Hort Innovation

Final Report

Improving pest management for the nursery industry

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Delivery partner:

Greenlife Industry Australia

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NY17009

Project:

Improving pest management for the nursery industry (NY17009)

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Content

Summary

The NY17009 *Improving Pest Management for the Nursery Industry* project has successfully delivered positive outcomes for the production nursery industry nationwide. Initially the project set out to evaluate the current national and international status for access to key pesticide groups and products, pressure points on future pesticide access, current status on neonicotinoid (neonic) pesticides, and strategies and alternative product options for the future. The project then implemented a comprehensive structured crop monitoring trial across seven key nursery production cropping systems nationwide. Assessment of a range of business costs associated with management of weed, pest and disease management were made as a baseline measurement before employing structured crop monitoring. Professional crop monitoring was carried out by professional providers over a full year cropping cycle, with education and advice provided on IPM strategies, enterprise specific pest thresholds, expanded pesticide options and increased use of beneficials. At the conclusion of this trial year, costs associated with management of weed, pest and disease were again assessed to provide a full before and after comparison and establish a basic cost benefit ratio.

In a firm endorsement of the value of employing structured crop monitoring in a production nursery, all participants state they will continue to utilize the process moving forward. All participant nurseries have a better understanding of the range of pests that affect them, the beneficial organisms that can assist them, and the pesticide suite required to make their IPM program work effectively. There is no doubt there are major benefits in early detections and informed decisions on the best integrated pest management strategy to adopt for management. Participant production nurseries report, through project data and verbal feedback, significant reductions in discards due to pest and disease issues in the order of 12-16%, as well as reductions in overall pest management costs, some in the order of 10%. Greenlife Industry Australia has established a standard 5% productivity gain can be expected through the adoption of a robust crop monitoring program. This confirms the project aim of the economic benefits associated with a combination of crop monitoring and strategic use of IPM resources.

The production nursery industry has established that some of the most prevalent or economically damaging pests are Aphids, Fungus Gnats, Mites, Scale Insects and Western Flower Thrips. Project resource outcomes include publication of five IPM Management Plans for these key industry pests available on the industry web based technical information portal. Furthermore, an educational training course has been added to the GIA e-Learning platform to guide industry members on how to use these IPM management plans in their business. The course, titled *'How to implement a IPM Management Plan'* is available for industry on the eLearning platform. The industry pesticide minor use program (MUP) has continued to add more options for growers throughout the project. Several of these new additions are 'alternative chemistry' to replace noenicitinoid chemicals. Others are what are referred to as 'softer' options and include bio-pesticides and bio-controls.

The project has confirmed the basic principles of the industry plant protection and biosecurity program, BioSecure HACCP, as an effective way to integrate crop monitoring into everyday business activities. Those production nurseries that employ a rigorous and regular system of crop monitoring position themselves to make the most informed and well-timed decisions on pest, disease and weed management issues. All personnel at these production nurseries buy into the many benefits of knowing your pest and its life cycle, structured monitoring activities to establish pest populations and relevant thresholds, and deployment of an integrated pest management program that manages the pest whilst minimizing negative effects in the cropping system, community and the environment.

Keywords

Integrated Pest Management, IPM, pest management, insects, pests, beneficial insects, beneficials, crop monitoring, nursery production, cost benefit analysis, BioSecure HACCP, plant protection, pesticides, neonics, neonicotinoid.

Introduction

Pressure on industry to utilise available pesticides in an environmentally and socially responsible manner is building as is the maintenance of pesticide efficacy (resistance management) and cost is increasing for new chemistry, technology, and farm labour. Recent supply chain decisions by a major greenlife retailer driven through international influences, and the subsequent knock-on effect from other retailers, has restricted growers utilising a key pesticide group (neonicotinoids) since 2020, an important part of industry insect pest management for the past two decades. This move is the first such market driven restriction on a registered pesticide in Australia that has been made without supportive evidence, nor regulatory backing. This has highlighted the exposure of Australian production nurseries to such decision drivers within the supply chain and the potential adverse impacts on business continuity and sustainability.

Therefore, it is vital the industry understands and implements actions that preserve the access, efficacy, and cost of current synthetic pesticides through informed decision making, judicious application, improved application technology, rotation of chemical mode of action (MoA) groups and pest resistance management strategies. Integrated Pest Management (IPM) is the selection and application of multiple appropriate pest management options (practices & control) into a cropping system to keep plant pest populations below economic thresholds. In nursery production these IPM options include prevention practices to minimise pest entry, establishment and spread. Hygiene strategies such as access controls and disinfestation procedures. Other options are storage practices for raw materials, crop protection pest management strategies including beneficial biological control and targeted synthetic pesticide use.

NY17009 has fulfilled two key assessments to improve and inform pest management within the production nursery industry. The two major disciplines are general plant protection processes including pesticide access, and the economic benefits associated with structured crop monitoring and associated IPM.

The two key assessments were firstly a desk top national and international review of future access to key pesticide groups/products. This delivered detail on the pressure points for pesticide access, status of neonic pesticides, alternative product options and their impact on crop quality, pest management efficacy and cost of alternative products. The second assessment for the project was the implementation of crop monitoring trials across seven key nursery production cropping systems. Evidence was collected through economic assessments of pest management related business costs before and after the implementation of robust crop monitoring procedures and IPM measures to investigate the benefit/cost to growers of undertaking a critical element of a IPM program.

The project addressed two Outcomes from the Nursery Industry Strategic Investment Plan 2017 – 2021:

- Outcome 3 - Improved industry protection from exotic, emerging and endemic pests and diseases.
- Outcome 4 - Improved productivity, profitability and professionalism through the creation and adoption of innovation and industry BMP's.

The specific strategies addressed under each Outcome include:

- Outcome 3 – Increase the awareness of the requirement of biosecurity to industry and stakeholders and maintain access to chemicals through the Minor Use Permits.
- Outcome 4 includes the strategies of 'Identify and fill R&D production gaps where research would provide a collective benefit to industry, Review and update the industry BMP modules to promote and expand these programs, including accreditation; and
- Develop and conduct extension activities to drive adoption of BMP practices.

