

Understanding the demography and pests and diseases to identify opportunities for the Australian Rubus industry

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Purpose of the report

This report presents the outcomes of a demographic survey conducted to identify the current practices and future direction of the Australian Rubus industry. It also details the key pest and disease issues identified through field visits, discussions with growers and online surveys.

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Media summary

The Australian Rubus industry has more than doubled in size over the last 10 years (RABA 2012). Berries are now being grown in greater quantities and across more geographic areas than ever before. A demographic survey was conducted to capture the current status of the industry and to identify future research and development needs to ensure a profitable and sustainable future. More than 145 ha are planted to Rubus berries in Australia, with the largest areas under production in NSW and Victoria. While the industry has a core of long-term (>20 years) growers, a number of new growers are entering the industry. The majority of berries are currently grown under field-based production systems but survey responses indicate that the industry is undergoing a shift towards protected cropping, substrate, and hydroponic technologies. Around 10% of the respondents produce berries organically or biodynamically. The peak harvest season occurs between December and April with a small proportion of growers harvesting all year round. Year round harvesting is likely to increase as cropping cycles and production methods are modified and new varieties introduced. Survey respondents indicated key challenges for the industry in the next 10 years as pest and disease management, preventing exotic incursions, labour costs, availability of new varieties, market access, competition from imported berries and the development of new production technologies.

Pest and disease surveys were conducted through diagnostic laboratory submissions, field visits, discussions with growers and an online survey. Key pests identified included Green Stink Bug, Green Vegetable Bug, Two-spotted Mite and various caterpillars. Key diseases included Phytophthora, Yellow Rust and Botrytis. Two posters were developed to assist growers to diagnose key pests and diseases and to better understand conditions that are conducive to their occurrence. These have been disseminated to the industry through RABA.

Key recommendations include:

- The development of a comprehensive pest and disease booklet or mobile app to cover all geographic locations and production systems.
- Research into new production technologies including irrigation, hydroponic and protected cropping as adoption increases.
- Issues including market access and labour costs need to be addressed by the industry.

Technical summary

The Australian Rubus industry has more than doubled in size over the last 10 years. Berries are now being grown in greater quantities and across more geographic areas than ever before. Due to the spread of berry production areas across the country, cultivation and management practices differ, as do the potential pests and disease threats. A thorough understanding of the current status and future growth trends are fundamental to ensuring long-term sustainable production in the industry. Identifying key pests and diseases is essential to ensure future research can be targeted towards developing appropriate management options. A demographic survey was conducted to capture the current status of the industry and to identify future research and development needs. Survey responses indicate that more than 145 ha are now planted to Rubus berries, with the majority grown in NSW and Victoria. While the industry has a core of long term (>20 years) growers, a number of new growers are entering the industry. The majority of berries are currently grown under field-based production systems but survey responses indicate that the industry is undergoing a shift towards protected cropping and hydroponic technologies. Around 10% of the respondents produce berries organically or biodynamically. The peak harvest season occurs between December and April with a small proportion of growers harvesting all year round. Year round harvesting is likely to increase as cropping cycles and production methods are modified and new varieties introduced. Survey respondents indicated key challenges for the industry in the next 10 years as pest and disease management, preventing exotic incursions, labour costs, availability of new varieties, market access, competition from imported berries and the development of new production technologies.

Pest and disease surveys were carried out to identify key pests and diseases and to guide the development of pest and disease diagnostic posters that would be relevant to industry. Surveys were conducted through diagnostic laboratory submissions, field visits, discussions with growers and an online survey. Key pests identified included Green Stink Bug, Two-spotted Mite and various caterpillars. Key diseases included Phytophthora, Yellow Rust and Botrytis. Two posters were developed to assist growers to diagnose key pests and diseases and to better understand conditions that are conducive to their occurrence. These have been disseminated to the industry through RABA.

Key recommendations include:

- The development of a more detailed pest and disease guide to cover all geographic locations, the seasonality of the appearance of pest and diseases and the resulting symptoms or damage, and details about the occurrence or prevalence of pests and diseases under different cropping systems as the industry moves toward new production technologies. This will require a collaborative national effort with input from growers, diagnostic laboratories and other industry stakeholders.
- Research into new production technologies including irrigation, hydroponic and protected cropping as adoption increases.
- Issues including market access and labour costs need to be addressed by the industry.

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Introduction

The Australian Berry Industry has expanded rapidly over the last 10 years, more than doubling in size, and emerging in areas not traditionally used for berry production as new technologies and varieties are adopted. Fundamental to the continued sustainable growth of the industry is an understanding of its current status and future production trends to ensure that research and development are targeted to support the industry in relevant areas. This is particularly significant for the Rubus industry as production moves away from traditional field-based cropping and new technologies including hydroponics, alternative substrates and protected cropping are adopted. These new technologies introduce new variables for management including nutritional requirements, irrigation options and changes to pest and disease management (O'Neill et al. 2012; Xu et al. 2011). The development and application of an effective and sustainable integrated pest and disease management program and appropriate agronomic practices are also essential to maintain high yield and product quality. Berries are considered a high-end, niche product and must be consistently well presented to expand market opportunities and maintain consumer confidence.

No thorough survey of pests and diseases of Rubus crops has been conducted in Australia since 1980 (Bruzzese 1980a,b) when a survey was conducted in Victoria as part of a study into biological control options for European Blackberry (*Rubus fruticosus*). These surveys found three fungal pathogens to be commonly associated with introduced *Rubus* sp.: *Keuhneola uredinis* (rust), *Septoria rubi* (leaf spot) and *Elsinoe veneta* (anthracnose). Another 20 fungi were isolated less frequently. More than 44 insect species and two mite species were found to be associated with *Rubus* spp. in the same survey. Those considered to be of most concern to growers were *Epiphyas postvittana* (Light brown apple moth) and *Thrips imaginis* (Plague thrips). Insects recorded on Rubus in other states include *Bactrocera tryoni* (Queensland fruit fly), *Philomastix macleaii* and *P. nancarrowi* (sawflies) (Allman 1941 and May 1953 in Bruzzese 1980b). Very few records of pest and pathogens of *Rubus* species in Australia are recorded in the scientific literature or on public databases. It is likely that most records are held in the internal files of diagnostic laboratories and state agriculture departments.

This project was developed to identify the current and developing trends in Rubus production. The information collated from demographic, pest and disease surveys can be used to identify opportunities and concerns for the industry concerns and to better target future research and development. This report presents outcomes from a demographic survey, pest and disease survey and pest and disease diagnostic materials that were developed.

Materials and Methods

Demographic survey

A survey was developed, in consultation with the RABA Industry Development Manager (IDM) to determine the current and future (within 5 years) practices of the Rubus industry in Australia (Appendix I). The survey comprised 22 questions about the socio-economic and agronomic characteristics of the Rubus industry. The survey also provided the respondents with the opportunity to share their opinions and views about the research and development priorities for the industry. The survey was mailed to all RABA members in early December 2012. It was mailed to a further approximately 30 non-RABA members in October 2013.

The data collected were collated and entered into a database for RABA. Data was analysed in Excel and responses presented graphically or in tables.

Pest and Disease Survey

This survey was conducted in three ways:

(1) growers were asked to send in samples to the Plant Health Diagnostic Laboratory at Elizabeth Macarthur Agricultural Institute, NSW DPI for diagnosis.

- Growers were asked to send in diseased material through notices in the RABA newsletter, and at the RABA Annual General Meeting (AGM) held at Berry Quest, held in Victoria in 2013. Sample submission forms and detailed instructions were included. Costs were covered by the project.

(2) field visits and discussions with growers to identify key diseases.

- At the RABA AGM at Berry Quest, growers were also asked if they would permit us to visit their farm. Field visits were made to two growers in Victoria and to one grower in NSW. Samples were also collected during field visits as part of Berry Quest tours.

(3) an online survey of pests and diseases emailed to growers through the RABA Industry Development Manager (IDM).

- An online survey (Appendix II) was developed using Survey Monkey with graphic design assistance from Evolution 7, Melbourne. The survey links were emailed to all RABA members on 2 June 2014. The survey remained open until 25 June 2014.

