Hort Innovation

## Final Report

# Building the resilience and on-farm biosecurity capacity of the Australian production nursery industry

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**Delivery partner:**

Queensland Department of Agriculture and Fisheries

**Project code:**

NY15002

**Project:**

Building the resilience and on-farm biosecurity capacity of the Australian production nursery industry (NY15002)

**Disclaimer:**



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# Content

## Summary

Building the resilience and on-farm biosecurity capacity of the Australian production nursery industry (NY15002) enhanced biosecurity preparedness for the Australian nursery industry using a framework of knowledge and expertise, innovation, collaboration and frontline delivery. This included the development of online resources to assist growers in the management of common pests and diseases, face-to-face workshops and diagnostic capacity. The project also assisted the production nursery industry in their biosecurity capacity, creating and updating pest specific contingency plans and completion of the biosecurity simulation, Exercise Fastidious.

NY15002 was very successful in the development and delivery high quality pest and disease management extension resources including 22 factsheets, 9 pest management plans and 5 nursery papers. These resources were written specifically for the Australian production nursery industry and therefore were uniquely suited to clients (compared to resources available from overseas). A total of 28 workshops (615 participants) and 14 webinars (263 attendees and about 9400 subsequent views) were completed on various aspects of pest and disease management. Over 2300 samples were received by the diagnostic service Grow Help Australia from production nurseries. About half of these samples were from NIASA businesses across Australia. Lastly, the production nursery industry's Pest ID tool (a web-based photo database of pest and disease symptoms) was updated significantly; hundreds of new pages were created and edited.

Growers that used resources or interacted directly with the project team indicated that they benefited significantly. For example, attendees of workshops and webinars indicated that they had increased crop monitoring, reduced weed populations, chose pesticides more carefully and had general improvements in plant health as a result of implementing recommendations. High percentages of clients using the diagnostic service indicated that recommendations were relevant and resulted in moderate or greater reductions in pest/disease incidence, improvement in crop health and reductions in management costs.

Exercise Fastidious (EF) was also a great success with 59 participants including representatives from the Australian Government, all state and territory governments, 13 industries, PHA, Hort Innovation, CSIRO and 5 representatives from New Zealand (from government and industry). EF allowed several challenges to be identified in the event that *Xylella fastidiosa* were detected in Australia. Some of these areas have supported the need for further research and resulted in funded projects, e.g., on the diagnostics of *Xylella* and identifying potential native insect vectors. There were also flow on effects to other aspects of biosecurity policy. For example, EF increased understanding of how the agreed-in-principle Emergency Plant Pest Response Deed (EPPRD) elements relating to pathogen and vector complexes would function. EF also increased the familiarity of all participants in the use of the technical feasibility of eradication decision making tool, which will be used as part of CCEPP on a regular basis.

The project has led to the development of NY20000, Resourcing, supporting, and assessing biosecurity in nursery production. This project will provide greater support to production nurseries wanting to access diagnostic services (free samples to all production nurseries). It will also assess the impact of nursery hygiene practices on pest and disease incidence post-sale and post-planting.



## Keywords

Production nursery; pest and disease management; crop health; biosecurity; diagnostics; Grow Help Australia; workshops and webinars; factsheets; Exercise Fastidious; contingency plans.

# Introduction

The Australian production nursery industry supports a number of sectors including urban horticulture, food supply via fruit and vegetable cropping, fibre production through forestry, and the environment under land care and revegetation. The industry underpins the production sector and provides substantial additional value down the supply chain in the retail and services sectors.

Endemic and exotic pests and diseases 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 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. The extensive domestic and international movement of nursery stock through commercial trade also provides an ideal pathway for the spread of pests and diseases.

