

Cucumber Green Mottle Mosaic Virus (CGMMV) National Management Plan

Version Control		
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Acknowledgements

The Cucumber green mottle mosaic virus National Management Plan was a collaborative effort between representatives from the Australian Government, all state and territory governments, Nursery & Garden Industries Australia (NGIA), AUSVEG Ltd, the Australian Melon Association (AMA) and Northern Territory Farmers Association (NTFA).

The Plan was correct at the time of writing. Information should be checked with the relevant jurisdiction that regulations are unchanged from those described in the plan.

1 Introduction

Cucumber Green Mottle Mosaic Virus (CGMMV) was detected in Australia in 2014 and it has been nationally agreed that it is not technically feasible to eradicate the virus under the Emergency Plant Pest Response Deed (EPPRD).

As a trade sensitive pest there is a need for co-ordination of CGMMV management at the national level to contain CGMMV to known areas of infestation, prevent its spread to other growing regions and eventually eradicate the virus from Australian growing regions through medium to long term management.

This CGMMV National Management Plan (Management Plan) provides an overarching framework upon which jurisdictional operational plans should be developed to manage CGMMV. The Management Plan is underpinned by sound scientific risk assessment developed by an expert working group on CGMMV (Appendix 1).

The Management Plan describes symptoms, identification and testing of diseased plants, and precautionary measures and disinfection procedures to prevent disease spread. The Management Plan also outlines best practice approaches to farm biosecurity and provides a decision making tree to guide growers on best approaches should their crops become infested. Surveillance procedures to check for presence of CGMMV are also outlined. Importantly, the Management Plan articulates agreed roles and responsibilities of governments, industry and other stakeholders to manage CGMMV in Australia.

The Management Plan has been developed collaboratively by affected states, territories and industries and will provide the Australian community and trading partners with confidence that CGMMV is being actively managed in affected Australian production areas.

1.1 Purpose of the Management Plan

The purpose of the Management Plan is to minimise the impact of CGMMV by:

- (1) Preventing the spread of CGMMV to new regions;
- (2) Reducing the impact of CGMMV on currently affected regions; and
- (3) Minimising the impact of CGMMV on domestic and international trade.

1.2 Benefits of the Management Plan

The Management Plan has benefits to individual growers and to the cucurbit industry, including:

- a. Containment of CGMMV to current areas of infestation;
- b. Reduced production losses from CGMMV if the best practice measures are applied;
- c. Limiting the spread of other diseases through application of the best practice hygiene measures;
- d. Support for continued access to markets, including international markets.

1.3 Elements of the Management Plan

The key focus areas of the National Management Plan are:

- Early detection through monitoring for diseased plants;
- Isolation of suspect plants;
- Measures to prevent spread of infections;
- Breaking the cycle of infection between growing cycles.

Growers should consider how they will meet these elements in the most cost effective manner. Ideally, the requirements will fit in with existing hygiene practices and will not add significant cost or inconvenience to growers.

Growers need to document how they will meet the requirements, so that all staff can be aware of their role in CGMMV management. The procedures need to identify what actions are taken, who is responsible for the action, when it will be done and how it will be done. For development of a farm management plan, growers can adopt or modify the guiding documents provided in Appendices 4-7.

1.4 Constraints of the Management Plan

The management of CGMMV is difficult for many reasons, including:

- a) Potential for ongoing introductions of CGMMV via seed or other host material;
- b) Ease of transmission of CGMMV within areas of infestation;
- c) Detection of all outbreaks is not always feasible (as many viruses present with similar symptoms) or cost effective;
- d) Testing and identification is limited to suspect infestations rather than ongoing targeted surveillance;
- e) A mandatory program for the management of CGGMV involving all Australian cucurbit growers is not feasible.

1.5 Endorsement and Implementation of the Management Plan

The Management Plan has been endorsed by the following parties: the Australian Government, state and territory governments, Nursery & Garden Industries Australia (NGIA), AUSVEG Ltd, the Australian Melon Association (AMA) and Northern Territory Farmers Association (NTFA).

All partners in managing CGMMV have a role and responsibility in building capacity to manage CGMMV. These partners include federal and state governments, as well as 'at risk' industries.

2 Context

CGMMV was first found in the United Kingdom in 1935, but it has since been identified in other European countries, India, Greece (2002), Ukraine (2007), Japan (2009), China (2009), Korea (2008), Myanmar (2010), Israel (2013) and California, USA (2013).

Until 2014, CGMMV was exotic to Australia. It was first reported in September 2014 in Australia on commercial watermelon farms near Katherine and Darwin, Northern Territory. CGMMV has since been detected on a single farm near Charters Towers, Queensland, and on farms in Perth, Geraldton, Carnarvon and Kununurra, Western Australia.

The Northern Territory, Queensland and Western Australian governments implemented quarantine measures to contain and manage CGMMV. In Northern Territory and Queensland, these measures included removal and destruction of all infected host material, fallow periods and strict control measures on the movement of potentially infected material from the affected areas including fruit. To date, CGMMV has not been found in other states or territories of Australia.

Fruit that tested positive from the Northern Territory are watermelon, butternut pumpkin, cucumber and bitter melon. Although fruit (and seed from fruit) may be a source of potential infection, infested fruit is likely to be symptomatic, sub quality and not suitable for market. Unsaleable fruit is generally removed from the pathway at the farm, wholesale or retail stage.

Based on best available scientific advice, the likelihood of CGMMV being transmitted from an infested commercial production facility in Northern Territory or Queensland to a commercial cucurbit production facility in states or territories that do not have CGMMV is minimal. All fruit is sold directly to domestic markets for consumption.

In March 2015, the National Management Group (NMG) under the EPPRD for CGMMV agreed that it was not technically feasible to eradicate CGMMV from the Northern Territory. This was largely due to the number of infested properties across a number of regions, the detection of CGMMV in weed species known to be endemic to the Northern Territory and other parts of Australia.

In July 2015, the NMG agreed to close the CGMMV incident in the Northern Territory, noting that Queensland would continue to aim for eradication of CGMMV from its only infested property.

Plant Health Committee determined CGMMV to be a pest of national significance in June 2015 and agreed to a national management plan for CGMMV.

Any future detections of CGMMV are not considered to be an emergency plant pest under the EPPRD and will be managed in line with the Management Plan.

2.1 Northern Territory

The Northern Territory (NT) Government is managing to contain CGMMV to areas of current infestation and prevent its spread beyond the NT.

The Department of Primary Industry and Resources (DPIR) has adopted a coordinated management approach with growers in the Northern Territory. Regulations are in place which prevent the movement of plant material, seeds, soil, machinery and bee hives from the NT unless approved by the Chief Plant Health Manager (CPHM). Growers are required to have farm biosecurity plans which may be audited annually by NT Quarantine. These farm biosecurity plans must identify the risks of transmission of CGMMV onto and off the property and the measures the growers have implemented to address those risks.

For further information on management controls for CGMMV in the NT, contact NT Quarantine on (08) 8992118, or <https://nt.gov.au/industry/agriculture/food-crops-plants-and-quarantine/cucumber-green-mottle-mosaic-virus/cucumber-green-mottle-mosaic-virus>

2.2 Queensland

CGMMV was confirmed on one property west of Townsville in March 2015. Biosecurity Queensland is working with the property owner to ensure the infection remains confined at this site. The virus in Queensland is being managed in line with the Management Plan.