(4) database searches of publications in the literature

- The databases 'Web of Science', 'ANR-Index : Agriculture and Natural Resources Index and Archive' and 'Biosis Previews', and the 'National Plant Pest Database' (Plant Health Australia) were searched for records of pests and diseases reported in *Rubus* sp. in Australia.

Pest and disease reference guides

Two posters were developed as reference guides to assist growers with the preliminary diagnosis of key diseases and pests. Graphic design and layout was done by Pond Creative, Sydney. Drafts of the posters were sent out to selected industry members for comment via the Industry Development Manager. Posters were edited following feedback and then printed for dissemination to RABA members via the IDM.

Results and Discussion

Demographic survey

Thirty surveys were returned. Twenty seven had been completed and three were from respondents who had retired or sold their business. Two responses were from non-RABA members. It should be noted that not all RABA members are growers so not all members were fitting respondents. While it is acknowledged that the response rate is low, the information received does provide a reasonable overview about the current status and potential future growth of the industry. When looking at the survey response data, where percentages do not add up to 100% more than one answer per respondent was recorded.

The greatest number of responses was received from Victoria (74%) followed by Tasmania (7%), Queensland (7%), NSW (4%), WA (4%) and SA (4%).

Grower background

More than 40% of survey respondents have been growing berries for more than 20 years (Fig. 1). Almost 20% of respondents have been growing berries for less than 5 years, suggesting that a number of new growers are entering the industry (Fig. 2). While the long-term growers have the largest combined average area under production, the area under production is not related to the length of time in the industry. The total area under production (>145 ha) has doubled in the last 10 years from 77 ha in 2004 (ARGA 2004). It is probable that the survey result is an underestimation of what is actually planted as not all growers in the industry responded to the survey. Eighty percent of respondents indicated that they were likely to increase the area they had under production in the next five years (Fig. 3) suggesting expansion of the industry is likely.

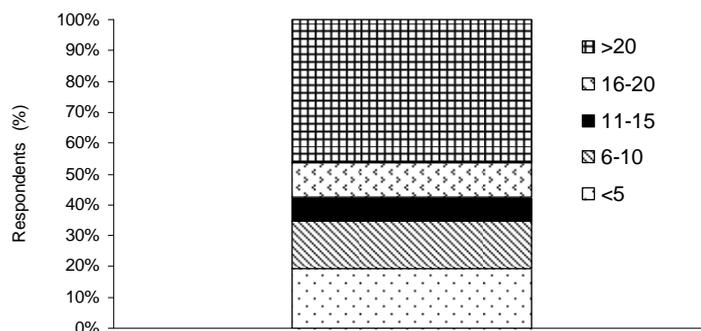


Fig. 1. Number of years that survey respondents have been growing berries.

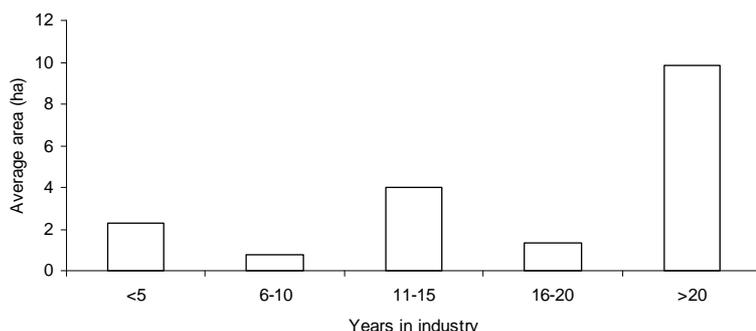


Fig. 2. Area under production based on the length of time a respondent has been in the industry.

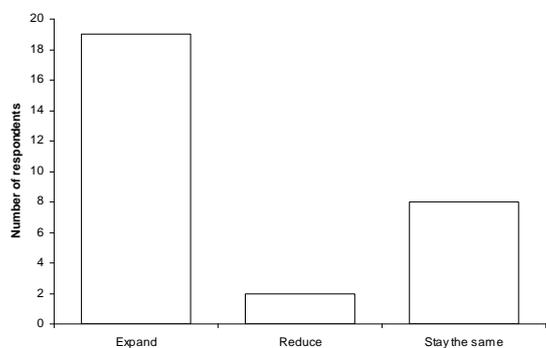


Fig. 3. Likelihood of respondents changing the area they have planted to berries.

Rubus berries under production

Raspberries were the most commonly grown berry, with a total area of 108 ha under production nationally, based on responses received (Table 1). Blackberries made up a smaller proportion of the industry with a total of 31 ha under production by respondents. Other berries comprised 6.4 ha of land under cultivation and included gooseberries, black currants, jostaberries and red currants. At least 59 varieties of Rubus berries are cultivated by the survey respondents, either under commercial production, for testing as potential varieties or in farm collections (Appendix III). The most commonly grown variety of raspberry was Himbotop (44%) followed by Heritage (33%). Chester was the most commonly grown blackberry variety (39%). All respondents grew more than one variety and several made their own selections.

Table 1. Average and total area planted to raspberries, blackberries and other berries by all respondents. Other berries include gooseberries and currants.

Berry	Average area (ha)	Total area (ha)
Raspberries	4.5	108.1
Blackberries	1.6	31.2
Other Rubus berries	0.6	6.4

Production methods

Of the respondents, 70% currently grow in the field, 35% grow undercover and 30% grow hydroponically (Fig. 4). Forty percent of the respondents grow berries using a more than one production method (field, hydroponic, protected or substrate methods). Fifteen percent of respondents produce berries organically, and a further 5% are converting to an organic system. Based on responses, it is likely that the industry will continue to move toward the use of tunnel houses or other protected structures in the next five years, as well as an increase in hydroponic and substrate based production (Fig. 5).

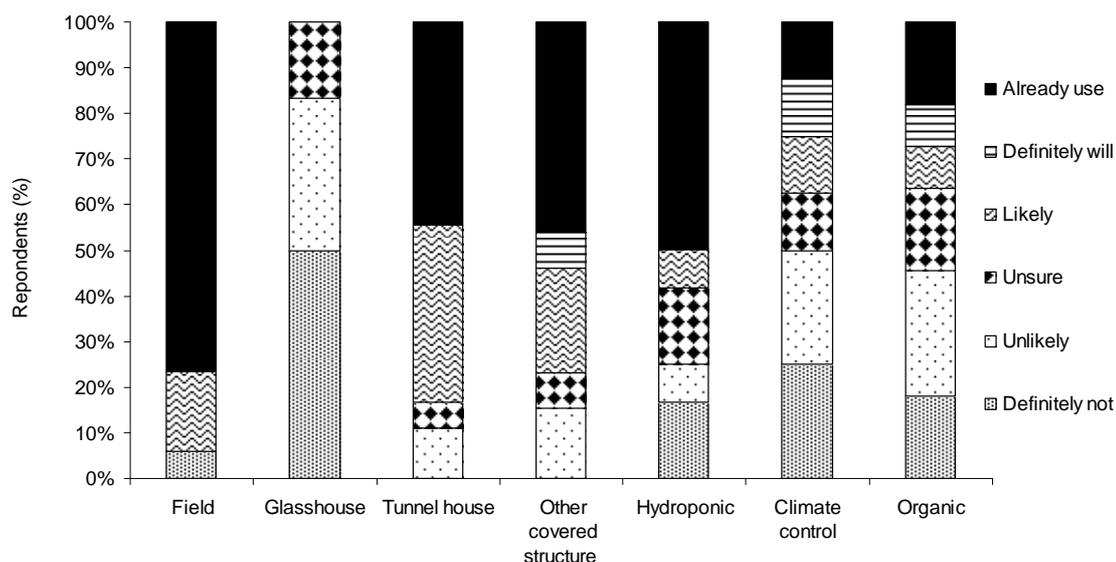


Fig. 4. Production systems currently used by survey respondents, and those that they expect to use in 5 years time. Respondents indicated whether they already used a given system and how likely they were to use a given system in 5 years time.

The peak harvest season for berries is from December through to April (Fig. 5). This corresponded with the summer and autumn cropping cycles practiced by the majority of respondents. Ten percent of respondents harvested all year round. Five percent of respondents expect to begin long cane production and harvest all year within the next five years. A further 34% expect to convert to long cane production with dual varieties for fruit in winter and spring within the next five years. During peak season, berries are harvested daily (62% of respondents) or every 2-4 days (43% of respondents). The change in production systems and extended harvest seasons is likely to lead to more available fruit in the market outside of the traditional berry season.

