Macadamia

Strategic Agrichemical Review Process (SARP)

July 2020

Hort Innovation
Project – MT19008

Hort Innovation Project Number:
MT19008 – Strategic Agrichemical Review Process (SARP) - Updates

SARP Service Provider:
AGK Services

Purpose of the report:
This report was funded by Hort Innovation to investigate the pest problem, agrichemical usage and pest management alternatives for the macadamia industry across Australia. The information in this report will assist the industry with its agrichemical selection and usage into the future.

Date of report:
July 2020

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Hort Innovation Strategic levy investment | MACADAMIA FUND

This project has been funded by Hort Innovation using the macadamia research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

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1. Summary

The strategic levy investment project Strategic Agrichemical Review Process (SARP) - Updates (MT19008) is part of the Hort Innovation Macadamia Fund. A Strategic Agrichemical Review Process (SARP), through the process of a desktop audit and industry liaison;

Assesses the importance of the diseases, insects and weeds (plant pests) that can affect a horticultural industry;

(i) Assesses the importance of the diseases, insects and weeds (plant pests) that can affect a horticultural industry;

(ii) Evaluates the availability and effectiveness of fungicides, insecticides and herbicides (pesticides) to control the plant pests;

(iii) Determines any gaps in the pest control strategy and

(iv) Identifies suitable new or alternatives pesticides to address the gaps.

Alternative pesticides should ideally be selected for benefits of:

- Integrated Pest Management (IPM) compatibility
- Improved scope for resistance management
- Sound biological profile
- Residue and trade acceptance domestically and for export

The results of this process will provide the Macadamia industry with sound pesticide usage for the future that the industry can pursue for registration with the manufacturer, or minor-use permits with the Australian Pesticide and Veterinary Medicines Authority (APVMA).

1.1 Diseases

The high priority diseases are:

Common name	Scientific name
Husk Spot	*Pseudocercospora macadamiae*

1.2 Insects and mites

The high priority insect and nematodes of macadamia are:

Common name	Scientific name
Fruit Spotting Bug / Banana Spotting Bug	*Amblypelta nitida / Amblypelta lutescens*

1.3 Weeds

No high priority weeds identified but Flaxleaf Fleabane and Mistletoe were nominated as a moderate priority. Mistletoe is reported as becoming more of a problem and control options are limited.

Common Name	Scientific Name
Moderate	
Flaxleaf Fleabane	*Conyza bonariensis*
Mistletoe	Loranthaceae

1.4 Plant Growth Regulators

There were no high priority Plant Growth Regulator issues identified but restriction of vegetative growth and promotion of uniform nut fall were rated as moderate priority.

Issue
Restriction of Vegetative Growth
Promote Uniform Nut Fall

2. The Australian Macadamia Industry

The macadamia industry has benefited from a sound export focused growth agenda and exports 81% of total production. Macadamia production occurs predominantly in Northern NSW and Bundaberg. The majority are sold in kernel form, however there are also some export markets that prefer nut in shell.

Production for the year ending June 2019 was 42,900 tonnes (in shell weight at 3.5% moisture) with a kernel equivalent yield of 14,157 tonnes. The value of production was worth $193.9 m while the wholesale value was $113.3 m.

Queensland and New South Wales dominate the Australian production and their growers can supply the market for a large part of the year. The ability to store macadamia nuts for extended periods allows the trade to continue year-round.

Macadamia Harvest Season by State (Kernel)[1]

State	18/19 Tonnes	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
New South Wales	6,512												
Queensland	7,635												
Western Australia	10												
Availability Legend			Harvest			End of Harvest					None		

Macadamia production has been growing strongly for many years, with increasing export volumes underpinning demand and continued favourable prices for growers. The majority of export volumes are sent to China, with lesser volumes being exported to Vietnam, Japan, United States and Hong Kong.

[1] Hort Innovation (2020). Australian Horticulture Statistics Handbook 2018/19. [online] Available at: https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/australian-horticulture-statistics-handbook/

3. Introduction

3.1 Background

Growers of some horticultural crops suffer from a lack of legal access to crop protection products (pesticides). The problem may be that whilst a relatively small crop area is valuable in an agricultural sense, it may not be of sufficient size for Agrichemical companies to justify the expense of registering a product use on that crop. Alternately, the disease, pest, or weed problem may be regional or spasmodic, making Agrichemical companies unwilling to bear the initial high cost of registering suitable pesticides.

Growers may face severe losses from diseases, pests and weeds due to a lack of registered or approved (via a permit) chemical control tools.

Environmental concerns, consumer demands, and public opinion are also significant influences in the marketplace related to pest management practices. Industry IPM practitioners must strive to implement best management practices and tools to incorporate a pest management regime where strategies work in harmony with each other to achieve the desired effects while posing the least risks.

In combination with cultural practices, pesticides are important tools in Macadamia production and respective IPM programs. They control the various diseases, insects and weeds that affect the crop and can cause severe economic loss in modern high intensity growing operations. Pesticides are utilised during establishment and development, and to maximise quality and customer appeal.

As a consequence of the issues facing the Macadamia industry regarding pesticide access, Hort Innovation undertook a review of the pesticide requirements via a Strategic Agrichemical Review Process (SARP) in 2014. The current project is to update the SARP with the latest information and progress.

The SARP process identifies diseases, insect pests and weeds of major concern to the Macadamia industry. Against these threats, available registered or permitted pesticides are evaluated for overall suitability in terms of IPM, resistance, efficacy, trade, human safety and environmental issues. Where tools are unavailable or unsuitable the process aims to identify potential future solutions. Potential new risks to the industry are also identified.

The results will provide the Macadamia industry with a clear outlook of gaps in existing pest control options. This report is not a comprehensive assessment of ALL pests and control methods used in Macadamias but attempts to prioritise the major problems.

Exotic plant pests, not present in Australia, are not addressed in this document. A biosecurity plan has been developed for the Macadamia Industry in consultation with industry, government and scientists. The Biosecurity Plan outlines key threats to the industry, risk mitigation plans, identification and categorisation of exotic pests and contingency plans. High priority exotic pests have been assessed based on their potential to enter, establish, and spread in Australia (e.g. environmental factors, host range, vectors) and the cost to industry of control measures. More information is available at the link below.

https://www.planthealthaustralia.com.au/industries/macadamias/

3.2 Minor use permits and registration

From a pesticide access perspective, the APVMA classifies macadamias as a major crop. The crop fits within the APVMA crop group Crop Group 022: Tree Nuts. Therefore, access to minor use permits can be relatively difficult. Possible justification for future permit applications could be based on:

- New disease, insect or weed identified as a cropping issue
- No pesticide approved for the problem
- Insufficient options for resistance management
- Current pesticides ineffective due to resistance
- Trade risk - current pesticides unsuitable where crop commodities will be exported
- IPM, environment or OH&S issues
- Loss of pesticides due to removal from market or chemical review restrictions
- Opportunity to extrapolate a use pattern when a new, effective pesticide is registered in another crop
- Alternate pesticide has overseas registration or minor use permit
- Market failure – insufficient return on investment for registrant.

With each of these options, sound, scientific argument is required to justify any new permit applications. Another option for the macadamia industry is for manufacturers to register new pesticides uses in the crop.

3.3 Methods

The current update of the Macadamia Strategic Agrichemical Review Process (SARP), which was last updated in 2015, was conducted by desktop audit and included an online industry survey. The process included gathering, collating and confirming information. The steps in the process were:

Process of Review	Activity / Date
Industry survey	Preparation and circulation of online industry survey to update priority pests and identify priority control gaps. Survey released: 14 January 2020 Survey closed: 31 March 2020
SARP data updated via a desktop audit	Updated registrations and permits Updated MRL tables Updated available and potential pesticides against low, moderate and high priority pests, including an assessment of their suitability Included information on regulatory risks from MT17019
Captured industry input	Collated and analysed survey results Consolidated and incorporated industry needs and insights

3.4 Results and discussions

3.4.1 Detail

Results and discussions are presented in the body of this document.

3.4.2 Appendices

Refer to additional information in the appendices:

Appendix 1. Products available for disease control in Macadamias
Appendix 2. Products available for control of insects and mites in Macadamias
Appendix 3. Products available for weed control in Macadamias
Appendix 4. Plant Growth Regulators available in Macadamias
Appendix 5. Current permits for use in Macadamias
Appendix 6. Macadamia Maximum Residue Limits (MRLs)
Appendix 7. Macadamia regulatory risk assessment

4. Diseases, pests and weeds of Macadamias

Resistance management: To manage the risk of resistance development, integrated disease/pest/weed management (IDM/IPM/IWM) strategies should be adopted. The general principle is to integrate diverse chemical and non-chemical strategies; maximise efficacy; not rely on singular tools and rotate between different modes of action. It is always essential to follow all the label instructions. Specific resistance management strategies may apply. These can be found, along with other useful information, on the CropLife Australia website. https://www.croplife.org.au/resources/programs/resistance-management/

Information on regulatory risk derived from project MT17019 (Chapter 4) - Regulatory support and coordination (Appendix 6) has been incorporated.
Some of the suggested options have no overseas MRLs (see Appendix 6). If treated fruit is to be exported nil residues at harvest would be needed for these options.
While care has been taken to ensure the accuracy of the information provided in this document the APVMA registered label and where relevant the APVMA approved permit must always be followed.

4.1 Diseases of Macadamias

4.1.1 Disease priorities

Common name	Scientific name
High	
Husk Spot	*Pseudocercospora macadamiae*
Moderate	
Phytophthora Root Rot	*Phytophthora cinnamomi*
Trunk Canker	*Phytophthora cinnamomi*
Grey Mould / Blossom Blight	*Botrytis cinerea*
Flower Blight / Dry Flower[2]	*Pestalotiopsis* spp. and *Neopestalotiopsis* spp.
Low	
Branch Dieback	*Neofusiccocum and Lasiodipolodia* spp.
Alternaria	*Alternaria* spp.
Anthracnose	*Colletotrichum gloeosporioides*
Graft Dieback / Phomopsis Husk Rot	*Phomopsis* spp.

Husk Spot remains the most significant disease in macadamias. The key to managing the disease is for growers to use a combination of cultural and chemical controls every season. The disease is more prevalent in varieties with sticktight husks. Growing alternate varieties can assist with disease management, as well as opening the tree canopy to improve airflow and removing sticktights from the trees to limit ongoing infections. In recent years there has been a greater range of fungicides available for use in controlling husk spot in macadamias. The judicious use of these fungicides in a planned protectant strategy allows for the disease to be managed effectively. The Husk Spot risk assessment tool can assist with planning and implementing an effective disease program.

[2] https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/flower-blights-in-macadamia/

Grey Mould (Blossom Blight) occurs mostly in mature flowers and is favoured by warm, moist conditions at flowering. It is a moderate priority due to its prevalence in NSW crops, although it is not a major issue in most Queensland growing regions. It's occurrence also varies from year to year depending on the prevailing weather at flowering time. Maintaining an open canopy can assist with reducing infection levels. The regular husk spot protectant program assists in keeping the disease in check even though there are limited options available specifically for Botrytis in macadamia.

Phytophthora Root Rot can occur in parts of orchards that experience poor drainage. Maintaining good soil and tree health will assist trees to resist and recover from Phytophthora. There are also several chemical options available.

Dry Flower is an emerging problem which has a large potential to impact on yields. Research is underway to understand the pathology and to develop effective control measures. A number of pathogens are thought to be causal agents of Dry Flower. Early indications are that orchard hygiene and variety selection will be important cultural controls that form part of an Integrated Disease Management strategy.

Branch Dieback is a moderate priority and is favoured by hot, dry seasons. In recent years it has been a significant issue in Queensland, but not as much in NSW regions.

There is a Disease Resistance Management Strategy for the management of Husk Spot in the macadamia industry[3]. In future, this may be extended to encompass the full range of diseases.

[3] www.croplife.org.au/resources/programs/resistance-management/macadamia-husk-spot/

4.1.2 Available and potential products for priority diseases

TABLE KEY: Note that blank fields in the table indicate no information has been provided.

Availability		Regulatory risk (refer to Appendix 7)	
A	Available via either registration or permit approval	R1	Short-term: Critical concern over retaining access
P	Potential - a possible candidate to pursue for registration or permit	R2	Medium-term: Maintaining access of significant concern
P-A	Potential, already approved in the crop for another use	R3	Long-term: Potential issues associated with use - Monitoring required
Withholding Period (WHP) – Number of days from last treatment to harvest (H) or Grazing (G)			
Harvest	H	Not Required when used as directed	NR
Grazing	G	No Grazing Permitted	NG

