34.0	4.4
TAS	3	62	20.7	4.7
SA	4	122	30.5	4.4
WA	4	105	26.0	4.4
TOTAL	31	853	27.5	4.5

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. Note that "overall benefit" is just one component of workshop feedback evaluated under the category of "workshop content". Additional workshop feedback is summarized in Table 4.

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.

Mean ratings for workshop "facilities" (training room, equipment and associated facilities) were rated highly in all states/territories (range 4.4-4.6), as were ratings for "workshop content" (range 4.3-4.7) and "workshop facilitators" (range 4.5-4.9) (Table 4). These results suggest that participants are gaining benefit from their attendance at the training workshops.

Table 4: Summary of workshop feedback over the duration of NY11001

State/Territory	No. of workshops ¹	Mean rating – facilities (1-5 scale) ²	Mean rating – workshop content (1-5 scale) ²	Mean rating – facilitators (1-5 scale) ²
NT	4	4.6	4.5	4.7
QLD	7	4.6	4.5	4.7
NSW/ACT	4	4.6	4.6	4.7
VIC	4	4.4	4.4	4.6
TAS	3	4.6	4.7	4.9
SA	4	4.4	4.3	4.5
WA	4	4.4	4.4	4.5
NATIONWIDE MEAN		4.5	4.5	4.7

¹ Excludes workshop at NGIA National Conference at the Gold Coast in 2012 (no feedback available)

² Workshop participants evaluated various aspects of each workshop using a 1-5 scale where 1=poor and 5=excellent. Results averaged over all workshops conducted in each state.

Information

Fact sheets: A series of 24 fact sheets on common nursery pests and pathogens, as well as key biosecurity threats, were produced over the life of the project. The titles of these fact sheets are listed in Table 5, and are available for download from the NGIA website¹.

Table 5: Fact sheets produced over the life of the project.

Title of fact sheet ¹
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)
Cycad blue butterfly – a pretty name for an ugly problem
Downy mildew – early management is critical
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
Mealy bugs – a pest of a different scale
Phytophthora diseases – problematic in the nursery and beyond
Phytophthora ramorum: a biosecurity threat to the Australian nursery industry
Powdery mildew – a myriad of nursery pathogens
Protect your nursery from virus diseases
Pythium species: a constant threat to nursery production
Rhizoctonia: a variable and versatile nursery pathogen
Root and leaf nematodes – microscopic worms with major consequences
Scale insects – a hard problem that can be managed
The biology and management of Colletotrichum diseases in production nurseries

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 6). These are available from the NGIA website¹.

Table 6: Nursery papers produced over the life of the project

Title of nursery paper ¹	Issue
Cylindrocladium diseases of nursery plants	September 2012, Issue no. 8
Management of fungus gnats in nursery production	June 2013, Issue no. 5
Accurately diagnosing weeds, pests and diseases affecting nursery crops	February 2014, Issue no. 1
National plant health and biosecurity project delivers benefits	December 2015

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 soil-borne diseases of nursery crops (Table 7). These are available from the NGIA website¹

Table 7: Pest management plans produced over the life of the project

Title of pest management plan ¹
Fungus gnat pest management plan for production nurseries
Integrated pest management plan for whiteflies in production nurseries
Soilborne root pathogens in production nurseries
Mite pest management plan for production nurseries

¹ Available at: https://www.ngia.com.au/Category?Action=View&Category_id=689

Project-generated fact sheets, nursery papers and pest management plans have proven to be a valuable resource in a number of regards. These documents were included in information packs provided to industry members attending our pest and disease management workshops, and have been available industry-wide via the NGIA website. They have also been used extensively in our diagnostic reports as an attached link to relevant document on the NGIA website. Pest management plans in particular have provided a high level of detail to enable nursery producers to develop an integrated strategy for management of selected groups of pests based on a combination of chemical, biological and cultural practices. Project fact sheets on biosecurity threats have also been a useful resource to complement pest contingency plans that have been developed in this and past projects. In the event of EPP detection, a fact sheet summarizing aspects pest symptoms, biology and management is a helpful tool during the eradication and containment phases of a response.

Pest ID tool: Fifty pest and disease descriptions as well as associated images were provided for the Nursery Industry’s Pest ID tool over the course of the project (Table 8). 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.