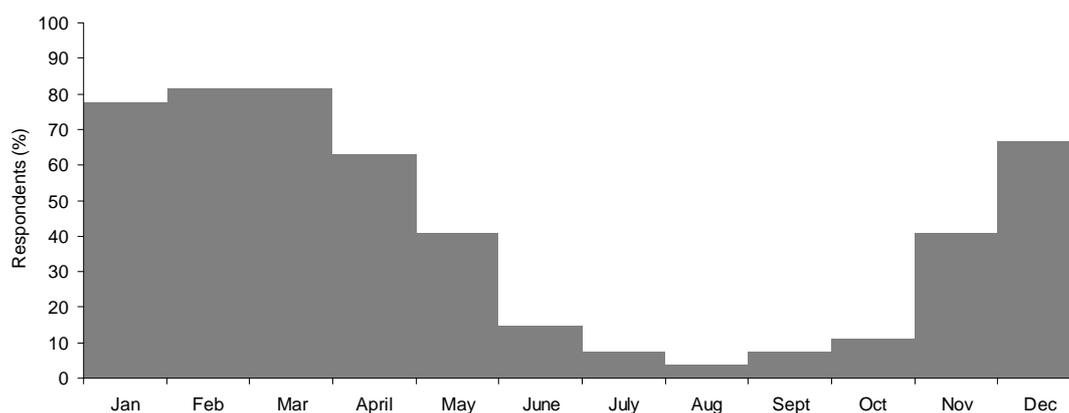


Fig. 5. Harvest periods of berries reported by survey respondents.

Agronomic practices

Half (51%) of respondents had soil and leaves analysed to tailor fertiliser needs. The majority (89%) of respondents drip irrigated using dam water (74%). Irrigation timing was generally determined according to the available moisture (74%) and the cropping cycle (40%). If irrigation water was treated, it was to adjust the pH or to add biological agents or fertiliser. No respondents reported disinfecting or sanitising their water prior to irrigation. Sixty three percent of respondents regarded new technologies, including hydroponics, substrates and irrigation, as important research areas for the industry.

Labour

Labour costs were a big concern for growers. The main sources of labour for picking berries, particularly for smaller growers were family and friends, while larger growers employed full time and seasonal pickers (Table 2). High labour costs were raised as a significant concern by 40% of respondents.

Table 2. Sources of labour for picking berries used by respondents (n=27)

Labour source	Number of respondents
Family	31
Friends /neighbours	6
'Pick-your-own' visitors	5
Full time employees	5
Seasonal labour	17
Other (volunteers)	1

Extension and information

The majority of survey respondents sourced information from RABA (59%), other growers (52%) and the internet (56%). This highlights the importance of actively including growers in extension activities to disseminate information. Other sources of information included books (41%), state agricultural departments (30%), sales representatives (11%) and private consultants (11%). A large proportion of growers (20%) also conducted their own trials, particularly when selecting varieties or testing new agronomic practices.

Challenges for the Rubus industry as identified by survey respondents

The top five challenges for the Australian Rubus industry identified by survey respondents as 'significant' included:

- Keeping out exotic pests and diseases (41%)
- Cost of labour (41%)
- Managing pests and diseases (37%)
- Availability of improved varieties (37%)
- Imported berries and berry products (40%)

The most important research and development areas for survey respondents included:

- Improved pest management (85%)
- Improved varieties (81%)
- Improved disease management (81%)
- Certified planting material (81%)
- Reducing chemical usage (81%)

The complete prioritised lists of the most significant challenges facing the industry over the next 10 years, and the most important research and development areas, as identified by survey respondents, are presented in Appendix IV.

The database of results from the industry survey was provided to the RABA IDM.

Pest and disease survey

Submission of samples to the PHDS diagnostic laboratory

No samples were received by the PHDS laboratory from Rubus growers. This may be because there were no diseases present that growers needed to have diagnosed, there was no interest in the diagnosis, or the message was not communicated well enough. Requests for samples were communicated through the RABA newsletter and at the RABA AGM held at Berry Quest, Victoria 2013.

Field visits and discussions with growers

Pest and disease assessments were conducted during field visits as part of Berry Quest 2013, and on two farms (one tunnel house production and one field grown) in Victoria in December 2013 and on one farm in NSW in November 2011. Pest and disease problems were also discussed with growers in NSW and with growers attending the Berry Quest meeting in Victoria in October 2013.

The following pests were observed during farm visits in Victoria in December 2013: caterpillars, two-spotted mites and green vegetable bugs.

The following diseases were identified during surveys in NSW in November 2012 and January 2014 and in Victoria in December 2013: Raspberry Bushy Dwarf Virus (RBDV), Anthracnose (*Elsinoë veneta*), Phytophthora root rot (*Phytophthora* spp.), Botrytis fruit rot (*Botrytis cinerea*), Downy mildew (*Peronospora sparsa*) and Botryosphaeria cane canker (*Botryosphaeria* sp.).

Key pests in raspberries and blackberries as identified by growers include Rutherglen Bug (*Nysius vinitor*), Green Vegetable Bug (*Nezara viridula*), Queensland Fruit Fly (*Bactrocera tyroni*), Loopers (*Chrysodeixis* spp.), a range of caterpillars, birds and possums. Key diseases reported by growers include Phytophthora (*Phytophthora fragariae*) in raspberries, and Botrytis (*Botrytis cinerea*) in all Rubus berries, and downy mildew (*Peronospora sparsa*) of blackberry. A full list of those pests and diseases identified as common problems during field visits and through discussions with growers are listed in Tables 3 and 4.

Table 3. Pests identified as priorities and common problems.

Common name	Scientific name	Rubus crop	Notes
Rutherglen Bug, Grey Cluster bug	<i>Nysius vinitor</i> , <i>N. clevelandensis</i>	All	
Green Stink Bug	<i>Plautia affinis</i>	All	Physical presence; Difficult to get rid of.
Queensland Fruit Fly	<i>Bactrocera tryroni</i>	Blackberries, and others	Damage to fruit; unmarketable
Two-spotted mite	<i>Tetranychus urticae</i>	All	Particularly under humid conditions and in poorly ventilated tunnels
Loopers	<i>Chrysodeixis argentifera</i>	All	
Leafhoppers	<i>Empoasca fabae</i>	All	
Green vegetable bug	<i>Nezara viridula</i>	All	Physical presence
Coddling moth	<i>Cydia pomonella</i>	All	Hard to get rid of
Light brown apple moth	<i>Epiphyas postvittana</i>	All	
Broad mite	<i>Polyphagotarsonemus latus</i>	All	Leaf damage
Thrips	<i>Thrips imaginis</i> , <i>T. tabaci</i>	All	
Caterpillars, Heliothis, Helicoverpa	<i>Heliothis</i> sp., <i>Helicoverpa</i> sp. and other Lepidopteras	All	Damage to fruit and leaves; Physical presence
Fungus gnat	<i>Bradysia</i> spp.	Raspberries	Particularly a problem in hydroponic systems

Other pests include birds, possums, wallabies and birds, particularly in Victoria.

Table 4. Pests identified as priorities and common problems.

Common name	Scientific name	Rubus crop	Notes
Phytophthora	<i>Phytophthora</i> sp.	Raspberry	Problem in poorly drained areas
Botrytis	<i>Botrytis cinerea</i>	All	Particularly in cool areas
Downy mildew	<i>Peronospora sparsa</i>	Raspberry	
Anthracnose	<i>Elsinoë veneta</i>	Raspberry, loganberry, youngberry	
Raspberry Bushy Dwarf (RBDV)	RBDV	Raspberry	
Crown gall	<i>Agrobacterium</i> sp.	Raspberry	Tasmania
Yellow rust	<i>Phragmidium rubi-idaei</i>		Becoming a problem again.
Botryosphaeria cane canker	<i>Botryosphaeria</i> sp.	Blackberry	Dieback, especially after pruning
Cladosporium flower and fruit rots	<i>Cladosporium</i> sp.	Raspberry	Particularly in poorly ventilated crops/tunnel houses

During field visits and discussions with growers it became apparent that the disease and pest issues were often associated with geographic location, and dependent on production systems used by growers. Pest and disease incidence was generally considered greater in humid, warm conditions. For example, where berries were grown under cover, diseases and pests were likely to become significant problems as humidity and temperature increase in poorly ventilated tunnel houses. Two-spotted mite, thrips and aphids were identified as a problem in tunnels, as were Botrytis and Cladosporium. In field situations, in the southern areas, diseases including Botrytis (*Botrytis cinerea*), Anthracnose (*Elsinoë veneta*), Phytophthora (*Phytophthora* sp.), Raspberry Bushy Dwarf Virus (RBDV) were common problems, as were pests including Loopers, Green Vegetable Bug and two-spotted mites. In northern growing regions, common problems were caused by Green Stink Bug, Broad Mite, caterpillars and Yellow Rust. A few growers, who were located in more isolated, or cooler areas reported that they did not have any significant pest and disease problems.