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Macadamia Husk Spot *(Pseudocercospora macadamiae)* **Priority: High**							
Husk Spot is a high priority disease in all regions. Most varieties are prone to husk spot, but it is more prevalent in varieties with sticktight husks. Rain splash easily spreads fungal spores from diseased sticktights to developing nuts. A combination of cultural and chemical controls is required to manage the disease.							
Azoxystrobin + Tebuconazole (Custodia) Adama	11+3	Protectant / Curative	15	A	ALL	Registered in macadamias for control of **Husk Spot**. Use as part of protectant fungicide program. Commence application at match head stage and repeat application 14-28 days later. Treatments per season not limited.	R3
Carbendazim	1	Protectant / Curative	H:14 G:28	A	ALL	Registered in macadamias for control of **Husk Spot**. Apply at 5 and 8 weeks after main flowering – Stage 2 anthesis (white flowering stage). Remove any fallen nuts from under trees prior to spraying. Do not use more than 2 applications per season.	R3
Copper (Cu) present as copper ammonium acetate	M1	Protectant	1	A	QLD, NSW & NT	Registered in macadamias for control of Phytophthora Stem Canker, **Husk Spot**, Anthracnose Husk Rot and Pink Limb Blight. Apply from nut set (late September) to December. Apply at least 3 sprays at 3-4 week intervals. Treatments per season not limited.	-
Copper (Cu) present as Copper Oxychloride	M1	Protectant	1	A	QLD, NSW & NT	Registered in macadamias for control of **Husk Spot**, Anthracnose Husk Rot and Pink Limb Blight. Apply from nut set (late September) to December. Apply at least 3 sprays at 3-4 week intervals. Treatments per season not limited.	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Copper (Cu) present as Cupric Ammonium Complex	M1	Protectant	1	A	QLD, NSW, WA & NT	Registered in macadamias for control of Phytophthora Stem Canker and **Husk Spot**. Apply from nut set (late September) to December. Apply at least 3 sprays at 3-4 week intervals. Treatments per season not limited.	-
Copper (Cu) present as Cupric Hydroxide	M1	Protectant	1	A	QLD, NSW & NT	Registered in macadamias for control of Phytophthora Stem Canker, **Husk Spot**, Anthracnose Husk Rot and Pink Limb Blight. Apply from nut set (late September) to December. Apply at least 3 sprays at 3-4 week intervals. Treatments per season not limited.	-
Copper (Cu) present as cuprous oxide	M1	Protectant	1	A	QLD, NSW & NT	Registered in macadamias for control of Phytophthora Stem Canker, **Husk Spot**, Anthracnose Husk Rot and Pink Limb Blight. Apply from nut set (late September) to December. Apply at least 3 sprays at 3-4 week intervals. Treatments per season not limited.	-
Difenoconazole (Score) Syngenta	3	Protectant / Curative	NR	A	QLD, NSW & NT	Registered in macadamias for control of **Husk Spot**. Use in a protectant fungicide program containing fungicides from different chemical groups. Apply from nut set (late September) to late December, with applications at 3-4 week intervals. Apply a maximum of 2 applications per season.	R3
Penthiopyrad (Fontelis) Corteva	7	Protectant	14	A	ALL	Registered in macadamias for control of **Husk Spot**. Commence application at match head stage and repeat application 14-28 days later. Do not apply more than 2 consecutive applications and do not apply more than 3 total applications per season.	-
Pyraclostrobin (Cabrio) BASF	11	Protectant / Curative	NR	A	ALL	Registered in macadamias for control of **Husk Spot**. Commence application at match head stage and repeat application 14-28 days later. Do not apply more than 2 applications per season.	-
Pyraclostrobin + Fluxapyroxad (Merivon) BASF	11+7	Protectant / Curative	21	A	ALL	Registered in macadamias for control of **Husk Spot**. Commence application at match head stage and repeat applications at 21 day interval. Apply a maximum of 3 applications per year and no more than 2 consecutive applications.	-
Fluopyram + Tebuconazole (Luna Experience) Bayer	7+3	Protectant / Curative	TBC	P	ALL	Hort Innovation project ST16006 complete and data submitted to Bayer for label extension for the tree nut group. Registration pending and expected end of 2020 for control of Macadamia Husk Spot and Botrytis Blight in macadamia. Fluopyram - AU MRL 0.1 mg/kg. Codex MRL 0.04 mg/kg. Tebuconazole - AU MRL T*0.01 mg/kg. Codex MRL *0.05 mg/kg.	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Fluopyram + Trifloxystrobin (Luna Sensation) Bayer	7+11	Protectant / Curative		P		Current AU registration in almonds, pome and stone fruit for various diseases. Bayer intend on expanding the label to include the tree nut crop group. Fluopyram - AU MRL 0.1 mg/kg. Codex MRL 0.04 mg/kg. Trifloxystrobin – AU MRL *T0.05 mg/kg. Codex MRL 0.02 mg/kg.	-
Phytophthora Root Rot *(Phytophthora cinnamomi)* **Trunk (Stem) Canker** *(Phytophthora cinnamomi)* **Priority: Moderate**							
Phytophthora is a major pathogen in macadamia plantations that can produce different symptoms throughout the macadamia tree, often seen as trunk (stem) canker or root decay and eventuating as loss of the tree. Present in all regions, Phytophthora can cause significant impacts on tree health in wet years. Phytophthora infections are best managed through cultural controls. The most important of these is to ensure trees are planted in sites with good drainage. Chemical controls should be used to assist in managing the disease during times of high disease risk. Due to the multiple paths of infection, having different application methods available provides more effective control.							
Copper (Cu) present as Copper Hydroxide + Metalaxyl M (Ridomil Gold Plus) Syngenta	M1+4	Protectant / Curative	28	A	QLD, NSW	Registered in macadamias for control of **Phytophthora Root Rot** and Trunk Canker. Apply to the affected trunk and limbs and as a soil drench to approximately 1 m2 around the base of the tree. Apply at the beginning of the summer wet season and again at 8-12 weeks later. Treatments per season not limited.	-
Metalaxyl M (Ridomil Gold) Syngenta	4	Protectant / Curative	28	A	QLD, NSW	Registered in macadamias for control of **Phytophthora Root Rot** and Stem Canker. Use as a soil application at the start of summer wet season and repeat at 3-6 month intervals. Apply in alternate years only.	-
Phosphorous (Phosphonic) Acid present as Mono- and Dipotassium Phosphite (Agri-Fos 600)	33	Protectant / Curative	28	A	NSW, QLD & WA	Registered in macadamias for control of **Phytophthora Root Rot** and Trunk (Stem) Canker. Foliar or Trunk Application. Apply a maximum of 2 applications per crop.	-
Phosphorous (Phosphonic) Acid present as Mono- and Dipotassium	33	Protectant / Curative	14	A	NSW, QLD & WA	Permitted in macadamias for control of **Phytophthora Root Rot** and Trunk (Stem) Canker. Foliar or Trunk Application. Apply a maximum of 2 applications per crop. In Jan-2019 the use was registered on the Agri-Fos 600 Label with a 28-day WHP. Therefore, this permit will not be renewed past its expiry date (30-Nov-22).	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Phosphite (PER84766)							
Mandipropamid (Revus) Syngenta	40	Protectant		P		Current AU registration for control of Downy Mildew in grapes, lettuce, leafy vegetables and oilseed poppies. Registered in the US for Phytophthora in various crops, including as a foliar application for protection of citrus from Phytophthora Root Rot. No MRLs in place for AU or Codex.	-
Oxathiapiprolin (Zorvec Enicade) Corteva	49	Protectant		P		Current AU registrations for control of Downy Mildew in bulb vegetables, brassicas, cucurbits, leafy vegetables and poppies. Registered in the US for control of Phytophthora Canker and Brown Rot in citrus. No MRLs in place for AU or Codex.	-
Grey Mould / Blossom Blight *(Botrytis cinerea)* **Priority: Moderate**							
Botrytis is rated as a moderate priority but is a major issue in wet seasons, especially when warm, moist conditions prevail at flowering time. It can be a problem in NSW but is generally not an issue in QLD.							
Iprodione (Rovral)	2	Protectant / Curative	NR	A	ALL	Registered in macadamias for control of **Botrytis Blight**. Apply as a preventative treatment as flowers are opening, with a follow-up spray one week later if wet conditions persist during flowering. Treatments per season not limited.	R2
Carbendazim	1	Protectant / Curative	H:14 G:28	P-A	ALL	Registered in macadamias for control of Husk Spot. Only 2 applications per season which are generally used at flowering time, will have activity on Botrytis if it is present at that time.	R3
Penthiopyrad (Fontelis) Corteva	7	Protectant	14	P-A	ALL	Registered in macadamias for control of Husk Spot. Registered for control of Botrytis in strawberries and onions and could be used at flowering to help protect against Botrytis.	-
Fluopyram + Tebuconazole (Luna Experience) Bayer	7+3	Protectant / Curative		P		Hort Innovation project ST16006 complete and data submitted to Bayer for label extension to the tree nut group. Registration pending and expected end of 2020 for control of Macadamia Husk Spot and Botrytis Blight. Fluopyram - AU MRL 0.1 mg/kg. Codex MRL 0.04 mg/kg. Tebuconazole - AU MRL T*0.01 mg/kg. Codex MRL *0.05 mg/kg.	-
Aureobasidium pullulans (Botector) Nufarm	-	Biological / Protectant	NR	P		Registered as a preventative treatment for *Botrytis cinerea* in grapes and berries. The registered label also includes suppression of Anthracnose, Phomopsis spp. and Rhizopus spp. in various berries. No MRLs required for biological product.	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Bacillus amyloliquefaciens (strain QST 713) (Serenade Opti) Bayer	44	Biofungicide Protectant	NR	P		Registered for control of Botrytis in grapes and strawberries. No MRLs required for biological product.	-
Bacillus amyloliquefaciens (Serifel) BASF	44	Biofungicide Protectant	NR	P		Registered for control of Botrytis in grapes and strawberries. No MRLs required for biological product.	-
Fenhexamid (Teldor) Bayer	17	Protectant		P		Registered for control of Botrytis in strawberries. AU MRL 0.1 mg/kg. Codex 0.02 mg/kg.	-
Fenpyrazamine (Prolectus) Sumitomo	17	Protectant / Curative		P		Registered in AU for Botrytis control in grapes and has registrations for Botrytis control in the US for various crops. No MRLs in place for AU or Codex.	-
Isofetamid (Kenja) ISK	7	Protectant / Curative		P		Registered for Botrytis control in various crops in the US. AI has been approved in AU; no indication of crops planned for registration as yet. No MRLs in place for AU or Codex.	-
Flower Blight / Dry Flower (*Pestalotiopsis* spp. and *Neopestalotiopsis* spp.) **Priority: Moderate**							
It is favoured by dry, warm conditions and as such is potentially a greater problem in QLD than NSW. Hort Innovation research is ongoing as part of the Macadamia Integrated Disease Management Project (MC16018) into the cause of Flower Blight and what control measures can be employed to manage the disease. No chemical controls are available although growers anecdotally report some impact on disease and yield increases from existing fungicides used in macadamia. Can be confused with Botrytis Blight, with diseased flowers turning dark brown and remaining attached to the rachis. Cultural practices to prevent Flower Blight are under investigation. An open, well-ventilated canopy is generally less prone to infection.							
Carbendazim	1	Protectant / Curative	H:14 G:28	P-A	ALL	Registered in macadamias for control of Husk Spot. Only 2 applications per season which are generally used at flowering time, may have activity on Flower Blight if it is present at that time.	R3
Copper (Cu)	M1	Protectant	1	P-A	QLD, NSW, WA & NT	Registered in macadamias for control of Phytophthora Stem Canker, Husk Spot, Anthracnose Husk Rot and Pink Limb Blight. A protectant program with copper is likely to provide ongoing suppression of Dry Flower although it is unlikely that complete disease control will be achieved.	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Difenoconazole (Score) Syngenta	3	Protectant / Curative	NR	P-A	QLD, NSW & NT	Registered in macadamias for control of Husk Spot.	R3
Penthiopyrad (Fontelis) Corteva	7	Protectant	14	P-A	ALL	Registered in macadamias for control of Husk Spot.	-
Pyraclostrobin + Fluxapyroxad (Merivon) BASF	11+7	Protectant / Curative	21	P-A	ALL	Registered in macadamias for control of Husk Spot.	-
Cyprodinil (Solaris) Adama	9	Protectant / Curative		P		Registered in almonds for control of *Botrytis* spp., Prune Rust and Shot Hole and in pome and stone fruit for control of *Monolinia* spp., Apple Scab and Pear Scab. No MRL for AU. Codex MRL 0.04 mg/kg.	-
Cyprodinil + Fludioxonil (Switch) Syngenta	9+12	Protectant / Curative		P		Registered in various vegetable crops for control of several diseases, including *Botrytis* spp., *Sclerotinia* spp. and Anthracnose. Cyprodinil - No MRL for AU. Codex MRL 0.04 mg/kg. Fludioxonil – No MRLS for AU or Codex.	-
Fluopyram + Tebuconazole (Luna Experience) Bayer	7+3	Protectant / Curative		P		Hort Innovation project ST16006 complete and data submitted to Bayer for label extension to the tree nut group. Registration pending and expected end of 2020 for control of Macadamia Husk Spot and Botrytis Blight. Fluopyram - AU MRL 0.1 mg/kg. Codex MRL 0.04 mg/kg. Tebuconazole - AU MRL T*0.01 mg/kg. Codex MRL *0.05 mg/kg.	-
Pyrimethanil (Scala) Bayer	9	Protectant / Curative		P		Registered in bananas for control of various diseases and in grapes and strawberries for control of Grey Mould. No MRLS for AU or Codex.	-
Branch Dieback (Botryosphaeriaceae - *Lasidioplodia* spp. and *Botryosphaeria* spp.) **Priority: Low**							
Branch Dieback is an emerging problem for macadamias. It has been favoured by recent dry seasons and has been a concern in QLD growing regions. No specific chemical controls available. Diseased branches should be removed and destroyed to limit the spread of infection.							
No Options Available							

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Alternaria (*Alternaria* spp.) **Priority: Low**							
No fungicides are specifically registered for management of Alternaria in macadamias. Many broad-spectrum fungicides have some activity on Alternaria.							
Florylpicoxamid (Adavelt) Corteva	21	Protectant / Curative		P		New Mode of Action fungicide being developed in AU. Corteva claim activity on Alternaria.	-
Fluopyram + Tebuconazole (Luna Experience) Bayer	7+3	Protectant / Curative		P		Hort Innovation project ST16006 complete and data submitted to Bayer for label extension for the tree nut group. Registration pending and expected end of 2020 for control of Macadamia Husk Spot and Botrytis Blight in macadamia. Fluopyram - AU MRL 0.1 mg/kg. Codex MRL 0.04 mg/kg. Tebuconazole - AU MRL T*0.01 mg/kg. Codex MRL *0.05 mg/kg.	-
Mefentrifluconazole (Belanty) BASF	3	Protectant & Curative		P		BASF claim activity on Alternaria. No MRLs for AU or Codex.	-
Anthracnose *(Colletotrichum gloeosporioides)* **Priority: Low**							
Anthracnose is rated a low priority in macadamias. Regular copper program for Husk Spot is providing protection from anthracnose as well.							
Copper (Cu) present as copper ammonium acetate	M1	Protectant	1	A	QLD, NSW & NT	Registered in macadamias for control of Phytophthora Stem Canker, Husk Spot, **Anthracnose Husk Rot** and Pink Limb Blight. Apply from nut set (late September) to December. Apply at least 3 sprays at 3-4 week intervals. Treatments per season not limited.	-
Copper (Cu) present as Copper Oxychloride	M1	Protectant	1	A	QLD, NSW & NT	Registered in macadamias for control of Husk Spot, **Anthracnose Husk Rot** and Pink Limb Blight. Apply from nut set (late September) to December. Apply at least 3 sprays at 3-4 week intervals. Treatments per season not limited.	-
Copper (Cu) present as Cupric Hydroxide	M1	Protectant	1	A	QLD, NSW & NT	Registered in macadamias for control of Phytophthora Stem Canker, Husk Spot, **Anthracnose Husk Rot** and Pink Limb Blight. Apply from nut set (late September) to December. Apply at least 3 sprays at 3-4 week intervals. Treatments per season not limited.	-

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Copper (Cu) present as cuprous oxide	M1	Protectant	1	A	QLD, NSW & NT	Registered in macadamias for control of Phytophthora Stem Canker, Husk Spot, **Anthracnose Husk Rot** and Pink Limb Blight. Apply from nut set (late September) to December. Apply at least 3 sprays at 3-4 week intervals. Treatments per season not limited.	-
Pyraclostrobin + Fluxapyroxad (Merivon) BASF	11+7	Protectant / Curative	21	P-A	ALL	Registered in macadamias for control of Husk Spot.	-
Aureobasidium pullulans (Botector) Nufarm	-	Biological / Protectant	NR	P		Registered for suppression of Anthracnose, Phomopsis Fruit Rot and Rhizopus Fruit Rot in berries, as well as control of *Botrytis cinerea* in berries and grapes. No MRLs required for biological product.	-
Bacillus amyloliquefaciens (strain QST 713) (Serenade Opti) Bayer	44	Biofungicide Protectant	NR	P		Registered for control of Anthracnose in avocados. No MRLs required for biological product.	-
Fluopyram + Tebuconazole (Luna Experience) Bayer	7+3	Protectant / Curative	TBC	P	ALL	Hort Innovation project ST16006 complete and data submitted to Bayer for label extension for the tree nut group. Registration pending and expected end of 2020 for control of Macadamia Husk Spot and Botrytis Blight in macadamia. Fluopyram - AU MRL 0.1 mg/kg. Codex MRL 0.04 mg/kg. Tebuconazole - AU MRL T*0.01 mg/kg. Codex MRL *0.05 mg/kg.	-
Graft Dieback / Phomposis Husk Rot (*Phomopsis* spp.) **Priority: Low**							
Low incidence in macadamias. No fungicides are specifically registered for management of Graft Dieback.							
Azoxystrobin + Tebuconazole (Custodia) Adama	11+3	Protectant / Curative	15	P-A	ALL	Registered in macadamias for control of Husk Spot. Azoxystrobin is registered for Phomopsis control in mangoes.	R3

Disease / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Regulatory risk
Copper	M1	Protectant	1	P-A	Qld, NSW, NT, WA	Registered in macadamias for control of Phytophthora Stem Canker, Husk Spot, Anthracnose Husk Rot and Pink Limb Blight. The regular application of copper sprays as protectants for Husk Spot will provide protection from Graft Dieback. Copper is registered for Phomopsis control in citrus.	-
Pyraclostrobin (Cabrio) BASF	11	Protectant / Curative	NR	P-A	ALL	Registered in macadamias for control of Husk Spot. Has US registration for Phomopsis control in cotton.	-
Pyraclostrobin + Fluxapyroxad (Merivon) BASF	11+7	Protectant / Curative	21	P-A	ALL	Registered in macadamias for control of Husk Spot. Has US registration for Phomopsis control in cotton.	-
Aureobasidium pullulans (Botector) Nufarm	-	Biological / Protectant	NR	P		Registered for suppression of Anthracnose, Phomopsis Fruit Rot and Rhizopus Fruit Rot in berries, as well as control of *Botrytis cinerea* in berries and grapes. No MRLs required for biological product.	-

4.2 Insect and mite pests of Macadamias

4.2.1 Insect and mite pest priorities

Common name	Scientific name
High	
Fruit Spotting Bug / Banana Spotting Bug	*Amblypelta nitida / Amblypelta lutescens*
Moderate	
Macadamia Seed Weevil	*Kuschelorhynchus macadamiae*
Macadamia Lace Bug	*Ulonemia* spp.
Scirtothrips	*Scirtothrips* spp.
Broad Mites	*Brevipalpus* spp.
Macadamia Felted Coccid	*Eriococcus ironsidei*
Leptocoris Bug	*Leptocoris* spp.
Macadamia Nut Borer	*Cryptophlebia ombrodelta*
Macadamia Flower Caterpillar	*Homoeosoma vagella* and *Xanthodes congenita*
Green Vegetable Bug	*Nezara viridula*
Low	
Bark Beetle / Scolytid Beetle	*Hypothenemus and Cryphalus* spp.
African Black Beetle	*Heteronychus arator*
Argentinian Scarab	*Cyclocephala signaticollis*
Plague Thrips	*Thrips imaginis*
Latania Scale	*Hemiberlesia lataniae*
Banana Fruit Caterpillar	*Tiracola plagiata*
Macadamia Twig Girdler	*Xylorycta luteotactella*
Loopers	*Chrysodeixis* spp., *Thysanoplusia* spp., *Ectropis* spp.
Light Brown Apple Moth	*Epiphyas postvittana*
Macadamia Kernel Grub	*Assara seminivale*
Macadamia Cup Moth	*Mecytha fasciata*
Macadamia Leafminer	*Acrocercops chionosema*
Painted Vine Moth	*Agarista agricola*
Flat Mites	*Polyphagotarsonemus* spp.