Methodology

GIA engaged the services of AgAware Consulting Pty Ltd to undertake a desktop investigation and engagement program to investigate the national and international agchem landscape now and into the foreseeable future. The first of the key activities was a global review of literature, including international and domestic stakeholders, being performed to address and report on the following points:

Liaisone with key overseas regulators, industry representatives, researchers and agchem companies in countries including USA, UK, and EU regarding their nursery industry and pesticide availability on:

- Current and future neonicotinoid restrictions.
- Current neonicotinoid alternatives for the nursery industry.
- Possible future neonicotinoid alternatives for the nursery industry.
- Impact on nursery industry to neonicotinoid removal/restrictions.
- Other current restrictions on nursery industry pesticides.
- Proposed future restrictions on nursery industry pesticides.
- Alternative pest management strategies to pesticides for the nursery industry.
- Proposed future restrictions on pesticides.

The second priority was to liaison with key Australian agchem companies regarding their involvement in the nursery industry and pesticide availability on:

- Current neonicotinoid restrictions.
- Current neonicotinoid alternatives for the Australian nursery industry.
- Future neonicotinoid alternatives for the Australian nursery industry.
- Impact on the Australian nursery industry to neonicotinoid removal / restrictions.
- Current APVMA position on neonicotinoids.
- Development of neonicotinoid alternatives and crops in Australia.
- Possible future restrictions on the Australian nursery industry pesticides.
- Possible alternative pest management strategies to pesticides for the Australian nursery industry.

The above component of the project was performed and delivered by AgAware Consulting Pty Ltd over the initial 6 months of the project (May 2019 – Dec 2019). The review methodology included a global review of literature including international and domestic stakeholders investigating neonic insecticide use, restrictions and alternatives. Liaison with key Australian agchem companies regarding their involvement in the nursery industry and pesticide availability including neonics, alternatives, future influences on pesticide access and overall alternative pest management strategies being considered.

The report highlighted the importance of the neonicotinoid insecticides (acetamiprid, clothianidin, dinotefuran, imidacloprid, thiacloprid and thiamethoxam) to Australian agriculture and the importance of dinotefuran, imidacloprid and thiamethoxam to the Australian production nursery industry by controlling major sucking, chewing and soil insect pests.

The report identified potential replacement insecticides to the neonicotinoids. Production nurseries through GIA have been very active in recent years to identify replacement insecticides and obtain access via APVMA minor-use permits. These insecticides include: azadirachtin, Clitoria ternatea, flonicamid, pirimicarb, spinetoram, spirotetramat and sulfoxaflor found here: https://nurseryproductionfms.com.au/apps-mup-search/

The second key activity was an economic analysis performed over two years on volunteer participant production nurseries before & after adopting IPM practices. The IPM practices included crop monitoring, site surveillance, consignment inspections and activity recording consistent with the BioSecure HACCP procedures and Australian Plant Production Standard (APPS).

Participating production nurseries were chosen to represent regionally diverse cropping systems with a range of crops produced across 6 – 7 primary supply chains. Locations of production nurseries include Western Australia, New South Wales, South Australia, Queensland and Victoria.

At initiation of the first year of assessment on the cost of managing pests in production nurseries before implementing IPM practices, each of the seven participating growers was visited by the project economist to undertake a financial assessment of their business costs related to pest, disease and weed management and implement the appropriate structures to capture pest management related costs and financial data for assessment against year three of the project. These metrics included costs associated with stock losses, stock turnover, picking/despatch, pesticide use and labour. This was then used for financial benchmarking against same data which would be collected in the following year, where the aforementioned IPM procedures were implemented along with the provision of professional crop monitoring performed by Biological Services.

For the second year evaluating the cost of managing pests in the participant nurseries, Biological Services provided all the professional crop monitoring and decision support services (advice/recommendations on managing pests detected utilising all elements of IPM including pesticide recommendations that consider impacts on beneficial organisms) across the seven businesses of the second year of the economic assessment. Biological Services performed a total of 211 crop monitoring activities over this time frame. Some crop monitoring data was collected by production nurseries who were affected by border closures because of the COVID-19 pandemic. The data in these instances was collected by nominated persons in the nursery who had undergone training by Biological Services staff and were supported by Biological Services with recommendations on actions to take during meetings held after crop monitoring. A crop monitoring procedure for these production nurseries was developed and given to those businesses performing co-monitoring events.

In the area of extension, the end of the project involved field days which were held at 5 of the 7 sites to feedback project findings and advice on IPM to industry. Each demonstration lasted four hours. The demonstration field days were centered on three components:

1. Presentation and discussion on the theories of IPM principles with strong emphasis on crop monitoring techniques, inspections, and pest surveillance utilising BioSecure HACCP procedures as guidance and pest management decision making processes presented by Biological Services.

2. Practical exercises for participants guided by staff from Biological Services on how to apply the theories of IPM. These were centered on the process of adapting IPM principles (cultural, physical, biological & pesticide) and developing a tailored strategy which is responsive to pest pressures growers are facing and how the information gathered from monitoring and surveillance is used to inform pest management decision making.

3. Presentation of the assessed and validated economic benefits achieved on-site by adopting IPM techniques were presented by GIA Plant Protection Officers. This portion of the presentation included commentary by the production nursery owners and/or key staff on their experiences while participating in NY17009 including the challenges they faced and how they overcame these challenges and the benefits they have realised within their business through the adoption of IPM techniques. Presentations by GIA also included introduction to the Australian Plant Production Standard, Best Management Practice and IPM resources at https://nurseryproductionfms.com.au/ along with Integrated Pest Management Strategies developed under NY17009 for the top 5 SARP pests (https://nurseryproductionfms.com.au/ipmpage/). An E-learning training module titled 'How to implement an IPM Management Plan' has been developed to encourage use of each of these strategies and is presented on the GIA eLearning website: https://ngia.talentlms.com/index.