The industry is very aware of chemicals and many growers prefer to avoid using pesticides, favouring biological control measures where available. Many had IPDM programs in place. The most commonly used insects for IPM were *Neoseiulus californicus* for and *Phtyoseiulus persimilis* for two-spotted mite (*Tetranychus urticae*). Chemical use is often restricted because berries are harvested daily or every-second day, and the withholding periods for many pesticides are generally longer than one day. There is a need for more research in to control measures with a short, or no, withholding period.

Online survey

The online survey was prepared in February 2014 but was not sent out to RABA members until 2 June 2014 due to technical difficulties at RABA. All responses have been provided to the RABA IDM on a CD.

Respondents to the online survey were from Victoria (2), NSW (3), Queensland (1), South Australia (1) and West Australia (1). The respondents grew raspberries (NSW, Victoria, SA, Queensland), blackberry (NSW, Victoria, West Australia), jostaberry (SA), Gooseberry (SA), Currants (SA), Silvanberry (SA) and Boysenberry (NSW, SA). Summaries of the diseases (Table 5) and pests (Table 6) considered most important by respondents are presented below.

Table 5. Summary of diseases considered most important by respondents and their location.

Disease	State
Anthraxnose	NSW
Botrytis grey mould	NSW, Queensland, WA, Victoria
Cladosporium	Queensland
Downy mildew	Victoria
Phytophthora rot	Queensland, SA
Yellow rust	Victoria, WA
Other fruit rots	Victoria, WA

Table 6. Summary of pests considered most important by respondents and their location

Pest	State
Broad mite	NSW, Queensland
Carpophilus	Victoria
Grasshoppers	Queensland
Greenhouse whitefly	NSW
Green stink bug	NSW
Green vegetable bug	Victoria
Heliothis, loopers and other Caterpillars	NSW, Queensland, Victoria
Red berry mite	Victoria
Two-spotted mites	Queensland, Victoria
Western flower thrip, thrips	NSW, Victoria

Reports of Rubus pests and diseases in the literature and databases.

Very few reports of pests and diseases of Rubus in Australia were found in the scientific literature or through database searched. A summary of the reports of Rubus diseases and pests in Australia that were found are presented in Appendix V. The *Industry Biosecurity Plan for the Rubus Industry* prepared by Plant Health Australia was launched at Berry Quest in Victoria in 2013 and is available through Plant Health Australia. The plan identified more than 200 exotic pests of Rubus, including 13 high priority pests, that, if they were to enter Australia could cause significant damage to the industry. This plan should be available to all growers who need to be aware of

what to look for in their crops. There also should be a system in place to ensure that the plan is updated regularly.

Pest and disease posters

Initially, the pests and diseases to be included on the reference posters were to be identified following analysis of the responses of the online survey. However, because of the delay in sending out the links for the survey, the seven pests and diseases included in the posters were selected based on discussions held with growers during field visits. The pest poster included basic information and photos about the biology, epidemiology and damage caused, to assist in the identification of Green Vegetable Bug (*Nezara viridula*), Queensland Fruit Fly (*Bactrocera tyroni*), Two-Spotted Mite (*Tetranychus urticae*), Rutherglen Bug (*Nysius vinitor*) and Grey Cluster Bug (*Nysius clevelandensis*), Leaf Hoppers (*Empoasca fabae*), Caterpillars (including Heliothus, Helicoverpa and Loopers), Light Brown Apple Moth (*Epiphyas postvittana*). The disease poster provides information about Botrytis Grey Mould (*Botrytis cinerea*), Phytophthora (*Phytophthora* sp.), Botryosphaeria Cane Canker (*Botryosphaeria* spp.), Downy Mildew (*Peronospora sparsa*), Powdery Mildew (*Podosphaera macularis*), Raspberry Bushy Dwarf Virus and Yellow Rust (*Phragmidium rubi-idaei*).

Two hundred pest and 200 disease posters were printed for dissemination to RABA members through the IDM. Copies of the posters are included in Appendix VI.

During the industry review of the posters, it became apparent that more information about more pests and diseases was desired by growers. Many suggested that a 'ute guide' with details of known geographic locations of pests and diseases would be beneficial.

Technology Transfer

- Details of the project were presented at the RABA Strategy meeting in August 2013 and at the RABA AGM held at Berry Quest in October 2013. The presentation was also used as an opportunity to ask growers to send in disease samples for diagnosis as part of the disease survey being conducted as part of this project, and to ask growers if we can access their properties to survey for pests and diseases.
- Project updates were regularly communicated to the Rubus Industry via the industry newsletter '*round the Rubus*'. This included an article presenting the demographic survey outcomes.
- Articles about Phytophthora root rot and Botrytis cane blight and fruit rot were also prepared and included in the industry newsletter in September 2013.
- The project leader and team member Len Tesoriero visited growers in Victoria in December 2013 to discuss key pest and disease issues, and to assess pest and disease severity in orchards of two growers.
- Pest and disease diagnostic posters were developed and disseminated to industry members at the end of the project.

Recommendations

Three key recommendations can be made from this project:

1. The most effective way to gather information from growers is to spend time with them on their farm.

2. Information about geographic location and the effect of production systems on the occurrence of pests and diseases.

There is a need for more detailed information about the pests and diseases that occur under different production systems and geographic areas. This needs to be a collaborative effort with input from growers, diagnostic services and other industry stakeholders in each state. Growers are a key to the collation of this information and development of a detailed guide as they are on-the-ground and the most frequent observers of pests and diseases in their crops. Information from diagnostic services across the country would provide a better understanding of the pattern of occurrence of pests and diseases. Such information could be collected beginning with a forum held at an industry meeting such as Berry Quest to 'advertise' the project and begin to collect information and details of interested stakeholders, and followed up with a detailed national farm visit/survey designed in collaboration with the Industry Development Manager and Growers. The inclusion of production systems in this guide is essential as the pests and diseases that occur in field grown crops are often different to those that are more problematic under covered systems. The information could be prepared in a 'ute-guide', or similar format.

3. Research into new production technologies including irrigation, hydroponic and protected cropping.

This is important as an increasing number of growers adopt these technologies. Issues including dissemination of pests and diseases under these systems, optimum substrates, nutritional requirements, irrigation design and protected cropping technologies could be investigated.

4. Industry marketing and production issues.

Issues that need to be addressed by the industry body that were raised during surveys and discussions with growers include market access and labour costs.

5. It would be useful to conduct a thorough virus survey across the industry so that it is known what occurs in Australia, and what should be screened for during post-entry quarantine as new materials are imported.

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Appendix I. Demographic survey sent out to RABA members



Survey of the Australian Rubus Industry

Dear Rubus grower,

My name is Rosalie Daniel. I work for the NSW Department of Primary Industries. Earlier this year you may have received a survey in the mail to assess the current and future characteristics of the Australian Rubus industry. So far, we have had a 20% response rate. To get a more accurate picture of the industry we would like to increase the number of responses received.

This survey is funded by levy funds and Horticulture Australia Ltd. through HAL Project RB120008: '*Understanding the demography and pests and diseases of the Australian Rubus Industry*'.

Why is the survey being conducted?

The survey is being conducted to identify the opportunities and challenges faced by Rubus growers across different growing regions to plan for the future of the industry in Australia. The survey contains questions about agronomic activities, orchard management and your opinions on the current and future opportunities and challenges faced by the Australian Rubus Industry.

Who has received the survey?