This project was linked directly to the National Plant Biosecurity Strategy and the nursery industry biosecurity plan, and assisted in building Australia's ability to prepare for, and respond to, pest incursions through the production of new and updated contingency plans. The project continued to train nursery staff to better recognise pests and diseases, including exotic species. Furthermore, the project promoted best practice management of pests and diseases. These practices serve to increase the likelihood that a nursery will detect and eradicate a pathogen from the nursery at an early stage and reduce the likelihood that an outbreak will occur in the first place. Effectively, this assists in completing a number of action items identified in the nursery industry biosecurity plan including (but not limited to) on-farm biosecurity training packages and the production of biosecurity awareness material.

This project, NY15002, followed on from NY11001 (Plant health, biosecurity, risk management and capacity building for the nursery industry), which successfully developed capacity in the area of plant health and biosecurity in production nurseries. NY11001 developed similar outputs and outcomes to the current project, but on a smaller scale and with less focus on biosecurity related outcomes. Momentum built in NY11001 was carried over and ramped up in NY15002. In a similar fashion, NY20000 follows NY15002, building on its successes and adding new areas of research that will assist industry in achieving its strategic investment plan.

# Methodology

There were two main aspects to NY15002, both being relevant to biosecurity actions across Australia.

1. Assist the nursery industry to build biosecurity preparedness and planning, both at an industry and on-farm perspective.

   Industry biosecurity preparedness and planning was achieved by completing a major, national biosecurity exercise to simulate the incursion of *Xylella fastidiosa* the number one National Priority Plant Pest in Australia. This aspect of the project was completed in collaboration with Plant Health Australia and a committee of industry and state government biosecurity representatives. Exercise Fastidious was completed as a two-day exercise with a diverse group of participants including state and federal jurisdictions, Australian industry representatives and NZ government and industry representatives. For more detail refer to the final report.

   The project team also reviewed and updated existing contingency plans. These included significant additions to the response sections of the plans specific to each pest as well as updating other sections as appropriate (e.g., the biology and diagnostics). In addition, new contingency plans were written over the course of the project. These documents will assist biosecurity organisations and industry respond to these pests in the event that they are detected in Australia.

   Lastly, support will be provided to the nursery industry's National Biosecurity Officer assisting during EPP incursions by providing expertise in the areas of pest biology, host range and pest impacts.

2. Assist production nurseries to identify and manage pests and diseases more efficiently. This aspect of the project was achieved through improved diagnostic capacity to enhance grower preparedness, contributions to the industry web-based plant health and biosecurity resource material and training through national grower workshops and webinars.

   a. Diagnostic capacity

      The project team provided pest and disease diagnostic work for the Australian nursery industry under the umbrella of DAF's diagnostic service, Grow Help Australia. All NIASA nurseries received 10 free samples per year. All production nurseries received a significant discount, providing identification of the problem and specific recommendations suited to their business for the cost of about $85 per sample. Most reports included colour photographs of symptoms and relevant pests/diseases detected to assist nursery managers and staff in the recognition of diagnosed problems. De-identified photographs taken from diagnostic samples will be used in fact sheets and other web-based resource materials.

   b. Contributions to industry web-based plant health and biosecurity resource material

      The team developed a suite of plant health and biosecurity resource materials to underpin activities within NY15004 (National Nursery Industry Biosecurity Project) and compliment NIASA and Biosecure HACCP programs. These materials, which were developed in collaboration with the project reference group, included pest and disease factsheets, nursery papers and pest management plans, as well as images and descriptions of pests and diseases for inclusion in the industry's web-based information package (Pest ID tool).

   c. Training in identification, monitoring and management of pest and diseases in production nurseries

      The project team delivered on-farm field days and industry workshops on pests, diseases and biosecurity preparedness in every state/territory each year of the project. As such a total of 7 workshops per year were expected but were not possible in 2020 because of COVID-19. Workshops focused on the identification and management of key nursery pest & disease groups, and were framed around current plant health and biosecurity resource material available through industry and government sources, such as BioSecure HACCP and NIASA Best Management Practice Guidelines (production nursery accreditation scheme).

      Webinars were completed in each year of the project. Each 1-hour webinar focused on a specific area, e.g. management of leaf spots, root rots, leaf feeding insects etc. Four webinars were completed in the first year of the project. The PRG decided to complete two webinars per year

thereafter and replace two webinars with one factsheet. However, additional webinars were also completed in 2020 to replace workshops.