Outputs

The project set out to provide industry with the following information:

- *International and national trends in progressing past the use of neonic insecticides (alternative active ingredients) that will inform both the industry pesticide Minor Use Permit program and the broader agenda for future pesticide applications under the AgVet Reform agenda.*

  Greenlife Industry Australia engaged AgAware Consulting to conduct 'A review of external influences on the availability of Neonicitinoid and other pesticides for the Australian Nursery Industry' (Appendix 3). This report established that whilst some nations had suspended or banned use of Neonicitinoid pesticides, others have since reinstated its registration. The report continued by examining a range of 'new chemistry' options in use or under development by a range of AgChem companies, some of which are is use in other agricultural sectors. Moving forward, consideration will be given to registration applications under the industry MUP program. The report also established a considerable list of pesticides under review both in Australia, but also Canada, the USA and the EU. Many of the pesticides under review are currently part of the industry Minor Use Program and are considered a critical component of the suite of pesticides normally utilised.

- A report on the and pest management strategies being considered, researched, or employed to manage plant pests without the use of neonic insecticides, *The threat of neonicotinoid insecticides to the nursery industry of Australia - A Review* (Appendix 3).

  The AgAware report explored the current options available to the industry, listing a range of pesticides that might be considered as reasonable replacements for Neonicitinoid pesticides in the future. Most of these options would require application under the industry Minor Use Program. There is increased research and development by AgChem companies to further develop 'new chemistry' options that will eventually reduce industry reliance on Neonicitinoids.

  The project has proven that by employing an Integrated Pest Management (IPM) strategy, participant nurseries have reduced their pesticide use in a broad sense and expect it to continue to reduce over time. The project proved that the basic BioSecure HACCP principles of crop and site inspection within a robust and structured system provide the information needed for informed decision making. Utilisation of these procedures has enabled production nurseries to take advantage of early detection of pest issues, which results in targeted application of pesticides before the pest issue gets out of control. Coupled this with use of beneficial organisms as part of the broad IPM program, and production nursery operators are now using less Neonicitinoid and other pesticides.

- *National and international data on pesticide trends to inform the nursery industry of options and/or actions required to address gaps in the industry's capacity.*

  As stated previously, the AgAware Consulting Pty Ltd report examined international information on pesticide trends as pressure mounts on the use of Neonicitinoid pesticides. Considerable research was conducted on available and under development options suitable to fill the gaps in the production nursery industry capacity to deal with a range of pest traditionally controlled with Neonicitinoid pesticides.

  This information will be used to inform the industry Minor Use Program (MUP) moving forward as additional options are registered to manage both pests and diseases.

- *Undertake a controlled program of structured crop monitoring across seven (7) cropping systems that will evaluate the efficacy of the BioSecure HACCP procedures and provide evidence to support upgrading the BioSecure HACCP manual (procedures) as required.*

  Seven (7) participant NIASA accredited production nurseries were established nationwide. These seven businesses represented a broad range of cropping systems including, potted colour, revegetation, indoor foliage plants, tube-stock, fruit trees and general flowering shrubs. Professional crop monitoring services were deployed across all nurseries. The Covid-19 pandemic did provide some access issues into a number of states. In those states where access was difficult, comprehensive education of applicable staff members coupled with regular online support ensured the rigour of the crop monitoring program was maintained throughout. The structured crop monitoring followed the basic principles of BioSecure HACCP

and continued for a 12-month period. All participant nurseries report that they will continue to utilize a robust crop monitoring system moving forward. This provides direct evidence of the tangible benefits of the current BioSecure HACCP procedures and further validates the system as a whole.

- *Delivery of benefit/cost assessments, at a grower level, based on businesses implementing a structured crop monitoring, site surveillance and inspection system that will provide economically validated data to support grower uptake of core IPM activities. These outputs will be built into a range of industry engagement resources including the BioSecure HACCP program, NY15004 / NY20001 project engagement and through the levy funded communication program (e.g., Case Studies).*

  The direct benefit to cost assessment component of the project has been severely impacted by external influences. The first year of the project saw the baseline data collection occur. In many cases, the production nursery participants had variable levels of data collection capacity that could be related to the various parameters required within the project. In essence, for many there was an educational aspect required simply to get the business measuring applicable data. This first year was also impacted by weather and market conditions that provided downward pressure on sales and sentiment for many. Data collected in subsequent second year was impacted by the pandemic, as boom time sales for many meant that data was severely skewed, and crop lifecycles and related pest and disease issues were not typical. Overall, it meant the figures compared year to year could not be considered as fairly comparing 'apples with apples.'

  There is little doubt that the participant nurseries all see value in employing a structured crop monitoring system based on BioSecure HACCP. In formal project interviews, all production nursery participants confirm they will continue to use the system utilized in the project past the end date of the project. They report the multifaceted benefits as their rationale, citing a range of positive outcomes. Using IPM is a confidence related activity. The educational aspects of the project have resulted in a group of industry leaders who are now better informed about their pests, the applicable beneficial organisms and the structure required to make a comprehensive IPM program work in a cost-effective manner. They have used the system in their businesses for long enough to see the benefits themselves. They are real advocates for using IPM and specifically the benefit of structured crop monitoring to underpin it.

  There will be a case study created from a specific participant nursery (as part of project NY20001 'National biosecurity and sustainable plant production program'), with more in depth analysis of the relevant benefit to cost ratio. One aspect that was repeated throughout the project was the sentiment that the full benefit of employing a structured crop monitoring program may only become obvious in years after the completed project. Development of the case study will potentially help uncover some of the medium-term benefits as the participant nursery will have experienced a further full year of utilization of crop monitoring and be able to report on any increased overall benefit. The Acadian Analysis project final report is available as Appendix 1.