This survey has been sent to all RABA members. The survey is anonymous and participation is voluntary. You do not need to write your name on the survey and will not be identified. Please be assured that information provided will remain confidential. Data will be aggregated at the state or national levels.

What does the survey involve?

The survey comprises 22 questions and will take approximately 30 minutes to complete. Your responses will contribute to ensuring that future research and marketing directions are relevant to the Rubus Industry. The information collected will be collated and results made available through RABA.

How can you participate in the survey?

There are two ways in which you can complete this survey:

1. Complete this paper version and return it to us in the envelope supplied.
2. By phone. Send an email to rosalie.daniel@dpi.nsw.gov.au and we will call you at a convenient time.

If you have any questions about the survey please contact Rosalie Daniel at rosalie.daniel@nsw.dpi.gov.au or on (02) 4640.6226.

Please return the completed survey in the enclosed envelope to:

Rosalie Daniel
Elizabeth Macarthur Agricultural Institute
NSW Department of Primary Industries
Private Bag 4008
Narellan, NSW 2567

A. Grower profile

1. In which state(s) do you grow berries? (please tick)

Victoria	<input type="checkbox"/>
NSW	<input type="checkbox"/>
Queensland	<input type="checkbox"/>
Tasmania	<input type="checkbox"/>
Western Australia	<input type="checkbox"/>
ACT	<input type="checkbox"/>
Northern Territory	<input type="checkbox"/>

2. How many years have you been growing berries?

<5	<input type="checkbox"/>
6-10	<input type="checkbox"/>
11-15	<input type="checkbox"/>
16-20	<input type="checkbox"/>
>20	<input type="checkbox"/>

3. Which of the following describes your method of production (please tick all that apply)?

Organic	<input type="checkbox"/>
In the process of converting to organic	<input type="checkbox"/>
Field grown	<input type="checkbox"/>
Undercover	<input type="checkbox"/>
Hydroponic	<input type="checkbox"/>

Other (please list): _____

4. Which of the following sources do you rely on for picking? (please tick any that apply)

Family	<input type="checkbox"/>
Friends	<input type="checkbox"/>
'Pick-your-own' visitors	<input type="checkbox"/>
Full time employees	<input type="checkbox"/>
Seasonal labour	<input type="checkbox"/>

Other _____

B. Agronomic information

5. How many hectares do you have planted to berries?

Raspberries	
Blackberries	
Other Rubus berries	

6. How many canes do you grow per linear meter?

Raspberries	
Blackberries	
Other Rubus berries	

7. What row spacing do you apply?

Raspberries	
Blackberries	
Other Rubus berries	

8. In the next 5 years are you likely to change the area you have planted to berries?

	Definitely not	Unlikely	Unsure	Likely	Definitely will
Expand					
Reduce					
Stay the same					

9. In the next 5 years, how likely are you to use the following methods of production?

	Definitely not	Unlikely	Unsure	Likely	Definitely will	Already use now
Field						
Glasshouse						
Tunnel house						
Other covered structure (eg. bird net)						
Hydroponics						
Climate control						
Organic						

11. What cropping cycle do you have now and what do you anticipate to use in the future?

	Current	In 5 years
Summer cropping (Floricane)		
Autumn cropping (Primocane)		
Summer and autumn cropping with a dual variety		
Long cane production (fruit in winter and spring)		
Primocane production for fruit in winter and spring		
All year		
Other		

12. Do you have your soil and leaves analysed to tailor fertiliser needs to the crop?

Yes

No

13. Which irrigation system do you use?

No irrigation

Drip

Mini sprinkler

Flood

Overhead sprinkler

Other

14. If you irrigate, how do you determine when to irrigate?

Have set daily irrigation schedule

Monitor soil/potting medium moisture and/or weather patterns and irrigate accordingly

According to crop cycle (ie. vegetative growth, flowering, fruit set etc.)

Other

15. Where do you source your irrigation water?

Town water supply

Dam water

Bore water

Truck in water

Rain water

Other

16. Do you treat your irrigation water?

Yes	<input type="checkbox"/>
No	<input type="checkbox"/>
Sometimes	<input type="checkbox"/>

If so, how?

17. Which months of the year do you harvest?

January	<input type="checkbox"/>	May	<input type="checkbox"/>	September	<input type="checkbox"/>
February	<input type="checkbox"/>	June	<input type="checkbox"/>	October	<input type="checkbox"/>
March	<input type="checkbox"/>	July	<input type="checkbox"/>	November	<input type="checkbox"/>
April	<input type="checkbox"/>	August	<input type="checkbox"/>	December	<input type="checkbox"/>
				All year	<input type="checkbox"/>

18. How frequently do you harvest during peak season?

Daily	<input type="checkbox"/>
Every 2-4 days	<input type="checkbox"/>
Weekly	<input type="checkbox"/>
Other:	<input type="checkbox"/>

C. Information sources, extension and the future of the industry

19. Where do you source information about berry production?

RABA	<input type="checkbox"/>
DPI/State agricultural department	<input type="checkbox"/>
Other growers	<input type="checkbox"/>
Diagnostic laboratory	<input type="checkbox"/>
Sales reps	<input type="checkbox"/>
Internet	<input type="checkbox"/>
Books	<input type="checkbox"/>
Other (please list):	<input type="checkbox"/>

20. How great a challenge you think the following pose to the Australian Rubus industry in the next 10 years?

	Not relevant	Minor	Neutral	Major	Significant challenge
Managing pests and diseases					
Availability of more chemical options for pest and disease control					
Availability of non-chemicals for pests and disease management					
Keeping out exotic insect pests and diseases					
Post-harvest disease management					
Availability of improved varieties					
Healthy planting material					
Pollination					
Improving water use efficiency					
Overproduction locally					
Interstate market access					
Imported berries and berry products					
Shelf life/handling practices					
Marketing; increasing consumption					
Sourcing labour					
Cost of labour					
Increasing costs of inputs (eg. fertiliser, chemicals)					
Attracting young people to the industry					
Grower skills and training in agronomic practices					
Grower skills and training in business management					
Limited agricultural industry support services					
Urban expansion into arable land					
Climate change					
Other (<i>please list</i>)					

21. How important do you think the following are to the Rubus industry over the next 10 years?

	Not important	No opinion	Important
Improved varieties			
Improved pest management			
Improved disease management			
Improved agronomic management			
Certified clean planting material			
More targeted chemicals			
Extending the cropping season			
Reducing chemical use			
Improved post-harvest technologies			
New technologies (eg. hydroponics, media, irrigation, disinfection, polyhouse design etc.)			
Greater market access (national and international)			
Improved marketing			
Improved generic promotion			

Other (please list):

22. If you have any other comments please list them here:

Thank you for taking the time to complete the survey.

Appendix II. Online surveys for pests and diseases.

This survey was run through Survey Monkey online. Photos were added for each of the diseases and pests.

Introductory page

What is this survey about?

This survey is being conducted by NSW Department of Primary Industries as part of a Horticultural Australia Limited (HAL) and Raspberries and Blackberries Australia (RABA) levy-funded project. The survey aims to identify key pests and diseases impacting on Rubus production in Australia. The information collected will be compiled and used to develop pest and disease identification material. The pest and disease information may also be used by RABA to identify future research and development directions for the Australian Rubus industry.

What does the survey involve?

You will be asked to log in using a username and password. Please keep these in a safe place.

The survey contains three sections.

The first is a general section to establish the location of your farm, and hence the location of the pests and diseases, and the type of Rubus crop on which they occur. It also asks you to identify the 3 pests and 3 diseases that are the most serious on your farm.

The second and third sections present images and descriptions of 11 pests and 10 diseases. You will be asked whether you have these on your farm, at what time of year they are a problem, how significant a problem they are, and what, if any, control measures you apply. There are 6 questions for each pest and 6 questions relating to each disease.

Not all pests and diseases affecting Rubus crops can be included in this kind of survey. If you are concerned about a pest or disease in your crop you can send in a photo, or contact us for information on how to send in a sample for diagnosis.

Once you have logged in you can stop and restart at any time. The survey will be available on line until March 9 2014.

Do you want more information?

If you have any questions or suggestions, please contact Rosalie Daniel at NSW DPI:

T: (02) 46406217

E: rosalie.daniel@dpi.nsw.gov.au

Section 1. General information

1) In which region do you grow berries?

