



Tasmanian Institute of Agriculture submission to the Legislative Council Government Administration Committee 'B' Sub-Committee

Inquiry into Blueberry Rust in Tasmania

13 October 2017

This submission was approved and submitted by Mr James Stronach, Acting Director, Tasmanian Institute of Agriculture James.stronach@utas.edu.au | 6226 7503

Introduction

The Tasmanian Institute of Agriculture (TIA) welcomes the opportunity to contribute to the Legislative Council Government Administration Committee 'B' Sub-Committee Inquiry into Blueberry Rust in Tasmania.

TIA has worked closely with the Department of Primary Industries, Parks, Water and Environment (DPIPWE) to provide independent scientific advice to assist with the response to blueberry rust in Tasmania.

As a dedicated agricultural research institute, TIA is committed to supporting the productivity, competitiveness and sustainability of Tasmania's agriculture sectors through high-quality research, development and extension.

Researchers and technical experts at TIA have developed a set of strategic research and extension options to assist growers implement the most effective and appropriate management strategies to minimise the impact of blueberry rust to their production.

After reviewing the best available science and consulting with subject experts, TIA's position is that containment is the most effective strategy for the management of blueberry rust in Tasmania.

About the Tasmanian Institute of Agriculture

Established in 1996 as a joint venture between the Tasmanian Government and the University of Tasmania, TIA conducts globally relevant research with local impact. TIA performs an important role in guiding the future economic and environmental sustainability of agriculture and food sectors through priority-driven research, development, extension (RD&E) and education.

TIA has a dynamic team of scientists and technical experts many of whom are internationally renowned, with access to world-class facilities and equipment.

The University, through TIA, is recognised internationally and was recently ranked 44th in the world and 4th in Australia for excellence in agricultural sciences (ARWU 2017).

Contents

| | |
|--|----|
| Contents..... | 3 |
| Blueberry rust research and extension options..... | 5 |
| High priority research questions..... | 5 |
| Pathogen biology and disease epidemiology in Tasmania | 5 |
| Assumptions..... | 5 |
| 1 - Pathogen Biology | 5 |
| 2 - Blueberry Rust Epidemiology..... | 6 |
| 3 - Blueberry rust becomes widespread in Tasmania – potential future scenario..... | 7 |
| 4- Alternative management options for blueberry rust | 8 |
| Extension options to assist growers manage the risk of blueberry rust to their farms | 9 |
| Extension and communication of currently available information | 9 |
| On-Farm biosecurity and farm hygiene | 9 |
| Appendix 1 – TIA scientific advice on blueberry rust, 2016..... | 11 |
| Appendix 2: TIA scientific advice on blueberry rust, 2017 | 13 |
| Blueberry rust – scientific advice (management response) | 16 |
| What is the most appropriate management response by blueberry growers? | 16 |
| General approach | 16 |
| Key recommendations | 16 |
| Management response during containment phase | 16 |
| Management response after widespread establishment..... | 17 |

This submission addresses Point 1 and Point 3 of the Terms of Reference of the Inquiry into Blueberry Rust in Tasmania.

Terms of reference point 1:

The actions taken by Biosecurity Tasmania to address the 2014 and 2016 outbreaks of blueberry rust;

At the time of rust outbreaks in 2014 and 2016, TIA provided scientific advice to the Department of Primary Industries Water and Environment (DPIPWE) based on the best available knowledge at the time. The advice is provided here as Appendix 1 and 2.

Terms of reference Point 3:

The future of Tasmania's blueberry industry, including the impacts of previous, current and any future outbreaks of blueberry rust.

TIA has developed a series of high priority research questions and extension options that seek to assist growers manage the current risk of blueberry rust so as to reduce the impact of the disease on industry.

The key research and extension options target knowledge gaps identified through feedback and discussion with blueberry growers and include:

- Disease epidemiology (progress of the disease in time and space) in Tasmania (high priority)
- Spore viability and overwintering ability of blueberry rust under Tasmanian conditions (high priority)
- Organic management options for blueberry rust (priority)
- Extension of blueberry rust information (priority)
- Varietal tolerance of blueberry rust (lower priority)

Growers highlighted that they did not wish to see research which involved uncontrolled or unmanaged blueberry rust in Tasmania, with this research better conducted in areas where the disease was prevalent.