Table 8: Pest and pathogen descriptions and images provided for the nursery industry’s electronic pest ID tool¹

Year 1	Year 2	Year 3	Year 4
Phytophthora Pythium Rhizoctonia Cylindrocladium Fusarium Colletotrichum Alternaria Botrytis Chalara Powdery mildew	Phoma Frangipani rust Pelargonium rust Gliocladium Bipolaris Cycad blue butterfly Impatiens necrotic spot virus Cucumber mosaic virus Tomato yellow leaf curl virus Tomato mosaic virus	Azalea leaf gall Camellia leaf gall Ash whitefly Southern red mite Black vine beetle Vegetable leaf miner Root knot nematodes Honey fungus Bacterial wilt Cypress canker Apple scab Red-shouldered leaf beetle Hibiscus beetle Garden weevil	American serpentine leaf miner Bean aphid Poinsettia thrips Serpentine leaf miner Pierce’s spider mite False codling moth Tomato/potato psyllid Summer fruit tortix Colorado potato beetle Western plant bug Bacterial canker Dutch elm disease Zebra chip Fire blight Phytophthora blight

¹ Available at: <https://pestid.com.au/>. State-based NGI members receive 40% discount

A desktop audit of microbial products with potential application for the control of plant diseases and nematodes in nursery production was conducted. This was forwarded to NGIA in June 2014.

Biosecurity/Industry support

Pest contingency plans: Four pest specific contingency plans were developed during the course of the project (Table 9). 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. The huanglongbing and fire blight contingency plans are also currently available on the Plant Health Australia website.

Table 9: Pest specific contingency plans developed

Title of pest contingency plan
Threat specific contingency plan for huanglongbing and its vectors ¹
Threat specific contingency plan for fire blight ²
Threat specific contingency plan for giant African snail
Threat specific contingency plan for Dutch elm disease

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 provided technical support to industry in relation to 18 EPP detections over the life of the project, particularly in relation to supplying information on pest biology, host range and management. Of these 18 EPPs, 13 were in relation to pests (7 mites, 5 insects and 1 snail species) and 5 in relation to pathogens (1 virus and 3 fungal pathogens). This technical advice has assisted industry to make informed decisions in relation to current EPP threats.

Nursery Industry Pesticide Minor Use Program: Twenty-four products or pesticide actives were suggested for possible inclusion in the Nursery Industry's Pesticide Minor Use Program. These were provided in NY11001 milestone reports 104, 106 and 108.

Project Steering Committee

The Project Steering Committee (PSC) met on 10 occasions during the course of the project. It was not always possible to schedule meetings every 3 months due to the various work commitments of PSC members, but in most instances meetings were held every 4-5 months. In the final year of the project, fewer formal meetings were conducted as the project work schedule was very well defined. However, the project team continued to liaise with the NGIQ Industry Development Manager (John McDonald) to ensure that project activities remained on schedule.

A mid-term review of the project was conducted by the PSC in April 2013 (see attached). The PSC concluded that they were happy that project outcomes were being achieved as scheduled. PSC minutes for NY11001 were provided as attachments to each NY11001 milestone report, including the mid-term review which was conducted during PSC meeting 5 (April 23, 2013).



Evaluation and Discussion

The implementation of a new database during the early stages of NY11001 to track diagnostic samples processed through Grow Help provided a useful tool for evaluating diagnostic activities over the course of the project. Database searches revealed significant increases in total sample numbers received through Grow Help between 2011 and 2015, including both NIASA and non-NIASA nursery samples. Data also showed increases in samples received from states other than Queensland over the course of the project. These observations suggest that the support provided through NY11001 was facilitating this increase in diagnostic capacity, most likely be due to a combination of factors, including:

- Increased staffing in the fields of entomology and plant pathology as a result of project funding
- Discounted charging schedule for all nursery samples, and complimentary samples (3 per annum) for NIASA nursery businesses
- Website upgrading and improvements in sample submission processes (e.g. creation of an electronic sample submission form on the Grow Help website) and reduced sample handling times
- Improvements in sample reporting (new professional template with test results, high resolution photographs, diagnosis, recommendations and links to further information)
- Enhanced collaboration with NGIA and state-based NGI's to promote the national diagnostic service
- Increased utilization of molecular methods in the species identification of nursery pathogens

Database searches also revealed the very high diversity of host plant species handled by the project team over the past four years, and the wide range of pathogen species isolated from disease symptoms. As such, diagnostic services such as Grow Help provide an ideal opportunity to detect new pests and pathogens which potentially pose a biosecurity threat to nursery production.