Additional information on state management of CGMMV can be found at <https://www.daf.qld.gov.au/plants/health-pests-diseases/a-z-significant/cucumber-green-mottle-mosaic-virus>

2.3 Western Australia

CGMMV was first detected in Geraldton in July 2016, but suspect symptoms were seen two to three years prior. The Department of Agriculture and Food, Western Australia (DAFWA) and Vegetables WA are working together to ensure growers are aware of and are implementing strong on-farm biosecurity practices for control of the virus.

Additional information on state management of CGMMV can be found at

<https://www.agric.wa.gov.au/cgmmv>

3 Pest Characteristics

3.1 Hosts

There are at least five strains of CGMMV whose symptoms can vary between hosts. Other mosaic diseases, caused by potyviruses, are known to occur in northern Australia and express somewhat similar symptoms. This makes it difficult to visually identify CGMMV.

CGMMV infects members of the Cucurbitaceae, including watermelon, melon, cucumber, pumpkin, squash and gourds. Apart from cucurbit crop plants, CGMMV has also been found to infect the weeds *Amaranthus blitoides*, *Amaranthus retroflexus*, *Heliotropium europaeum*, *Portulaca oleracea* and *Solanum nigrum* and some wild cucurbit plants, such as pie melon. Refer to the CGMMV scientific advice in Appendix 1 for an extended list of potential hosts.

3.2 Symptoms

The symptoms found on an infected plant will vary with the genus, species and cultivar of the plant and the strain of the virus.

Symptoms described for this virus range from light yellow green spots and vein clearing on young leaves to chlorotic mottling, leaf deformation, plant stunting, and necrosis at later stages of growth. Mature leaves can become bleached and fruit drop is common. In watermelons, symptoms include misshapen fruit with internal discoloration, rotting and necrosis.

Examples of CGMMV infested plants and fruit are available in Appendix 2.

3.3 Transmission

CGMMV is highly virulent and easily transmissible. It can be transmitted through sap, seeds and soil, on clothing, shoes, hands, machinery and packaging materials. Entry into the plant is generally through wounds. CGMMV may remain dormant within the seed coat and remain viable for long periods in infected crop debris, in the soil, on machinery and tools.

Introduction through contaminated seed and soil are among the most common means of infestation. CGMMV can be disseminate by several means, including:

- Infection of roots can occur in soil that is contaminated with infective plant debris. The virus can spread through root to root contact;
- In water or in nutrient solutions in soilless culture;
- Mechanical transfer, especially in protected or high input culture systems where plants are pruned, staked, handled or touched frequently;
- Machinery used for cultivation or weed control can spread the virus;
- Infected rootstock plants can serve as a source for outbreaks if plants are grafted;
- Seed harvested from infected plants may carry CGMMV, and transmission frequency can be 20% or more;
- Some weed species can have symptomless infection and act as incubators of CGMMV;
- In greenhouse or equipment surfaces or on tools;
- It has been reported that CGMMV may be transmitted in pollen in artificial pollination under greenhouse conditions, but it has yet to be confirmed that spread occurs via pollen naturally in the field;
- To date no insect has been proven to vector CGMMV. It is theoretically possible that some chewing insects could vector the virus, but this has not been confirmed experimentally.

4 Managing CGMMV in Australia

4.1 Principles for Managing CGMMV

The following principles underpin the management of CGMMV in Australia:

- a. CGMMV in Australia is managed in line with the principles of Australian and New Zealand Standard for Risk Management ISO 31000;
- b. CGMMV is a reportable disease in Australia;
- c. To whatever extent possible CGMMV will be managed by growers through good on farm biosecurity practices;
- d. Where required government will implement regulatory measures to mitigate the risk of transmission of CGMMV to areas not infested with CGMMV;
- e. Where ever possible quarantine controls will be used as a last resort;
- f. Industry, growers, governments and the public will work together to manage and monitor the impacts of CGMMV in Australia.

4.2 CGMMV is a Notifiable Pest

CGMMV is a notifiable pest in Australia. Growers are required to report any suspected detections of CGMMV to the CPHM in their jurisdiction. If in an area or jurisdiction that is currently not infested with CGMMV, the CPHM may request the grower to provide symptomatic plant material for testing.

The CPHM will notify the Australian Chief Plant Protection Officer (ACPPPO) and affected industries if there is a confirmed positive diagnosis in accordance with the current jurisdictional diagnostic requirements. Reporting of new cases of CGMMV will be made when the detection changes area freedom or the virus is detected on a previous unknown host.

4.3 Management of Risk Pathways

The Management Plan applies a Hazard Analysis Critical Control Point (HACCP) based approach for managing CGMMV. High risk pathways and the points at which regulatory or other control measures are required have been identified. Table 1 describes the agreed points at which management controls are required to manage the risk pathways of CGMMV. Table 1 should be read in conjunction with the scientific advice in Appendix 1.

Table 1: Points at which controls are to be applied to manage Cucumber Green Mottle Mosaic Virus in Australia

Risk Pathway	Import into Australia	State or Territory Borders	CGMMV Infested Region	CGMMV Infested Property within a Region	Un-infested Property	Supply Chain
Soil						
Control required:	Yes	Yes	Yes	Yes	No	No
Action:	<p>Control on soil that may have come into contact with infected plants.</p> <p>Nursery stock cannot be imported in soil. If soil is present then requirements are mandatory irradiation or cleaning to remove soil.</p> <p>Appropriate certification required.</p>	<p>Control on soil that may have come into contact with infected plants.</p> <p>Certification required from CPHM.</p>	<p>Control on soil that may have come into contact with infected plants.</p> <p>Jurisdiction to manage on a situational basis.</p> <p>Grower to manage movement of soil onto and off property.</p>	<p>Control on soil that may have come into contact with infected plants.</p> <p>Jurisdiction to manage on a situational basis.</p> <p>Grower to manage movement of soil onto and off property.</p>	<p>If outside of infected region.</p> <p>Supported by proof of Area freedom.</p>	

Seed Control required: Action:	Yes All host seed to be tested in accordance with ISTA 7-026 method of ELISA on a sample of 9,400 seeds and national seed testing guidelines for CGMMV.	Yes All host seed to be tested in accordance with ISTA 7-026 method of ELISA on a sample of 9,400 seeds and national seed testing guidelines for CGMMV. Certification required from CPHM.	Yes All host seed to be tested in accordance with ISTA 7-026 method of ELISA on a sample of 9,400 seeds and national seed testing guidelines for CGMMV. Certification required from CPHM.	Yes All host seed to be tested in accordance with ISTA 7-026 method of ELISA on a sample of 9,400 seeds and national seed testing guidelines for CGMMV. Certification required from CPHM.	Yes All host seed to be tested in accordance with ISTA 7-026 method of ELISA on a sample of 9,400 seeds and national seed testing guidelines for CGMMV.	No
Nursery Stock (tissue culture and seedlings) Control required: Action:	Yes Controls on Nursery Stock of host plants. Imports of nursery stock for host plants	Yes Controls on Nursery Stock of host plants from infected states. CPHM certification required.	Yes Controls on Nursery Stock of host plants from infected areas. Jurisdiction to manage on a situational basis	Yes Controls on Nursery Stock of host plants from infected properties. Jurisdiction to manage on a situational basis	No If outside of infected region Supported by proof of area freedom.	No

	currently suspended.					
Fruit*						
Control required:	No	No	No	No	No	No
Action:	n/a	n/a	n/a	n/a	n/a	May introduce a HACCP plan for distribution points
Cucurbit plant including debris and waste from previous crops.						
Control required:	n/a	Yes	Yes	Yes	No	No
Action		Controls on movement and destruction of cucurbit plants including debris and waste from previous crops. CPHM certification required to move out of infested state.	Controls on movement and destruction of cucurbit plants. Jurisdiction to manage on a situational basis.	Controls on movement and destruction of cucurbit plants. Jurisdiction to manage on a situational basis.	Supported by proof of area freedom.	