Exotic pests and new incursions which could be potential threats are listed below:

Common Name	Scientific name
Fall Armyworm	*Spodoptera frugiperda*

Fruit Spotting Bug and Banana Spotting Bug are the only high priority insect pests of macadamias. The two species are commonly referred to as Fruit Spotting Bugs and the same pest control strategies apply to managing both types. Significant yield losses (10 percent) can occur if left uncontrolled. Plantations situated close to native scrubland can be more at risk of infestation, so trees should be planted away from those areas if possible. Natural predators include egg parasitoids and assassin bugs and spiders prey on the nymphs and adults. Managing Fruit Spotting Bugs with an Integrated Pest Management (IPM) approach has been difficult because the insecticides available have been disruptive to beneficials. The older, more disruptive chemistry is coming under regulatory pressure and the industry will benefit from having new products available that are softer to beneficials. Multiple Hort Innovation projects have investigated and continue to investigate IPM and management of these native pests (MC06021, MT10049, MT12024, MC16004 to MC16008 & MC16018).

There are several insect pests identified as moderate priority. Macadamia Seed Weevil (formerly Sigastus Weevil) and Lace Bug are two pests that were identified as high priority in the 2015 Macadamia SARP Report but are now considered as moderate priority. The macadamia industry has successfully implemented integrated approaches to managing these pests in recent years. The key aspects being a combination of cultural controls, the use of effective, selective insecticides and more efficient spray application techniques. Other insects and mites of moderate priority are Scirtothrips, Broad Mites, Macadamia Felted Coccid, Leptocoris Bug, Macadamia Nut Borer, Macadamia Flower Caterpillar and Green Vegetable Bug. All of these require control with insecticides, although they tend to be sporadic and regionally focussed.

Bees are a critical element of macadamia production as they play an important role in pollination. The control of insect pests at flowering presents a significant challenge because this is an important crop stage for preserving bees and other beneficials. Flower insect pests such as Lace Bug and Flower Caterpillar can cause substantial yield loss if not controlled. The beekeeping industry is an important partner to the macadamia industry and appropriate pest control strategies will protect their interests as well.

Guidelines have been developed by the Australian Macadamia Society and the NSW Beekeepers Association to assist with pest control in macadamias during flowering[4]:

- Use only registered or permitted crop protection compounds during flowering. Maintain a copy of the permit and/or label in your spray records and follow the requirements outlined in the critical use comments section.
- Do not spray while bees are foraging (from mid-morning to mid-afternoon) during flowering. Flower spray applications should occur when bees are not foraging (from late afternoon through the evening) and should be finished before bee flight the following morning.
- Communicate with your beekeeper and your neighbours. Have a pollination agreement with your beekeeper. Know where the beehives are and ask your neighbours if they have any hives. If you have hives on your property, notify your beekeeper if you will be spraying and what product will be used. Give the beekeeper enough notice to be able to move the hives if they need to.
- Take note of other flowering plants within bee range.
- Be aware of spray drift and the effect it may have on bees and beneficial insects.

[4] www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/bee-management-tips-during-flowering-fact-sheet/

4.2.2 Available and potential products for priority insects and mites

TABLE KEY: Note that blank fields in the table indicate no information has been provided.

Availability		Regulatory risk (refer to Appendix 7)	
A	Available via either registration or permit approval	R1	Short-term: Critical concern over retaining access
P	Potential - a possible candidate to pursue for registration or permit	R2	Medium-term: Maintaining access of significant concern
P-A	Potential, already approved in the crop for another use	R3	Long-term: Potential issues associated with use - Monitoring required
Withholding Period (WHP) – Number of days from last treatment to harvest (H) or Grazing (G)			
Harvest	H	Not Required when used as directed	NR
Grazing	G	No Grazing Permitted	NG
IPM – indicative overall impact on beneficials (based on the Cotton Pest Management Guide 2019-20 and cotton use patterns)			
VL – Very low; L – Low; M – Moderate; H – High; VH – Very High; - not specified			

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Fruit Spotting Bug *(Amblypelta nitida)* **& Banana Spotting Bug** *(Amblypelta lutescens)* **Priority: High**								
A high priority in all regions. Currently with limited Integrated Pest Management (IPM) compatible products registered, the macadamia industry is seeking contemporary IPM compatible products for the control of spotting bugs. The main infestations generally occur between October to February depending on the crop and location. The economic impact of spotting bug damage is contributed to an estimated 10% yield loss. Damage to immature nuts will generally cause premature nut fall. More mature nuts do not drop when attacked but can become unmarketable. Multiple Hort Innovation projects have investigated and continue to investigate IPM and management of these native pests (MC06021, MT10049, MT12024, MC16004 to MC16008 & MC16018)								
Acephate (Orthene)	1B	Contact	NR	A	QLD, NSW, NT, WA	Registered in macadamias for control of Macadamia Nutborer, **Fruit Spotting Bug**, **Banana Spotting Bug**, Macadamia Leaf Miner, Red Shouldered Leaf Beetle, Flower Eating Caterpillar and Flower Thrips. Apply when pest activity first observed and repeat at 14-21 day intervals or as necessary. Treatments per season not limited.	H Bee H	R3
Acetamiprid + Pyriproxyfen (Trivor) Adama	4A+7C	Contact / Systemic and IGR	14	A	ALL	Registered in macadamias for control of **Fruit Spotting Bug**, Pink Wax Scale, Soft Brown Scale, Citrus Mealybug and Long Tailed Mealybug. Should be applied post-flowering when monitoring indicates the pest is becoming active in the crop. Do not use more than 2 applications per season and ensure that an alternative mode of action insecticide is used prior to using a second application if necessary.	M Bee H	R2

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Beta-Cyfluthrin (Bulldock) Bayer	3A	Contact	7	A	QLD, NSW, ACT & WA	Registered in macadamias for control of Macadamia Nutborer and **Fruit Spotting Bug.** Apply when pest numbers indicate control is warranted. Subsequent sprays may be required on 2-3 week intervals. Treatments per season not limited.	VH Bee H	-
Flupyradifurone (Sivanto Prime) Bayer	4D	Contact and Ingestion	H:20 NG	A	ALL	Outcome of a Hort Innovation project with Bayer (MT12024 - The development of DC-092 for the control of spotting bug in macadamia nut). Registered in macadamias for control of Macadamia Lace Bug, **Fruit Spotting Bug** and **Banana Spotting Bug**, and suppression of Scirtothrips. Apply once pest threshold is reached from early nut set. Apply a maximum of one application per year.	L Bee L	-
Methidathion (Suprathion) Adama Registration Cancelled	1B	Contact	21	A	QLD, NSW & WA	**Note: Suprathion Registration Cancelled by ADAMA and the use of Suprathion will not be permitted after 4-Feb-21.** Previously registered in macadamias for control of Macadamia Felted Coccid, Macadamia Nutborer, Macadamia Twig Girdler, **Banana Spotting Bug**, Black Citrus Aphid, Macadamia Leaf Miner, **Fruit Spotting Bug**, Brown Olive Scale, Pink Wax Scale, Soft Brown Scale, White Wax Scale, Long Soft Scale, Macadamia Mussel Scale, Macadamia White Scale, Citrus Mealy Bug, Hibiscus Mealy Bug and Longtail Mealy Bug. Spray thoroughly when pests are noticed. Repeat monthly or as required. Treatments per season not limited.	H Bee H	R1
Sulfoxaflor (Transform) Corteva	4C	Contact and Ingestion	NR	A	ALL	Registered in macadamias for control of **Fruit Spotting Bug**, **Banana Spotting Bug** and Lace Bug. Apply only when monitoring of the crop indicates that the pest is present and active in sufficient numbers to cause economic damage. DO NOT apply more than 2 applications per year with a minimum of 21 days between consecutive sprays.	M Bee VH	-
Trichlorfon (Lepidex)	1B	Contact	2	A	QLD, NSW & NT	Registered in macadamias for control of **Fruit Spotting Bug**, **Banana Spotting Bug** and Flower Eating Caterpillar. Apply when premature nut fall is evident. A second application 2 weeks later may be necessary.	H Bee H	R2

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Trichlorfon (Lepidex) (PER13689)	1B	Contact	2	A	QLD, NSW	Permitted in macadamias for control of Macadamia Lace Bug, **Fruit Spotting Bug**, **Banana Spotting Bug** and Green Vegetable Bug. Apply when premature nut fall is evident. Apply a maximum of 4 applications at a minimum of 14 day intervals.	H Bee H	R2
SYNFOI21 Syngenta	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for various pests including Thrips, Bugs, Mites and Caterpillars. Development in macadamia is underway.		-
NUL3445 Nufarm	TBC			P		Product in development, macadamia in scope. Nufarm claim activity on spotting bugs.		-
Macadamia Seed Weevil (formally named Sigastus Weevil) *(Kuschelorhynchus macadamiae)* **Priority: Moderate**								
Macadamia Seed Weevil is spread throughout the Northern Rivers area of NSW and the Atherton area of Far North Queensland. There have been isolated incidences of MSW in the Gympie area, but it has not yet been reported in Bundaberg, the Glasshouse Mountains or the Mid North Coast of NSW. Keeping orchard floors clean is critical for controlling this pest. Best results have been achieved with a combination of good hygiene (removing infested nuts) and targeted spraying during spring at match head stage.								
Acephate (Orthene) (PER81463) Permit Surrendered	1B	Contact	NR	A	NSW, QLD	Permit in macadamias for control of **Sigastus Weevil** has been surrendered with the APVMA (16-Jul-20). Recent efficacy trials demonstrated acephate had very poor activity on macadamia seed weevil in comparison with Indoxacarb and Tetraniliprole (MT17007).	H Bee H	R3
Indoxacarb (PER86827)	22A	Contact / Ingestion	H:42 NG	A	NSW, QLD	Permitted in macadamias for control of **Macadamia Seed Weevil**. DO NOT exceed a maximum of two applications per season. Make the first application at the beginning of nut set when nuts are pea sized. Make the second application 10-14 days later if required. Prevents the weevil from egg laying into soft-shell nuts. Hort Innovation provided efficacy and residue data generated under MC17007 to FMC to support a label registration. FMC plan to submit data for a label extension in late 2020 for Avatar eVo Insecticide (300g/kg)	M Bee H	R3

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Tetraniliprole (Vayego 200 SC) Bayer	28	Ingestion	H:10 NG	A	ALL	Registered in macadamia for control of **Sigastus Weevil**. Monitor the weevil population and commence applications when weevils are active and after petal fall. Apply a maximum of 3 applications, with a 14-28 day interval between applications as required until shell hardening.	L-M Bee VH	-
Macadamia Lace Bug *(Ulonemia* spp.*)* **Priority: Moderate**								
A serious and damaging pest in NSW but not an issue in QLD regions. In recent years there has been an increase in the number of damaged blocks recorded as a result of this pest. Macadamia lace bug is a native insect that feeds on the flower raceme. The raceme damage caused by feeding adult and nymphs affecting nut set. Early detection and management are vital to preventing crop damage. Multiple Hort Innovation projects have investigated and continue to investigate IPM and management of these native pests (MC06021, MT10049, MT12024, MC16004 to MC16008 & MC16018).								
Diazinon (PER14276)	1B	Contact	H:14 G:14	A	QLD, NSW & WA	Permitted in macadamia for control of **Macadamia Lace Bug**. Apply at pre-flowering, immediately prior to main flower opening. Repeat spray treatment (if required) prior to second flower opening. **Note: Diazinon permit will be surrendered once Sivanto Prime is available for use on Macadamia for Macadamia Lace bug.**	H Bee H	R3
Flupyradifurone (Sivanto Prime) Bayer	4D	Contact and Ingestion	H:20 NG	A	ALL	Outcome of a Hort Innovation project with Bayer (MT12024 - The development of DC-092 for the control of spotting bug in macadamia nut). Registered in macadamias for control of **Macadamia Lace Bug**, Fruit Spotting Bug and Banana Spotting Bug, and suppression of Scirtothrips. Monitor crops from early flowering and apply once pest threshold is reached. Apply a maximum of one application per year.	L Bee L	-
Pyrethrins (Pyganic Organic Insecticide) Sumitomo	3A	Contact	1	A	ALL	Registered in macadamias for control of **Macadamia Lace Bug**. Apply at first sign of infestation, pre-flowering, immediately prior to main flower opening. Repeat treatment if required prior to second flower opening, continuing to nut set if pressure persists. Apply a maximum of 5 applications per crop with a minimum of 7 days between applications.	VH Bee H	-
Sulfoxaflor (Transform) Corteva	4C	Contact and Ingestion	NR	A	ALL	Registered in macadamias for control of Fruit Spotting Bug, Banana Spotting Bug and **Lace Bug**. DO NOT make more than 2 applications per season. Apply immediately when the pest is detected. Make a second application as needed.	M Bee VH	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Trichlorfon (Lepidex) (PER13689)	1B	Contact	2	A	QLD, NSW	Permitted in macadamias for control of **Macadamia Lace Bug**, Fruit Spotting Bug, Banana Spotting Bug and Green Vegetable Bug. Apply a maximum of 4 applications at a minimum of 14 day intervals.	H Bee H	R2
SYNFOI21 Syngenta	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for various pests including Thrips, Bugs, Mites and Caterpillars. Development in macadamia is underway.		-
NUL3445 Nufarm	TBC			P		Product in development, macadamia in scope. Nufarm claim activity on various bugs.		-
Scirtothrips (*Scirtothrips* spp.) **Priority: Moderate**								
Rated as a moderate priority. Scirtothrips can cause significant damage, especially at flowering but also with new vegetative flushes. Timely control is important. Scirtothrips until recent, were regarded as relatively insignificant pests of macadamia nuts. However, in recent years there has been an increase in the number of damaged blocks recorded as a result of this pest. An introduced pest in 2002, they appear to have a wide host range including mango and macadamia nut. Economic damage with this pest has been recorded during the vegetative stage of macadamia. Both the larvae and adults feed on soft new leaves. Heavily infested leaves may be stunted and deformed, and severely damaged young shoots may turn black and fall off. The loss of these shoots affects production in the subsequent season as fewer branches are available for flowering.								
Abamectin (PER87510)	6	Contact and Ingestion	H:28 NG	A	ALL	Registered in macadamias for control of **Thrips**, Broad Mites and Flat Mites. Make no more than 1 spray application per season. Abamectin should not be applied in 2 consecutive seasons without a chemical from a different MoA Group being used in between. Apply in July as protection for the spring flush, or in December as protection for the summer flush. MRL's are in place for AU and Codex although they are low necessitating use pattern with a long WHP. NOTE: Dangerous to bees. Do not spray any plants in flower while bees are foraging.	M Bee H	-
Acephate (Orthene)	1B	Contact	NR	A	QLD, NSW, NT & WA	Registered in macadamias for control of Macadamia Nutborer, Fruit Spotting Bug, Banana Spotting Bug, Macadamia Leaf Miner, Red Shouldered Leaf Beetle, Flower Eating Caterpillar and **Flower Thrips**. Apply at early flowering if pests evident. One to three sprays may be required depending on time and severity of infestation. NOTE: Harmful to bees. Do not apply during active foraging of bees and avoid spraying at flowering time.	H Bee H	R3

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Flupyradifurone (Sivanto Prime) Bayer	4D	Contact and Ingestion	H:20 NG	A	ALL	Outcome of a Hort Innovation project with Bayer (MT12024 - The development of DC-092 for the control of spotting bug in macadamia nut). Registered in macadamias for control of Macadamia Lace Bug, Fruit Spotting Bug and Banana Spotting Bug, and suppression of **Scirtothrips**. Monitor crops from early flowering and apply once pest threshold is reached, but only after flowering. Apply a maximum of one application per year. NOTE: Moderately toxic to bees. The use pattern is not expected to result in adverse impact on colonies but may have transient effects on honey bee behaviour for a short period after application.	L Bee L	-
Potassium Salts of Fatty Acid (Natrasoap)		Contact	NR	A	ALL	Soft option registered in nut crops for control of Aphids, **Thrips**, Mealybug, Two-Spotted Mite, Spider Mite and Whitefly. Apply as a cover spray. Treatments per season not limited.	L Bee L	-
Spinetoram (Success Neo) Corteva	5	Ingestion	7	A	ALL	Registered in macadamias for control of Macadamia Nutborer, **Thrips**, including Red Banded Thrips, Flower Eating Caterpillar, Macadamia Twig Girdler and Yellow Peach Moth. Commence application once pests become active and repeat every 10-14 days if pests are still active. Do not use more than 4 applications per season. Do not use more than twice during flowering or twice after the completion of flowering. NOTE: Highly toxic to bees. Will kill bees foraging in crop or in hives that are oversprayed. Do not spray while bees are actively foraging. Residues may remain toxic to bees for 3 days after application.	M Bee VH	-
Acetamiprid + Pyriproxyfen (Trivor) Adama	4A+7C	Contact / Systemic and IGR	14	P-A	ALL	Registered in macadamias for control of Fruit Spotting Bug, Pink Wax Scale, Soft Brown Scale, Citrus Mealybug and Long Tailed Mealybug. Registered for control of Kelly's Citrus Thrips in citrus. NOTE: Moderately toxic to bees. Do not spray while bees are actively foraging. Residues potentially remain at levels toxic to bees for several days following application.	M Bee H	R2