# Outputs

A number of outputs were completed on an annual basis all specifically produced for the Australian production nursery industry. These included fact sheets, nursery papers, management plans, workshops and webinars. Diagnostic support was provided to the production nursery industry; all production nurseries received discounted rates and NIASA businesses received 10 free samples per year of the project. In addition, contingency plans were created, a biosecurity simulated incursion (Exercise Fastidious) was completed in collaboration with Plant Health Australia and support was provided to industry on specific pests that had been detected in Australia for the first time. Each of these areas will be covered in more detail below. Note that NY15002 did not have an M&E plan.

### Exercise fastidious

Exercise fastidious (EF) simulated the incursion of the very serious bacterial pathogen and national priority plant pest, *Xylella fastidiosa*. The two-day exercise had 59 attendees including representatives from the Australian Government, all state and territory governments, 13 industries, PHA, Hort Innovation, CSIRO, and 5 representatives from New Zealand (from government and industry). EF was led by PHA with guidance from steering committee members from multiple state and federal government agencies and industry representatives. A detailed final report of EF is online.

### Biosecurity support

Technical support in relation to 10 exotic pests was required during the life of the project. Many additional pests were reported during this time, but assistance was not required from the project team.

### Fact sheets, nursery papers, management plans and contingency plans

A total of 22 fact sheets on various pests, diseases and disorders were completed (Table 1). All fact sheets completed are available on the production nursery FMS website. Almost all are available on the pest and disease fact sheet page. Where they are available on a different page, links are provided below. These documents were a minimum of 4 printed pages. Some topics were complex or required additional information to tailor and make it more relevant to the Australian production nursery managers.

**Table 1.** Topics of factsheets produced over the life of NY15002

| Year | Factsheet topic |
|---|---|
| 2016 | • Aphids<br>• Gall producing insects<br>• Gummy stem blight<br>• Dutch elm disease |
| 2017 | • Botrytis<br>• Thrips<br>• Leaf spot pathogens<br>• Scarab beetles<br>• Leaf beetles |
| 2018 | • General fungal pathogen biology<br>• Phytophthora ramorum<br>• Invasive exotic ants<br>• Southern red mite |

| Year | Factsheet topic |
|---|---|
| 2019 | • Fungicides, resistance and its management<br>• Water disinfestation<br>• True bugs<br>• Wood-boring insects<br>• High health grafting |
| 2020 | • Edema<br>• Preventing disease in propagation<br>• Pest/disease transmission in nurseries<br>• Managing microbiological populations* |

* This topic is in the final stages of review, will be finalized early in 2021 and made available online.

One nursery paper was completed per year of the project (Table 2). These are strictly 4-page documents that are communicated to industry via their communication channels and GIA website. Nine pest management plans were produced over the life of the project. Seven contingency plans against specific pest threats were completed and an additional plan is being completed in collaboration with the Hort Innovation funded area wide management project (VG16086) by the end of 2021 (Table 2). All pest management plans and contingency plans are available on the nursery production FMS website.

**Table 2.** Topics of Nursery papers, management plans and contingency plans completed each year of NY15002.

| Year | Nursery Paper topic | Management plan topic | Contingency plan topic |
|---|---|---|---|
| 2016 | Phytophthora baiting method | • Thrips<br>• Scale insects | • Pierces disease (update)<br>• Brown marmorated stink bug |
| 2017 | Latent fungal infections | • Gall producing insects | • Glassy winged sharp shooter |
| 2018 | Rust fungi | • Non-pathogenic disorders<br>• Aphids<br>• Caterpillars | • Exotic invasive ants<br>• Phytophthora ramorum |
| 2019 | How to develop a personalized management plan | • Leaf spot pathogens | • Bean aphid |
| 2020 | Insecticides, resistance and its management | • Weeds*<br>• Liverwort | • Pseudomonas syringae (exotic strains)*<br>• Thrips and tospovirus** |

* This topic is in the final stages of review, will be finalized early in 2021 and made available online.