<p>Conveyances (includes crates, boxes, bins, pallets)</p> <p>Control required:</p> <p>Action:</p>	<p>No</p>	<p>Yes</p> <p>Controls on Conveyances that may have come into contact with infected plants.</p>	<p>Yes</p> <p>Controls on Conveyances that may have come into contact with infected plants.</p> <p>Jurisdiction to manage on a situational basis.</p> <p>May be managed by via on farm biosecurity /auditable HACCP.</p>	<p>Yes</p> <p>Controls on Conveyances that may have come into contact with infected plants.</p> <p>Jurisdiction to manage on a situational basis.</p> <p>May be managed by via on farm biosecurity /auditable HACCP.</p>	<p>No</p> <p>Supported by proof of area freedom.</p> <p>May be managed by via on farm biosecurity /auditable HACCP.</p>	<p>No</p> <p>May be managed by via on farm biosecurity /auditable HACCP.</p>
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<p>Tools, equipment, machinery used on farm.</p> <p>Control required:</p> <p>Action</p>	<p>Yes</p> <p>Used machinery/equipment must be clean and free of soil.</p>	<p>Yes</p> <p>Controls on Tools, equipment, machinery used on farm that may have come into contact with infected plants or soil.</p> <p>CPHM certification required</p>	<p>Yes</p> <p>Controls on Tools, equipment, machinery used on farm that may have come into contact with infected plants or soil.</p> <p>Jurisdiction to manage on a situational basis</p> <p>May be managed by via on farm biosecurity /auditable HACCP</p>	<p>Yes</p> <p>Controls on Tools, equipment, machinery used on farm that may have come into contact with infected plants or soil.</p> <p>Jurisdiction to manage on a situational basis</p> <p>May be managed by via on farm biosecurity /auditable HACCP.</p>	<p>No</p> <p>Supported by proof of area freedom.</p> <p>May be managed by via on farm biosecurity /auditable HACCP.</p>	<p>No</p>
<p>Transport vehicles</p> <p>Control required:</p>	<p>No</p>	<p>No</p> <p>To be managed at property level.</p>	<p>No</p> <p>To be managed at property level.</p>	<p>No</p> <p>To be managed at property level.</p>	<p>No</p> <p>To be managed at property level.</p>	<p>No</p> <p>To be managed at property level.</p>

Personnel						
Control required:	No	No	No	No	No	No
Bees						
Control required:	Yes	Yes	Yes	Yes	No	No
Action	Post-entry quarantine required for any imported bees.	Controls on bee hives that may have been used to pollinate infected plants. Testing of bee hives for presence of CGGMV required as per NT procedure.	Controls on bee hives that may have been used to pollinate infected plants. Jurisdiction to manage on a situational basis.	Controls on bee hives that may have been used to pollinate infected plants Jurisdiction to manage on a situational basis.	If outside of infected region Supported by proof of area freedom.	
Domestic livestock, pest animals						
Control required:	n/a	No	No	No	No	n/a
Action		To be managed at property level.	To be managed at property level.	To be managed at property level.	To be managed at property level.	

Weeds	n/a	No. To be managed at property level.	No To be managed at property level.	No To be managed at property level.	No To be managed at property level.	n/a
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*Controls on fruit may change subject to international trading requirements.

A suite of decision making tools underpinned by the HACPP approach have been developed to assist growers to identify the risks on their properties and the steps needed to control them. The Decision Tree in Appendix 3 is intended as a resource for reducing the risk of CGMMV transmission and should be used as a component of state or territory CGMMV Operational Plans. The Decision Tree has been developed to be used in concert with the CGMMV Biosecurity Action Planner (Appendix 5) and Checklist (Appendix 6).

4.4 Importation of Seed into Australia

CGMMV can be transmitted in seed. Imported seeds must either be:

- a) Tested by ELISA using a sample size of 9,400 seeds following the protocol of the International Seed Testing Association (ISTA) '7-026 Detection of Squash mosaic virus, Cucumber green mottle mosaic virus and Melon necrotic spot virus in cucurbits'. The testing of seeds may be conducted offshore or onshore.

Where tested offshore, seed must be accompanied by an official government phytosanitary certificate and/or laboratory test certificate.

OR

- b) For specified small seeds lots, the seed must be ELISA tested in Australia at Department of Agriculture recognised laboratory using 20% of the seed.

A method of testing for the detection of CGMMV in cucurbit host seeds using Polymerase Chain Reaction (PCR) is still under development.

Cucurbit seed varieties that need to be tested are outlined in Table 2.

Table 2: Seed varieties to be tested.

Common Name	Scientific Name	Small seed lot weight
Cucumber	<i>Cucumis sativus</i>	2kg or less
Melon (Rockmelon & Honeydew)	<i>Cucumis melo</i>	2kg or less
Watermelon	<i>Citrullus lanatus</i>	3kg or less
Zucchini, Squash, Pumpkin	<i>Cucurbita pepo</i>	10kg or less
Pumpkin	<i>Cucurbita maxima</i>	10kg or less
Pumpkin	<i>Cucurbita moschata</i>	10kg or less
Bottle gourd	<i>Lagenaria siceraria</i>	5kg or less
Serpent gourd	<i>Trichosanthes cucumerina</i>	5kg or less

At this stage *Luffa* varieties and other related Asian-style vegetables do not require seed testing. Seeds classed as 'heritage seeds' can be kept if grown from a healthy crop but growers are advised not to share the seeds in case of contamination. Sharing of seeds is not advised and you do so at your **OWN RISK**.

Check with BICON at <http://biconnet.daff.gov.au/BICONWeb/> for current standards and testing requirements for each species/variety before submitting samples.

A national diagnostic protocol for seed is currently being finalised. Until a final National Diagnostics Protocol for CGMMV is endorsed, an interim testing protocol is being applied by diagnostic laboratories for testing of bulk seed samples.

4.5 Importation of Tissue Culture Material into Australia

Known hosts are *Benincasa hispida*, *Citrullus lanatus*, *Cucumis anguria*, *Cucumis sativus*, *Cucumis melo*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Luffa acutangula*, *Luffa cylindrica*, *Momordica*

charantia and *Trichosanthes cucumerina*. The importation of these species as tissue culture and nursery stock has been suspended until further notice.

4.6 Moving Plant Material, Soil, Machinery and Bee Hives within Australia

Movement of plant material, soil, machinery and bee hives may differ between states and territories. For further information about specific requirements regarding the movement of plant material, soil, machinery and bee hives within Australia, growers are encouraged to check with local biosecurity officers or refer to the following websites.