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Sulfoxaflor (Transform) Corteva	4C	Contact and Ingestion	NR	P-A	ALL	Registered in macadamias for control of Fruit Spotting Bug, Banana Spotting Bug and Lace Bug. Registered for control of Kelly's Citrus Thrips in citrus and Greenhouse Thrips in spinach. NOTE: Highly toxic to bees. Will kill foraging bees directly exposed through contact during spraying and while spray droplets are still wet. Do not apply while bees are foraging in the crop to be treated.	M Bee VH	-
SYNFOI21 Syngenta	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for various pests including Thrips, Bugs, Mites and Caterpillars. Development in macadamia is underway. Note: Product will not be suitable for application at flowering time, which may limit suitability for controlling scirtothrips.		-
NUL3445 Nufarm	TBC			P		Product in development, macadamia in scope. Nufarm claim activity on thrips.		-
Broad Mites (*Brevipalpus* spp.) **Priority: Moderate**								
Broad Mites are rated as a moderate priority and are more prevalent in NSW than QLD. The use of broad-spectrum chemistry can lead to outbreaks of mites in macadamia. Mites will cause russeting damage to leaves, flowers and nuts.								
Abamectin (PER87510)	6	Contact & Ingestion	H:28 NG	A	ALL (excl. VIC)	Permitted in macadamias for control of Thrips, **Broad Mites** and Flat Mites. Make no more than 1 spray application per season. Abamectin should not be applied in 2 consecutive seasons without a chemical from a different MoA Group being used in between. Apply in July as protection for the spring flush, or in December as protection for the summer flush.	M Bee H	-
Etoxazole (Paramite) Sumitomo	10B	IGR / Contact		P		Registered for control of Bryobia Mite, European Red Mite and Two Spotted Mite in almonds. AU MRL 0.5 mg/kg, No Codex MRL.	L Bee VL	-
Spiromesifen (Oberon) Bayer	23	Ingestion		P		No registration in AU but studies underway with Hort Innovation. Macadamia not currently in scope.	M Bee VL	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Macadamia Felted Coccid (*Eriococcus ironsidei*) **Priority: Moderate**								
The Macadamia Felted Coccid is the most prevalent type of scale in macadamia and is generally the only species that will require treatment. Scale will infest trunks, branches, leaves and flowers. Severe infestations lead to honeydew accumulation and growth of sooty mould.								
Methidathion (Suprathion) Registration Cancelled	1B	Contact	21	A	QLD, NSW & WA	**Note: Suprathion Registration Cancelled by ADAMA and the use of Suprathion will not be permitted after 4-Feb-21.** Previously registered in macadamias for control of **Macadamia Felted Coccid**, Macadamia Nutborer, Macadamia Twig Girdler, Banana Spotting Bug, Black Citrus Aphid, Macadamia Leaf Miner, Fruit Spotting Bug, Brown Olive Scale, Pink Wax Scale, Soft Brown Scale, White Wax Scale, Long Soft Scale, Macadamia Mussel Scale, Macadamia White Scale, Citrus Mealy Bug, Hibiscus Mealy Bug and Longtail Mealy Bug. Treatment required when the pest is evident, usually late November onwards. Retreat monthly as necessary. Treatments per season not limited.	H Bee H	R1
Petroleum Oil (PER11635)		Contact	NR	A	NSW, QLD	Permitted in macadamias for control of **Macadamia Felted Coccid**. Multiple applications will be necessary for ongoing management of the pest population. DO NOT apply when temperatures exceed 32 degrees Celsius or when soil is dry and trees are suffering from moisture stress. DO NOT apply product during flowering. Treatments per season not limited.	L Bee L	-
Acetamiprid + Pyriproxyfen (Trivor) Adama	4A+7C	Contact / Systemic and IGR	14	P-A	ALL	Registered in macadamias for control of Fruit Spotting Bug, Pink Wax Scale, Soft Brown Scale, Citrus Mealybug and Long Tailed Mealybug. Use may be prioritised to control of Fruit Spotting Bugs which may limit usefulness for scale control. Limit of 2 applications per season.	M Bee H	R2
Flupyradifurone (Sivanto Prime) Bayer	4D	Contact and Ingestion	H:20 NG	P-A	ALL	Registered in macadamias for control of Macadamia Lace Bug, Fruit Spotting Bug and Banana Spotting Bug, and suppression of Scirtothrips. Also has activity on scale insects. Apply a maximum of one application per year.	L Bee L	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Sulfoxaflor (Transform) Corteva	4C	Contact and Ingestion	NR	P-A	ALL	Registered in macadamias for control of Fruit Spotting Bug, Banana Spotting Bug and Lace Bug. Registered for control of scale insects in citrus. DO NOT apply more than 2 applications per year with a minimum of 21 days between consecutive sprays.	M Bee VH	-
Buprofezin (Applaud) Corteva	16	Contact / Systemic		P		Registered for control of scale insects in various tropical fruit crops and citrus. No MRLs for AU or Codex.	M Bee L	-
NUL3145 Nufarm	TBC			P		Product in early stage development. Nufarm claim activity on scale insects.		-
Spirotetramat (Movento) Bayer	23	Ingestion		P		Registered on scale for various crops. AU MRL 0.5 mg/kg, No Codex MRL.	M Bee L	-
Leptocoris Bug (*Leptocoris* spp.) **Priority: Moderate**								
Leptocoris are becoming an increasing problem in macadamia, rated as moderate priority and widely distributed in all regions. Large infestations can attack macadamia and cause significant crop losses by feeding damage on the young developing nuts. Damage is similar to that caused by Fruit Spotting Bugs.								
Flupyradifurone (Sivanto Prime) Bayer	4D	Contact and Ingestion	H:20 NG	P-A	ALL	Registered in macadamias for control of Macadamia Lace Bug, Fruit Spotting Bug and Banana Spotting Bug, and suppression of Scirtothrips. Apply a maximum of one application per year.	L Bee L	-
Sulfoxaflor (Transform) Corteva	4C	Contact and Ingestion	NR	P-A	ALL	Registered in macadamias for control of Fruit Spotting Bug, Banana Spotting Bug and Lace Bug. DO NOT use more than 2 applications per season.	M Bee VH	-
SYNFOI21 Syngenta	TBC			P		Hort Innovation contracted a grant funded project – ST19020 in June 2020 to generate the required data for a new label registration in macadamia. SYNFOI21 is not registered but the first global application is proposed for 2020/21 for various pests including Thrips, Bugs, Mites and Caterpillars. Development in macadamia is underway.		-
NUL3445 Nufarm	TBC			P		Product in development, macadamia in scope. Nufarm claim activity on spotting bugs.		-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Macadamia Nut Borer *(Cryptophlebia ombrodelta)* **Priority: Moderate**								
Nut Borer is the most significant Lepidopteran pest of macadamias. They can cause substantial damage to the nuts and can continue to cause problems such as premature nut drop after shell hardening. Removing fallen nuts and the use of parasitoid wasps form part of an integrated approach to managing the pest.								
Acephate (Orthene)	1B	Contact	NR	A	QLD, NSW, NT & WA	Registered in macadamias for control of **Macadamia Nutborer**, Fruit Spotting Bug, Banana Spotting Bug, Macadamia Leaf Miner, Red Shouldered Leaf Beetle, Flower Eating Caterpillar and Flower Thrips. Apply when pest activity first observed and repeat at 14 to 21 day intervals or as necessary. Treatments per season not limited.	H Bee H	R3
Beta-Cyfluthrin (Bulldock) Bayer	3A	Contact	7	A	QLD, NSW, ACT & WA	Registered in macadamias for control of **Macadamia Nutborer** and Fruit Spotting Bug. Spray when pest numbers indicate, or at 2 to 3 weekly intervals during the period when pests are normally active. Treatments per season not limited.	VH Bee H	-
Carbaryl (Bugmaster)	1A	Contact	NR	A	ALL	Registered in macadamias for control of **Macadamia Nutborer**, Macadamia Twig Girdler, Red Shouldered Leaf Beetle, Cornelian (butterfly), Macadamia Cup Moth, Macadamia Nut Moth, Yellow Peach Moth and Wingless Grasshopper. Apply as a preventative spray after moths have been flighting. Treatments per season not limited.	H Bee H	R3
Methidathion (Suprathion) Registration Cancelled	1B	Contact	21	A	QLD, NSW & WA	**Note: Suprathion Registration Cancelled by ADAMA and the use of Suprathion will not be permitted after 4-Feb-21.** Previously registered in macadamias for control of Macadamia Felted Coccid, **Macadamia Nutborer**, Macadamia Twig Girdler, Banana Spotting Bug, Black Citrus Aphid, Macadamia Leaf Miner, Fruit Spotting Bug, Brown Olive Scale, Pink Wax Scale, Soft Brown Scale, White Wax Scale, Long Soft Scale, Macadamia Mussel Scale, Macadamia White Scale, Citrus Mealy Bug, Hibiscus Mealy Bug and Longtail Mealy Bug. Spray when pests are noticed. Repeat applications monthly as necessary. Treatments per season not limited.	H Bee H	R1

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Methoxyfenozide (Prodigy) Corteva	18	Ingestion	H:28 NG	A	ALL	Registered in macadamias for control of Macadamia Flower Caterpillar and **Macadamia Nutborer**. Spray when pest numbers reach economic threshold levels. Target sprays against eggs and early instar larvae. Treatments per season not limited.	VL Bee VL	-
Spinetoram (Success Neo) Corteva	5	Ingestion	7	A	ALL	Registered in macadamias for control of **Macadamia Nutborer**, Thrips, including Red Banded Thrips, Flower Eating Caterpillar, Macadamia Twig Girdler and Yellow Peach Moth. Commence applications when pest numbers reach local thresholds and repeat 10-14 days later if pests are still active. Do not use more than 4 applications per season. Do not use more than twice during flowering or twice after the completion of flowering	M Bee VH	-
Tebufenozide (Mimic) Corteva	16A	IGR / Ingestion	28	A	ALL	Registered in macadamias for control of Macadamia Flower Caterpillar and **Macadamia Nutborer**. Spray when pest numbers reach economic threshold levels. Treatments per season not limited.	L Bee L	-
Bacillus thuringiensis Berliner subsp. *aizawai* strain GC-91 (Bacchus WG) Campbell	11C	Ingestion	NR	P-A	ALL	Registered in macadamia for control of Armyworm, Cotton Bollworm, Native Budworm, Cabbage Moth, Cabbage White Butterfly, Loopers, Light Brown Apple Moth and Vine Moth. Time spraying to coincide with egg hatch.	VL Bee VL	-
Indoxacarb (Avatar) FMC	22A	Contact / Ingestion	H:42 NG	P-A	NSW, QLD	Permitted in macadamia for control of Macadamia Seed Weevil. Also has activity on Lepidoptera.	M Bee H	R3
Tetraniliprole (Vayego 200SC) Bayer	28	Ingestion	H:10 NG	P-A	ALL	Registered in macadamia for control of Sigastus Weevil. Also has activity on Lepidoptera.	L-M Bee VH	-
Indoxacarb + Novaluron (Plemax) Adama	22A+15	Contact / Ingestion		P		Registration pending in AU. Crops not known at this stage. Adama claim activity on lepidoptera. Indoxacarb – AU MRL T*0.01 mg/kg. No Codex MRL. Novaluron – AU MRL 0.1 mg/kg. No Codex MRL.	M Bee H	R3

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
SYNFOI21 Syngenta	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for various pests including Thrips, Bugs, Mites and Caterpillars. Development in macadamia is underway.		-
Macadamia Flower Caterpillar (*Cryptoblabes hemigypsa*) **Priority: Moderate**								
Moderate priority pest across all regions. Larval feeding destroys buds and flowers, leaving the raceme covered by webbing. Flower Caterpillars can severely reduce a nut crop if not controlled. Insecticide application should be avoided during flowering when bees are foraging. Most insecticides are toxic to bees and the product label will provide specific guidelines about protection of bees during application and timing. A fact sheet providing tips for managing bees during flowering is available on the Hort Innovation website[5]								
Acephate (Orthene)	1B	Contact	NR	A	QLD, NSW, NT & WA	Registered in macadamias for control of Macadamia Nutborer, Fruit Spotting Bug, Banana Spotting Bug, Macadamia Leaf Miner, Red Shouldered Leaf Beetle, **Flower Eating Caterpillar** and Flower Thrips. Apply when pest activity first observed and repeat at 14 to 21 day intervals or as necessary. Treatments per season not limited. NOTE: Harmful to bees. Do not apply during active foraging of bees and avoid spraying at flowering time.	H Bee H	R3
Methoxyfenozide (Prodigy) Corteva	18	Ingestion	H:28 NG	A	ALL	Registered in macadamias for control of **Macadamia Flower Caterpillar** and Macadamia Nutborer. Treatments per season not limited. Low hazard to bees. May be applied on plants at any time.	VL Bee VL	-
Tebufenozide (Mimic) Corteva	16A	IGR / Ingestion	28	A	ALL	Registered in macadamias for control of **Macadamia Flower Caterpillar** and Macadamia Nutborer. Treatments per season not limited. Low hazard to bees. May be applied on plants at any time.	L Bee L	-

[5] https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/bee-management-tips-during-flowering-fact-sheet/

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Spinetoram (Success Neo) Corteva	5	Ingestion	7	A	ALL	Registered in macadamias for control of Macadamia Nutborer, Thrips, including Red Banded Thrips, **Flower Eating Caterpillar**, Macadamia Twig Girdler and Yellow Peach Moth. Commence applications when pest numbers reach local thresholds and repeat 10-14 days later if pests are still active. Do not use more than 4 applications per season. Do not use more than twice during flowering or twice after the completion of flowering. NOTE: Highly toxic to bees. Will kill bees foraging in crop or in hives that are oversprayed. Do not spray while bees are actively foraging. Residues may remain toxic to bees for 3 days after application.	M Bee VH	-
Trichlorfon (Lepidex)	1B	Contact	2	A	QLD, NSW & NT	Registered in macadamias for control of Fruit Spotting Bug, Banana Spotting Bug and **Flower Eating Caterpillar**. Apply when premature nut fall is evident. A second application 2 weeks later may be necessary. NOTE: Dangerous to bees. Do not spray any plants in flower while bees are foraging.	H Bee H	R2
Bacillus thuringiensis Berliner subsp. *aizawai* strain GC-91 (Bacchus WG) Campbell	11C	Ingestion	NR	P-A	ALL	Registered in macadamia for control of Armyworm, Cotton Bollworm, Native Budworm, Cabbage Moth, Cabbage White Butterfly, Loopers, Light Brown Apple Moth and Vine Moth. Activity on Flower Caterpillar undetermined, but favourable for use during flowering because of safety to bees. Treatments per season not limited.	VL Bee VL	-
Green Vegetable Bug (*Nezara viridula*) **Priority: Moderate**								
Green Vegetable Bug are a moderate priority pest in the Bundaberg region but are less of an issue in NSW. It can be sporadic and infestations usually stem from surrounding weed hosts and alternate crops such as soybeans. The use of broad-spectrum chemistry can lead to flaring of this pest. Adults and nymphs will feed on nuts at all stages and the damage is similar to that caused by Fruit Spotting Bugs.								
Trichlorfon (Lepidex) (PER13689)	1B	Contact	2	A	QLD, NSW	Permitted in macadamias for control of Macadamia Lace Bug, Fruit Spotting Bug, Banana Spotting Bug and **Green Vegetable Bug**. Monitor crops and commence applications once local thresholds are reached. Apply a maximum of 4 applications at a minimum of 14 day intervals.	H Bee H	R2