** The thrips and tospovirus will be completed in collaboration with team members of the project 'Area wide management of vegetable diseases: viruses and bacteria (VG16086)' in 2021.

**Workshops and webinars**

Workshops and webinars were completed each year of the project (except extra webinars were completed in 2020 to eliminate travel requirements because of Covid 19). A total of 28 workshops were completed with 615 total attendees (Table 3). 14 webinars were completed over the life of the project with 263 total attendees and about 9,400 total subsequent views (Table 4). Some webinars have been viewed more than others ranging from about 1 to 20 views per week. All webinars are able to viewed on the GIA YouTube channel at the following playlist.

**Table 3.** Workshops presented 2016-2019 and the number of attendees.

| Year | Location | Date | Attendees |
|---|---|---|---|
| 2016 | Brisbane | April 20 | 22 |
| | Perth | April 22 | 12 |
| | Darwin | June 22 | 25 |
| | Melbourne | Sept 14 | 18 |
| | Adelaide | Sept 16 | 30 |
| | Sydney | Nov 10 | 27 |
| | Hobart | Nov 17 | 47 |
| 2017 | Melbourne | May 30 | 25 |
| | Adelaide | June 1 | 20 |
| | Cairns | Aug 2 | 17 |
| | Darwin | Aug 4 | 24 |
| | Perth | Nov 8 | 29 |
| | Gold Coast | Nov 10 | 18 |
| 2018 | Darwin | 13 June | 12 |
| | Adelaide | 15 Jun | 25 |
| | Brisbane | 19 Sept | 9 |
| | Sunshine coast | 21 Sept | 28 |
| | WA | 7 Nov | 23 |
| | Vic | 9 Nov | 14 |
| 2019 | Brisbane | 18 June | 20 |
| | Melbourne | 19 June | 45 |
| | Adelaide | 20 Jun | 25 |
| | Mildura | 21 Jun | 28 |
| | Townsville | 13 Aug | 6 |
| | Darwin | 14 Aug | 20 |
| | Western Sydney | 9 Oct | 12 |
| | Perth | 13 Nov | 25 |
| | Bunbury | 14 Nov | 9 |
| | Total | 28 workshops | 615 attendees |

**Table 4.** Webinar topics, attendees and YouTube.

| Webinar topic – number of attendees on the day | Date published | Total views, Nov 2016 | Total views, Nov 2017 | Total views, Nov 20, 2018 | Total view, Nov 18, 2019 | Total views, 6 Jan, 2021 | Views per week – Nov 2019 | Views per week – Jan 2021 |
|---|---|---|---|---|---|---|---|---|
| Insects pests vs beneficials - 26 | 28/9/2016 | 122 | 505 | 777 | 1,103 | 1,608 | 6.73 | 7.21 |
| Insects and pesticides - 11 | 13/10/2016 | 52 | 121 | 138 | 274 | 457 | 1.70 | 2.07 |
| Fungal vs bacterial leaf spots – 10 | 13/11/2016 | 9 | 231 | 482 | 818 | 4,234 | 5.21 | 19.56 |
| Leaf spots and pesticides – 9 | 13/11/2016 | 9 | 168 | 295 | 417 | 533 | 2.65 | 2.46 |
| Mite identification and mgmt – 32 | 27/4/2017 | NA | 97 | 120 | 158 | 210 | 1.18 | 1.09 |
| Virus identification and mgmt – 20 | 24/5/2017 | NA | 98 | 133 | 156 | 198 | 1.20 | 1.05 |
| Pesticide selection for resistance mgmt – 16 | 29/3/2018 | NA | NA | 47 | 96 | 146 | 1.12 | 1.01 |
| Causes and symptoms of phytotoxicity - 11 | 26/4/2018 | NA | NA | 148 | 443 | 1,390 | 5.43 | 9.87 |
| Root pathogens – 14 | 2/9/2019 | NA | NA | NA | 45 | 126 | 4.09 | 1.79 |
| Leaf feeding insects - 17 | 10/8/2020 | NA | NA | NA | NA | 147 | NA | 6.91 |
| Preventing diseases in nurseries – 18 | 10/8/2020 | NA | NA | NA | NA | 162 | NA | 7.61 |
| Sustainable use of fungicides – 14 | 10/8/2020 | NA | NA | NA | NA | 94 | NA | 4.42 |
| Neonic alternatives – 31 | 15/9/2020 | NA | NA | NA | NA | 64 | NA | 3.96 |
| Climate change on pest populations - 34 | 14/10/2020 | NA | NA | NA | NA | 33 | NA | 2.75 |