Tasmania (Tasmanian Biosecurity Import Requirements Database)

<http://imports.dpipwe.tas.gov.au/ImportRx.nsf>

Northern Territory (Contact NT Quarantine) <https://nt.gov.au/industry/agriculture/food-crops-plants-and-quarantine/plants-and-quarantine/plant-quarantine-contacts-and-plant-inspectors>

New South Wales (Plant Quarantine Manual) <http://www.dpi.nsw.gov.au/content/biosecurity/plant>

Queensland (Queensland Biosecurity Manual)

https://www.daf.qld.gov.au/data/assets/pdf_file/0004/379138/QLD_Biosecurity_Manual_2016.pdf

Victoria (Plant Quarantine Manual) <http://agriculture.vic.gov.au/agriculture/horticulture/moving-plants-and-plant-products/importing-plants>

Western Australia (Import Requirements Database) <https://www.agric.wa.gov.au/iaquarantine/>

South Australia (Plant Quarantine Standard) http://www.pir.sa.gov.au/biosecurity/plant_health

5 Surveillance

5.1 National Surveillance

A national surveillance protocol for CGMMV is currently being developed by the Subcommittee on National Plant Health Surveillance, and will provide a common framework for undertaking CGMMV surveillance. It will ensure consistency, alignment with national and international standards and provide a level of confidence for claiming pest free status if this becomes necessary for the purposes of international trade. When the national protocol is finalised it will be appended to this plan.

5.2 On-Farm Surveillance

During routine surveillance, growers should record all observations including a lack of detection as this information may become a crucial component of supporting international market access.

An easy to use, rapid diagnostic kit from Agdia®, the ImmunoStrip® is commercially available. This type of test can be useful for developing a preliminary diagnosis. These diagnostic kits are not a definitive test for the presence or absence of CGMMV due to the number of other viruses that are similar to CGMMV. Should growers suspect a CGMMV infestation, they should immediately apply strict biosecurity protocols to limit the potential spread on any infestation. If concerned, growers can submit a sample of symptomatic tissue to the biosecurity authority in the state or territory that it occurs. However, growers are encouraged to contact the local biosecurity office in the first instance. Details for state diagnostics agencies can be found in the Risk Mitigation Summary Guide found in Appendix 7.

6 On-Farm Management

Once a crop is infested with CGMMV, the risk of spread throughout the crop is likely to be high and it may remain viable in the soil for many years even after the crop has been destroyed. Crop infection should be carefully managed to prevent spread of the virus.

Growers can implement simple procedures to prevent the movement of CGMMV onto or off their properties:

- a) Use seed from a reputable producer that has been adequately tested for CGMMV;
- b) If transplants are used, ensure that they are inspected for the disease prior to planting;
- c) Follow good sanitation and cultural practices that include controlling weeds, especially cucurbit species that border fields, and chewing insects as a precaution;
- d) Inspect fields for symptoms at regular intervals;
- e) Take plant tissue samples and have a diagnostic analysis completed on suspect plants;
- f) Restrict farm visitor access;
- g) Clean and disinfect tools, clothing and machinery before these leave the property.

When managing a new CGMMV detection:

- a) Wear gloves and protective clothing and place plants in bags for disposal;
- b) Dispose of plant material by burning or deep burial;
- c) Sanitise equipment used in conjunction with infected plants;
- d) Restrict contractors and visitors entering the farm.

A decision tree is provided in Appendix 3 to assist growers to determine the risk of CGMMV on their property and how to manage the risk. A simple On-Farm Risk Mitigation Summary Guide can be found in Appendix 7.

7 Roles and Responsibilities

To manage CGMMV effectively, each section of the management hierarchy has roles and responsibilities. The management hierarchy includes partners at the national, state/territory, industry and individual grower level. These roles and responsibilities are outlined in Table 3.

Table 3: Roles and responsibilities for Management of CGMMV

Activity	Grower Responsibility	Peak Industry Body Responsibility	State and Territory Government Responsibility	Australian Government Responsibility
Monitoring, surveillance and diagnostics	<p>Understanding of signs and symptoms of infection.</p> <p>Monitoring crops for infection.</p> <p>Collecting and submitting samples for testing where there is concern that a crop may be infected.</p>	<p>Development of CGMMV awareness material for growers.</p> <p>Encouraging grower support for the Plan.</p> <p>Coordinating and facilitating grower involvement in applicable surveillance programs.</p>	<p>Development of National Surveillance Protocol</p> <p>Providing guidance on development of awareness material for growers.</p>	<p>Development of National Surveillance Protocol</p> <p>Providing guidance on development of awareness material for growers.</p>
	<p>Be aware of infection symptoms Provide feedback on effectiveness and currency of awareness material.</p> <p>Be aware of procedures for appropriate collection and transport of samples.</p>	<p>Identify and contribute to RD&E that would improve diagnostic methods.</p> <p>Contribute to development of national protocols for diagnostics of CGMMV.</p>	<p>Provide diagnostic services to growers.</p> <p>Finalise the National CGMMV Diagnostic Protocol.</p> <p>Identify and contribute to RD&E that would facilitate continued development of diagnostic methods for CGMMV.</p>	<p>Finalise the National CGMMV Diagnostic Protocol.</p> <p>Identify and contribute to RD&E that would facilitate continued development of diagnostic methods for CGMMV.</p>
Reporting	<p>Report suspect detection to biosecurity agency in the state/ territory where it occurs via the Exotic Plant Pest Hotline 1800 084 881.</p>	<p>Report suspect detection to Chief Plant Health Manager in the affected jurisdiction.</p>	<p>Reporting of new infestations of CGMMV beyond existing areas of infestation.</p>	<p>Report national and regional plant CGMMV status to international community.</p>

<p>CGMMV onshore management</p>	<p>Implementing appropriate on-farm biosecurity procedures for control of the pest in accordance with guidelines in the Plan.</p>	<p>Continued management of CGMMV in accordance the nationally agreed measures.</p> <p>Develop and coordinate awareness and general on farm biosecurity best practice training.</p> <p>Contributing development and ongoing review/maintenance of the Plan.</p> <p>Ensuring the Plan is published, publicised and accessible to growers.</p> <p>Promotion of farm biosecurity practices, in accordance with the Plan.</p>	
<p>CGMMV offshore risk management</p>	<p>n/a</p>	<p>n/a</p>	<p>Advise on risk requirements to support market access.</p> <p>Maintain measures to minimise CGMMV risk on imports as appropriate.</p> <p>Maintain and communicate Australia's plant pest status with respect to CGMMV.</p> <p>Advise on minimum requirements to support export market access.</p>

8 References

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9 Appendices

Appendix 1 - CGMMV Scientific Advice

Revised as at 12 September 2016

Scientific advice relating to *Cucumber Green Mottle Mosaic Virus* (CGMMV)

The CGMMV Risk Assessment Working Group was established to provide **scientific advice** on CGMMV with a view to gaining national agreement on hosts, risk material and risk pathways that support the development of the national CGMMV management strategy.

The seven questions asked of the group and the group's responses are provided below.¹ This advice and the relevant sections in the management plan will be updated to include information about risk management in other countries as that information comes to hand.

Context

It is essential that risk material and pathways for CGMMV be identified as they provide the foundation for any trade restrictions, movement controls and biosecurity risk management practices. A CGMMV Risk Assessment Working Group was established to provide scientific advice on CGMMV with a view to gaining national agreement on hosts, risk material and risk pathways that support the development of the national CGMMV management strategy. The group has agreed to the following information based on expert opinion for determining hosts, risk materials, risk pathways and level of risk.