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Flupyradifurone (Sivanto Prime) Bayer	4D	Contact and Ingestion	H:20 NG	P-A	ALL	Registered in macadamias for control of Macadamia Lace Bug, Fruit Spotting Bug and Banana Spotting Bug, and suppression of Scirtothrips. Apply a maximum of one application per year.	L Bee L	-
Sulfoxaflor (Transform) Corteva	4C	Contact and Ingestion	NR	P-A	ALL	Registered in macadamias for control of Fruit Spotting Bug, Banana Spotting Bug and Lace Bug. DO NOT use more than 2 applications per season.	M Bee VH	-
SYNFOI21 Syngenta	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for various pests including Thrips, Bugs, Mites and Caterpillars. Development in macadamia is underway.		-
Scolytid Beetles / Bark Beetles (*Cryphalus* spp. & *Hypothenemus* spp.) **Priority: Low**								
Bark beetles can infect the nut in shell, potentially impacting on harvest quality. Damage is influenced by shell thickness. Maintaining tree health and general orchard hygiene is critical, particularly reducing the number of fallen nuts left on the ground after harvest.								
Tetraniliprole (Vayego 200SC) Bayer	28	Ingestion	H:10 NG	P-A	ALL	Registered in macadamia for control of Sigastus Weevil and has activity on other beetles. Apply a maximum of 3 applications, with a 14-28 day interval between applications as required until shell hardening.	L-M Bee VH	-
Indoxacarb + Novaluron (Plemax) Adama	22A+15	Contact / Ingestion		P		Registration pending in AU. Crops not known at this stage. Adama claim activity on African Black Beetle but not Bark Beetles. Indoxacarb – AU MRL T*0.01 mg/kg. No Codex MRL. Novaluron – AU MRL 0.1 mg/kg. No Codex MRL.	M Bee H	R3
SYNFOI21 Syngenta	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for various pests including Thrips, Bugs, Mites and Caterpillars. Development in macadamia is underway.		-
NUL3445 Nufarm	TBC			P		Product in development, macadamia in scope. Nufarm claim activity on Carpophilus Beetles but not Bark Beetles.		-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
African Black Beetle (*Heteronychus arator*) **Argentinian Scarab** (*Cyclocephala signaticollis*) **Priority: Low**								
Currently low priority pests but have the potential to be an emerging problem in macadamias. They can particularly cause problems in new plantations especially in areas that have previously been farmed for sugar cane. They are soil-dwelling and the adults and larvae can cause significant damage to the crowns and stems of young trees during establishment.								
Tetraniliprole (Vayego 200SC) Bayer	28	Ingestion	H:10 NG	P-A	ALL	Registered in macadamia for control of Sigastus Weevil. Also has activity on other beetles, although the current cover spray application method may not suit control of soil borne pests.	L-M Bee VH	-
Plague Thrips (*Thrips imaginis*) **Priority: Low**								
Infrequent pest that can cause damage to flowers and developing nuts.								
Abamectin (PER8751)	6A	Contact and Ingestion	H:28 NG	A	ALL	Permitted in macadamias for control of **Thrips**, Broad Mites and Flat Mites. Make no more than 1 spray application per season. Abamectin should not be applied in 2 consecutive seasons without a chemical from a different MoA Group being used in between. Apply in July as protection for the spring flush, or in December as protection for the summer flush. MRL's are in place for AU and Codex although they are low necessitating use pattern with a long WHP.	M Bee H	-
Potassium Salts of Fatty Acid (Natrasoap)		Contact	NR	A	ALL	Soft option registered in nut crops for control of Aphids, **Thrips**, Mealybug, Two-Spotted Mite, Spider Mite and Whitefly. Apply as a cover spray. Treatments per season not limited.	L Bee L	-
Spinetoram (Success Neo) Corteva	5	Ingestion	7	A	ALL	Registered in macadamias for control of Macadamia Nutborer, **Thrips**, including Red Banded Thrips, Flower Eating Caterpillar, Macadamia Twig Girdler and Yellow Peach Moth. Commence application once pests become active and repeat every 10-14 days if pests are still active. Do not use more than 4 applications per season. Do not use more than twice during flowering or twice after the completion of flowering	M Bee VH	-
Beauveria bassiana (Velifer) BASF	UN			P		Registered for suppression of Onion Thrips and Western Flower Thrips in protected vegetables and ornamentals.		-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
SYNFOI21 Syngenta	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for various pests including Thrips, Bugs, Mites and Caterpillars. Development in macadamia is underway.		-
NUL3445 Nufarm	TBC			P		Product in development, macadamia in scope. Nufarm claim activity on thrips.		-
Spirotetramat (Movento) Bayer	23	Ingestion		P		Registered on thrips in various crops. AU MRL 0.5 mg/kg, No Codex MRL.	M Bee L	-
Latania Scale (*Hemiberlesia lataniae*) **Priority: Low**								
Latania Scale is a low priority in all regions. Scale will infest trunks, branches, leaves and flowers. Severe infestations lead to honeydew accumulation and growth of sooty mould.								
Petroleum Oil (PER11635)		Contact	NR	P-A	NSW, QLD	Permitted in macadamias for control of Macadamia Felted Coccid. Multiple applications will be necessary for ongoing management of the pest population. DO NOT apply when temperatures exceed 32 degrees Celsius or when soil is dry and trees are suffering from moisture stress. DO NOT apply product during flowering.	L Bee L	-
Acetamiprid + Pyriproxyfen (Trivor) Adama	4A+7C	Contact / Systemic and IGR	14	P-A	ALL	Registered in macadamias for control of Fruit Spotting Bug, Pink Wax Scale, Soft Brown Scale, Citrus Mealybug and Long Tailed Mealybug. Use may be prioritised to control of Fruit Spotting Bugs which may limit usefulness for scale control. Limit of 2 applications per season.	M Bee H	R2
Flupyradifurone (Sivanto Prime) Bayer	4D	Contact and Ingestion	H:20 NG	P-A	ALL	Registered in macadamias for control of Macadamia Lace Bug, Fruit Spotting Bug and Banana Spotting Bug, and suppression of Scirtothrips. Also has activity on scale insects. Apply a maximum of one application per year.	L Bee L	-
Petroleum Oil (PER11635)		Contact	NR	P-A	NSW, QLD	Permitted in macadamias for control of Macadamia Felted Coccid. Multiple applications will be necessary for ongoing management of the pest population. DO NOT apply when temperatures exceed 32 degrees Celsius or when soil is dry and trees are suffering from moisture stress. DO NOT apply product during flowering.	L Bee L	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Sulfoxaflor (Transform) Corteva	4C	Contact and Ingestion	NR	P-A	ALL	Registered in macadamias for control of Fruit Spotting Bug, Banana Spotting Bug and Lace Bug. Registered for control of scale insects in citrus. DO NOT apply more than 2 applications per year with a minimum of 21 days between consecutive sprays.	M Bee VH	-
Buprofezin (Applaud) Corteva	16	Contact / Systemic		P		Registered for control of scale insects in various tropical fruit crops and citrus. No MRLs for AU or Codex.	M Bee L	-
NUL3145 Nufarm	TBC			P		Product in early stage development. Nufarm claim activity on scale insects.		-
Spirotetramat (Movento) Bayer	23	Ingestion		P		Registered on scale for various crops. AU MRL 0.5 mg/kg, No Codex MRL.	M Bee L	-
Banana Fruit Caterpillar (*Tiracola plagiata*) **Priority: Low**								
Banana Fruit Caterpillar is a low priority, but it is more prevalent in QLD than NSW. Pupation occurs among the trash at the base of plants, and the larvae feed on the foliage, flowers and developing nuts. Can cause substantial damage to yield if not controlled.								
Methomyl (Lannate) PER12796	1A	Contact	NR	A	QLD	Permitted in macadamia for control of Banana Fruit Caterpillar. Ground surface treatment only using spray boom or equivalent application equipment. Apply one application only during late flowering/early fruit development. Time spray to coincide when larvae activity is initially observed. Ensure thorough coverage of all leaf litter and soil surface along treeline. Do not spray tree foliage, flowers or developing nutlets.	H Bee H	R2
Spinetoram (Success Neo) Corteva	5	Ingestion	7	P-A	ALL	Registered in macadamias for control of Macadamia Nutborer, Thrips, including Red Banded Thrips, Flower Eating Caterpillar, Macadamia Twig Girdler and Yellow Peach Moth. Commence applications when pest numbers reach local thresholds and repeat 10-14 days later if pests are still active. Do not use more than 4 applications per season. Do not use more than twice during flowering or twice after the completion of flowering.	M Bee VH	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Indoxacarb (Avatar) FMC	22A	Contact / Ingestion	H:42 NG	P-A	NSW, QLD	Permitted in macadamia for control of Macadamia Seed Weevil. Also has activity on Lepidoptera.	M Bee H	R3
Tetraniliprole (Vayego 200SC) Bayer	28	Ingestion	H:10 NG	P-A	ALL	Registered in macadamia for control of Sigastus Weevil. Also has activity on Lepidoptera.	L-M Bee VH	-
SYNFOI21 Syngenta	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for various pests including Thrips, Bugs, Mites and Caterpillars. Development in macadamia is underway.		-
Macadamia Twig-Girdler (*Xylorycta luteotactella*) **Priority: Low**								
Macadamia Twig Girdler is a low priority, but it is more prevalent in QLD than NSW. It can be a persistent problem in young trees, as it will take out new branches and limit crop development.								
Carbaryl (Bugmaster)	1A	Contact	NR	A	ALL	Registered in macadamias for control of Macadamia Nutborer, **Macadamia Twig Girdler**, Red Shouldered Leaf Beetle, Cornelian (butterfly), Macadamia Cup Moth, Macadamia Nut Moth, Yellow Peach Moth and Wingless Grasshopper. Apply as a preventative spray after moths have been flighting. Treatments per season not limited.	H Bee H	R3
Methidathion (Suprathion) Registration Cancelled	1B	Contact	21	A	QLD, NSW & WA	**Note: Suprathion Registration Cancelled by ADAMA and the use of Suprathion will not be permitted after 4-Feb-21.** Previously registered in macadamias for control of Macadamia Felted Coccid, Macadamia Nutborer, **Macadamia Twig Girdler**, Banana Spotting Bug, Black Citrus Aphid, Macadamia Leaf Miner, Fruit Spotting Bug, Brown Olive Scale, Pink Wax Scale, Soft Brown Scale, White Wax Scale, Long Soft Scale, Macadamia Mussel Scale, Macadamia White Scale, Citrus Mealy Bug, Hibiscus Mealy Bug and Longtail Mealy Bug. Spray when pests are noticed. Repeat applications monthly as necessary. Treatments per season not limited.	H Bee H	R1

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Spinetoram (Success Neo) Corteva	5	Ingestion	7	A	ALL	Registered in macadamias for control of Macadamia Nutborer, Thrips, including Red Banded Thrips, Flower Eating Caterpillar, **Macadamia Twig Girdler** and Yellow Peach Moth. Commence applications when pest numbers reach local thresholds and repeat 10-14 days later if pests are still active. Do not use more than 4 applications per season. Do not use more than twice during flowering or twice after the completion of flowering.	M Bee VH	-
Indoxacarb (Avatar) FMC	22A	Contact / Ingestion	H:42 NG	P-A	NSW, QLD	Permitted in macadamia for control of Macadamia Seed Weevil. Also has activity on Lepidoptera.	M Bee H	R3
Tetraniliprole (Vayego 200SC) Bayer	28	Ingestion	H:10 NG	P-A	ALL	Registered in macadamia for control of Sigastus Weevil. Also has activity on Lepidoptera.	L-M Bee VH	-
Other Lepidoptera, including: **Light Brown Apple Moth** (*Epiphyas postvittana*), **Loopers** (*Chrysodeixis* spp., *Thysanoplusia* spp., *Ectropis* spp.), **Macadamia Cup Moth** (*Mecytha fasciata*), **Macadamia Kernel Grub** (*Assara seminivale*), **Macadamia Leafminer** (*Acrocercops chionosema*), **Painted Vine Moth** (*Agarista agricola*) **Priority: Low**								
Lepidoptera are not prevalent and generally cause few issues in macadamias.								
Bacillus thuringiensis Berliner subsp. *aizawai* strain GC-91 (Bacchus WG) Campbell	11C	Ingestion	NR	A	ALL	Registered in macadamia for control of Armyworm, Cotton Bollworm, Native Budworm, Cabbage Moth, Cabbage White Butterfly, **Loopers**, **Light Brown Apple Moth** and **Vine Moth**. Time spraying to coincide with egg hatch. Treatments per season not limited.	VL Bee VL	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Methidathion (Suprathion) Registration Cancelled	1B	Contact	21	A	QLD, NSW & WA	**Note: Suprathion Registration Cancelled by ADAMA and the use of Suprathion will not be permitted after 4-Feb-21.** Previously registered in macadamias for control of Macadamia Felted Coccid, Macadamia Nutborer, Macadamia Twig Girdler, Banana Spotting Bug, Black Citrus Aphid, **Macadamia Leaf Miner**, Fruit Spotting Bug, Brown Olive Scale, Pink Wax Scale, Soft Brown Scale, White Wax Scale, Long Soft Scale, Macadamia Mussel Scale, Macadamia White Scale, Citrus Mealy Bug, Hibiscus Mealy Bug and Longtail Mealy Bug. Spray when pests are noticed. Repeat applications monthly as necessary. Treatments per season not limited.	H Bee H	R1
Methoxyfenozide (Prodigy) Corteva	18	Ingestion	H:28 NG	P-A	ALL	Registered in macadamias for control of Macadamia Flower Caterpillar and Macadamia Nutborer.	VL Bee VL	-
Spinetoram (Success Neo) Corteva	5	Ingestion	7	P-A	ALL	Registered in macadamias for control of Macadamia Nutborer, Thrips, including Red Banded Thrips, Flower Eating Caterpillar, Macadamia Twig Girdler and Yellow Peach Moth.	M Bee VH	-
Tebufenozide (Mimic) Corteva	16A	IGR / Ingestion	28	P-A	ALL	Registered in macadamias for control of Macadamia Flower Caterpillar and Macadamia Nutborer.	L Bee L	-
Indoxacarb (Avatar) FMC (PER86827)	22A	Contact / Ingestion	H:42 NG	P-A	NSW, QLD	Permitted in macadamia for control of Macadamia Seed Weevil. Also has activity on Lepidoptera.	M Bee H	R3
Tetraniliprole (Vayego 200SC) Bayer	28	Ingestion	H:10 NG	P-A	ALL	Registered in macadamia for control of Sigastus Weevil. Also has activity on Lepidoptera.	L-M Bee VH	-
Indoxacarb + Novaluron (Plemax) Adama	22A+ 15	Contact / Ingestion		P		Registration pending in AU. Crops not known at this stage. Adama claim activity on Lepidoptera. Indoxacarb – AU MRL T*0.01 mg/kg. No Codex MRL. Novaluron – AU MRL 0.1 mg/kg. No Codex MRL.	M Bee H	R3

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
SYNFOI21 Syngenta	TBC			P		SYNFOI21 is not registered but the first global application is proposed for 2020/21 for various pests including Thrips, Bugs, Mites and Caterpillars. Development in macadamia is underway.		-
Tarsonemid Mites – Flat Mites (*Polyphagotarsonemus* spp.) **Priority: Low**								
Low incidence in macadamias.								
Abamectin (PER87510)	6A	Contact and Ingestion	H:28 NG	A	ALL (excl. VIC)	Permitted in macadamias for control of Thrips, Broad Mites and **Flat Mites**. Make no more than 1 spray application per season. Abamectin should not be applied in 2 consecutive seasons without a chemical from a different MoA Group being used in between. Apply in July as protection for the spring flush, or in December as protection for the summer flush. MRL's are in place for AU and Codex although they are low necessitating use pattern with a long WHP.	M Bee H	-
Etoxazole (Paramite) Sumitomo	10B	IGR / Contact		P		Registered for mite control in various crops. AU MRL 0.5 mg/kg, No Codex MRL.	L Bee VL	-
Spiromesifen (Oberon) Bayer	23	Ingestion		P		No registration in AU but studies underway with HIA. Macadamia not in scope.	M Bee VL	-
Petroleum Oil (PER11635)		Contact	NR	P-A	NSW, QLD	Permitted in macadamias for control of Macadamia Felted Coccid and will provide suppression of aphids. Multiple applications will be necessary for ongoing management of the pest population. DO NOT apply when temperatures exceed 32 degrees Celsius or when soil is dry and trees are suffering from moisture stress. DO NOT apply product during flowering.	L Bee L	-
Sulfoxaflor (Transform) Corteva	4C	Contact and Ingestion	NR	P-A	ALL	Registered in macadamias for control of Fruit Spotting Bug, Banana Spotting Bug and Lace Bug. Registered for control of aphids in various crops. DO NOT apply more than 2 applications per year with a minimum of 21 days between consecutive sprays.	M Bee VH	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Beauveria bassiana (Velifer) BASF	UN			P		Registered for suppression of Onion Thrips and Western Flower Thrips in protected vegetables and ornamentals and has activity on Thrips, Aphids, Whitefly and Mites. No MRLs required for a biological product.	L Bee L	-
Fall Armyworm *(Spodoptera frugiperda)* **Priority: Unknown**								
Fall Armyworm has recently been detected in Australia for the first time. It has not been seen in macadamia crops and the potential impact is currently unknown.								
Chlorantraniliprole (Altacor) FMC PER89353	28	Ingestion	H:10 NG	A	ALL (excl. VIC)	Permitted in tree nuts (except almonds) for control of **Fall Armyworm**. Treat when pests appear, targeting eggs at hatch or small larvae (prior to third instar stage) before the pest becomes entrenched. Do not apply more than 3 applications per crop. Do not apply more than 2 consecutive sprays per crop, with a minimum interval of 7 days. Further treatments should be made with an alternative mode of action insecticide.	L Bee VL	-
Indoxacarb (Avatar) FMC PER89278	22A	Ingestion	H:42 NG	A	ALL (excl. VIC)	Permitted in macadamia for control of **Fall Armyworm**. Treat when pests appear, targeting eggs at hatch or small larvae (prior to third instar stage) before the pest becomes entrenched. Do not exceed a maximum of 2 applications per crop with a 10 day re-treatment interval.	M Bee H	R3
Methomyl (Lannate) PER89293	1A	Contact	NR	A	ALL	Permitted in macadamia for control of **Fall Armyworm**. Target sprays against eggs and newly hatched larvae (prior to third instar stage) before they become entrenched. Apply as a ground surface treatment only. Ensure thorough coverage of all leaf litter and soil surface along tree line. Do not spray tree foliage, flowers or developing nutlets. Do not use more than 1 application per crop	H Bee H	R2
Spinetoram (Success Neo) Corteva PER89241	5	Ingestion	7	A	ALL (excl. VIC)	Permitted in macadamia for control of **Fall Armyworm**. Treat when pests appear, targeting eggs at hatch or small larvae (prior to third instar stage) before the pest becomes entrenched. Repeat every 10-14 days if necessary. Do not use more than 4 applications per season. Do not use more than twice during flowering or twice after the completion of flowering	M Bee VH	-

Pest / Active Ingredient (Trade Name)	Chemical group	Activity	WHP, days	Availability	States	Comments	Impact on beneficials	Regulatory risk
Tetraniliprole (Vayego 200SC) Bayer	28	Ingestion	H:10 NG	P-A	ALL	Registered in macadamia for control of Sigastus Weevil. Also has activity on Lepidoptera.	L-M Bee VH	-

4.3 Weeds of Macadamias

4.3.1 Weed priorities

Common Name	Scientific Name
Moderate	
Flaxleaf Fleabane	*Conyza bonariensis*
Mistletoe[6]	Loranthaceae

No high priority weeds identified but Flaxleaf Fleabane and Mistletoe were nominated as a moderate priority. Flaxleaf Fleabane is a widespread pest that is difficult to control with herbicides.