Diagnostic activities conducted as part of NY11001 have assisted a large number of individual nursery businesses across Australia manage their day-to-day plant health issues. The project team also provided an indexing service to clients to demonstrate virus-free status of nursery plants, an important tool for businesses wanting to supply clean motherstock to customers and obtain phytosanitary certification for interstate trade.

An assessment of portable diagnostic test kits was undertaken as a minor objective of NY11001. While this process did provide a degree of validation of the selected kits, it was agreed by the Project Steering Committee to discontinue this activity mid-way through the project as it was felt that a more controlled evaluation process was desirable but beyond the scope of NY11001.

Training workshops on the identification and management of nursery pests and diseases were evaluated by means of post-workshop participant feedback. This feedback consistently returned high levels of participant satisfaction across all aspects of the workshops (workshop facilities, content, facilitators), and high workshop attendance numbers supported this finding. Future workshops could be evaluated in more detail by monitoring the changes in production practices implemented by selected nursery businesses as a result of workshop participation, and assessing the impact of these changes on production.

Fact sheets, nursery papers, pest management plans and other written resources produced during NY11001 have undisputedly generated an extensive amount of information on nursery plant health and on-farm biosecurity. It is difficult to directly quantify the value of these resources, but they have been used as inclusions in workshop information kits and as attachments to diagnostic reports, are also freely available for download at any time from the NGIA and NGIQ websites. Obtaining metrics on website download numbers may be a useful evaluation tool in future projects, giving some indication of the accessibility, awareness and demand for these resources.

The value of preparing pest specific contingency plans during the project is another aspect that is difficult to quantify, but the potential benefits can be very significant. The eradication and/or containment costs of an incursion of a major exotic pest or disease such as HLB, fire blight, giant African snail or Dutch elm disease into Australia would likely be in the millions of dollars, as has been the case with myrtle rust (estimated cost of \$9M in first year of detection in Queensland alone) and fire ants (approx. \$18M per year since its introduction). If even one exotic pest was detected and eradicated more effectively/efficiently as a result of project activities, the benefit to Australia could be very high.

In summary, NY11001 has provided a framework to the Australian nursery industry for obtaining on-going support in relation to plant health and biosecurity issues. It has provided industry accessibility to a range of resources based on information, training, diagnostics and technical support. The close partnership with industry through NGIA and state-based NGI's has been a critical element in achieving this outcome.

Recommendations

- The funding provided by the Australian nursery industry, HIA and DAF for this project over the past four years has provided dedicated plant pathology and entomology support for industry during this period. Given the success of this approach, combined with the fact that significant capacity has been built over the course of the project (specifically in the area of nursery production plant health and biosecurity), it is recommended that this collaboration be continued if possible so that industry members have ongoing access to technical support, information, diagnostics and training.
- Given the particular vulnerability of the nursery industry to exotic plant pest incursions, increased emphasis on biosecurity preparedness in any planned future activities is recommended. This could include a continuation of similar biosecurity activities undertaken in NY11001 (e.g. pest contingency plans, EPP incursion support), as well as introduce new aspects such as conducting EPP simulation exercises and preparing emergency permit applications in readiness for a potential EPP detection.
- Any future training and diagnostic activities could be subject to more rigorous evaluation by conducting telephone interviews with nursery producers following workshop attendance or diagnostic sample submission. This could involve documenting the changes implemented by producers as a result of workshop attendance or sample submission, and assessing impacts over time on their production practices.
- To provide training to a wider segment of industry, as well as to businesses operating in remote locations, it is suggested to trial the use of webinars (in addition to hands-on workshops) in future.

Scientific Refereed Publications

Journal article

Kolesik, P., Manners, A.G., Hill, K. 2015. A new species of gall midge (Diptera: Cecidomyiidae) feeding on ornamental *Cordyline fruticosa* (Asparagaceae) in Australia. *Austral Entomology* **54**, 259-264.

Intellectual Property/Commercialisation

No commercial IP generated.

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Last but certainly not least, the project leader would like to thank her dedicated and highly capable project team for their tremendous contribution to this project.

Project Team

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