- *Industry adoption and information access through a minimum of 7 field days, one at each of the 7 participating businesses, across the 5 states (QLD, NSW, VIC, SA & WA). Further opportunities exist to communicate project progress and outcomes through the nursery levy funded communication program.*

  A series of 7 field days were planned during June and July 2021 across the 5 states. Through a constant roll-out of Covid-19 related lockdowns in all jurisdictions, delivery was somewhat hampered. The 2 field days in Queensland were eventually combined into a single event, where a maximum capacity of 30 attendees participated. In Victoria, South Australia and Western Australia, event dates were changed, often multiple times due to Covid-19 lockdowns however 5 state events have now been successfully completed. In New South Wales the field day event was fully subscribed with 25 attendees. In Western Australia, the event was a moderate success with 11 attendees. In Victoria, one event yielded full capacity at 24 attendees. The second Victorian event had been postponed and rescheduled many times however the extended Covid-19 lockdowns in Victoria forced the cancellation of this event. The South Australian event, after many delays, eventually occurred in mid-October and had an attendance of 22.

  In summary, a total of 5 field day events across 5 states with 112 attendees. Feedback was extremely positive, with most attendees stating they learned a lot about crop monitoring, digital record keeping and IPM in general. Tables summarising feedback from two events in Queensland and Victoria are provided in the Outcomes section of the report below.

  Industry wide communication during this reporting period consisted of NY20001 *National Biosecurity and*

Sustainable Plant Production Project team engaging with industry during extension visits to participate in the IPM Field Days and one national communication summerising the project through GIA eNews.

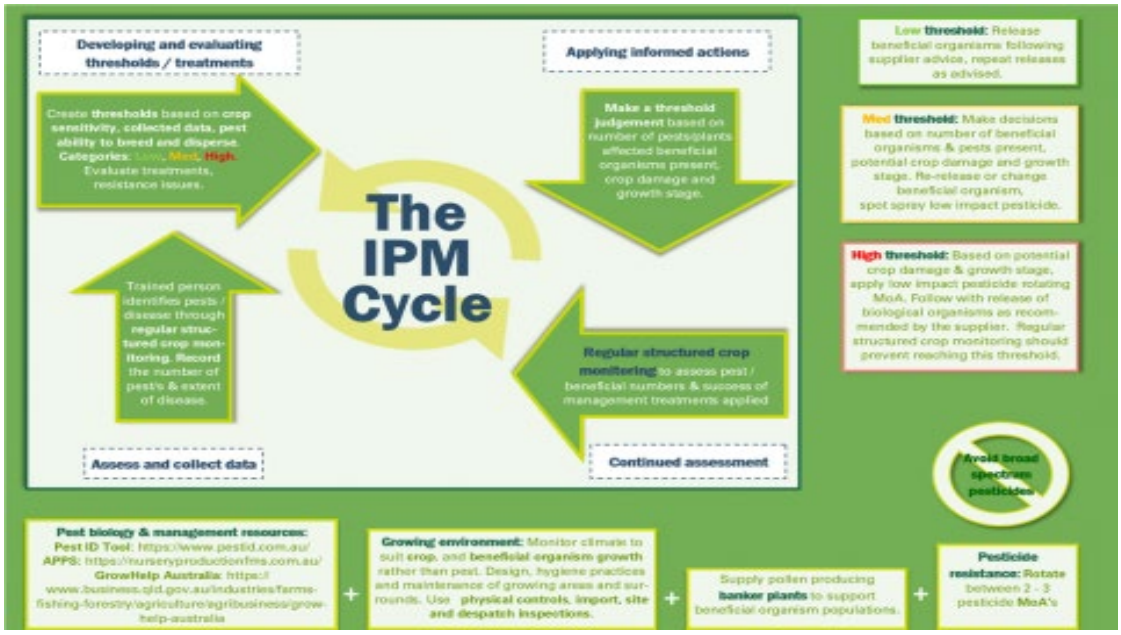
- *Process frameworks created to assist growers develop IPM strategies for the top 5 SARP pests of nursery production (Fungus gnats, mites, scales, western flower thrips and aphids).*

  Five (5) comprehensive IPM Management Plans have been developed for the five identified SARP pests in production nurseries. Each Management Plan describes the lifecycle for each pest, identifying key stages with photographs. It describes what IPM is and how and why the system works, including employment of crop monitoring. Considerable information is added on cultural control methods and biological control methods. These IPM Management plans have been uploaded to the APPS website https://nurseryproductionfms.com.au/ipmpage/ under the Pest and Disease tab.

- *Legacy outputs include developing IPM eLearning resources capturing outcomes that will be made available to industry for ongoing training and education from field days GIA will make all project outcomes available to industry through the technical website at www.nurseryproductionfms.com.au and in reference texts such as BioSecure HACCP Manual.*

  A 'How to implement an IPM Management Plan' eLearning module has been added to the GIA eLearning portal https://ngia.talentlms.com (see below). This 'how to guide' is meant to ensure greater adoption of the five (5) IPM Management Plans by explaining the IPM rationale and guiding production nurseries toward full utilization of a pest specific IPM program.

  Figure 1. How to Implement an IPM Management Plan



The 5-project specific IPM Field Days were very well attended and received. This has prompted GIA to utilize its extension officer network to continue to roll out these Field Day events as a legacy item from the project. There is clear intent to run at least one of these Field Days before the end of the 2021 year, with expectation they will continue to deliver research outcomes and training into the future. A copy of the PowerPoint presentation used at the Field Days is attached in the appendices (Appendix 2). This will form the basis for any future deliveries of the Field Day nationwide. There will be particular focus on delivery of the Field Day project outcomes in regional areas.

- *Six-month milestone status reports including two communications to industry for each milestone report.*

  Milestone reports numbered 101-106 have been submitted on time as required throughout the project timeline. All milestone reports have been accepted and approved by Hort Innovation. As reported in each individual milestone report, regular communication activities have continued throughout the project.