Not in the scope of this submission:

1. Market access considerations for Tasmania blueberries
2. Socio-economic analysis of blueberry rust in Tasmania
3. Potential for eradication of blueberry rust from Tasmania

Blueberry rust research and extension options

This document details research and extension options to assist in the understanding and management of the risk of blueberry rust to Tasmanian blueberry orchards. The options have been developed by the Tasmanian Institute of Agriculture (TIA) research and extension staff based on scientific principles, current knowledge of blueberry rust disease and information gathered from blueberry growers on their knowledge and skills needs.

Although TIA presents the options, it does not assume to be the necessary or best provider of research and extension services in this case.

The research questions have been developed by TIA research scientists Dr Kathy Evans and Professor Roger Stanley and extension options by Michele Buntain.

Contributors to this submission:

Dr Katherine Evans, Senior Research Fellow, katherine.evans@utas.edu.au
Professor Roger Stanley, Director Centre for Food Innovation, roger.stanley@utas.edu.au
Michele Buntain, Horticulturist, Extension & Communication, michele.buntain@utas.edu.au

High priority research questions

Pathogen biology and disease epidemiology in Tasmania

The high priority research questions have been developed to address 3 key areas

1. Pathogen biology
2. Disease epidemiology
3. Research relevant to potentially widespread blueberry rust in Tasmania
4. Alternative management options for blueberry rust

The high priority research questions are based on the following assumptions.

Assumptions

- The cause of blueberry rust in Tasmania is *Thekopsora minima*
- The alternate host for this heteroecious rust is rare in Tasmania
- Infections of blueberry are non-systemic; that is, they do not spread internally
- The uredinial spore state is the only one contributing to epidemics of blueberry rust in Tasmania
- Infection of blueberry by urediniospores of *Thekopsora minima* is a critical control point

1 - Pathogen Biology

Research Questions

- Is *Thekopsora minima* overwintering in Tasmania? If so, how?
- Is *Thekopsora minima* overwintering as uredinia on evergreen blueberry leaves?
- On what plant tissues do uredinia form under Tasmanian conditions?
- What is the viability of urediniospores sampled from uredinia visible on blueberry plants and on fallen leaves (or other plant remnants) at any given time during the year? (viability x time-of-year/host physiological state x variety)
- Are rust uredinia evident on any species of *Vaccinium* (Ericaceae) in Tasmania? If so, what pathogen species is the cause of these infections?

Secondary/point of interest question:

Do teliospores form on blueberry leaves in Tasmania? (Noting that basidiospores forming from a germinating teliospore would have nowhere to go without an alternate host)

2 - Blueberry Rust Epidemiology

Plant disease epidemiology is the study of the progress of a disease in time and space during epidemics that are caused by populations of pathogens in populations of plants. Knowledge of disease epidemiology underpins the design of an effective disease management strategy. Disease management tactics are then selected based on the crop production context and the regulatory environment.

The following question can only be addressed in those blueberry fields in which the rust has re-appeared or represents a new incursion:

Overarching question

What is the timing and rapidity of rust development in a blueberry orchard? How does the disease develop spatially in a blueberry orchard? How does disease development vary from one blueberry orchard and cultivar to another?

What will this tell us?

Information to inform the timing and relative intensity of a protective spray program and/or cultural control measures. Mapping spatial variation in the incidence and severity of rust disease can inform a practical sampling strategy to detect the presence of rust disease in future growing seasons.

Research questions

- What is the timing and nature of the onset of a rust epidemic in a Tasmanian blueberry orchard in relation to crop phenology, environmental conditions and the crop management/production system?
- How does rust disease progress in a Tasmanian blueberry field in both time and space? (Describe the disease progress curve plus associated environmental and host conditions)
- What is the range in latent period for symptoms and uredinia in the field? What is the time between the appearance of sporulating uredinia and the next generation of sporulating uredinia in the field over a range of environmental and host conditions? How many (healthy and susceptible) leaves emerge per latent period of uredinia?

Secondary/point of interest question:

What is the effect of temperature and leaf age on the latent period for symptoms and the latent period for uredinia? (Controlled-environment study)

Longer-term applications:

Development of a disease risk index:

Development of a daily or 7-day running average 'environmental favourability index' that also includes a parameter for relative host susceptibility.