Questions

1. Hosts for CGMMV

Cucumber green mottle mosaic virus (CGMMV) has a narrow host range mainly within the family Cucurbitaceae (Hollings et al. 1975). The family Cucurbitaceae has 122 genera and 960 species (Mabberley 2008), however; not all of these genera or species are commonly cultivated (McCormack

¹ The approach used by the working group is outlined in the Method for collating scientific advice relating to *Cucumber green mottle mosaic virus* (CGMMV). This approach differs to the Department of Agriculture's Pest Risk Assessment methodology for plant imports into Australia as follows:

- Australia undertakes Pest Risk Analyses, including the Pest Risk Assessment stage, in accordance with the International Standards for Phytosanitary Measures. The international definition of a pest risk assessment for quarantine pests is the 'evaluation of the probability of the introduction and spread of a pest and of the magnitude of the associated potential economic consequences'. The pest risk assessment provides technical justification for identifying quarantine pests and for establishing phytosanitary import requirements.
- Australia uses a risk estimation matrix to combine the estimates of the probability of entry, establishment, spread and the overall consequences of a pest, to determine the unrestricted risk estimate.
- The World Trade Organisation Sanitary and Phytosanitary Agreement (WTO SPS Agreement) defines the concept of an 'appropriate level of sanitary or phytosanitary protection (ALOP)' as the level of protection deemed appropriate by the WTO member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. Australia's ALOP is aimed at reducing risk to a very low level, but not to zero.
 - If the unrestricted risk estimate is very low or negligible, then risk management measures are not required.
 - If the unrestricted risk estimate is low, moderate, high or extreme, then risk management measures are required.
 - If Australia estimated that CGMMV had an unrestricted risk estimate of 'low' risk for a particular commodity, then risk management measures would be required to manage the risk to at least a very low level. In contrast, it is noted that pathways that are considered to have a low risk for the "Scope of Risk Management" document (e.g. volunteer plants within infected properties from infected crops) may not require risk management measures.

2005; Freeman et al. 2015). There is suspicion that all cucurbits could be infected by CGMMV, however the following list of hosts is used as the basis for this paper and is supported by scientific literature as at September 2015. According to the published evidence not all of these genera or species within the family Cucurbitaceae are natural hosts of CGMMV. The table below lists the natural hosts of CGMMV and known seed-borne hosts of this virus are in bold type.

Table 1 Natural hosts of CGMMV and its association with host seeds

Scientific name	Common name (s)	Natural host of CGMMV	Seed-borne
CROPS			
<i>Benincasa hispida</i> (Thunberg) Cogniaux [Cucurbitaceae]	Ash gourd, Wax gourd, White gourd	Yes (Noda et al. 1993)	No evidence of CGMMV being seed-borne in this species.
<i>Citrullus lanatus</i> (Thunberg) Matsumura & Nakai [Cucurbitaceae]	Watermelon	Yes (Lee et al. 1990; Yoon et al. 2008; Reingold et al. 2015)	Yes (Lee et al. 1990; Yoon et al. 2008).
<i>Cucumis anguria</i> Linnaeus [Cucurbitaceae]	Bur cucumber, West Indian gherkin	Yes (Rashmi et al. 2005)	No evidence of CGMMV being seed-borne in this species.
<i>Cucumis melo</i> Linnaeus [Cucurbitaceae]	Cantaloupe, Melon	Yes (Sugiyama et al. 2006; Tian et al. 2014; Reingold et al. 2015)	Yes (Tian et al. 2014; Reingold et al. 2015).
<i>Cucumis sativus</i> Linnaeus [Cucurbitaceae]	Cucumber	Yes (Liu et al. 2014)	Yes (Faris-Mukhayyish & Makkouk 1983; Liu et al. 2014).
<i>Cucurbita maxima</i> Duchesne [Cucurbitaceae]	Buttercup squash, Kabotcha, Pumpkin	Yes (Stephen West [NT Department of Primary Industry and Fisheries (DPIF)] 2015, pers. comm., 9 September)	Yes (Fiona Constable [Department of Economic Development, Jobs, Transport and Resources, Victoria (DEDJTR)] 2015, pers. comm., 2 December).

Scientific name	Common name (s)	Natural host of CGMMV	Seed-borne
<i>Cucurbita maxima</i> Duchesne x <i>Cucurbita moschata</i> Duchesne [Cucurbitaceae]	Kabotcha, Pumpkin	Yes (Fiona Constable [DEDJTR] 2015, pers. comm., 2 December)	Yes (Fiona Constable [DEDJTR] 2015, pers. comm., 2 December).
<i>Cucurbita moschata</i> Duchesne [Cucurbitaceae]	Butternut pumpkin, Butternut squash, Calabaza pumpkin, Pumpkin, Tropical pumpkin	Yes (Noda et al. 1993; Zhang et al. 2009)	Yes (Fiona Constable [DEDJTR] 2015, pers. comm., 2 December).
<i>Cucurbita pepo</i> Linnaeus [Cucurbitaceae]	Acorn squash, Pumpkin, Summer squash, Zucchini	Yes (Qin et al. 2005; Al-Tamimi et al. 2009)	Yes (Al-Tamimi et al. 2009; Kwon et al. 2014).
<i>Lagenaria siceraria</i> (Molina) Standley [Cucurbitaceae]	Bottle gourd, Calabash, Korean native gourd, Long melon	Yes (Boubourakas et al. 2004; Zhang et al. 2009)	Yes (Choi 2001; Boubourakas et al. 2004).
<i>Luffa acutangula</i> (Linnaeus) Roxburgh [Cucurbitaceae]	Angled luffa, Chinese okra, Ridged gourd	Yes (Noda et al. 1993; Sharma et al. 2014)	No evidence of CGMMV being seed-borne in this species.
<i>Luffa cylindrica</i> (Linnaeus) Roemer [Cucurbitaceae]	Smooth loofah gourd	Yes (Noda et al. 1993)	No evidence of CGMMV being seed-borne in this species.
<i>Momordica charantia</i> Linnaeus [Cucurbitaceae]	Balsam apple, Balsam pear, Bitter gourd, Bitter melon	Yes (Pandey & Joshi 1989; Noda et al. 1993)	No evidence of CGMMV being seed-borne in this species.
<i>Trichosanthes cucumerina</i> Linnaeus [Cucurbitaceae]	Serpent gourd, Snake gourd	Yes (Nagendran et al. 2015)	Yes (Ariyaratne et al. 2005).
WEEDS			
<i>Amaranthus blitoides</i> Watson [Amaranthaceae]	Mat amaranth, Prostrate amaranth	Yes (Boubourakas et al. 2004)	No evidence of CGMMV being seed-borne in these species.
<i>Amaranthus retroflexus</i> Linnaeus [Amaranthaceae]	Redroot amaranth, Redroot pigweed	Yes (Boubourakas et al. 2004)	

Scientific name	Common name (s)	Natural host of CGMMV	Seed-borne
<i>Amaranthus viridis</i> Linnaeus [Amaranthaceae]	Green amaranthus	Yes (Stephen West [NT DPIF] 2015, pers. comm., 9 September)	
<i>Chenopodium album</i> Linnaeus [Chenopodiaceae]	Fat hen	Yes (Boubourakas et al. 2004)	No evidence of CGMMV being seed-borne in this species.
<i>Ecballium elaterium</i> (Linnaeus) Richard [Cucurbitaceae]	Squirting cucumber	Yes (Antignus et al. 1990)	No evidence of CGMMV being seed-borne in this species.
<i>Heliotropium europaeum</i> Linnaeus [Boraginaceae]	Common heliotrope	Yes (Boubourakas et al. 2004)	No evidence of CGMMV being seed-borne in this species.
<i>Heracleum moellendorffii</i> Hance [Apiaceae]	Duan mao du huo, Eosuri	Yes (Cho et al. 2015)	No evidence of CGMMV being seed-borne in this species.
<i>Portulaca oleracea</i> Linnaeus [Portulacaceae]	Parsley, Pigweed, Purslane	Yes (Boubourakas et al. 2004)	No evidence of CGMMV being seed-borne in this species.
<i>Solanum nigrum</i> Linnaeus [Solanaceae]	Blackberry nightshade, Black nightshade	Yes (Boubourakas et al. 2004)	No evidence of CGMMV being seed-borne in this species.