Mistletoe is an emerging pest in the macadamia industry, affecting tree growth, nut yield and interfering with orchard operations. It has caused problems in the Northern Rivers, Gympie, Bundaberg and Rockhampton regions. Current approaches to orchard establishment and management increase the susceptibility of macadamias to mistletoe infection. Mistletoes are more likely to establish on trees with access to more water and nutrients and with a well-lit canopy. Macadamia varieties with an open canopy and canopy management that trims the crown and removes inner branches inadvertently increases the susceptibility to mistletoe infection.

Hort Innovation Project MC18001[7] summarised the current knowledge in the industry about mistletoe biology and, ecology and what management strategies are used to reduce the impact of the pest. The research found that the most effective mistletoe control in macadamia plantations is apply integrated pest management principles:

- Monitor regularly to detect mistletoe growth and regrowth
- Remove existing mistletoes through pruning
- Minimise reinfection by encouraging more continuous canopies, as mistletoe is more likely to germinate and establish when exposed to light
- Work with natural enemies to reduce mistletoe vigour.

The project team noted that further research is needed to establish best-practice detection and removal methods, estimate the effect of mistletoe infection on macadamia tree growth and yield, and explore cost-effective control strategies that align with existing operations.

Specific resistance management strategies for high resistance risk (A and B) and moderate resistance risk (C, D, F, G, I, J, K, L, M, N, Q and Z) herbicide modes of action are available on the CropLife Australia webpage.
https://www.croplife.org.au/resources/programs/resistance-management/herbicide-resistance-management-strategies-2/

[6] https://www.horticulture.com.au/search/?search=Mistletoe
[7] www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/mc18001/

4.3.2 Available and potential products for weed control

TABLE KEY: Note that blank fields in the table indicate no information has been provided.

Availability			
A	Available via either registration or permit approval		
P	Potential – a possible candidate to pursue for registration or permit		
P-A	Potential, already approved in the crop for another use		
Resistance risk		**Regulatory risk (refer to Appendix 7)**	
		R1	Short-term: Critical concern over retaining access
**	Moderate resistance risk	R2	Medium-term: Maintaining access of significant concern
***	High resistance risk	R3	Long-term: Potential issues associated with use - Monitoring required
Withholding Period (WHP) – Number of days from last treatment to harvest (H) or Grazing (G)			
Harvest	H	Not Required when used as directed	NR
Grazing	G	No Grazing Permitted	NG

Active ingredient (Trade Name)	Chemical Group	Crop/ Situation	Comment / Use / Weed	WHP (days)	Availability	States	Regulatory risk
Flaxleaf Fleabane *(Conyza bonariensis)* **Priority: Moderate**							
Rated as moderate priority weed, Fleabane is widely distributed through all growing regions. Difficult weed to manage because it can germinate year-round and there are limited herbicides available.							
Glufosinate (Basta)	N**	Tree Nuts / directed or shielded spray	Registered in tree nuts for control of grass and broadleaf weeds, including **Flaxleaf Fleabane**. Do not allow spray to contact any part of the tree, including the trunk. Grass and broadleaf weeds.	NR	A	ALL	R3
Mistletoe (Loranthaceae) **Priority: Moderate**							
Mistletoe is having a significant impact on production in some plantations and growers have highlighted the need to find suitable control options. There are no chemical options available and the current strategy involves regular monitoring and physical removal from affected trees.							
No control options available.							

Active ingredient (Trade Name)	Chemical Group	Crop/ Situation	Comment / Use / Weed	WHP (days)	Availability	States	Regulatory risk
Grass and Broadleaf Weeds **Priority: Low**							
The key to weed management in orchards is maintaining ground cover in the inter-row with grass and mulch.							
Carfentrazone-Ethyl (Spotlight)	G**	Macadamia / directed spray / pre-flowering	Registered in macadamia for control of **broadleaf weeds** including Australian Crassula, Chickweed, Paterson's Curse, Smallflower Mallow and Subterranean Clover. If weeds are already present, use as a spike in a mixture with glyphosate or paraquat.	NR	A	ALL	-
Glufosinate (Basta)	N**	Tree Nuts / directed or shielded spray	Registered in tree nuts for control of **grass and broadleaf weeds**. Do not allow spray to contact any part of the tree, including the trunk. Grass and broadleaf weeds.	NR	A	ALL	R3
Glyphosate (Roundup)	M**	Macadamia / directed spray, shielded spray or wick wiper	Registered in macadamia for control of **grass and broadleaf weeds**. Do not allow spray to contact any part of the tree, including the trunk. Grass and broadleaf weeds.	NR	A	ALL	R3
Haloxyfop (Verdiict)	A***	Nut Trees / directed spray or spot spray	Registered in tree nuts for control of **grass weeds**. Apply as a directed spray or spot spray.	NR	A	ALL	-
Oryzalin	D**	Macadamia / directed spray	Registered in macadamia for the control of **grass and broadleaf weeds**. Apply as a directed spray.	NR	A	ALL	-
Oxyflourfen (Goal)	G**	Macadamia / directed spray	Registered in macadamia control of **grass and broadleaf weeds**. If weeds are already present, use as a spike in a mixture with glyphosate or paraquat.	H:NR NG	A	ALL	-
Paraquat (Gramoxone)	L**	Orchards / directed spray or spot spray	Registered in orchards for control of **annual grass and broadleaf weeds**. Apply as a directed spray or spot spray.	H:1 G:7	A	ALL	R3
Pendimethalin (Stomp)	D**	Macadamia / directed spray / residual weed control	Registered in macadamia for pre-emergent control of **grass and broadleaf weeds**. Do not allow spray to contact any part of the tree, including the trunk.	NR	A	ALL	-

4.4 Plant Growth Regulators in Macadamias

4.4.1 Plant Growth Regulator Priorities

Priority
Moderate
Promote Uniform Nut Fall
Restriction of Vegetative Growth
Low
Promote Nut Ripening
Promote Vegetative Growth
Initiation of Flowering

Plant Growth Regulators (PGRs) are a minor component of managing macadamia orchards. No PGR issues have been nominated as high priority. Promoting uniform nut fall and restriction of vegetative growth were identified as being of moderate priority.

Ethephon can be used to promote nut fall in macadamias. It is not regularly used in NSW, but it is becoming more common in Queensland. It is applied when the nuts are mature and have started to drop naturally. Nuts are harvested after the nuts drop to the ground, and the nuts will drop over several months if left to natural processes. Ethephon shortens the harvest period which enables more efficient harvesting. It also assists in maintaining orchard hygiene by allowing timely removal of unharvested nuts and sticktight nuts. There is some concern that ethephon can cause stress and reduce sap flow, which can leave trees more susceptible to attack from borers.

There are currently no PGRs available for restricting vegetative growth in macadamias. There are practical advantages in maintaining tree size and avoiding dense canopies, particularly in managing pests and diseases. An open canopy will allow improved airflow and reduce the incidence of disease in trees. Smaller trees with open canopies also assist in achieving optimal spray coverage with insecticides and fungicides. Restricting vegetative growth may also enhance yield by allowing more resources to be diverted to the nuts. Mechanical pruning is used to manage tree height and canopy density. The availability of a PGR to reduce vegetative growth would be particularly desirable for use in high density plantings.

4.4.2 Available and Potential Plant Growth Regulators

TABLE KEY: Note that blank fields in the table indicate no information has been provided.

Availability		Regulatory risk (refer to Appendix 7)	
A	Available via either registration or permit approval	R1	Short-term: Critical concern over retaining access
P	Potential - a possible candidate to pursue for registration or permit	R2	Medium-term: Maintaining access of significant concern
P-A	Potential, already approved in the crop for another use	R3	Long-term: Potential issues associated with use - Monitoring required
Withholding Period (WHP) – Number of days from last treatment to harvest (H) or Grazing (G)			
Harvest	H	Not Required when used as directed	NR
Grazing	G	No Grazing Permitted	NG

Active ingredient (Trade Name)	Chemical Group	Crop/ Situation	Comment / Use / Weed	WHP (days)	Availability	States	Regulatory risk
Promote Uniform Nut Fall **Priority: Moderate**							
Uniform nut fall is desirable because it shortens the harvest period which enables more efficient harvesting. It also assists in maintaining orchard hygiene by allowing timely removal of unharvested nuts and sticktight nuts.							
Ethephon	Plant Growth Regulator	Macadamia Nuts / Own Choice, H2 Variety	Registered in macadamia to aid harvesting by **promoting uniform nut fall**. Apply late March to early May when nuts are mature. Nuts will be stimulated to fall within 10-14 days after application. Mechanical shaking may be used 7-10 days after application. Do not use on Teddington variety.	7	A	NSW, WA	-
Ethephon PER11462	Plant Growth Regulator	Macadamias	Permitted in macadamia to **promote nut fall** after maturity reached. Do not spray trees if they are stressed. Do not spray close to flowering or after flower buds have begun to expand. Spray at the first sign of natural nut drop. Applications should be made before the end of May.	7	A	NSW, QLD, NT & WA	-

5. References

5.1 Information:

AgChem Access Priority Access Forum	https://www.agrifutures.com.au/national-rural-issues/agvet-chemicals/
Australian Pesticide and Veterinary Medicines Authority	www.apvma.gov.au
APVMA Chemical review	https://apvma.gov.au/chemicals-and-products/chemical-review/listing
APVMA MRLs	www.comlaw.gov.au/Series/F2012L02501
APVMA Permit search	https://productsearch.apvma.gov.au/permits
APVMA Product search	https://productsearch.apvma.gov.au/products
Codex MRL database	http://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/en/
Cotton Pest Management Guide 2019-20	https://www.cottoninfo.com.au/publications/cotton-pest-management-guide
CropLife Australia	https://www.croplife.org.au/
Growcom – Infopest Database	www.infopest.com.au
Hort Innovation	www.horticulture.com.au

5.2 Abbreviations and Definitions:

APVMA	Australian Pesticides and Veterinary Medicines Authority
IPM	Integrated pest management
LOQ	Limit of quantification
MRL	Maximum residue limit (mg/kg or ppm)
Pesticides	Plant protection products (fungicide, insecticide, herbicide, nematicides, rodenticides, etc.).
Plant pests	Diseases, insects, nematodes, rodents, viruses, weeds, etc.
SARP	Strategic Agrichemical Review Process
TBC	To be continued
WHP	Withholding Period

5.3 Acknowledgements:

Thanks go to the many industry people who contributed information and collaborated on the review of this report.

6. Appendices

Appendix 1. Products available for disease control in Macadamias
Appendix 2. Products available for control of insects and mites in Macadamias
Appendix 3. Products available for weed control in Macadamias
Appendix 4. Plant Growth Regulators available in Macadamias
Appendix 5. Current permits for use in Macadamias
Appendix 6. Macadamia Maximum Residue Limits (MRLs)
Appendix 7. Macadamia regulatory risk assessment

Appendix 1. Products available for disease control in Macadamias

Active Ingredient (Trade Name)	Chemical group	Situation	Diseases / Comments	States	WHP Days	Regulatory risk
Azoxystrobin + Tebuconazole (Custodia) Adama	11+3	Macadamia	Husk Spot (*Pseudocercospora macadamiae*)	ALL	15	-
Carbendazim	1	Macadamia	Husk Spot (*Pseudocercospora macadamiae*)	ALL	H:14 G:28	R3
Copper (Cu) present as copper ammonium acetate	M1	Macadamia	Phytophthora Stem Canker	QLD, WA	1	-
			Husk Spot (*Cercoseptoria* spp.) Anthracnose Husk Rot (*Colletotrichum* spp.) Pink Limb Blight (*Corticum salmonicoler*)	QLD, NSW & NT		
Copper (Cu) present as Copper Oxychloride	M1	Macadamia	Husk Spot (*Cercoseptoria* spp.) Anthracnose Husk Rot (*Colletotrichum* spp.) Pink Limb Blight (*Corticum salmonicoler*)	QLD, NSW & NT	1	-
Copper (Cu) Present as Cupric Ammonium Complex	M1	Macadamia	Phytophthora Stem Canker	QLD, WA	1	-
			Husk Spot (*Pseudocercospora macadamiae*)	QLD, NSW, WA & NT		
Copper (Cu) present as cupric hydroxide	M1	Macadamia	Husk Spot (*Cercoseptoria* spp.) Anthracnose Husk Rot (*Colletotrichum* spp.) Pink Limb Blight (*Corticum salmonicoler*)	QLD, NSW & NT	1	-
		Fruit and Nuts	Phytophthora Stem Canker	QLD, WA		
Copper (Cu) present as cuprous oxide	M1	Macadamia	Phytophthora Stem Canker	ALL	1	-
			Husk Spot (*Cercoseptoria* spp.) Anthracnose Husk Rot (*Colletotrichum* spp.) Pink Limb Blight (*Corticum salmonicoler*)	QLD, NSW & NT		
Copper (Cu) Present as Tribasic Copper Sulphate	M1	Macadamia	Phytophthora Stem Canker	ALL	1	-

Active Ingredient (Trade Name)	Chemical group	Situation	Diseases / Comments	States	WHP Days	Regulatory risk
Copper (Cu) present as Copper Hydroxide + Metalaxyl M (Ridomil Gold Plus) Syngenta	M1+4	Macadamia	Phytophthora Root Rot and Trunk Canker	QLD, NSW	28	-
Difenoconazole (Score) Syngenta	3	Macadamia	Husk Spot (*Pseudocercospora macadamiae*)	QLD, NSW & NT	NR	R3
Iprodione (Rovral)	2	Macadamia	Botrytis Blight (*Botrytis* spp.)	ALL	NR	R2
Metalaxyl M (Ridomil Gold) Syngenta	4	Macadamia	Phytophthora Root Rot and Stem Canker	QLD, NSW	28	-
Penthiopyrad (Fontelis) Corteva	7	Macadamia	Husk Spot (*Pseudocercospora macadamiae*)	ALL	14	-
Phosphorous (Phosphonic) Acid present as Mono- And Dipotassium Phosphite	33	Macadamia	Phytophthora Root Rot (*Phytophthora* spp.) Trunk (Stem) Canker (*Phytophthora cinnamomi*)	NSW, QLD & WA	28	-
Phosphorous (Phosphonic) Acid present as Mono- And Dipotassium Phosphite PER84766	33	Macadamia	Phytophthora Root Rot (*Phytophthora* spp.) Trunk (Stem) Canker (*Phytophthora cinnamomi*)	NSW, QLD & WA	14	-
Pyraclostrobin (Cabrio) BASF	11	Macadamia	Husk Spot (*Pseudocercospora macadamiae*)	ALL	NR	-
Pyraclostrobin + Fluxapyroxad (Merivon) BASF	11+7	Macadamia	Husk Spot (*Pseudocercospora macadamiae*)	ALL	21	-