3 - Blueberry rust becomes widespread in Tasmania – potential future scenario

Overarching questions

- What is the relative susceptibility of blueberry varieties to rust in Tasmania?
- What is the impact of blueberry rust on plant biomass, and components of fruit yield and composition over the range of production conditions in Tasmania?

What will this tell us?

Knowledge to growers about the relative threat/likely consequences and to inform future planting decisions.

Specific research questions

- What is the relative susceptibility of different blueberry varieties grown under Tasmanian conditions? (Disease severity is a G x E x M response – need to remove effect of ‘E’ and ‘M’ to assess properly e.g. plant all in one location and assess over multiple growing seasons)
- What is the relative susceptibility of different blueberry varieties exposed to rust strains isolated from Tasmanian blueberry fields when assayed under controlled-environment conditions?
- What is the impact of rust epidemics of varying intensity (multiple sites/seasons) on blueberry plant biomass and components of fruit yield and composition? (fungicide exclusion experiment)
- What is the effect of multiple inoculations (twice-weekly) on components of biomass of potted blueberry plants (starting at shoot expansion stage) under optimal conditions for plant growth and rust development? (Could be done outside Tasmania - assessing impact of worst case scenario)

4- Alternative management options for blueberry rust

Overarching Research Question

What alternative management options for blueberry rust have potential to reduce pathogen inoculum in organic production systems?

Background

Electrolysed water (EW) is an oxidising sanitation agent that has potential for use in organic production systems.

- Oxidising sanitation agents such as electrolysed water (EW), hypochlorite, peracetic acid, chlorine dioxide, ozone, Nylate, hydrogen peroxide are extensively used for post-harvest food, equipment and environment sanitation
- They kill microorganisms by oxidation of the cell membrane surfaces to disrupt viability but rapidly degrade and have no residual effects and do not leave active residues
- Oxidising agents are different from detergent based membrane disruptors eg Sporekill and more effective in the short term
- There is no known build-up of resistance to their mechanism of action
- Some (eg hypochlorite, EW) have organic treatment status under the USDA Organic Approval process.
- EW is a hypochlorous acid based oxidising agent made on-demand by electrolysis using salt and water so is extremely low cost once the capital cost of the automated production plant is covered.
- EW can be sprayed in conventional sprayer systems but can also be applied via misting (eg protected horticulture), fertigation systems and via large scale spray irrigation
- EW reacts with organic matter so efficacy is compromised if microbial infection sources are enclosed in biofilms or within tissue.

Assumptions

- Sanitation using food use approved oxidising sanitation agents is a permitted pre-harvest treatment
- Sanitation treatments only kill spores, and do not treat disease symptoms

Specific research questions for proof of concept

Does electrolysed water (EW) kill urediniospores of blueberry rust (*Thekopsora minima*)?

The research would involve in vitro assays (spore suspension) and in situ tests (spores deposited on plant tissues or those emerging from erumpent pustules).

Longer term research questions once proof of concept has been established

- What is the duration of activity of EW against spores?
- Does EW provide any protection against blueberry rust infection?
- Is EW an effective sanitizer suitable for treatment of blueberry plants and/or fruit for export?

Extension options to assist growers manage the risk of blueberry rust to their farms

Three extension categories are presented as options for assisting growers manage the risk of blueberry rust to their farms:

1. Extension and communication of currently available information
2. Farm biosecurity extension resource
3. Extension of future research findings

Extension and communication of currently available information

Farm Hygiene:

Workshops have been conducted by Biosecurity Tasmania in September 2017

Crop protection and management:

A TIA factsheet was distributed to growers at recent biosecurity workshops and is on the TIA web page. The information includes

- Symptoms of disease infection at different stages
- Conditions that favour disease infection and development
- Options for protecting crops from blueberry rust including chemical, cultural and biological management options.

Further distribution of the factsheet and information regarding additional resources (eg monitoring resources, spray application and safety resources) could be via Biosecurity Tasmania surveillance staff, podcasts or webinar by researchers, TIA berrylink (E-news) and print media such as Tasmanian Country.