**Diagnostics**

Over 2300 samples were received from NIASA and non-NIASA production nurseries across every state in Australia (no samples were received from ACT or NT) (Table 5). Over half of production nursery samples received were from NIASA nurseries. Of NIASA samples, about half were from Queensland (Table 6). Most samples received from non-NIASA nurseries were from Queensland, however, there was a growing trend of non-Queensland non-NIASA production nurseries submitting samples (data not presented). The high preponderance of Queensland samples is likely due to a number of factors including a long-standing, strong historical relationship between DAF, NGIQ and production nurseries leading to many nurseries having a habit of submitting samples to DAF. The diagnostic laboratories of most other state jurisdictions do not receive production nurseries samples, with the notable exception of Crop Health Services in Victoria.

Bulk indexing samples were submitted with a specific purpose (e.g. testing for a specific virus or other pest) and generally had no disease symptoms. This testing was completed to facilitate market access, either interstate or internationally, and assisted businesses in exporting in the order of hundreds of thousands of plants (unfortunately, this data was not quantified consistently).

Over the life of the project the most common pests diagnosed were from the genera *Pythium*, *Phytopythium*, *Fusarium*, *Phytophthora* and *Colletotrichum*.

**Table 5.** Total number of production nursery samples received from NIASA and non-NIASA businesses received each year of the NY15002. See text above for an more details on bulk indexing samples

| Year | Non-NIASA | NIASA | Nursery Bulk indexing | Total |
|---|---|---|---|---|
| 2016 | 61 | 152 | 450 | 663 |
| 2017 | 130 | 103 | 40 | 273 |
| 2018 | 147 | 143 | 0 | 290 |
| 2019 | 136 | 148 | 495 | 779 |
| 2020 | 154 | 131 | 83 | 368 |
| Total | 628 | 677 | 1068 | 2373 |

**Table 6.** Total number of production nursery samples received from NIASA and non-NIASA businesses from each state over the life of NY15002 (excluding bulk indexed samples).

| State | Non-NIASA | NIASA | Total |
|---|---|---|---|
| NSW | 18 | 77 | 95 |
| NT | 0 | 0 | 0 |
| Qld | 534 | 341 | 875 |
| SA | 4 | 15 | 19 |
| Tas | 37 | 25 | 62 |
| Vic | 9 | 78 | 87 |
| WA | 26 | 141 | 167 |
| Total | 628 | 677 | 1305 |

**Pest ID tool**

DAF completed 75 full page factsheets and provided ver 1000 photographs for inclusion in the database. NGIQ was sub-contracted to administer the database and complete additional pages as required. A full report of their activities is provided as Appendix 1.

A summary of their outputs includes:

- Creation of over 400 new pages
- Editing about 600 existing pages
- Removing about 800 superfluous or obsolete pages
- Provided technical assistance to users
- Development of promotional material

# Outcomes

The outcomes from the project have been determined based on evaluation activities completed over the life of the project (listed in the M&E section below). The outcomes of each area of the project that was evaluated, are treated separately below.