Appendix 2. Products available for control of insects and mites in Macadamias

Active Ingredient (Trade Name)	Chemical group	Situation	Pests / Comments	States	WHP Days	Regulatory risk
Abamectin PER87510	6	Macadamia	Thrips (*Scirtothrips* spp.) Broad Mites (*Brevipalpus* spp.) Flat Mites (*Polyphagotarsonemus* spp.)	ALL (excl. VIC)	H:28 NG	-
Acephate (Orthene)	1B	Macadamia	Macadamia Nutborer Fruit Spotting Bug Banana Spotting Bug Macadamia Leaf Miner Red Shouldered Leaf Beetle Flower Eating Caterpillar Flower Thrips	QLD, NSW, NT & WA	NR	R3
Acetamiprid + Pyriproxyfen (Trivor) Adama	4A+7C	Macadamia	Fruit Spotting Bug (*Amblypelta nitida, Amblypelta lutescens*) Pink Wax Scale (*Ceroplastes rubens*) Soft Brown Scale (*Coccus hesperidum*) Citrus Mealybug (*Planococcus citri*) Long Tailed Mealybug (*Pseudococcus longispinus*)	ALL	14	R2
Bacillus thuringiensis Berliner subsp. *aizawai* strain GC-91 (Campbell Bacchus WG)	11C	Macadamia	Armyworm (*Spodoptera* spp.) Cotton Bollworm (*Helicoverpa armigera*) Native Budworm (*Helicoverpa punctigera*) Cabbage Moth (*Plutella xylostella*) Cabbage White Butterfly (*Pieris rapae*) Loopers (*Chrysodeixis* spp., *Extropis excursaria*, *Thysanoptera orichalcea*) Light Brown Apple Moth (*Epiphyas postvittana*) Vine Moth (*Phalaenoides glycinae*, *Agarista agricola*)	ALL	NR	-
Beta-Cyfluthrin (Bulldock)	3A	Macadamia	Macadamia Nutborer Fruit Spotting Bug	QLD, NSW, ACT & WA	7	-

Active Ingredient (Trade Name)	Chemical group	Situation	Pests / Comments	States	WHP Days	Regulatory risk
Carbaryl (Bugmaster)	1A	Macadamia	Macadamia Nutborer Macadamia Twig Girdler Red Shouldered Leaf Beetle Cornelian (butterfly) Macadamia Cup Moth Macadamia Nut Moth Yellow Peach Moth Wingless Grasshopper	ALL	NR	R3
Chlorantraniliprole (Altacor) FMC PER89353	28	Tree Nuts (except almonds)	Fall Armyworm (*Spodoptera frugiperda*)	ALL (excl. VIC)	H:10 NG	-
Chlorpyrifos PER13642	1B	Tree Nuts	Australian Plague Locust (*Chortoicetes terminifera*)	ALL (excl. VIC)	H:28 G:2	R1
Diazinon	1B	Macadamia	Macadamia Felted Coccid Macadamia Leaf Miner	QLD, NSW	14	R3
Diazinon PER14276	1B	Macadamia	Macadamia Lace Bug (*Ulonemia concave* and *Physatochelia* spp.)	QLD, NSW & WA	H:14 G:14	R3
Flupyradifurone (Sivanto Prime) Bayer	4D	Macadamia	Macadamia Lace Bug (*Ulonemia concave, Ulonemia decoris*) Fruit-Spotting Bug (*Amblypelta nitida*) Banana-Spotting Bug (*Amblypelta lutescens*) Suppression of Scirtothrips (*Scirtothrips dorsalis*)	ALL	H:20 NG	-
Indoxacarb (Avatar) FMC PER86827	22A	Macadamia	Macadamia Seed Weevil (*Kushelorhynchus macadamiae*)	NSW, QLD	H:42 NG	R3

Active Ingredient (Trade Name)	Chemical group	Situation	Pests / Comments	States	WHP Days	Regulatory risk
Indoxacarb (Avatar) FMC PER89278	22A	Macadamia	Fall Armyworm (*Spodoptera frugiperda*)	ALL (excl. VIC)	H:42 NG	R3
Maldison PER13642	1B	Tree Nuts	Australian Plague Locust (*Chortoicetes terminifera*)	ALL (excl. VIC)	H:NR G:2	-
Methidathion (Suprathion) **Note: Suprathion Registration Cancelled by ADAMA and the use of Suprathion will not be permitted after 4-Feb-21.**	1B	Macadamia	Macadamia Felted Coccid Macadamia Nutborer Macadamia Twig Girdler Banana Spotting Bug Black Citrus Aphid Macadamia Leaf Miner Fruit Spotting Bug Brown Olive Scale Pink Wax Scale Soft Brown Scale White Wax Scale Long Soft Scale Macadamia Mussel Scale Macadamia White Scale Citrus Mealy Bug Hibiscus Mealy Bug Longtail Mealy Bug	QLD, NSW & WA	21	R1
Methomyl (Lannate) PER12796	1A	Macadamia	Banana Fruit Caterpillar (*Tiracola plagiata*)	QLD	NR	R2
Methomyl (Lannate) PER89293	1A	Macadamia	Fall Armyworm (*Spodoptera frugiperda*)	ALL	NR	R2

Active Ingredient (Trade Name)	Chemical group	Situation	Pests / Comments	States	WHP Days	Regulatory risk
Methoxyfenozide (Prodigy) Corteva	18	Macadamia	Macadamia Flower Caterpillar Macadamia Nutborer	ALL	H:28 NG	-
Petroleum Oil PER11635		Macadamia	Macadamia Felted Coccid (*Eriococcus ironsidei*)	NSW, QLD	NR	-
Potassium Salts of Fatty Acid (Natrasoap)		Nut Crops	Aphids Thrips Mealybug Two-Spotted Mite Spider Mite Whitefly	ALL	NR	-
Pyrethrins (Pyganic Organic Insecticide) Sumitomo	3A	Macadamia Nuts	Macadamia Lace Bug (*Ulonemia* spp.)	ALL	1	-
Spinetoram (Success Neo) Corteva	5	Macadamia	Macadamia Nutborer Thrips, including Red Banded Thrips Flower Eating Caterpillar Macadamia Twig Girdler Yellow Peach Moth	ALL	7	-
Spinetoram (Success Neo) Corteva PER89241	5	Macadamia	Fall Armyworm (*Spodoptera frugiperda*)	ALL (excl. VIC)	7	-
Sulfoxaflor (Transform) Corteva	4C	Macadamia	Fruit-Spotting Bug (*Amblypelta nitida*) Banana-Spotting Bug (*Amblypelta lutescens*) Lace Bug (*Ulonemia concave*)	ALL	NR	-
Tebufenozide (Mimic) Corteva	16A	Macadamia	Macadamia Flower Caterpillar Macadamia Nutborer	ALL	28	-

Active Ingredient (Trade Name)	Chemical group	Situation	Pests / Comments	States	WHP Days	Regulatory risk
Tetraniliprole (Vayego 200SC) Bayer	28	Macadamia	Sigastus Weevil / Macadamia Seed Weevil (*Kuschelorhynchus macadamiae*)	ALL	H:10 NG	-
Trichlorfon (Lepidex)	1B	Macadamia	Fruit Spotting Bug Banana Spotting Bug Flower Eating Caterpillar	QLD, NSW & NT	2	R2
Trichlorfon (Lepidex) PER13689	1B	Macadamia	Macadamia Lace Bug Fruit Spotting Bug Banana Spotting Bug Green Vegetable Bug	QLD, NSW	2	R2

Appendix 3. Products available for weed control in Macadamias

Active ingredient (Trade Name)	Chemical Group	Situation	Comment / Use / Weed	WHP (days)	States	Regulatory risk
Carfentrazone-Ethyl (Spotlight)	G**	Macadamia / directed spray / pre-flowering	If weeds are already present, use as a spike in a mixture with glyphosate or paraquat. Weeds Controlled: Australian Crassula, Chickweed, Paterson's Curse, Smallflower Mallow, Subterranean Clover	NR	ALL	-
Glufosinate (Basta)	N**	Tree Nuts / directed or shielded spray	Do not allow spray to contact any part of the tree, including the trunk. Grass and broadleaf weeds	H:NR G:56	ALL	R3
Glyphosate (Roundup)	M**	Macadamia / directed spray, shielded spray or wick wiper	Do not allow spray to contact any part of the tree, including the trunk. Grass and broadleaf weeds.	NR	ALL	R3
Haloxyfop (Verdict)	A***	Nut Trees / directed spray or spot spray	Grass weeds	NR	ALL	-
Oryzalin	D**	Macadamia / directed spray	Grass and broadleaf weeds	NR	ALL	-
Oxyfluorfen (Goal)	G**	Macadamia / directed spray	Grass and broadleaf weeds. If weeds are already present, use as a spike in a mixture with glyphosate or paraquat.	H:NR NG	ALL	-
Paraquat (Gramoxone)	L**	Orchards / directed spray or spot spray	Annual Grass and broadleaf weeds	H:1 G:7	ALL	R3
Pendimethalin (Stomp)	D**	Macadamia / directed spray / Residual Weed Control	Do not allow spray to contact any part of the tree, including the trunk. Grass and broadleaf weeds.	NR	ALL	-

Chemical Group Resistance Risk: ** Moderate, *** High

Appendix 4. Plant Growth Regulators available in Macadamias

Active ingredient (Trade Name)	Chemical Group	Situation	Comment / Use / Weed	WHP (days)	States	Regulatory risk
Ethephon	Plant Growth Regulator	Macadamia Nuts / Own Choice, H2 Variety	Aid harvesting by promoting uniform nut fall	7	NSW, WA	-
Ethephon PER11462	Plant Growth Regulator	Macadamias	Promote Nut Fall	7	NSW, QLD, NT & WA	-

Appendix 5. Current permits for use in Macadamias

Permit ID	Description	Date Issued	Expiry Date	Permit holder
PER11462 Version 3	Ethephon / Macadamias / Promote Nutfall	07-May-09	30-Jun-25	Hort Innovation
PER11635 Version 3	Petroleum Oil / Macadamia / Macadamia Felted Coccid	01-Jul-10	30-Jun-25	Hort Innovation
PER12796 Version 2	Methomyl / Macadamia / Banana Fruit Caterpillar	22-Jul-11	30-Jun-21	AMS
PER13642 Version 2	Chlorpyrifos & Maldison / Tree Nuts / Australian Plague Locust	01-Sep-12	30-Jun-25	ANIC C/Hort Innovation
PER13689 Version 4	Trichlorfon / Macadamia Nuts / Macadamia Lace Bug, Fruit-Spotting Bug, Banana-Spotting Bug, Green Vegetable Bug	14-May-13	30-Sep-21	AMS C/Hort Innovation
PER14276 Version 2	Diazinon / Macadamia / Macadamia Lace Bug	01-Dec-13	30-Nov-20	AMS C/Hort Innovation
PER87510	Abamectin / Macadamias / Thrips, Broad Mites & Flat Mites	17-Jun-19	30-Jun-24	Hort Innovation
PER81463	Acephate / Macadamia / Sigastus Weevil Permit Surrendered	24-Dec-15	31-Jan-21	AMS C/Hort Innovation
PER84766	Phosphorous Acid (Foliar & Trunk Applications) / Macadamia / Phytophthora Root Rot & Trunk (Stem) Canker 14-Day WHP (Use now covered by the Agri-Fos 600 Label with a 28-day WHP)	30-Nov-17	30-Nov-22	AMS C/Hort Innovation
PER86827	Indoxacarb / Macadamia / Macadamia Seed Weevil (Sigastus)	13-Sep-18	30-Sep-21	Hort Innovation
PER89241	Spinetoram / Various Including Macadamia / Fall Armyworm	6-Mar-20	31-Mar-23	Hort Innovation
PER89278	Indoxacarb / Macadamia /Fall Armyworm (*Spodoptera frugiperda*)	13-Mar-20	31-Mar-23	Hort Innovation
PER89293	Methomyl / Macadamia / Fall Armyworm (*Spodoptera frugiperda*)	10-Apr-20	30-Apr-23	Hort Innovation
PER89353 Version 2	Chlorantraniliprole (Altacor Hort Insecticide / Coragen) / Tree nuts (Except Almonds) / Fall Armyworm (*Spodoptera frugiperda*)	5-May-20	31-May-23	Hort Innovation

Appendix 6. Macadamia Maximum Residue Limits (MRLs)

CODEX commodity groupings of Macadamia and subgroups:

TN 0669 Macadamia nuts
TN 0085 Tree nuts

Note: Major export markets for macadamias include China, Vietnam, Japan, United States and Hong Kong. Available information indicates that in the absence of specific limits in legislation, that most countries defer to Codex, followed by EU MRL standards, or apply a 0.01ppm default value. Food exported to New Zealand from Australia may be legally sold if it complies with Australian requirements. MRLs and legislation are subject to change; the values presented should not be relied on.

Chemical	Codex Code	Description	APVMA MRL mg/kg	Codex MRL mg/kg
2,4-D	TN 0085	Tree nuts	-	0.2
Abamectin	TN 0669	Macadamia nuts	*T0.01	-
Abamectin	TN 0085	Tree nuts	-	*0.005
Acephate see also Methamidophos	TN 0669	Macadamia nuts	*0.1	-
Acetamiprid	TN 0669	Macadamia nuts	*0.01	-
Acetamiprid	TN 0085	Tree nuts	-	0.06
Azinphos-methyl	TN 0669	Macadamia nuts	*0.01	-
Azoxystrobin	TN 0669	Macadamia nuts	*0.01	-
Azoxystrobin	TN 0085	Tree nuts	-	0.01
Bifenazate	TN 0085	Tree nuts	-	0.2
Bifenthrin	TN 0085	Tree nuts	-	0.05
Boscalid	TN 0085	Tree nuts	-	*0.05
Captan	TN 0085	Tree nuts	3	-
Carbaryl	TN 0669	Macadamia nuts	2	-
Carbaryl	TN 0085	Tree nuts	-	1
Carbendazim	TN 0669	Macadamia nuts	0.1	-
Carbendazim	TN 0085	Tree nuts	-	*0.1
Carfentrazone-ethyl	TN 0085	Tree nuts	*0.05	-
Chlorantraniliprole	TN 0085	Tree nuts	0.1	0.02
Chlorpyrifos	TN 0085	Tree nuts	T0.05	-
Clofentezine	TN 0085	Tree nuts	-	0.5
Cyantraniliprole	TN 0085	Tree nuts	-	0.04
Cyflumetofen	TN 0085	Tree nuts	-	*0.01
Cyfluthrin	TN 0669	Macadamia nuts	0.05	-
Cyhalothrin (includes lambda-cyhalothrin)	TN 0085	Tree nuts	-	*0.01
Cypermethrins (including alpha- and zeta-cypermethrin)	TN 0085	Tree nuts	-	*0.05
Cyprodinil	TN 0085	Tree nuts	-	0.04
Diazinon	TN 0085	Tree nuts	0.1	-
Difenoconazole	TN 0669	Macadamia nuts	*0.01	-
Difenoconazole	TN 0085	Tree nuts	-	0.03
Diflubenzuron	TN 0085	Tree nuts	-	0.2
Diquat	TN 0085	Tree nuts	*0.05	-

Chemical	Codex Code	Description	APVMA MRL mg/kg	Codex MRL mg/kg
Emamectin benzoate	TN 0085	Tree nuts	-	*0.001
Ethephon	TN 0669	Macadamia nuts	*0.1	-
Etoxazole	TN 0085	Tree nuts	-	*0.01
Fenbuconazole	TN 0085	Tree nuts	-	*0.01
Fenpropathrin	TN 0085	Tree nuts	-	0.15
Fenpyroximate	TN 0085	Tree nuts	-	*0.05
Flubendiamide	TN 0085	Tree nuts	-	0.1
Flumioxazin	TN 0085	Tree nuts	*0.02	*0.02
Fluopyram	TN 0085	Tree nuts	-	0.04
Flupyradifurone	TN 0669	Macadamia nuts	*0.01	-
Fluxapyroxad	TN 0085	Tree nuts	0.07	0.04
Fosetyl Al	TN 0085	Tree nuts	-	400
Glufosinate and Glufosinate ammonium	TN 0085	Tree nuts	0.1	-
Glufosinate-Ammonium	TN 0085	Tree nuts	-	0.1
Glyphosate	TN 0085	Tree nuts	0.2	-
Haloxyfop	TN 0085	Tree nuts	*0.05	-
Hexythiazox	TN 0085	Tree nuts	-	*0.05
Hydrogen Phosphide	TN 0085	Tree nuts	-	Po0.01
Imidacloprid	TN 0085	Tree nuts	-	0.01
Indoxacarb	TN 0669	Macadamia nuts	*T0.01	-
Iprodione	TN 0669	Macadamia nuts	*0.01	-
Isoxaben	TN 0085	Tree nuts	*0.01	-
Maldison	TN 0085	Tree nuts	8	-
Metalaxyl	TN 0669	Macadamia nuts	1	-
Methidathion	TN 0669	Macadamia nuts	*0.01	-
Methomyl see also Thiodicarb	TN 0669	Macadamia nuts	T1	-
Methoxyfenozide	TN 0669	Macadamia nuts	0.05	-
Methoxyfenozide	TN 0085	Tree nuts	-	0.1
Methyl Bromide	TN 0085	Tree nuts	-	*Po0.01
Norflurazon	TN 0085	Tree nuts	*0.2	-
Oryzalin	TN 0085	Tree nuts	0.1	-
Oxyfluorfen	TN 0085	Tree nuts	0.05	-
Paraquat	TN 0085	Tree nuts	*0.05	0.05
Pendimethalin	TN 0085	Tree nuts	*0.05	0.05
Penthiopyrad	TN 0085	Tree nuts	0.1	0.05
Phosmet	TN 0085	Tree nuts	-	0.2
Phosphine	TN 0085	Tree nuts	*0.01	-
Phosphorous acid	TN 0085	Tree nuts	3000	-
Piperonyl butoxide	TN 0085	Tree nuts	8	-
Pirimicarb	TN 0085	Tree nuts	*T0.05	-
Propiconazole	TN 0085	Tree nuts	T0.2	-
Pyraclostrobin	TN 0085	Tree nuts	0.07	*0.02
Pyrethrins	TN 0085	Tree nuts	1	*Po0.5
Pyridaben	TN 0085	Tree nuts	*T0.05	-
Pyriproxyfen	TN 0669	Macadamia nuts	*0.01	-