Information and experiences from other production regions and researchers:

1. Collect and present stories from other grower experiences in climatically similar production regions to Tasmania, eg New Zealand or Oregon as video or slide show. This has the opportunity to tell it through a growers eyes, dispel some myths and hopefully allay fears around the manageability of blueberry rust.
2. Workshop including latest research information from Horticulture Innovation Australia funded project BB13002 'Management of blueberry rust' due for completion in December 2017. An experienced grower from NZ could be invited to talk to growers in Tasmania. The workshop could also include invited organic disease management specialists;

On-Farm biosecurity and farm hygiene

- **What:** A short induction video for of pickers and other visitors to blueberry orchards on farm biosecurity
- **Why:** Many visitors to blueberry orchards are not aware of the best ways to prevent introducing pests or diseases. Often blueberry pickers do not have English as their first language. A video may help to highlight best practice for farm biosecurity particularly aimed at blueberry production.
- **Distribution:** Safe Farming Tasmania are currently producing a short video on orchard farm safety for fruit growers in Tasmania. Discussion with Safe farming Tasmania has suggested that a short farm hygiene video could be distributed on the Safe Farming Tasmania USB (Phil Johns pers. comms). It could also be loaded on You Tube and fruit growing websites for individual growers to share or download.

New research and development information

As new information becomes available from both local and external research sources, this may be communicated and extended to blueberry growers in Tasmania by a variety of methods including: grower workshops, seminars, webinars, podcasts and discussion groups with specialists, advisors, agronomists and growers.

Information could be communicated using a variety of channels including hard copy fact sheets, web based information, podcasts, e-news, media.

Appendix 1 – TIA scientific advice on blueberry rust, 2016

Tasmanian Institute of Agriculture (TIA) scientific advice provided to Department of Primary Industries, Water and Environment (DPIPWE) in October, 2016.

Blueberry rust options for Tasmania

Introduction of a management regime as an alternative to eradication in Tasmania would be preferred, *If*

1. The negative economic/social impact of eradication is significantly greater than that of management in the short and longer (5 Year+) term
2. The likelihood of success of eradication is low
 - a. *If* Costas management program has been ineffective at preventing new infections on site
 - b. *If* removal of all infection sources is highly impractical
 - c. *If* there has been an inability to contain the spore load present at the infection site and there is a high chance that spores have spread and infected hosts/alternate/alternative hosts (Tsuga, rhododendron) beyond the infection site OR to a significant number of neighbouring plants that are currently not expressing obvious visual symptoms

Features of rust that would make eradication difficult:

- Rust pathogens are well known for their ability for long-range dispersal (Nagarajan & Singh 1990; Agrios 1997).
- Rust urediniospores are relatively thick-walled and resistant to degradation by UV light, radiation, temperature and relative humidity. Consequently, urediniospores can survive outside a host for several days and hence can remain viable while transported over long distances (Agrios 1997).
- All blueberries in Tasmania would now be receptive to infection by wind borne spores (urediniospores)

TIA capability

TIA has significant capability in rust epidemiology and characterization. This may be useful in determining if the current incursion is due to failed eradication or due to a new incursion.

Dr Katherine Evans

- Genetic diversity in the blackberry rust pathogen, *Phragmidium violaceum*, in Europe and Australasia as revealed by analysis of SAMPL
- Evans, Katherine J., et al. "Overcoming limits on rust epidemics in Australian infestations of European blackberry." XI International Symposium on Biological Control of Weeds. 2004.

Dr Morag Glen

- Myrtle rust: Life cycle, host range and epidemiology

Impact of non-eradication

1. Major impact is the loss of market access to Victoria, SA and WA. Protocols would need to be developed similar to the NSW ICA that would still preclude organic growers sending fruit to these markets. This would also apply to transit to NSW and Qld through Victoria.

2. Lesser impact is the cost of management. NZ and North American experience in a similar climate to Tasmania has indicated management requirements include protectant fungicide application and canopy architecture management. This is particularly true for deciduous whereas management in semi-evergreen may require more intensive management.

Appendix 2: TIA scientific advice on blueberry rust, 2017

Prepared by Dr Kathy Evans, with input from A/Prof Caroline Mohammed, Dr Morag Glen and Prof Holger Meinke

Approved by Prof Holger Meinke, Director, TIA

Conclusion

- Based on the scientific knowledge of the lifecycle of the disease, **permanent eradication of the disease (i.e. eradication beyond 2-5 years) in the current outbreak is not feasible** because of the effort needed to locate and survey all potential plant hosts and then remove them. Infections at a very low incidence in a given area can be missed, even by the most well-trained personnel.
- **The rust pathogen cannot be eradicated** from the State even temporarily because dissemination has advanced beyond the stage when it can be contained.
- Science-based checklists of conditions tending to favour the prospects of an eradication campaign point to two key factors working against successful eradication of a rust fungus; that is, (1) rust spores are easily and rapidly dispersed, and (2) rust fungi can complete multiple generations in a single growing season through rapid, asexual propagation. New infections cannot be detected until disease symptoms are evident days later. This means that any removal of plants with visible rust symptoms may not represent the entire pathogen population.