**Workshops**

Workshop evaluation was completed after each workshop on various aspects of the day including the content of topics presented, facilities and overall benefit. Typically, on the day workshop evaluation scored 4.3-4.7 out of 5 (5 being the highest score). In general, 50-60% of workshop attendees that completed the evaluation indicated that they would make at least one positive change as a result of the workshop. Long term evaluation (at least one year after attending a workshop) indicated a number of common areas that attendees had changed as a result of workshops:

- Increased crop monitoring
- Improved ability to triage sick plants
- Reduced weed populations
- Improved hygiene practices
- Accessed nursery resources more frequently
- Become more proactive, not as reactive
- Increased use of biological control
- Decreased pest/disease incidence, including fewer discarded plants
- Improvements in plant health

**Webinars**

In general, 15-20% of webinar attendees completed follow-up surveys. Respondents indicated that the webinars increased their knowledge of the webinar topic to a high degree and were consistently relevant to their business. As a result of attending the webinars, respondents indicated that they would make changes to nursery practices including:

- Improving plant health monitoring
- Increasing the number of hygiene and cultural practices to reduce pest pressure and need to apply pesticides
- Completing small-scale, in-field trials to improve crop growth/pest management
- Choosing pesticides more carefully to better manage the target pest

**Diagnostics**

On three years (2017, 2018 and 2020), surveys were sent to production nursery businesses that had submitted samples the previous year (about 300 clients). This resulted in 39 respondents. Across the three years, similarly positive feedback was received:

- About 90% of respondents indicated that recommendations were mostly or very relevant
- About 70% of respondents indicated a moderate or greater reduction in pest/disease incidence as a result of implementing recommendations
- About 85% indicated a moderate or greater improvement in crop health
- About 60% indicated a moderate or greater reduction in management costs

This feedback indicate that most clients that submit samples to Grow Help benefit greatly after just one season of implementing recommendations.

**Exercise Fastidious**

The overall aim of EF was to improve the appreciation of critical determining factors for technical feasibility decision making and effective response strategies implemented for *Xylella fastidiosa* under the Emergency Plant Pest Response Deed framework. This was achieved on many levels and are included in a detailed report. A brief summary of outcomes have been included here. EF has assisted Australian preparedness identifying 18 research needs. This has assisted in prioritizing separate research projects by the Xylella coordinator project (MT17006).

Three additional objectives included:

1. Investigate Affected Parties' capability to determine technical feasibility of eradication for *Xylella fastidiosa* in the absence of a known vector utilising the newly developed technical feasibility of eradication (TFE) decision making tool.
    a. At the conclusion of the exercise, participants recognised the value of using the TFE tool to drive informed decision making on the specific elements in isolation, before coming back to consider the entire picture. As a result, there was strong support for the TFE tool's utilisation to assist in EPP response decision making. This is essential as CCEPP will be using the TFE tool on a regular basis to assess feasibility of eradication. As such the exercise has had a broad impact as there had been resistance to use the tool because of lack of familiarity.
2. Examine potential strategies for responding to *Xylella fastidiosa* in a plant production setting and understand the consequent impacts to industry
    a. In the development of a detailed response strategy, participants focused on surveillance, movement controls and destruction, disposal and decontamination activities. Participants were able to generate the appropriately detailed response strategy across all of these areas, noting that several challenges were identified through these activities (some of which have been prioritized and funded for research projects, e.g., on diagnostics of *Xylella* and identifying potential native vectors).
3. Increase the understanding of the implementation of relevant agreed-in-principle Emergency Plant Pest Response Deed (EPPRD) elements relating to complexes.
    a. To increase awareness of how the agreed-in-principle EPPRD variations would be implemented, all exercise activities were conducted as if the variations were in place. Given the structure of the exercise, this predominantly related to the identification of Affected Industry Parties for the Incident and the operational considerations when developing the response strategy. A broader demonstration of the variations was provided through a presentation on all relevant aspects by the Felicity Andriunas (Manager, EPPRD at PHA).

**Summary**

Long- and short-term evaluation of various aspects of NY15002 indicated that businesses have changed practices based on their interaction with the project team. Semi-quantitative evaluation data provided above is difficult to translate into a monetary return on investment. For illustrative purposes, therefore, it is assumed that the project resulted in a 0.05% improvement in GVP across the nursery sector. With even this small increase, it would equate to a benefit of about $1.2 million/year (based on GVP of $2.4 billion). This amounts to about a 4:1 benefit cost ratio from the resources produced and diagnostic service provision. If this percentage improvement were half this amount, it would still provide a positive benefit cost ratio.