Chemical	Codex Code	Description	APVMA MRL mg/kg	Codex MRL mg/kg
Saflufenacil	TN 0085	Tree nuts	*0.03	0.01
Simazine	TN 0085	Tree nuts	*0.1	-
Spinetoram	TN 0085	Tree nuts	0.02	0.01
Spinosad	TN 0085	Tree nuts	*T0.01	0.07
Spirodiclofen	TN 0085	Tree nuts	-	0.05
Spirotetramat	TN 0085	Tree nuts	-	0.5
Sulfoxaflor	TN 0669	Macadamia nuts	*0.01	-
Sulfoxaflor	TN 0085	Tree nuts	-	0.03
Sulfuryl fluoride	TN 0085	Tree nuts	7	Po3
Tebuconazole	TN 0669	Macadamia nuts	*0.01	-
Tebuconazole	TN 0085	Tree nuts	-	*0.05
Tebufenozide	TN 0669	Macadamia nuts	0.05	-
Tetraniliprole	TN 0669	Macadamia nuts	*0.01	-
Thiacloprid	TN 0085	Tree nuts	-	0.02
Trichlorfon	TN 0669	Macadamia nuts	0.1	-
Trifloxystrobin	TN 0669	Macadamia nuts	*T0.05	-
Trifloxystrobin	TN 0085	Tree nuts	-	*0.02

NOTE: MRLs are constantly under review and subject to change. Check for current MRLs and do not rely on the values stated above.
NOTE: For the groups "Tree Nuts" listed above (Macadamia), crop group exclusions (if any) have not been specified.
Note: Major export markets for macadamias include China, Vietnam, Hong Kong and Japan. Available information indicates that in the absence of specific limits in legislation, most countries defer to Codex, followed by EU MRL standards or apply a 0.01ppm default value. Food exported to New Zealand from Australia may be legally sold if it complies with Australian requirements. MRLs and legislation are subject to change; the values presented should not be relied on.

* Indicates that an MRL is at the Limit of Quantitation (LOQ)
T = Temporary MRL
E = The MRL is based on extraneous residues
Po = The MRL accommodates post-harvest treatment of the commodity

Sources:
APVMA MRLs: Agricultural and Veterinary Chemicals Code (MRL Standard) Instrument 2019. Compilation 4. Prepared 15 January 2020.
CODEX MRLs: CODEX Alimentarius International Food Standards database (February 2020), http://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/en/

Appendix 7. Macadamia regulatory risk assessment

Macadamia
Agrichemical Regulatory
Risk Assessment

July 2020

Regulatory pressures on agrichemicals are increasing globally, with many being either restricted or withdrawn from use. For older agrichemicals these pressures are often the result of reconsiderations involving new or refined risk assessment methodologies that requiring the generation of new data. A consequence of which can be that many of these agrichemicals are not meeting contemporary risk assessment standards as the necessary data is unavailable, or where data is available, the risk posed is considered unacceptable.

The use of agrichemicals can also be impacted through differences in standards between trading partners. The lack of an appropriate pesticide maximum residue limit (MRL) in an importing country can, for practical purposes, effectively prohibit use in the exporting country so as to ensure compliance, as an MRL breach would adversely affect market access.

The effects of the above are greater regulatory pressure placed on the use of individual agrichemicals or chemical groups. As a consequence, it is possible that the number of approved agrichemical options could be adversely impacted.

To assist strategic planning, with respect to future pest management options, the following tables have been developed to highlight the regulatory threats to agrichemicals currently approved for the management of the pests and diseases in macadamia nuts as well as current initiatives aimed at addressing identified pest management deficiencies.

Macadamia regulatory risk assessment

R1	Short-term: Critical concern over retaining access
R2	Medium-term: Maintaining access of significant concern
R3	Long-term: Potential issues associated with use - Monitoring required

Problem	Active Constituents	Chemical Group	Comment	Activities
Ants				
Fire ants	Indoxacarb	**22A**		
	Pyriproxyfen	**7C**		
	S-methoprene	**7A**		
Yellow crazy ants	Fipronil + S-methoprene	**2B+7A**		
Aphids				
Aphids	Sulfoxaflor	**4C**	USA – Pollinator concerns	
Black citrus aphid	Methidathion	**1B**	Use will not be permitted in AU after 4 February 2021. Registrant will remove from sale and all authorisations will be cancelled. Europe – Deregistered USA - Deregistered	
	Sulfoxaflor	**4C**	USA – Pollinator concerns	

Macadamia regulatory risk assessment

Problem	Active Constituents	Chemical Group	Comment	Activities
Beetles				
Macadamia seed weevil / Sigastus weevil	Indoxacarb (PER86827)	**22A**	EU: Proposed non-renewal of authorisation	MC17007 data generation project undertaken and completed to support renewal of Indoxacarb permit and a label registration with FMC for Avatar eVo Insecticide.
	Acephate (PER81463) Permit Surrendered	**1B**	APVMA – Nominated for review Canada – Under review Europe - Deregistered	
	Tetraniliprole	**28**		
Red shouldered leaf beetle	Acephate	**1B**	APVMA – Nominated for review Canada – Under review Europe - Deregistered	
	Carbaryl	**1A**	Canada: Review recently completed, retained but with a large number of uses deleted Codex: Toxicology review scheduled 2020 Europe: deregistered	
Caterpillars				
Armyworms	Bt	**11**		
Banana fruit caterpillar	Methomyl (PER12796)	**1A**	APVMA – nominated for review Canada – Re-evaluation completed (2018). Majority of uses removed	
Caterpillars / Looper	Bt	**11**		
Cornelian	carbaryl	**1A**	Canada: Review recently completed, retained but with a large number of uses deleted Codex: Toxicology review scheduled 2020 Europe: deregistered	
Fall Armyworm	Chlorantraniliprole (PER89353)	**28**		
	Indoxacarb (PER89278)	**22A**	EU: Proposed non-renewal of authorisation	
	Methomyl (PER89293)	**1A**	APVMA – nominated for review Canada – Re-evaluation completed (2018). Majority of uses removed	

Macadamia regulatory risk assessment

Problem	Active Constituents	Chemical Group	Comment	Activities
Fall Armyworm	Spinetoram (PER89241)	**5**		
Helicoverpa	Bt	**11**		
Light brown apple moth	Bt	**11**		
Macadamia cup moth	Carbaryl	**1A**	Canada: Review recently completed, retained but with a large number of uses deleted Codex: Toxicology review scheduled 2020 Europe: deregistered, use acceptable	
Macadamia flower caterpillar	Acephate	**1B**	APVMA – Nominated for review Canada – Under review Europe - Deregistered	
	Methoxyfenozide	**18**		
	Tebufenozide	**18**		
	Trichlorfon	**1B**	APVMA – nominated for review Codex – No MRLs Europe – Deregistered US – No MRLs	
Macadamia leafminer	Acephate	**1B**	APVMA – Nominated for review Canada – Under review Europe - Deregistered	
	Diazinon	**1B**	To be reviewed by JMPR/Codex 2020/21.	
	Methidathion	**1B**	Use will not be permitted in AU after 4 February 2021. Registrant will remove from sale and all authorisations will be cancelled. Europe – Deregistered USA - Deregistered	
Macadamia nutborer	Acephate	**1B**	APVMA – Nominated for review Canada – Under review Europe - Deregistered	
	Beta-cyfluthrin	**3A**		

Macadamia regulatory risk assessment

Problem	Active Constituents	Chemical Group	Comment	Activities
Macadamia nutborer	Carbaryl	**1A**	Canada: Review recently completed, retained but with a large number of uses deleted Codex: Toxicology review scheduled 2020 Europe: deregistered, use acceptable	
	Methidathion	**1B**	Use will not be permitted in AU after 4 February 2021. Registrant will remove from sale and all authorisations will be cancelled. Europe – Deregistered USA - Deregistered	
	Methoxyfenozide	**18**		
	Spinetoram	**5**		
	Tebufenozide	**18**		
Macadamia twig-girdler	Carbaryl	**1A**	Canada: Review recently completed, retained but with a large number of uses deleted Codex: Toxicology review scheduled 2020 Europe: deregistered, use acceptable	
	Methidathion	**1B**	Use will not be permitted in AU after 4 February 2021. Registrant will remove from sale and all authorisations will be cancelled. Europe – Deregistered USA - Deregistered	
	Spinetoram	**5**		
Painted vine moth	Bt	**11**		
Yellow peach moth	Carbaryl	**1A**	Canada: Review recently completed, retained but with a large number of uses deleted Codex: Toxicology review scheduled 2020 Europe: deregistered, use acceptable	
	Spinetoram	**5**		
	Beta-cyfluthrin	**3A**		
	Spinetoram	**5**		

Macadamia regulatory risk assessment

Problem	Active Constituents	Chemical Group	Comment	Activities
Mites				
Broad mite	Abamectin (PER81162)	**6**	Broad mite	ST16006 – Data generation project completed to retain abamectin permit
Spider mites	Fatty acids - K salt	**-**		
Plant bugs and leaf hoppers				
Fruit-spotting bug / Banana-spotting bug	Acetamiprid + pyriproxyfen	**4A + 7C**	Acetamiprid – APVMA review underway	SYNFOI21 (Syngenta) New MOA in development in macadamia.
	Acephate	**1B**	APVMA – Nominated for review Canada – Under review Europe - Deregistered	
	Beta-cyfluthrin	**3A**		
	Flupyradifurone	**4D**		
	Methidathion	**1B**	Use will not be permitted in AU after 4 February 2021. Registrant will remove from sale and all authorisations will be cancelled. Europe – Deregistered USA - Deregistered	
	Sulfoxaflor	**4C**	USA – Pollinator concerns	
	Trichlorfon (PER13689)	**1B**	APVMA – nominated for review Codex – No MRLs Europe – deregistered US – No MRLs	
Green vegetable bug	Trichlorfon (PER13689)	**1B**		
Macadamia lace bug	Diazinon (PER14276)	**1B**	To be reviewed by JMPR/Codex 2020/21.	MT12024 - The development of DC-092 (Sivanto) for the control of spotting bug in macadamia nut. Sivanto Import tolerances pending April 2021
	Flupyradifurone	**4D**		
	Pyrethrins (PER14852)	**3A**		
	Trichlorfon	**1B**	APVMA – nominated for review Codex – No MRLs Europe – deregistered US – No MRLs	

Macadamia regulatory risk assessment

Problem	Active Constituents	Chemical Group	Comment	Activities
Scale and mealybug				
Citrus mealybug / Longtailed mealybug	Acetamiprid + pyriproxyfen	**4A + 7C**	Acetamiprid – APVMA review underway	
	Methidathion	**1B**	Use will not be permitted in AU after 4 February 2021. Registrant will remove from sale and all authorisations will be cancelled. Europe – Deregistered USA - Deregistered	
Hibiscus mealybug	Methidathion	**1B**		
Long soft scale	Methidathion	**1B**		
Macadamia felted coccid	Diazinon	**1B**	To be reviewed by JMPR/Codex 2020/21.	
	Methidathion	**1B**	Use will not be permitted in AU after 4 February 2021. Registrant will remove from sale and all authorisations will be cancelled. Europe – Deregistered USA - Deregistered	
	Petroleum oil (PER11635)			
Macadamia mussel scale	Methidathion	**1B**	Use will not be permitted in AU after 4 February 2021. Registrant will remove from sale and all authorisations will be cancelled. Europe – Deregistered USA - Deregistered	
Macadamia white scale / Black (Brown olive) scale	Methidathion	**1B**		
Pink wax scale	Acetamiprid + pyriproxyfen	**4A + 7C**	Acetamiprid – APVMA review underway	
	Methidathion	**1B**	Use will not be permitted in AU after 4 February 2021. Registrant will remove from sale and all authorisations will be cancelled. Europe – Deregistered USA - Deregistered	
Soft brown scale	Methidathion	**1B**		
White wax scale	Methidathion	**1B**		

Macadamia regulatory risk assessment

Problem	Active Constituents	Chemical Group	Comment	Activities
Thrips				
Citrus thrips	Flupyradifurone	**4D**		ST19020 – AgVet Grant project contracted June 2020 SYNFOI21 (Syngenta) New MOA Thrips & Various bugs, including FSB and Leptocoris bug. ST16006 – Data generation project completed to retain abamectin permit
Flower thrips	Abamectin (PER81162)	**6**		
	Acephate	**1B**	APVMA – Nominated for review Canada – Under review Europe - Deregistered	
Others insect pests				
Plague locusts	Chlorpyrifos	**1B**	Currently under review by the APVMA & outcome uncertain. Potential issues w.r.t. environmental loading and dietary exposure. Ongoing issues internationally Canada – proposed cancellation of most agricultural uses. USA – Following court ruling, EPA decision due mid-July	
Wingless grasshopper	Carbaryl	**1A**	Canada: Review recently completed, retained but with a large number of uses deleted Codex: Toxicology review scheduled 2020 Europe: deregistered, use acceptable	
	Maldison	**1B**	APVMA – Under review - chemistry	

Problem	Active Constituents	Chemical Group	Comment	Activities
DISEASES				
Anthracnose	Copper	**M1**	Europe: Candidates for substitution and their uses to be phased out	
Botrytis blight	Iprodione	**2**	Europe – Deregistered Canada – Majority of food crop uses deleted Codex – Review scheduled for 2022	
Husk spot	Carbendazim	**1**	Codex – Periodic re-evaluation in 2022 Europe - Deregistered	ST16006 - Bayer – Luna Experience Macadamia husk spot & Botrytis blight label registration submitted and pending 2020. Luna Sensation label extension will also be submitted from the nut crop group.
	Copper	**M1**	Europe: Candidates for substitution and their uses to be phased out	
	Difenoconazole	**3**	APVMA - Nominated for review Canada – Currently being reviewed	
	Penthiopyrad	**7**		
	Pyraclostrobin	**11**		
Phomopsis husk rot & canker	Copper	**M1**	Europe: Candidates for substitution and their uses to be phased out	
Phytophthora root rot	Copper	**M1**	Europe: Candidates for substitution and their uses to be phased out	MC15002 – Data generation project to support permit and label registration of Phosphorous acid.
	Metalaxyl/ metalaxyl-M	**4**		
	Phosphorous acid	**33**		
Phytophthora Stem rot	Copper	**M1**	Europe: Candidates for substitution and their uses to be phased out	
Raceme blight (Grey mould)	Iprodione	**2**	Europe – Deregistered Canada – Majority of food crop uses deleted Codex – Review scheduled for 2022	
Trunk and stem canker	Copper	**M1**	Europe: Candidates for substitution and their uses to be phased out	
	Metalaxyl/metalaxyl-M	**4**		
	Phosphorous acid	**33**		

Macadamia regulatory risk assessment

Problem	Active Constituents	Chemical Group	Comment	Activities
WEEDS				
Broadleaf weeds and grasses	Carfentrazone-methyl	**G**		
	Diquat	**L**	APVMA - Currently under review Europe – deregistered	
	Flumioxazin	**G**		
	Glufosinate	**N**	Europe – deregistered	
	Glyphosate	**M**	Ongoing issues internationally	
	Haloxyfop-P	**A**		
	Isoxaben	**O**		
	Oryzalin	**D**		
	Oxyfluorfen	**G**		
	Paraquat	**L**	APVMA - Currently under review Europe – deregistered Rotterdam Convention - nominated	
	Pendimethalin	**D**		
PLANT GROWTH REGULATORS				
Plant growth regulators	Ethephon (PER11462)	**-**		
Vertebrate pests				
Rodents	Cholecalciferol	**-**		
	Coumatetralyl	**-**		
	Zinc phosphide	**-**		

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