- a) Tasmania
- b) Victoria – southern
- c) Victoria – northern
- d) New South Wales
- e) Queensland
- f) Western Australia
- g) South Australia
- h) Northern Territory

2) What are the main Rubus berries that you grow (please tick all that apply)

- Raspberry
- Blackberry
- Jostaberry
- Gooseberry
- Red or black currants
- Other

3) What do you consider to be the 3 most serious diseases in your berry crop?

- a)
- b)
- c)

4) What do you consider to be the 3 most serious pests in your berry crop?

- a)
- b)
- c)

5) In what format do you prefer information for the identification of pests and diseases to be presented?

- a) Poster
 - b) Pocket booklet
 - c) Electronic as a CD/DVD with clickable images
 - d) A smartphone app
 - e) Other: please provide details
-

Survey of pests of raspberry, blackberry and other berry crops

- 1) In which crop have you seen this pest (please tick all that apply)?
- | | |
|--|------------------------------|
| a) Never seen (LINK: continue to next pest question) | d) Jostaberry |
| b) Raspberry | e) Gooseberry |
| c) Blackberry | f) Red or black currants |
| | g) Other (please list) _____ |

- 2) At what time of year did you **see the pest**? (tick all that apply)
- | | | |
|------------|-------------|------------|
| • January | • June | • November |
| • February | • July | • December |
| • March | • August | • Not sure |
| • April | • September | |
| • May | • October | |

- 3) At what time of year did you **see the damage** caused by the pest (tick all that apply)?
- | | | |
|------------|-------------|------------|
| • January | • June | • November |
| • February | • July | • December |
| • March | • August | • Not sure |
| • April | • September | |
| • May | • October | |

- 4) On a scale of 1-10, how significant would you rate this pest on your farm (please tick)?
1 = not an issue, 10 = severe damage to plant vigour, fruit production, yield or economic losses.

1	2	3	4	5	6	7	8	9	10

- 5) a) What percentage of your crop does this pest affect in an average year (please tick)?

<10%	10-25%	25-50%	50-75%	>75%

- b) What percentage of your crop does this pest affect in a severe year (please tick)?

<10%	10-25%	25-50%	50-75%	>75%

- 6) Do you use any of the following to manage the pest? (Y/N)
- Chemicals
 - Biological control insects (IPM)
 - Traps
 - Other
 - None

Survey of diseases of raspberry, blackberry and other berry crops

- 1) In which crop have you seen this disease?
 - a) Never seen (Link: continue to next disease question)
 - b) Raspberry
 - c) Blackberry
 - d) Jostaberry
 - e) Gooseberry
 - f) Red or black currants
 - g) Other

- 2) At what time of year did you see the disease symptoms? (tick all that apply)
 - January
 - February
 - March
 - April
 - May
 - June
 - July
 - August
 - September
 - October
 - November
 - December
 - Not sure

- 3) On a scale of 1-10, how significant would you rate this disease on your farm?
1 = not an issue, 10 = severe damage to plant vigour, fruit production, yield or economic losses.

1	2	3	4	5	6	7	8	9	10

- 4) a) What percentage of your crop does this disease affect in an average year?

<10%	10-25%	25-50%	50-75%	>75%

- b) What percentage of your crop does this disease affect in a severe year?

<10%	10-25%	25-50%	50-75%	>75%

- 5) Do you use any of the following to manage the disease? (Y/N)
- Chemical treatments (fungicides, pesticides etc.)
 - Biological agents (eg. Compost teas, microbial preparations)
 - Cultural measures (eg. Weed control, sanitation, soil amendments such as compost, biochar etc.)
 - Other
 - None

Acknowledgements

Many thanks to the growers who allowed us on to their farm to look at pests and diseases and take photographs used in this survey.

References

Information and photos in this survey were sourced from the following:

- ACIAR (Australian Centre for International Agricultural Research): aciarc.gov.au
- American Phytopathological Society: apsnet.org
- Berries Northwest: berriesnw.com
- Cornell University Cornell Fruit: fruit.cornell.edu
- Department of Environment and Primary Industries: depi.vic.gov.au
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- Ontario Ministry of Agriculture and Food: omafra.gov.on.ca
- Pacific Northwest Disease Management Handbook: pnwhandbooks.org
- United States Department of Agriculture Agricultural Research Service: ars-grin.gov
- University of California Agriculture and Natural Resources: ipm.ucdavis.edu
- Washington State University Whatcom County Extension: whatcom.wsu.edu

Appendix III. List of varieties of Rubus berries grown by survey respondents.

Raspberry	Blackberry	Other berries	Other varieties
29D8	Black logan	Black current	own selections
3IN6	Black satin	Gooseberry	Sanford
A82-614	Boysen	Jostaberry	Test varieties
A82-SE8	Chester	Red currants	Tulant
Ashlen	Dirksten	Bilberry	Zing
Autumn Treasure	Karaka Black		
Bogong	Lawton		
Cardinal (Driscolls)	Lochness		
Chilcotin	Logan		
Chilliwack	Marion		
Clyde	Murrindindi		
Coho	Navajo		
Dinkum	Ouachita		
Driscoll	Ranui		
Driscolls Maravilla	Silvan		
Driscolls Pacifica	Smoothstem		
Glen Lyon	Tayberry		
Heritage	Thornfree		
Himbotop	Waldo		
Jewel	Young		
Joan Squire	Tulane		
Marwe			
Meeker			
Nootka			
Nowato			
Octavia			
Sevilliana (Driscolls)			
Tulameen			
Willamette			

Appendix IV. Challenges and issues for the Rubus industry

Table 1. Challenges to the Rubus industry over the next 10 years as prioritised by survey respondents.

Challenge	Respondents (%)
Keeping out exotic insect pests and diseases	40.7
Cost of labour	40.7
Managing pests and diseases	37.0
Availability of improved varieties	37.0
Imported berries and berry products	37.0
Increasing costs of inputs (eg. fertiliser, chemicals)	29.6
Availability of non-chemicals for pests and disease management	25.9
Healthy planting material	25.9
Marketing; increasing consumption	25.9
Sourcing labour	22.2
Attracting young people to the industry	22.2
Grower skills and training in agronomic practices	22.2
Urban expansion into arable land	22.2
Availability of more chemical options for pest and disease control	18.5
Post-harvest disease management	18.5
Pollination	18.5
Grower skills and training in business management	18.5
Limited agricultural industry support services	18.5
Improving water use efficiency	14.8
Overproduction locally	14.8
Shelf life/handling practices	14.8
Climate change	14.8
Interstate market access	11.1
Other* (please list)	3.7

*“Biological control methods”

Table 2. Importance of a range of issues faced by the Rubus industry over the next 10 years as ranked by survey respondents.

Issue	Respondents (%)
Improved pest management	85
Improved varieties	82
Improved disease management	82
Certified clean planting material	82
Reducing chemical use	78
Improved agronomic management	67
New technologies (eg. hydroponics, media, irrigation, disinfection, polyhouse design etc.)	63
Improved marketing	59
Improved generic promotion	59
Greater market access (national and international)	56
Improved post-harvest technologies	48
More targeted chemicals	44
Extending the cropping season	30
Other* (please list):	4

*Other includes:

- “Better resistance against root diseases”
- "The level of the AUD to the Euro and US\$ is critical to the domestic markets ability to compete with packaged imports from Europe. Especially during our summer harvest."
- "Too many things to comment on. You could write a lengthy essay on this."

Appendix V. Summary of pests and diseases of *Rubus* spp. in Australia as reported in the scientific literature and on public databases.

Table 1. Pathogens and diseases recorded on *Rubus* sp. in Australia from published scientific literature and government Agricultural departments.