The following resources have been developed for the nursery industry as part of the NY17009 project. These include:

1. Video recording and presentation of the on-site demonstration field days will be uploaded to the GIA YouTube channel with promotion via industry communication channels.
2. Development of IPM strategies for the top 5 industry pests, as identified via the industry SARP.
3. The development of a dedicated eLearning course on IPM, tailored for industry specifically for the IPM strategies developed for the top 5 SARP pests.
4. Development of the IPM Field Day resources that can continue to be delivered as a legacy item by industry extension programs such as NY20001 *National Biosecurity and Sustainable Plant Production* program.
5. Development of the 7 new mini-training modules to be delivered by the NY20001 *National Biosecurity and Sustainable Plant Production* project team as part of industry BMP programs. These training modules include; Imported Plant Inspection Procedure, Nursery Stock Crop Monitoring, Site Surveillance, Dispatch Plant Inspection Procedure, Sticky Trap Use, Pesticide Resistance Management (MoA), Indicator Plants as a crop monitoring tool.
6. Information exchange with project NY15004 / NY20001 on identified R&D gaps and needs for incorporation into their grower engagement program.

Outcomes

1. An understanding of and resilience to the national and international trends relative to the access and use of pesticides in nursery production and the potential opportunities and threats to industry pest management plans relative to available pesticides.

The production nursery industry is now acutely aware that international scrutiny and focus on the use of pesticides is a threat to the ongoing management of pests, diseases, and weeds in Australia. Access to what many be described as 'staples' in the realm of pesticides for many decades may now be compromised through this international pressure. Many of these 'go to' pesticides are under review, both internationally and via the standard APVMA review process. Irrespective of the industry need for science to rule when proving that a pesticide is not in the best interest of the environment or community, many decisions are seemingly made without that underlying principle.

The production nursery industry must develop a new resilience for the future. How it prepares for this future is multi-faceted. In the first instance, industry must be a far more judicious user of the suite of pesticides currently available. There is increased responsibility on all production nurseries to use a targeted and narrow focus to chemical use. During the project, participant nurseries generally expanded their pesticide suite. Whilst this may appear counter-intuitive, it means that they now have a more focused pesticide arsenal at their disposal and will avoid the traditional tendency toward blanket spraying mentality moving forward. In addition, their suite now includes 'softer' options that are more compatible with beneficial organisms. This means these operators are committed to adopting a broad IPM strategy that uses pesticides at a minimum, and only as part of an overall strategy where the pesticide is used as merely one of the management options.

2. The Australian nursery industry will be better informed on the active ingredients that have potential to fill the gaps in pest management plans due to the removal of neonics in some markets. Additionally, industry will have opportunities to consider alternative IPM strategies to the use of neonics identified in international markets.

The project engaged the specialist consultant AgAware to conduct a full review of the local and international circumstances surrounding Neonicitinoid pesticides, along with current and future trends in pesticide access. The industry has experienced recent pressures on the use of Organophosphates, with some removed from use and others under review and perhaps likely to soon be unavailable to the production nursery sector. The list of currently used pesticides under review worldwide, specifically in Canada, the USA, the EU and Australia contains many used regularly in production nurseries, some for many decades. The project has also identified several 'new chemistry' based pesticide options for consideration as part of the industry Minor Use Program (MUP) into the future.

Pressure is mounting and scrutiny on agricultural and horticultural activities is increasing. Without scientific reasoning, an individual pesticide may be temporarily or permanently removed from access. To best position the production nursery sector, a combination of appropriate targeted use of existing pesticides, appropriate application training and adoption of comprehensive IPM programs appears the best option. The project aim, to increase the informed decision-making capacity of production nurseries has been realised. Participant production nurseries have adopted new practices that inform them of pest populations through early detection, coupled with enhanced knowledge of the pest, beneficials and importantly the best and most effective non-neonic pesticide options available.

The project outcomes include a renewed focus on awareness of the range of 'mode of action (MoA)' available in both the current and future pesticide suites. The training and educational outputs from the project aim to inform production nurseries of efficient rotation of pesticide options, particularly with a view to their immediate effectiveness and their long-term efficacy and availability. Participant nurseries have expanded their pesticide suite and now also include softer options that are softer on their beneficials. There is an expanded knowledge of how this all contributes to a comprehensive IPM program, and how adopting these practices will drive productivity and profitability gains moving forward.

3. Access to crop monitoring, site surveillance and inspection procedures that are specific to nursery production that have been independently tested for efficacy, adjusted accordingly to deliver confidence in the processes, employed at a grower level to reduce plant pest threats, reduce pesticide use and meet market expectations.

All participant production nurseries used some form of irregular pest surveillance methods before involvement in

the project. One key aspect that has been established is the merit of an organized, robust, and structured crop monitoring procedure, based on the BioSecure HACCP procedure.

All growers report the benefit of the educational aspects provided by the professional crop monitoring service (Biological Services) provided throughout the project. Participants report that all personnel involved now have a better understanding of their key pests, their relevant life cycle components, key biological agents that can assist them, and other cultural and pesticide options that work in well with the broader IPM strategy. Growers report that this confidence will only increase over time resulting in reduced pest incidence, reduced pesticide application and better environmental and community outcomes.

The nursery industry BioSecure HACCP program has established procedures for; Imported plant inspections, Site surveillance, Crop monitoring, and Dispatch plant inspections. These production nursery specific core procedures have been validated throughout this project. Further refinement of the crop monitoring procedure has been an outcome of this project specifically reviewing the sampling methodology is ongoing. The NY20001 *National Biosecurity and Sustainable Plant Production* team have developed an improved system of crop monitoring methodology. The project team is designing a new sampling matrix based on scientifically rigorous processes to deliver a range of crop monitoring sampling protocols based on monitoring frequency, pest prevalence, and survey sensitivity to deliver confidence that the percentage of crop inspected will result in a satisfactory snapshot of pest populations.

Furthermore, participant production nurseries were encouraged to establish enterprise specific pest thresholds acceptable to each business. Some businesses might supply retail establishments or state jurisdictions that require zero insect activity on despatched plants. This puts pressure on an IPM program as it means beneficial insects may be perceived as a living organism upon receival and stock may be rejected. More work will need to be done to educate relevant organisations and agencies moving forward if IPM is to be fully realised as a benefit to all.