Summary

- The Tasmanian Institute of Agriculture is working closely with the Department of Primary Industries, Parks, Water and Environment (DPIPWE) to provide independent scientific advice to assist with the response to blueberry rust in Tasmania.
- We are committed to supporting Tasmania's agriculture industry through research, development and extension that is responsive to industry needs and supports productive, profitable and sustainable industries.
- After reviewing the best available science and consulting with subject experts, the Tasmanian Institute of Agriculture believes that containment is the most effective strategy to manage blueberry rust in Tasmania.
- Based on the best available science, we believe attempted eradication of blueberry rust would be a high-cost and unsustainable approach to the industry's long-term viability in Tasmania.
- Given the prevalence of the disease globally and its ability to spread across large distances, it is possible the disease would reoccur in Tasmania within five years after an attempted eradication. A re-appearance of the disease from existing undetected infections on plants in the State is also feasible.
- A science-based and well-implemented containment strategy that involves all industry members is recommended as the most effective way of managing blueberry rust in Tasmania.

Background

Rust fungi, in general, are extremely difficult to eradicate once infections are detected beyond an infection focus of several host plants. They produce a spore type (urediniospores) that is relatively resistant to damage by UV light and which can survive and travel more than 1000 km by air. This spore type has potential to survive mild winters in climates like Tasmania.

Agencies responsible for biosecurity have checklists of conditions tending to favour the prospects of an eradication campaign, and these are based on evidence from multiple case studies. Two key factors working against eradication of rust fungi are that the pathogen is highly mobile – rust spores are easily and rapidly dispersed – and that the pathogen reproduces asexually – rust fungi can complete multiple generations in a single growing season through asexual propagation.

Rust fungi have complicated life cycles. Evidence from diagnostics tests coordinated by DPIPW E indicates that that rust infections in Tasmania are caused by *Thekopsora minima*. *Thekopsora minima* does not need its alternate host to complete its lifecycle if the uredinial spore state can survive Tasmania's mild winter. *Thekopsora minima* has the potential to produce five different spore states. Three spore states can potentially form on blueberries, which belong to the genus of *Vaccinium*: uredinia, telia and basidia. **It is assumed that uredinia have been observed in Tasmania.** This spore state also forms on other ericaceous plants such as *Rhododendron* spp According to Biosecurity Tasmania, *Thekopsora minima* has not been observed on other ericaceous plants during surveys conducted in Tasmania, Victoria and New South Wales. Whether or not infections are occurring on plants other than blueberry in Tasmania is unknown.

Two other spore states – aecia and pycnia (spermatia) - form on an alternate host: *Tsuga* spp (a genus of conifers). The abundance of plants belonging to this genus in Tasmania is likely to be low. If *Tsuga* spp. are present in Tasmania, then it is not known whether or not infections of *Thekopsora minima* are occurring on plants of this genus.

Uredinia produce highly mobile, airborne spores that can initiate new infections on healthy plants of the same species, if not others. These spores have similar physical characteristics to pollen: they can potentially stick to the clothing of orchard workers when they were reaching into an infected blueberry bush, or via a spore plume released from rust pustules. In the absence of biosecurity measures, workers could potentially transport spores via their clothing to healthy blueberry bushes in another location, including other properties.

The **disease of Blueberry rust** (but NOT the pathogen) could be eradicated **temporarily** if there was an intensive survey accompanied by immediate removal of affected material by double-bagging and burial underground. This may have been the case with the 2014 incursion. However, the rust is highly likely to re-appear in the short to medium term (e.g. within 2-5 years) for the following reasons:

- Rust symptoms at the current (three) infected properties (IPs) are throughout the entire production area and not limited to a few plants.
- It is conceivable that spores (urediniospores) have already moved from current infected properties (IPs), via the air, to other blueberry plantations or another ericaceous host, in which case there may be a very low level of undetected infections elsewhere that are surviving the current winter. It is not known whether other ericaceous hosts play or will play a significant role in the disease epidemiology in Tasmania. If other ericaceous hosts play no role, then abundant numbers of blueberry plants in Tasmania provide a potential habitat for the rust to establish and persist.