Pathogen	Disease	Locations	Locations identified during this project	References
<i>Agrobacterium rubi</i> and <i>A. tumefaciens</i>	Crown gall	Vic	Tas	Hincksman & Fernando 2013
<i>Appendiculella calostroma</i>	Leaf spot	Vic		Bruzzese 1980a
<i>Armillaria mellea</i>	Root rot	Vic		Bruzzese 1980a; Hincksman & Fernando 2013;
<i>Ascochyta rubi</i>	Leaf and cane spot	Vic		Bruzzese 1980a;
<i>Botryosphaeria dothidea</i>	Botryosphaeria cane canker	NSW	NSW	PHDS* NSW DPI
<i>Botrytis cinerea</i>	Grey mould, cane botrytis	NSW, Tas, Vic	NSW, Tas, Vic	Bruzzese 1980a; Hincksman & Fernando 2013; TIA 2012
<i>Cladosporium</i> spp.	Fruit rot	NSW, Qld	NSW, Qld	PHDS NSW DPI
<i>Clethridium corticola</i> (<i>Seimatosporium lichenicola</i>)	Stem scab	Vic		Bruzzese 1980a
<i>Coniothyrium fuckelii</i>		NSW, Vic		Bruzzese 1980a;
<i>Coleroa chaetomium</i>	Leaf spot	Vic		Bruzzese 1980a
<i>Diapleella coniothyrium</i> (<i>Leptosphaeria</i> sp.)	Cane blight	Vic		Bruzzese 1980a;
<i>Didymella applanata</i> (Phoma sp.)	Spur blight	NSW, Vic		Bruzzese 1980a; Menzies & Brien 2002;
<i>Elsinoe veneta</i>	Anthraxnose	NSW, Vic	Vic	Bruzzese 1980a; Hincksman & Fernando 2013; Menzies & Brien 2002;
<i>Hamaspora acutissima</i>	Leaf rust	Vic		Bruzzese 1980a
<i>Herdersonia rubi</i>		Vic		Bruzzese 1980a;
<i>Kuehneola uredinis</i>	Leaf and cane rust	Vic		Bruzzese 1980a; Hincksman & Fernando 2013;

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Pathogen	Disease	Locations	Locations identified during this project	References
<i>Leptostroma virgultarum</i>		Vic		Bruzzese 1980a;
<i>Mycosphaerella confuse</i> (<i>Cercospora rubi</i>)	Blotch, leaf spot	Vic		Bruzzese 1980a
<i>Peronospora sparsa</i>	Downy mildew	Tas		TIA 2012
<i>Phragmidium barnardii</i>	Rust on native <i>Rubus</i> sp.	Vic		Bruzzese 1980a
<i>Phragmidium rubi-idaei</i>	Yellow rust	Vic, Tas	Vic, NSW	Bruzzese 1980a; Hincksman & Fernando 2013; TIA 2012
<i>Phragmidium violaceum</i>	Blackberry leaf rust	Vic	Vic	Hincksman & Fernando 2013; Mahr & Bruzzese 1998; Marks et al 1984; Washington 1987
<i>Phyllosticta rubicola</i>	Black rot	Vic		Bruzzese 1980a;
<i>Phytophthora cryptogea</i> , <i>Phytophthora rubi</i> and other species	Root rot	Vic, Tas	Vic	Hincksman & Fernando 2013; Menzies & Brien 2002; TIA 2012; Washington 1988
<i>Podospora aphanis</i>	Powdery mildew	Tas		TIA 2012
Raspberry Bushy Dwarf Virus	RBDV	NSW, Vic	Vic	Hincksman & Fernando 2013; Johnstone et al. 1983; Menzies & Brien 2002;
Raspberry Leaf Mottle Virus	RLMV	Tas		Johnstone et al. 1983
<i>Septoria rubi</i>	Leaf spot	Vic		Bruzzese 1980a; Hincksman & Fernando 2013;
<i>Sphaeropsis rubicola</i>	Stem lesions	Vic		Bruzzese 1980a
<i>Vararia</i> sp.	White root rot	Vic		Hincksman & Fernando 2013; Pascoe et al. 1984

*PHDS – Plant Health Diagnostic Service, Elizabeth Macarthur Agricultural Institute, NSW DPI

Table 2. Insects and mites associated with *Rubus* species in Australia from published scientific literature and government Agricultural departments.

Pest	Common name	Location	Reference
<i>Acanthucis trispinifer</i>		Vic	Bruzzese 1980b;
<i>Acalitus essigi</i>	Mite	Tas	Davies et al. 2002
<i>Acrida conica</i>		Vic	Bruzzese 1980b;
<i>Alcinous fossicollis</i>		Vic	Bruzzese 1980b;
<i>Ametastegia glabrata</i>	Dock sawfly	Vic	Hincksman & Fernando 2013;
<i>Anzygina sidnica</i> , <i>Anzygina</i> spp.	Leaf hopper	Qld, Australia	Fletcher et al 2009
<i>Aulacapsis rosae</i>	Rose scale	NSW, Vic	Bruzzese 1980b; Menzies & Brien 2002
<i>Aulicorthis solani</i>		Vic	Bruzzese 1980b;
<i>Bactrocera tryoni</i>	Queensland fruit fly	NSW, Qld, Tas	Allman 1941; May 1953; TIA 2012
<i>Bathylus albicinctus</i>		Vic	Bruzzese 1980b;
<i>Caedicia simplex</i>		Vic	Bruzzese 1980b;
<i>Carpophilus</i> spp.	Dried fruit beetle, Carpophilus beetle	Vic, Tas	Hincksman & Fernando 2013; TIA 2012
<i>Chloroclystis</i> spp.	Loopers	Tas	TIA 2012
<i>Choroicetes terminifera</i>		Vic	Bruzzese 1980b;
<i>Clania tnuis</i>		Vic	Bruzzese 1980b;
<i>Cryptophasa melanostigma</i>		Vic	Bruzzese 1980b;
<i>Cuspicona privata</i>		Vic	Bruzzese 1980b;
<i>Didymuria violescens</i>			Bruzzese 1980b;
<i>Dindymus versicolor</i>		Vic	Bruzzese 1980b;
<i>Diphucephala colaspoides</i>		Vic	Bruzzese 1980b;
<i>Ectropis</i> spp.	Caterpillars, loopers	Vic, Tas	Bruzzese 1980b; TIA 2012
<i>Entomobrya</i> sp.			Bruzzese 1980b
<i>Epiphyas postvittana</i>	Light brown apple moth	Vic, Tas	Bruzzese 1980b; Hincksman & Fernando 2013; TIA 2012
<i>Erythroneura</i> sp.			Bruzzese 1980b;
<i>Forficula auricularia</i>	Earwigs	Vic	Bruzzese 1980b; Hincksman & Fernando 2013
<i>Gastrimargus musicus</i>			Bruzzese 1980b;
<i>Haplothrips victoriensis</i>		Vic	Bruzzese 1980b;

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Pest	Common name	Location	Reference
<i>Helicoverpa</i> spp.	Heliothis	Tas	TIA 2012
<i>Macrosiphum euphorbiae</i>		Vic	Bruzzese 1980b;
<i>Maroga melanostigma</i>	Fruit tree borer	Vic	Hincksman & Fernando 2013;
<i>Mictis profana</i>		Vic	Bruzzese 1980b;
<i>Neostollia</i> sp.		Vic	Bruzzese 1980b;
<i>Nezara viridula</i>	Green Vegetable Bug	Vic, Tas, Qld	Bruzzese 1980b; Coombs & Sands 2000; Hincksman & Fernando 2013; TIA 2012
<i>Nirvana adelaideae</i>			Bruzzese 1980b;
<i>Nysius vinitor</i>	Rutherglen bug	NSW, Vic	Hincksman & Fernando 2013; Menzies & Brien 2002
<i>Oiketicus elongatus</i>		Vic	Bruzzese 1980b;
<i>Omyta centrolineata centrolineata</i>		Vic	Bruzzese 1980b;
<i>Oncocoris geniculatus</i>		Vic	Bruzzese 1980b;
<i>Phaulacridium vittatum</i> ; <i>P. gemini</i>	Wingless grasshopper		Bruzzese 1980b; Menzies & Brien 2002
<i>Philomastix macleaai</i> ; <i>P. nancarrowi</i>	Sawflies	Qld, NSW	Bruzzese 1980b
<i>PlauTIA 2012 affinis</i>	Green stink bug	Qld, Vic, NSW	Coombs and Khan 1998; PHDS
<i>Pontania morio</i>	Raspberry sawfly	NSW, Tas	Bruzzese 1980b; Naumann et al 2002
<i>Pratylenchus penetrans</i>	Root lesion nematode	Vic	Hincksman & Fernando 2013;
<i>Priophorus morio</i>		Vic	Bruzzese 1980b;
<i>Rhopalosiphun padi</i>		Vic	Bruzzese 1980b;
<i>Scolypopa australis</i>		Vic	Bruzzese 1980b;
<i>Setanodosa quinseta</i>		Vic	Bruzzese 1980b
<i>Siphanta acuta</i>		Vic	Bruzzese 1980b;
<i>Stethorus vagans</i>		Qld	Houston 1980
<i>Synanthedon tipuliformis</i>	Currant borer moth		Hely et al 1982
<i>Tetranychus urticae</i>	Two-spotted mite	Vic, Tas	Bruzzese 1980b; Hincksman & Fernando 2013; TIA 2012
<i>Thrips imaginis</i>	Plague thrips	Vic, Tas	Bruzzese 1980b; Hely et al 1982; Hincksman & Fernando 2013; TIA 2012

Table 3. Pathogens isolated from *Rubus* reported on the Australian Plant Pest Database, planthealthaustralia.com.au.