4. Economically validated value of IPM procedures (crop monitoring, etc.) that demonstrate the benefit/cost of implementing structured activities to manage plant pests that improve business productivity.

A key aim of this project was to evaluate the cost benefit of adopting a structured pest, disease and weed management strategy. A separate consultant, Acadian Analysis was engaged to assess a range of economic/financial metrics both before and after implementation of a structured IPM management system. Unfortunately, the project encountered some challenges here due to the highly volatile trading that occurred in 2020 and 2021 due to the COVID-19 pandemic. The 'before' year data was collected from businesses that clearly have differing established record keeping in the key metric areas required for the project. This presented an educational opportunity, however meant that across the seven participants, there was probably 7 different methods or rationale to collecting the data, ranging from extremely comprehensive to completely lacking. Couple this with a year where drought and other extreme market conditions compromised the data as a 'normal' situation. To further complicate matters, the second year data meant to show the relevant numbers 'after' adopting a full and comprehensive crop monitoring were also skewed due to external circumstances. The industry experienced a Covid-19 instigated boom, meaning that sales figures went up markedly, crop time on the ground shortened significantly, and throw outs/discards diminished substantially due to markets willingness to accept below par stock due to supply shortages. Whilst some pure economic data is contained in the Acadian Analysis project final report (Appendix 1) there was some excellent and consistent outcomes reported by most or 'all' participants. These include the following:

- All growers have a better understanding of the beneficial organisms available and how to manage them
- All growers have an increased education and understanding of identifying key pests, diseases and beneficial organisms
- All growers have expanded the pesticide suite and now also include some 'softer' options that work well with beneficials and an IPM system
- All growers report that the use of beneficials is better for staff, the workplace and the environment
- Growers have reported reduction in pest and disease discards by 12%, 14% and 16% respectively
- A grower reported pesticide costs went up by 18%, however labour was reduced by 15% and the total cost of pest and disease management was reduced by 10%
- Predators can provide a significant advantage over spraying as they can be released very quickly,

anytime, and do not restrict the access to the area afterwards due to pesticide re-entry periods, which equates to labour savings and easier organising of staff

- Belief that after staff are fully trained in crop monitoring, benefits from crop monitoring will increase over time as skills improve
- All growers will continue to adopt a structured crop monitoring system.

The above further validates other established Greenlife Industry Australia data that a productivity gain of 5% is easily achievable to those who adopt the BioSecure HACCP procedures as evidenced by growers in the program but outside of this trial. The data has been borne out of past case studies of pre and post adoption financial analysis. This information will continue to be disseminated to the industry in coming years. There is an expectation that as more production nurseries adopt these procedures and IPM strategies, there will be increased industry momentum where it becomes standard industry best management practice.

5. Improved pesticide usage practices that support active ingredients currently available through resistance management (MoA Group rotation) and targeted applications plus reduced worker exposure due to lower pesticide usage.

Participant production nurseries all report they experienced many benefits through an increased utilization of beneficial organisms as part of a broader IPM program. Personnel at these organisations report a greater willingness to participate in pest management activities when pesticide application is only part of the overall strategy. Staff enjoy releasing beneficial organisms into the crop and are fully engaged in the process of monitoring their numbers, as well as the pest numbers over time. Managers and staff alike can take advantage of zero down time amongst the crop as there are no re-entry or with-holding period issues to consider.

Most participant production nurseries experienced an expansion of their pesticide suite, to include both a broader range of pesticide options in conjunction with extra 'soft' options that are more compatible with an IPM program and beneficial organisms. A better understanding of how this expanded suite will support a more comprehensive MoA (Mode of Action) rotation strategy was established during the project. Participant production nurseries have established a much keener focus on getting on top of emerging issues earlier in the pest infestation. Regular crop monitoring, coupled with established enterprise specific pest thresholds, targeted narrow focus pesticide applications with deployment of beneficial organisms is now standard practice in these businesses.

A comprehensive field day PowerPoint presentation was developed and delivered across the five states (Appendix 2). This presentation explained the fundamentals of integrated pest management (IPM), promoted the adoption of a broad IPM strategy and established the rationale behind a structured monitoring program. It expanded on the project findings in the area of resistance management, MoA rotation, targeted pesticide application, the use of beneficials and the associated benefits to reduced pesticide use to both staff and the environment. Participants were also presented the economic cost-benefit findings from the project. This information will be disseminated further through a range of learning resources and extension services via NY20001 *National Biosecurity and Sustainable Plant Production* PPO (Plant Protection Officer) network.

6. Evidence that supports the implementation of aspects of BioSecure HACCP that improve pest management decision making leading to increased productivity and business profitability.

The project has clearly established the core BioSecure HACCP procedures as saving money and increasing productivity in the medium to long term. The relatively short-term nature of the project enabled most operators to get a good feel that there would be greater financial benefits in the longer term due to experience and skill improvements. For many the benefits in a financial sense did not necessarily materialise in the first year of implementation (year two of the project). Most of the businesses had some issues with how they collected data in the pest, disease and weed management area. Others had no real measurement of discards, another key metric, and others who did calculate this did not separate those attributable to pest and disease issues. Despite this lack of clear data to support the financial benefit of employing the BioSecure HACCP principles, all participants report they will continue to adopt structured crop monitoring and broad IPM program at the very least. Most report that they know there will be a financial benefit longer term, and this is a key motivator for their continued commitment to the process.

Greenlife Industry Australia has established that a productivity gain of 5% is easily achievable to those who adopt the BioSecure HACCP procedures. This data has been borne out of past case studies of pre and post adoption financial analysis. There is an expectation that as more production nurseries adopt these principles and IPM strategies, there will be a groundswell of industry momentum where it becomes the industry norm moving

forward.

7. Legacy learning resources developed to continue the education of industry across IPM and the implementation of good on-farm pest management and biosecurity.