- Undetected infections may have already established at locations in Tasmania beyond the infected properties via the transport of airborne spores over long distances, or from one location to another by workers wearing contaminated clothing. Even a highly trained specialist cannot always detect infections present at a very low incidence. If an infection is detected, then the rust pustule (lesion) may have already produced and released its spores to the air currents. If the alternate host (*Tsuga* spp) can be located and aecia have established, then looking for aecia in large trees would be extremely difficult and unlikely to be conclusive.
- The time between a spore landing on an uninfected leaf and the production of new spores can be as little as 10 days under weather conditions that are highly favourable for disease development. The minimum latent period for rust strains present in Tasmania is still unknown. New infections cannot be detected until disease symptoms are evident days later. This means that removal of plants with visible rust symptoms may not represent the entire pathogen population.
- It is also possible, albeit unlikely, that spores will be introduced to blueberry plants by future airborne movement of spores from elsewhere (NSW, Qld, New Zealand). Blueberry rust has had an extended presence in neighbouring regions and the direction of prevailing winds has perhaps reduced the chance of spore movement in Tasmania. Even so, there are known instances of spore movements in seemingly unpredictable directions due to unusual weather patterns or storm cells.
- If a vigilant blueberry grower detected the first rust infection on their property - say within one week of symptom appearance - then it is conceivable that they could eradicate the rust from their individual property. In practice, symptom detection usually occurs much later.
- It is not known how many generations (disease cycles) the rust can complete in a single growing season in Tasmania. Multiple generations provide an abundant source of airborne inoculum for all plantations in a given region.
- The rust was detected in a nursery in Victoria in 2014. Victoria has been assessed as 'rust free' based on implementation of an accepted biosecurity survey protocol following this detection.

Blueberry rust – scientific advice (management response)

Prepared by Dr Kathy Evans, with input from Ms Michele Buntain, A/Prof Caroline Mohammed and Dr Morag Glen

Approved by Prof Holger Meinke, Director, TIA

What is the most appropriate management response by blueberry growers?

General approach

It is assumed that widespread establishment of blueberry rust will eventuate. Current thinking among some blueberry growers – that the rust will be eradicated or the situation contained – is likely to inhibit an effective, industry-wide response. This means that a holistic intervention will be needed to identify and unite what appears to be a fragmented set of actors to facilitate knowledge exchanges and change through joint action based on a common, agreed sense of purpose and direction. A series of structured, facilitated interactions of relevant actors around a broad accountability framework is called for. A purposeful initiative would also help identify knowledge gaps for research and development, and inform appropriate extension activities.

Key recommendations

- **In-season integrated and preventative measures should be implemented more widely in 2017/18**, especially in the vicinity of the three infected properties.
- The primary and most effective management tactic is the application of **protective fungicides**; permits for specific spray materials may be needed.
- Testing and adaptation of spray programs developed for blueberry production regions with similar climates, including **organic options**
- **Expertise** from other jurisdictions should be consulted to fine-tune the management strategy
- An immediate **extension effort** to build knowledge and skills of blueberry growers for on-going and effective management of blueberry rust:
 - Implement whole-of-farm hygiene, including easy-to-follow advice
 - Awareness of rust symptoms and ways to monitor for the disease
 - Knowledge of needs/requirements around market access (for exporters)
- **One-on-one liaison and extension** with growers who need motivation, resources (e.g. equipment) and/or skills to apply spray materials, including organic options.

Management response during containment phase

Infected properties

Specific requirements are implemented by Biosecurity Tasmania, including facilitating negotiations around market access (A. Bishop, personal communication). Refer to information about biosecurity protocols [here](#) and reproduced in Appendix A. In summary, these measures include appropriate hygiene protocols, restricted movement of plant material, implementation of spray regimes, and site inspections by biosecurity officers.