Genus	species	State(s)	Number of reports
<i>Agrobacterium</i>	sp.	VIC	1
<i>Agrobacterium</i>	<i>tumefaciens</i>	VIC	1
<i>Amorbus</i>	<i>rubiginosus</i>	TAS	5
<i>Anchicera</i>	<i>lewisi</i>	TAS	1
<i>Aridius</i>	<i>bifasciatus</i>	TAS	1
<i>Botryosphaeria</i>	<i>dothidea</i>	NSW	1
<i>Botrytis</i>	<i>cinerea</i>	NSW	1
<i>Carpophilus</i>	<i>maculatus</i>	TAS	1
<i>Cercospora</i>	sp.	VIC	1
<i>Chauliognathus</i>	<i>lugubris</i>	TAS	1
<i>Cleobora</i>	<i>mellyi</i>	TAS	1
<i>Colletotrichum</i>	<i>acutatum</i>	NSW	1
<i>Colletotrichum</i>	<i>gloeosporioides</i>	VIC	1
<i>Coniothyrium</i>	<i>fuckelii</i>	NSW, TAS	2
<i>Criconemella</i>	sp.	TAS	1
<i>Cylindrocarpon</i>	<i>obtusisporum</i>	TAS	1
<i>Diarsia</i>	<i>intermixta</i>	TAS	2
<i>Dictyotus</i>	<i>conspicuous</i>	TAS	1
<i>Didymella</i>	<i>applanata</i>	TAS	3
<i>Dindymus</i>	<i>versicolor</i>	TAS	3
<i>Diphucephala</i>	<i>smaragdula</i>	TAS	9
<i>Diplodia</i>	sp.	NSW	1
<i>Elsinoe</i>	<i>veneta</i>	SA, TAS, VIC	9
<i>Epiphyas</i>	<i>postvittana</i>	TAS	2
<i>Epiphyas</i>	<i>xyloides</i>	TAS	2
<i>Euander</i>	<i>lacertosus</i>	TAS	8
<i>Eulecanium</i>	<i>tiliae</i>	TAS	2
<i>Fusarium</i>	<i>lateritium</i>	VIC	2
<i>Gloeosporium</i>	sp.	QLD	1
<i>Haplothrips</i>	<i>victoriensis</i>	TAS	6
<i>Hendersonia</i>	sp.	NSW	1
<i>Hypholoma</i>	sp.	VIC	1
<i>Leptosphaeria</i>	<i>coniothyrium</i>	SA	1
<i>Macrosiphum</i>	<i>euphorbiae</i>	TAS	4
<i>Neumichtis</i>	<i>nigerrima</i>	TAS	1
<i>Nysius</i>	<i>vinitor</i>	TAS	1
<i>Ocirrhoe</i>	<i>lutescens</i>	TAS	2
<i>Ogma</i>	sp.	TAS	1
<i>Pantomorus</i>	<i>cervinus</i>	TAS	1
<i>Phoma</i>	sp.	VIC	3
<i>Phragmidium</i>	<i>rubi-idaei</i>	ACT, NSW, QLD, SA, TAS, VIC	33
<i>Phragmidium</i>	sp.	TAS, VIC	3
<i>Phytophthora</i>	<i>bisheria</i>	VIC	1
<i>Phytophthora</i>	<i>cinnamomi</i>	VIC	1
<i>Phytophthora</i>	<i>cryptogea</i>	NSW, VIC	6
<i>Phytophthora</i>	<i>drechsleri</i>	NSW	2
<i>Phytophthora</i>	<i>fragariae</i>	SA, VIC	8
<i>Phytophthora</i>	sp.	SA, VIC	5
<i>Pratylenchus</i>	<i>crenatus</i>	VIC	1

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Genus	species	State(s)	Number of reports
<i>Pratylenchus</i>	<i>penetrans</i>	VIC	5
<i>Pythium</i>	sp.	TAS	1
<i>Pythium</i>	<i>ultimum</i>	VIC	1
<i>Rhizoctonia</i>	<i>solani</i>	VIC	1
<i>Rhyncocoris</i> group	–	TAS	8
<i>Schizopora</i>	<i>paradoxa</i>	VIC	2
<i>Scolypopa</i>	<i>australis</i>	TAS	10
<i>Seimatosporium</i>	<i>lichenicola</i>	NSW, TAS, VIC	3
<i>Seimatosporium</i>	sp.	VIC	1
<i>Septoria</i>	<i>rubi</i>	NSW, QLD, VIC	13
<i>Sphaceloma</i>	<i>necator</i>	VIC	3
<i>Sphaerella</i>	<i>rubicola</i>	VIC	1
<i>Stethorus</i>	<i>histrion</i>	TAS	5
<i>Stethorus</i>	<i>vagans</i>	TAS	7
<i>Trionymus</i>	–	TAS	1
<i>Vararia</i>	sp.	NSW, QLD, VIC	11
<i>Wynarka</i>	<i>sylvestre</i>	TAS	1
<i>Xylaria</i>	sp.	QLD	1

Table 4. Insect pests isolated from *Rubus* sp. reported on the Australian Plant Pest Database, planthealthaustralia.com.au

Genus	Species	Common name	State	Number of reports
<i>Diphucephala</i>	<i>smaragdula</i>		TAS	9
<i>Wynarka</i>	<i>sylvestre</i>		TAS	1
<i>Carpophilus</i>	<i>maculatus</i>		TAS	1
<i>Anchicera</i>	<i>lewisi</i>		TAS	1
<i>Eulecanium</i>	<i>tiliae</i>		TAS	2
<i>Trionymus</i>	sp.		TAS	1
<i>Rhyncocoris</i> group			TAS	8
<i>Epiphyas</i>	<i>xyloides</i>		TAS	2
<i>Amorbus</i>	<i>rubiginosus</i>		TAS	5
<i>Ocirrhoe</i>	<i>lutescens</i>		TAS	2
<i>Diarsia</i>	<i>intermixta</i>	chevron cutworm	TAS	2
<i>Pantomorus</i>	<i>cervinus</i>	Fuller's rose weevil	TAS	1
<i>Neumichtis</i>	<i>nigerrima</i>	green cutworm	TAS	1
<i>Dindymus</i>	<i>versicolor</i>	harlequin bug	TAS	3
<i>Epiphyas</i>	<i>postvittana</i>	lightbrown apple moth	TAS	2
<i>Stethorus</i>	<i>vagans</i>	mite-eating ladybird	TAS	7
<i>Aridius</i>	<i>bifasciatus</i>	mould beetle	TAS	1
<i>Scolypopa</i>	<i>australis</i>	passionvine hopper	TAS	10
<i>Chauliognathus</i>	<i>lugubris</i>	plague soldier beetle	TAS	1
<i>Macrosiphum</i>	<i>euphorbiae</i>	potato aphid, tomato aphid (Qld)	TAS	4
<i>Nysius</i>	<i>vinitor</i>	Rutherglen bug	TAS	1
<i>Dictyotus</i>	<i>conspicuous</i>	shield bug	TAS	1
<i>Cleobora</i>	<i>mellyi</i>	southern ladybird	TAS	1
<i>Euander</i>	<i>lacertosus</i>	strawberry bug	TAS	8
<i>Haplothrips</i>	<i>victoriensis</i>	tubular black thrips	TAS	6