CGMMV is reported to be seed-borne in the host taxa in **bold**.

Hybrids (for example, *Cucurbita moschata* x *maxima*) are proposed to be natural hosts if at least one of the parents is a natural host of CGMMV.

Experimental hosts and diagnostic hosts, such as *C. amaranticolor*, *Datura stramonium*, *Petunia* hybrids and other species, should not be assumed to be natural hosts, and should not be considered to have the same risk profile as natural hosts.

Response

a) Expert opinion

The specific plant host range of CGMMV is not clear due to the number of different strains of the virus recorded internationally

- Different virus strains may impact on different host species in different ways
- Insufficient work has been done to determine exactly which virus strains infect a particular host species/cultivar
- The number of virus strains in Australia remains unclear
- Genetic testing to date has shown the NT strain of CGMMV closely matches several strains (99%) but clusters with the Indian Bottle gourd strain. The NT strain, however, is being observed in different host species than those reported in the literature for the Indian Bottle Gourd Strain e.g. *Cucurbita moschata* (butternut)
- Current evidence suggests one strain of the virus exists in production crops, but it is not certain if this is the case in weed hosts.

b) R&D needs

- Highest priority is given to verification of production hosts:
 - This would be short term research (i.e. could be performed quite quickly)
 - priority should be for production cucurbits then weeds
- Characterise strains present in Australia.
- Inoculate a range of hosts (including Australian weeds) with those strains.
- Determine if Australian weeds are transmission hosts via seed and other tissues.

Note:

The CGMMV research needs, highlighted by the group, has been captured within a research grant proposal submitted to HIAL. The project will be led by the NT with collaboration from QLD, VIC, WA and NSW.

2. The risk of cucurbits that are not known to be hosts

Cucurbits that are not known to be a host include species from the following genera (APNI, 2014):

- *Coccinia* Scarlet gourd
- *Diplocyclos* Genus of climbing or trailing vine
- *Muellerargia* Native species
- *Austrobryonia* Native species- prostrate herb
- *Nealsomitra* Native species
- *Nothalsomitra* Subtropical vine
- *Sechium* Chayote
- *Sicyos* Burr cucumbers
- *Zehneria* Flowering vines

Response

The risk of unknown host cucurbits in the establishment and spread of CGMMV is negligible.

a) Expert Opinion:

- The genera above are not known to be a host for CGMMV
- Our considerations have not included these not known hosts

b) R&D needs:

- Verify the status of known (or suspected) non-hosts that occur in Australia, including weeds, in transmission trails.

3. Risk material (pathway) and level of risk associated with each host

CGMMV is seed-borne in some hosts and infects natural cucurbitaceous host plants systemically (Moreno et al. 2004). Therefore, propagative material (nursery stock, tissue culture and seeds) are potential risk pathways for the introduction and spread of CGMMV within Australia.

Only natural crop hosts have been considered in the response to this question. Experimental, weed and alternative hosts have been assessed as providing a low/negligible risk and may not need to be managed.

The risk material for CGMMV host crops is provided below:

Host	Risk material (pathway)
<i>Benincasa hispida</i>	Fruit, Nursery stock, tissue culture
<i>Citrullus lanatus</i>	Fruit, Nursery stock, tissue culture and seeds
<i>Cucumis anguria</i>	Fruit, Nursery stock, tissue culture
<i>Cucumis melo</i>	Fruit, Nursery stock, tissue culture and seeds
<i>Cucumis sativus</i>	Fruit, Nursery stock, tissue culture and seeds
<i>Cucurbita maxima</i>	Fruit, Nursery stock and tissue culture and seeds
<i>Cucurbita moschata</i>	Fruit, Nursery stock and tissue culture and seeds
<i>Cucurbita maxima x Cucurbita moschata</i>	Fruit, Nursery stock and tissue culture and seeds
<i>Cucurbita pepo</i>	Fruit, Nursery stock, tissue culture and seeds
<i>Lagenaria siceraria</i>	Fruit, Nursery stock, tissue culture and seeds
<i>Luffa acutangula</i>	Fruit, Nursery stock and tissue culture
<i>Luffa cylindrica</i>	Fruit, Nursery stock and tissue culture
<i>Momordica charantia</i>	Fruit, Nursery stock and tissue culture
<i>Trichosanthes cucumerina</i>	Fruit, Nursery stock, tissue culture and seeds

See section 5 for level of risk associated with host.

Response

- There is evidence that fruit carries the virus. The developmental stage at which the plant was infected will determine whether the fruit is infected (Dombrovsky 2014).
- Fruit that tested positive from the Northern Territory are watermelon and butternut pumpkin. This testing was conducted in both Victoria and South Australia (SA watermelon only).
- Infected fruit is a source of potential infection
- Infected fruit is likely to be symptomatic, and therefore unsaleable. Unsaleable fruit could be removed from the pathway at the farm, wholesale or retail stage.
- Unsaleable fruit that leaves the farm is likely to be returned to the grower (wholesale) or disposed of in municipal waste disposal systems (retail).
- There are multiple pathways, through contact, for CGMMV infection to transmit from an infected fruit to a new host– see sections 4, 5 & 6.
- Seedless fruit has no difference in risk than seeded fruit in terms of the flesh and rind carrying the virus (in plant tissue). The difference is the reduced number of viable seeds.
- Infected asymptomatic fruit is a risk material.
- Seed from an infected host may be a carrier of the virus. Depending upon the stage of development of the plant, a proportion of the seed in an infected fruit, may also be infected.
- Regardless of whether the seed is retail or commercial, it may carry the virus. All of these lines are tested in the same manner. (ISTA 7-026 ELISA test). The minimum sample size tested is dependent on lot size, but does not vary between retail or commercial seed. However there may be other sources of seed not currently captured. For instance, non-commercial seed may be purchased over the internet and mailed to Australia. However, all CGMMV host seed from any source that is imported into Australia with a Phytosanitary Certificate will be tested in the same manner; therefore, there is no difference in risk. CGMMV host seed that is not accompanied by a Phytosanitary Certificate will be screened at the Australian border; the seed would then be either subjected to testing, exported out of Australia or seized and destroyed.
- Seed imported prior to 4 November 2014 remains a possible source of virus; which will diminish as stocks are used. Note: up to 14 July 2015 there have been 283 imported seed sample submissions that have tested negative. Mandatory testing of imported seed came into effect on 4 November 2014. It is noted that to date seed lots with very low levels of infection have been detected on-shore by Australia’s emergency measures.
- Seed domestically produced is a potential source of the virus. There is some testing domestically with confirmed testing to be 288 sample submissions with the total number of 6761 seed sub-samples (up to 100 seed each) tested between 1 October 2014 and 14 July 2015.

a) Expert Opinion

Define resistance, immunity and tolerance (ISPM 5). Please note that these terms are not defined in ISPM 5. The International Seed Federation uses the following definitions (ISF 2012):

- **Resistance:** *“The ability of a plant variety to restrict the growth and development of a specified pest and/or the damage they cause when compared to susceptible plant varieties under similar environmental conditions and pest pressure. Resistant varieties may exhibit some disease symptoms or damage under heavy pest pressure. Two levels of resistance are defined.*

High resistance (HR*): *Plant varieties that highly restrict the growth and development of the specified pest under normal pest pressure when compared to susceptible varieties. These plant varieties may, however, exhibit some symptoms or damage under heavy pest pressure.*

Intermediate resistance (IR*): *Plant varieties that restrict the growth and development of the specified pest but may exhibit a greater range of symptoms or damage compared to high resistant varieties.*

Intermediately resistant plant varieties will still show less severe symptoms or damage than susceptible plant varieties when grown under similar environmental conditions and/or pest pressure.”