Non-infected properties

All other producers are being encouraged by Biosecurity Tasmania and Fruit Growers Tasmania to adopt a range of farm biosecurity measures that will assist in protecting a property from the entry and spread rust disease. Refer to information [here](#). Site Management Plans for infected properties developed by DPIPW provide a resource for the biosecurity staff member undertaking a crop inspection; however, it could be simplified for ease of use by growers.

Given capacity for rust spores to disperse over large distances, then it is assumed that widespread establishment of blueberry rust will eventuate. The implementation of preventative, protective measures in the 2017/18 growing season, especially in the vicinity of the three infected properties, is recommended. Options for integrated disease management are described in the next section, and need to be developed by sourcing relevant information and expertise from climatically similar regions such as the south island of New Zealand, Oregon and parts of Europe.

Extension efforts are needed to help blueberry growers prepare for longer-term management of the disease. It appears that some organic producers and smaller producers are not equipped to initiate spraying options. Moreover, orchard layout (row spacing), orchard aspect (topography) and structures such as netting/poles may not be amenable to effective spraying.

Extension efforts should build knowledge and skills to (a) implement whole-of-farm hygiene, (b) ensure staff are aware of plant diseases, and are familiar with rust symptoms, and (c) knowledge about needs and requirements around market access (for exporters). Growers will also need to develop skills and capacity to implement effective spraying operations and integrate these with cultural controls, if they are not doing so already. Organic producers, in particular, will require compatible spraying options, if they are willing to instigate spray operations.

Foundational work to develop the most cost-effective management response for blueberry growers should be initiated as soon as possible. This response will need to be integrated with current operations and be based on a good understanding of disease biology and epidemiology in Tasmania. There are many knowledge gaps to be addressed. For example, the location and importance of non-blueberry hosts (and hence, sanitation and movement of other plant material), disease development in relation to local weather and crop phenology (timing of new flush of leaf growth, fruit infection), and the (measured) impact of the disease on crop yield and quality.

There is an imperative to integrate research with knowledge exchanges among diverse actors with built in learning activities to build growers' capacity to manage the looming threat.

Management response after widespread establishment

The following response assumes that there has been an appropriate degree of foundational work and extension during the containment phase, and that these learning activities continue after widespread establishment – should that eventuate.

Blueberry rust can be managed effectively in non-organic orchards by an appropriate program of protective fungicides in the event the disease becomes widespread and requires ongoing management. An example of spray program for blueberry growers in NSW is described [here](#). Fungicide programs from climatically similar regions such as the south island of New Zealand, Oregon and parts of Europe should be evaluated and adapted to Tasmanian conditions. Sourcing expertise or information from these regions would be a first step in developing appropriate protection and management strategies. Permits may be needed for specific spray materials and spray programs, including organic options.

Information about the relative susceptibility of different blueberry varieties is available and the selection or breeding of less susceptible or resistant varieties is an option, although access may be limited issues associated with plant variety rights.

An integrated disease management is recommended, including:

- Use of clean planting material and a nursery certification scheme
- Canopy management to promote good ventilation
- Monitoring to detect symptoms early
- Protecting young shoots (treat early) with appropriate protective fungicides (synthetic or organic) when conditions are conducive to disease development (e.g. high humidity)
- Rotation of protective fungicides to manage fungicide resistance

The extension strategy for 'best practice' management (to enable practice change) will need to be developed with the industry so that learning needs and preferred modes of learning can be identified, and for consideration of the best communication channels for new insights. Again, a holistic intervention will encourage knowledge exchanges among the various actors and foster direct engagement with the researchers.

An immediate activity, in addition to developing a protective spray program, might be the review of existing fact sheets, with a view to developing new extension materials that are updated as the situation evolves and new information becomes available.

Appendix A

Example of Quarantine controls on infected properties

1. Entry to orchard is controlled - Wash-down of all vehicles and tools, footbaths and work clothing to remain onsite. Site map is prepared and provided to Biosecurity Tasmania to show where activity is occurring.
2. On exit from orchard - Full decontamination of vehicles (in an approved wash-down area), clothing and tools.
3. Fruit harvest - May be allowed with strict hygiene measures e.g. Fruit from infected plants not to leave property without freezing at required temperatures.
4. Pruning debris to be buried in an approved manner - recorded and mapped
5. Spray regime - must be documented for audit
6. Monitoring - Weekly checks of all plants and recorded
7. Weekly checks conducted by Biosecurity Tasmania staff.