# Monitoring and evaluation

NY15002 was contracted before the introduction of a requirement to have a M&E plan, therefore, this section has been modified somewhat. The PRG included the following people at the conclusion of the project:

Mr Peter Vaughan – CEO, Greenlife Industry Australia (GIA)

Mr John McDonald – National Biosecurity Officer, GIA

Dr Tim Smith – Director of Biosciences within Hort & Forestry Science, DAF

Dr Greg Chandler – R&D Manager for Biosecurity, Hort Innovation

Dr Andrew Manners – Principal Entomologist, DAF

Evaluation of project performance and outputs was completed at each PRG meeting. On a number of occasions areas appeared that were starting to become at risk. For example, during preparations for the biosecurity simulation a working group was set up including a number of DAF staff from Biosecurity Queensland. However, it quickly became clear that the project team did not have enough time to complete the output to the standard that was desired and complete all other outputs. Therefore, a variation was completed to formally collaborate with PHA and led to the completion of Exercise Fastidious.

A number of staff changes led to some delays early on in the project. Once staffing arrangements were settled and new staff trained, project outputs were caught up over time. It was anticipated that all outputs would have been completed if it weren't for COVID-19 in the final year of the project.

**COVID 19 Impacts**

COVID 19 has delayed certain aspects of the project. This occurred as a number of staff were forced into looking after school aged children and thus had reduced time to work as a consequence of lock down arrangements. There were significant administrative duties during the transition to working from home and how to mitigate the risk of infection and complete essential duties at work (e.g., the diagnostic laboratory). This was quite intense initially when it was unknown if the virus was going to rapidly increase. Social isolation also had an impact such the same amount of work took longer while working from home.

Initially the number of diagnostic samples was greatly reduced during the COVID lock down period and only samples were received from Queensland. This returned to normal and interstate nursery samples became more regular over time, particularly in the last half of 2020. For public health reasons workshops were not completed in 2020 and the PRG agreed that two additional webinars would be completed instead. This helped mitigate some of the delays as workshops usually occupy 2-3 weeks of travel.

A number of outputs were flagged as being at risk in MS110 (May 2020) including two contingency plans. One of these has been completed, but an output not previously recognized as being at risk has not been completed (refer to lessons learned in the recommendation section below).

**Project evaluation**

Project evaluation was received through surveys and feedback of various aspects of the project.

- Feedback surveys at the end of each workshop. Part of this feedback also included an opportunity for attendees to provide comments/feedback on fact sheets and other project outputs including longer term changes that may have been made as a result of attendance of previous workshops. These surveys were completed in hard copy on the day. Attendees were prompted to provide their email address if they were willing to receive additional evaluation surveys in the future.
- Feedback surveys at the end of each webinar. These surveys were completed via Survey Monkey, providing a link in a follow up email.
- Long term evaluation of the impact of workshop attendance was completed on a number of occasions via survey monkey. These surveys were sent out in the year after the workshops were held.
- Long term evaluation of the impact of submitting samples to the diagnostic service, Grow Help Australia. These surveys were sent to nursery growers on two occasions over the life of the project, targeting businesses that had submitted samples the previous year (to allow sufficient time that any management changes made as a result of recommendations could be realized).

- Independent mid-term review (appendix 2).
- Informal feedback from growers and industry representatives.

The results of these evaluations have been summarized in the outcomes section above and in the project mid-term evaluation, which gave specific examples of how different aspects of the project impacted their businesses.