A series of 7 field days were planned during June and July 2021 across the 5 states. Through a constant roll-out of Covid-19 related lockdowns in all jurisdictions, delivery was somewhat compromised. The 2 field days in Queensland were eventually combined into a single event, where a maximum capacity of 30 attendees participated. In Victoria, South Australia and Western Australia, event dates were changed, often multiple times due to lockdowns however most state events have now been successfully completed. In New South Wales the field day event was fully subscribed with 25 attendees. In Western Australia, the event was a moderate success with 11 attendees. In Victoria, one event yielded full capacity at 24 attendees. The second event had been postponed and rescheduled many times however the extended lockdown in Victoria forced the cancellation of this event. The South Australian event, after many delays, eventually occurred in mid-October and had an attendance of 22. In summary, a total of 5 field day events across 5 states with 121 attendees.

This 5 Field Day events were very well received nationwide. A sample of the feedback received from two of the events (Qld and Vic) are tabled below, and see example IPM Field Day feedback form template in Appendix 5. The IPM Field Day gave attendees a broad understanding of IPM principles, extends the findings of the project from the cost benefit analysis, and consolidates their knowledge of how BioSecure HACCP procedures can help them in their business today. The NY20001 *National Biosecurity and Sustainable Plant Production* PPO network will continue to deliver a version of this Field Day in coming years, moving the event to different locations and exposing more people to project findings and basic IPM principles.

Table 1. IPM Field Day Feedback – Azalea Grove Nursery Queensland 25/06/2021

Location	**Score max 5.00**
The location was suitable for the Field Day	4.88
The day was well organised	4.92
Field Day content	
General overview of IPM principles	4.71
Pest and Beneficial identification	4.71
The 5 comprehensive IPM strategies	4.71
Crop monitoring demonstration / nursery tour	4.64
Overall, I have benefited from attending the Field Day	4.64
Presenters	
Barry Naylor – PPO Greenlife Industry Australia	4.92
Jake Byrne – Biological Services	4.92
Ray Doherty – Azalea Grove Nursery	4.60
General Feedback / Comments	
More information on weeds and disease, pruning and resistant varieties and advice to bring a hat	
Very welcoming, happy to answer questions, great networking	
Money well spent!	
Would like a brief intro from all attendees	
More in-depth outline of each participant nursery's process/experience/outcome to understand in varied contexts	
Like more notice it was on / to book in	
Great day, very informative, very helpful	
Loved it	
Monitoring app for smart phone looks very useful	
Excellent workshop. Lots of great information	
All good	
Spot on	
Average Rating	**4.8**

Table 2. IPM Field Day Feedback – Biemond Nursery Victoria 15th July 2021

Location	**Score max 5.00**
The location was suitable for the Field Day	4.62
The day was well organised	4.62

Field Day content	
General overview of IPM principles	4.60
Pest and Beneficial identification	4.60
The 5 comprehensive IPM strategies	4.75
Crop monitoring demonstration / nursery tour	4.68
Overall, I have benefited from attending the Field Day	4.68
Presenters	
Kimberley Thomas – PPO Greenlife Industry Australia	4.81
Parag Borse – Biological Services	4.68
Jack Busacca – Biemond Nursery	4.68
General Feedback / Comments	
Bill Biemond (and reiterated by the other Biemond nursery team members present) said they were so pleased to have been a part of this project. It has helped take their business to the next level. They will be applying these procedures and IPM strategies across all 3 of their production sites.	
Crop monitoring and IPM is the future for our industry.	
Digital record keeping is better than hand-written records.	
Really enjoyed the networking opportunity.	
Glad we came, very educational!	
Excellent and well-planned event	
Great day, very informative with lots of useful information to apply.	
Definitely brought up some issues that we can look at implementing in the future.	
Great overview of IPM	
Monitoring app for smart devices is the way to go.	
Very enjoyable workshop. Lots of great information	
Well done, Kimberley!	
Thank you so much for today. I got heaps out of it, I'm really happy I was involved!	
Average Rating	**4.67**

The nursery industry has identified the top 5 SARP pests as Aphids, Fungus Gnats, Mites, Scale Insects and Western Flower Thrips in a separate project. A comprehensive IPM management plan has been developed for each of these pests and these documents have been made available on the GIA technical website. (See - www.nurseryproductionfms.com.au/download/ipm-management-plan-aphids/)

These IPM Management Plans describe the importance of knowing and being able to correctly identify the pest, understand it's life cycle, discusses suitable cultural, biological and chemical management measures, and recommends an overall systematic IPM management strategy. Growers are encouraged to consider additional issues such as how and when to deploy biological agents as well as MoA rotations during chemical applications.

8. Longer term outcomes will be greater adoption of structured IPM programs driven by crop monitoring, site surveillance and consignment inspections.

The NY20001 *National Biosecurity and Sustainable Plant Production Project* team have developed a new series of technical training courses (Mini Technical Skills Courses) to be delivered 'on-farm' in small groups. This project has helped focus attention on the further adoption of IPM strategies. Under the broad heading of Biosecurity and IPM practices, 7 new courses have been developed as follows:

- Imported Plant Inspection Procedure
- Nursery Stock Crop Monitoring
- Site Surveillance

- Despatch Plant Inspection Procedure
- Sticky Trap Use
- Indicator Plants as a Crop Monitoring Tool
- Pesticide Resistance Management – MoA groups

These new courses will be delivered on a regular basis in coming years to those enterprises interested in working to industry BMP. Further general advice will be provided by the extension services team promoting not only the project outcomes but encouraging the many benefits of adopting IPM practices more broadly.

This project has clearly validated the existing BioSecure HACCP procedures and principles. Whilst the BioSecure HACCP is all encompassing, the first four technical training course titles above form the basic underpinning principles. Prior to project commencement, the participant production nurseries all employed some of these practices in some semi-formal form, however, now understand the benefit of combining all procedures under a robust, structured, and recorded system. This key take-away message will continue to be promoted in the years ahead.