- **Immunity:** *“When a plant is not subject to attack or infection by a specified pest.”*
- **Tolerance:** *“The ability of a plant variety to endure abiotic stresses without serious consequences for growth, appearance and yield.”*

N.B. ISF (Vegetable and Ornamental Crops section) recommends that vegetable seed companies use the terms susceptibility, high or intermediate resistance, and immunity to describe the reaction of plants to pests and should avoid the term tolerance for this purpose.

- **Susceptibility:** *“The inability of a plant variety to restrict the growth and development of a specified pest.”*

b) R&D needs

- Need to validate the PCR test on seed (currently funded through Plant Biosecurity CRC)

Approaches undertaken in other countries:

- Meaningful exchange of information with Israel (Dr Dombrovsky), noting that in-country seed testing occurs in Israel
- No information available from other countries (California –USA , Canada, South Korea, Central America)

Note:

- Australia’s import conditions require seed testing for all host species for which there is scientific evidence that CGMMV is associated with the seed. There are approximately 960 species of cucurbits; CGMMV is only reported to be associated with the seed of nine of these species. This includes the following taxa, which are all tested for CGMMV under Australia’s current import conditions:

- *Citrullus lanatus*
- *Cucumis melo*
- *Cucumis sativus*
- *Cucurbita maxima*
- *Cucurbita moschata*
- *Cucurbita maxima* x *Cucurbita moschata*
- *Cucurbita pepo*
- *Lagenaria siceraria*
- *Trichosanthes cucumerina*.

Please note that Australia is a member of the World Trade Organisation and must follow internationally agreed plant health standards and guidelines when developing import conditions. These standards require that import conditions are justified by scientific evidence, and are applied at the species level, unless there is sound scientific justification to regulate at a higher or lower taxonomic level. If Australia does not follow its international obligations, other countries have the right to bring the case to the WTO for dispute settlement.

- The common name pumpkin applies to multiple species within Australia and can apply to a range of different species worldwide. Australia currently regulates the importation of pumpkin seeds of the taxa *Cucurbita maxima*, *C. moschata* and *C. pepo*.
- Hybrids whose parentage includes at least one regulated species are subject to regulation by default.

4. Mechanisms of natural spread (e.g. weeds, wildlife, bees etc.)

The mechanisms of natural spread are:

- Seed transmission (Liu et al. 2014)
- Debris and waste from infected plants (Hollings et al. 1975)
- Contaminated soil (Hollings et al. 1975)
- Contaminated water (Hollings et al. 1975)
- Mechanical transmission (e.g. tools, equipment, machinery) (Hollings et al. 1975)
- Contaminated hands and clothes of people (Hollings et al. 1975)
- Pollen (Liu et al. 2014) -

Response

Sources of infection for the above mechanisms include crops and weeds (refer to point 1 – Hosts for CGMMV)

- There is no clear evidence to support bees and insects as mechanisms to spread the virus, noting Dr Dombrovsky has no current evidence for bees. However, there is evidence of infected hives and hive material in the Northern Territory & Queensland. Bees are used as cucurbit pollinators and therefore pose a potential risk to the spread of the virus between properties, regions and possibly states.
- The contribution of wildlife to the spread of CGMMV whilst possible, is difficult to determine in the absence of available research.
- A differential outcome is expected for the spread of the virus from an infected area to a non-infected area by natural spread agents.

a) Expert Opinion:

As above

b) R&D needs:

- High priority is given to determining the ability of infected hives to act as a source of the virus.
- There has been additional work on this by Dr Dombrovsky. Bees can mechanically transmit the virus within a field. What remains unknown is if the bees from a hive that is infected can spread the virus further. This is the greater risk as the hives are often moved long distances.

5. The level of risk associated with backyard and non-commercial plantings (including composting)

Response

a) Expert Opinion:

- There is negligible likelihood of transmission of the virus from infected backyards and community gardens into commercial production. See diagram 1

CGMMV Infection Pathway From Domestic to Commercial Production

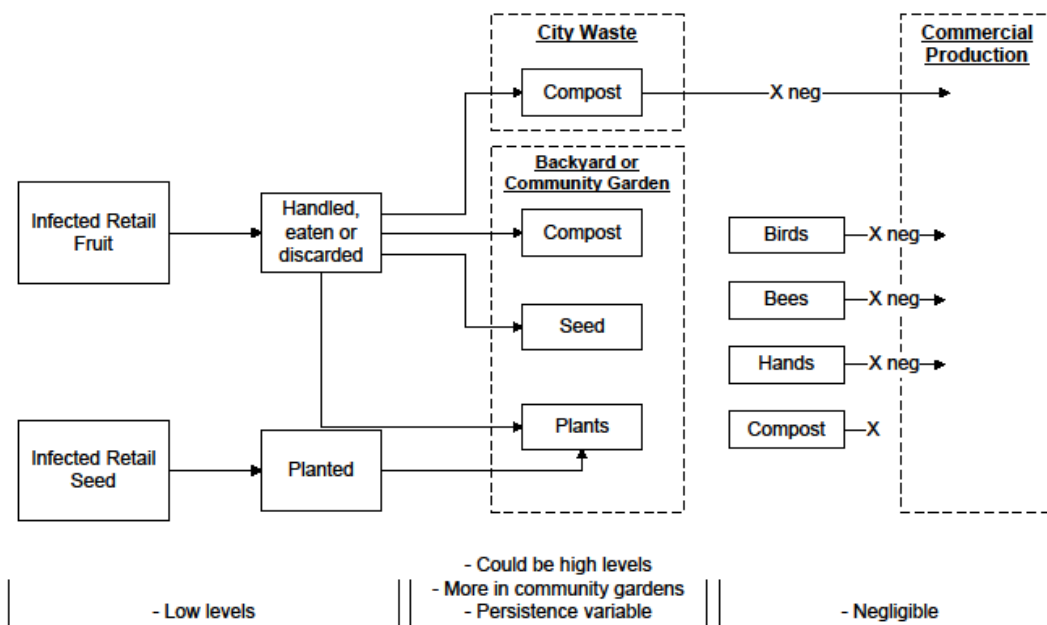


Diagram 1

- Backyards and community gardens may become infected from seed or from infected fruit from commercial production.
- It is likely that infected fruit, if in retail circulation will end up in a backyard or community garden.
- Mechanical transmission as a result of handling infected fruit, and then handling other host material in the yard is also possible.
- The propagation of retail seed from infected lines is a diminishing likelihood as pre October 2014 stocks are used up.
- The persistence of inoculum in backyards will vary between regions where breakdown time for plant tissues varies, and is also dependent on timing of re-introduction paths. Community gardens are considered to have higher levels of inoculum than backyards, and to have an increased risk of further spread.