# Recommendations

The key recommendation resulting from the mid-term review was to increase the uptake of resources and the diagnostic service. The project team continued outreach to production nursery businesses through the industry communications pathway, completing blogs and video promotional material. These recommendations will be continued to be actioned in NY20000 by changing the pricing for production nurseries using Grow Help. Over the life of NY15002, NIASA businesses received 10 free diagnostic samples per year, very few ever exceeded this number and about half of all NIASA nurseries submitted a diagnostic sample to Grow Help at least once. Contract rates for diagnostic services in NY20000 provide 6 free samples to all production nurseries, regardless of accreditation or affiliation. Given evaluation results from users of the service, it is hoped that this will greatly extend the reach of the project.

**Lessons learned**

As mentioned above, some delays were incurred from lockdowns associated with COVID-19. It was anticipated that most outputs would be completed in the final year of the project and this has been realized, with some small changes. In MS110, it was anticipated that all outputs would be completed with the following being at-risk:

1. The contingency plan on *Pseudomonas syringae* (exotic strains)
2. The contingency plan on Gypsy moth.
3. The contingency plan on thrips and tospovirus

Unfortunately, not all outputs have been completed as anticipated. The situation for each at-risk and incomplete output is summarized and a logical approach recommended, and these have been discussed with the R&D Manager – Biosecurity, at Hort Innovation.

1. The contingency plan on *P. syringae* (exotic strains) has been completed in final draft form and is in the final process of being reviewed before being submitted to PHA. This was a complicated contingency plan owing to the complexity of the taxonomy and species concept of this group. The plan, which was originally thought to be for just one species, quickly expanded to the *P. syringae* species complex, which includes nearly 400 strains worldwide from 13 phylogroups and 15 'type species'. As a result, the document took an inordinate amount of time to complete and is considered to be a contingency plan on more than one species and therefore take the place of two contingency plans (see point 2).
2. The contingency plan on gypsy moth has not been completed; only an early, rough and incomplete draft being available. As indicated above, the *P. syringae* plan can be considered as two plans and therefore it is recommended to cancel the requirement to complete the gypsy moth contingency plan. The incomplete document can be provided to the production nursery industry on request, with the understanding that it is incomplete and could not be used for the purposes of a response to this pest, in the event that it was detected in Australia.
3. A contingency plan on thrips and tospovirus is being completed as part of the Hort Innovation and vegetable levy funded project, 'Area wide management of vegetable diseases: viruses and bacteria (VG16086)' in 2021. There is agreement from Dr Cherie Gambley (DAF), the project leader for VG16086 to include a nursery component into this plan with collaboration from Dr Andrew Manners. It is recommended to include this output to be reported against in NY20000 until the output is completed.
4. The factsheet on managing beneficial insects and mites has not been completed. The reason for this is that a significant amount of time was spent completing the pest management plans this year (and over the life project). In 2020, the weed management was particularly time consuming because it included a large component on herbicide resistance management. In hindsight, this part of the management plan should have been pulled out as a separate factsheet, similar to those completed on insecticide and fungicide resistance management. Since this did not occur, the weed management plan can be considered to account for a pest

management plan and a factsheet. It is recommended to complete the factsheet on the management of beneficial insect and mite populations as part of NY20000 in 2021.

Over the life of NY15002, pest management plans have tended to be on the long side. We recommend that the project team be more proactive in keeping these documents less than 10 printed pages, separating documents into more discrete topics as required. Similarly, factsheets sometimes became larger than was initially anticipated. NY20000 needs to consider more carefully the size of topic to fit them into a resource of an appropriately length.

## Refereed scientific publications

Kolesik, P., Manners, A.G., Hills-Hayes, B., 2017. A new species of gall midge (Diptera: Cecidomyiidae) damaging ornamental *Callistemon* (Myrtaceae) in Australia. *Zootaxa* **4318(2)**, 395-400.

Kolesik, P., Baker, G., Hill, K., Manners, A.G., Dijkstra, E., 2018. New species of gall midge (Diptera: Cecidomyiidae) damaging flower buds of ornamental *Alstroemeria* plants. *Austral Entomology* **57(3)**, 285-291.

## Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialisation or confidentiality issues to report

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## Appendices

Appendix 1. NGIQ Pest ID tool final report.

Appendix 2. Project mid-term review.