Monitoring and evaluation

Monitoring and evaluation through proposed milestones detailing achievement criteria and deliverables. As the project had 3 key activities running for short durations the monitoring and evaluation of project progress was adequately achieved through review of milestone achievements. Milestone # 102 included M&E Plan (including project logic, key evaluation questions & measurables), Stakeholder Engagement Plan and Risk management Plan.

The key evaluation questions as detailed (Table 2) in the M&E plan are addressed in the below table:

Key evaluation questions	Project-specific questions	Project Response
Effectiveness		
1. To what extent has the project achieved its expected outcomes?	To what extent has the project increased the adoption of IPM supported by structured monitoring surveillance and consignment inspections? Has the project provided a suitable level of information	The feedback from participant production nurseries is unanimously positive, with each business committing to a broad structured IPM program moving forward. In addition, 112 participants at the 5 completed Field days are all now educated in the many benefits of IPM, in particular, structured crop monitoring. The NY20001 team will now continue to support not only those Field Day attendees but all production nurseries over the coming 4 years as they adopt IPM in their businesses.
Relevance		
2. How relevant was the project to the needs of intended beneficiaries?	To what extent has the project met the needs of industry in adopting more systematic approaches to IPM and facilitated awareness of and accessibility to alternative options to neonicotinoids. And more broadly augmented outcomes 3 & 4 of the industry SIP.	Prior to the project commencement approximately half of the participant production nurseries reported they utilized some form of crop monitoring. What became apparent to all participants was the degree of rigour involved in a structured crop monitoring program was above the systems they currently employed. Subsequently, these participant businesses realized the quantifiable benefits of a systematic approach to IPM, and most report that the benefits will likely continue to become evident in subsequent years. There is increased awareness of alternative options to neonicitinoids and a willingness to employ pesticide strategies that compliment an IPM approach, are better for industry

Key evaluation questions	Project-specific questions	Project Response
Effectiveness		
		personnel and the environment.
Process appropriateness		
3. How well have intended beneficiaries been engaged in the project?	Has progress on the project been provided through industry communication channels e.g. NY18001 (Australian nursery industry communications program)	Project progress has continued throughout the project via normal communications channels. This includes publication in GIA eNews and Your Levy At Work.
4. To what extent were engagement processes appropriate to the target audience/s of the project?	Did the project deliver a range of extension resources across learning styles to effectively engage industry with the project outcomes? Did these resources provide an accessible mechanism for growers to learn?	Fundamental communications include the publishing of project progress reports on the GIA eNews and Your Levy at Work platforms. These publications allow readers to access the information at a time of day that best suits them. Publishing of a project Video to YouTube provided a good visual snapshot of the project aims, objectives and progress. The 5 IPM Management Plans for the top 5 SARP pests provide a legacy resource to be accessed as required by production nurseries and the NY20001 team as required. The IPM Field Day was extremely well received and will continue to be delivered around the country as a legacy resource in coming years by the NY20001 team.
Efficiency		
5. What efforts did the project make to improve efficiency?	What efforts did the project make to improve efficiency through incremental improvements across the life of the project?	The project encountered many Covid-19 related challenges. There have been many delays, logistical difficulties and cross border access issues. These matters lead to the provision of a modest timeframe extension through to October 2021. There has been little opportunity to provide incremental project improvements.

The project was included into the NY15004 (NY20001) Project Reference Group with an additional grower added plus an IPM-expert. The NY15004 (NY20001) Project Reference Group met at a minimum frequency of twice per annum with additional meetings as required. The Project Reference Group membership is as follows:

Mr. John Bunker (Greenlife Solutions and SIAP)	Mr. Peter Vaughan (GIA)
Mr. Ray Doherty (Azalea Grove Nursery (NY17009	Mr. John McDonald (GIA)

Nursery))	
Dr. Greg Chandler (Hort Innovation)	Dr. Penny Measham (Hort Innovation: 2018 – 2019)
Ms. Yen Chan (Ball Australia: 2020)	Ms. Natasha Marocik (Lowes TC: 2020)

Milestones 101 through to 106 and milestone 190 were completed to satisfy all achievement criteria and deliverables. Some delays within milestones were because of the COVID-19 pandemic, particularly pertaining to the ability for crop monitoring to be performed in designated hot spots or because of border closures. However, these were overcome through the seeking of a variation (approved) to extend the due dates for milestone 106 and 190 with project end date being 25 October 2021.

Recommendations

1. Further financial analysis is likely required to further validate the cost benefit of employing a structured crop monitoring system as part of a comprehensive IPM program. As participants offer anecdotal support that they expect gains to be more evident in subsequent years to those within the project timeframe.

   A project recommendation is to select two specific participants from NY17009 and conduct a year 3 and 4 analysis to establish the long-term benefit to the business, both financially and culturally.

2. As the 7 participant production nurseries have all committed to utilize a structured crop monitoring program moving forward, future analysis of their status and the rationale applying to their ongoing commitment would be useful.

   A project recommendation is to add to the above potential additional project a review of each of the NY17009 project participants in 2 to 3 years' time to further assess ongoing commitment to structured crop monitoring. Further feedback could be received on their general experiences and established procedures.

3. AgAware consulting encourages engagement with AgChem companies to ensure the latest information is available regarding 'new chemistry' options moving forward. This will ensure the industry is well prepared in the advent of any further restrictions to neonicitinoid type pesticides or others under review both in Australia and overseas.

   A project recommendation is to continue to engage with AgChem companies and other experts to consider registration options as part of the industry Minor Use Program (MUP).

Refereed scientific publications

N/A

References

N/A

Intellectual property, commercialisation and confidentiality

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

Appendices

Appendix 1 – NY17009 Improving pest management for the Nursery Industry FINAL REPORT (Acadian Analysis)

Appendix 2 – NY17009 Improving pest management for the Nursery Industry (Field Day PowerPoint)

Appendix 3 - The threat of neonicotinoid insecticides to the nursery industry of Australia - A Review

Appendix 4 – Communications

Appendix 5 – IPM Field Day Feedback template