6. Other significant/important modes of CGMMV transmission need to be managed (e.g. soil, packaging, bins, transport etc)

For the following modes of transmission, what is the likelihood that the virus will enter a production environment if no mitigation methods are applied.

Mode of transmission	Likelihood
Seed	High - direct pathway to production system
Seedlings	High - direct pathway to production system
Plant debris and waste from pervious infected crop	High - direct pathway to production system
Movement of soil (on equipment, fruit, machinery, people)	High - direct pathway to production system
Water	Low to high dependant on the production system
Tools, equipment, machinery used on farm	High - many months persistent
Conveyances (e.g. fruit trays, packaging, bins , pallets etc)	See diagram 2 below.

Conveyances

	Back to farm	Re-used in supply chain	Likelihood is pathway for infection	Notes
Crate*	✓	✓	High	Property based, may be multiple properties, risk to growers
Box (from crate to market)	X	X	Neg	
Bins (to market)	X	✓	Low	Only if returns to Property
Pallet*	✓	✓	?	Dependent on life cycle of pallet. Does it return to production areas at risk?

*management required

Hands and clothes of farm personnel and visiting agronomists	High
Transport vehicles	Low - not a direct pathway
Hands and clothes of personnel in the supply chain	Low - not a direct pathway
Volunteer plants within infected properties from infected crops	Low - only one known site of infection in the Northern Territory and evidence from Dr Dombrovsky indicates 0.1% transmission from seed derived from inoculated plants.
Bees, domestic livestock, pest animals	Low

Response

- a) Expert Opinion
 - Noting that the previous SAP assumed a 2 year fallow quarantine period for infected properties based on limited information at hand.

- Expert opinion and unpublished experimental evidence from Dr Dombrovsky is that the virus is not detectible after a period in the order of 6-8 months. Dr Dombrovsky's opinion is that due to the Northern Territory's environmental conditions (wet and high microbial activity) that this period would be shorter.
- The Northern Territory is undertaking soil tests to determine the situation under Australian Northern Territory conditions.

b) R&D needs

- Optimisation of soil test for the virus and a method for testing soil
- Implementation of tests to prove production area freedom.
- Identification of non - host rotations.

Approaches undertaken in other countries:

Dr Dombrovsky's experience is that the virus is endemic in Israel and there are no restrictions in place. Restrictions are in place in California USA, and some inter province restrictions in Canada.

7. Factors that need to be considered for trade (both interstate and international)

a) Expert Opinion

- The factors that need to be considered for trade include:
 - Maintain a pathogen tested seed supply.
 - An agreed diagnostic protocol for seed.
 - Pest free places of production.

b) R&D needs

- Agreed diagnostic protocol for seed and plant material.

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Appendix 2 - Symptoms of CGMMV Virus Infection



Watermelon



Melon



Pumpkin



Bottle gourd



Cucumber

Appendix 3 - Decision Tree for Management of CGMMV

	Assessing Risk	Answer	Action	Comments
1	Am I in a State with CGMMV?	Yes	Go to 3	
		No	Go to 2	
2	Have I received any used packaging on my farm or received vehicles or people from an infected property or state?	Yes	Go to 3	
		No	Go to 5	see Note 1 - Transmission
3	Has my property been tested for CGMMV?	Yes	Go to 4	
		No	Go to 5	see Note 2 - Testing agencies
4	Was the test negative?	Yes	Go to 6	
		No	Liaise with State Biosecurity or PIB for Quarantine status	see Note 3 - Replanting
		No result yet	Assume infected until result known	
5	Did the seed I am using enter Australia prior to November 4, 2014?	Yes	Do not plant seed unless tested	see Note 1 - Transmission
		No	Go to 6	
		Unsure	Contact supplier	
6	Have I planted untested seed of the varieties implicated in CGMMV in the past three years, (eg variety trials), or observed any symptoms in crops in the last three years consistent with CGMMV infection?	Yes	There is potential for infection to exist. Check susceptible weed species around planted area. Consider testing soil from planted area for testing and also planting indicator species in soil collected from same areas. Go to 8	
		No	Go to 7	See Note 4 Indicator Species
		Unsure	Go to 8	
7	Unlikely to have CGMMV on farm – maintain a good On Farm Biosecurity Program	Go to 9		see note 5 Virus lifespan
8	Was CGMMV present in soil?	Yes	Liaise with State Biosecurity or PIB for Quarantine status	see Note 3 - Replanting
		No	Go to 7	
9	Do I have an on-farm Biosecurity Program?	Yes	Go to 10	
		No	Go to 11	See Note 6 On Farm Biosecurity
10	Is it up to date for CGMMV?	Yes	Ensure it is being implemented	
		No	Go to 11	
11	Develop an on-farm Biosecurity Program based upon CGMMV management template			See Note 6 - On Farm Biosecurity

Decision Tree Notes

1 Transmission Methods

CGMMV can be introduced into a crop in many ways, but use of infected seed and the movement of infected soil are the most common. CGMMV particles are very robust and they can readily infect plants, survive on surfaces and be spread by several means, including:

- infection of new plants through the contact of their roots in soil that contains plant debris from previously infected crops.
- direct infection by root-to-root contact of an infected plant, with an uninfected plant.
- in water or in nutrient solutions in soilless culture
- by mechanical transfer of infected plant sap (only microscopic amounts are needed) into wounds on healthy plants (just brushing leaves or stems and breaking plant hairs is sufficient to create wounds suitable for CGMMV transmission). This is especially important in protected or high-input culture systems where plants are frequently pruned, staked, handled or touched.
- mechanical transfer can occur via contaminated machinery, equipment, clothing, or even the hands of persons who have come in contact with infected plants.
- CGMMV particles can survive for long periods of time on surfaces such as packaging materials, and bins used for harvesting, storage or marketing fruit. Recycling of packaging materials should be avoided, unless bins etc can be thoroughly cleaned and decontaminated.
- spread in field grown crops can occur on machinery, equipment, pickers, and possibly by birds and other wildlife in the crop.
- infected rootstock plants and grafts.
- using seed harvested from infected host plants.

There are no published reports of CGMMV being transmitted by bees but there has been an indication of spread by artificial pollination under greenhouse conditions. It has yet to be established whether spread can occur via pollen naturally in the field. There are no published reports of transmission by bees under natural conditions.

Any vehicles involved in the transport of hives should be subject to the same restrictions in relation to cleaning and decontamination of other vehicles. If the hives themselves have been in physical contact with soil or cucurbits they will require disinfecting.

2 Testing Agencies

Crop Health Services
(03) 9032 7515

Send samples to:

AgriBio Specimen Reception
Main Loading Dock, 5 Ring Road,
La Trobe University, Bundoora VIC 3083

NSW Plant Health Diagnostic Service
(02) 4640 6327

Send samples to:

Sample Submissions
Elizabeth Macarthur Agricultural Institute
Woodbridge Rd
MENANGLE NSW 2568

Australia's import conditions require seed testing for all host species for which there is scientific evidence that CGMMV is associated with the seed. There are approximately 960 species of cucurbits; CGMMV is only reported to be associated with the seed of nine of these species. This includes the following taxa, which are all tested for CGMMV under Australia's current import conditions:

- *Citrullus lanatus*
- *Cucumis melo*
- *Cucumis sativus*
- *Cucurbita maxima*
- *Cucurbita moschata*
- *Cucurbita maxima x Cucurbita moschata*
- *Cucurbita pepo*
- *Lagenaria siceraria*
- *Trichosanthes cucumerina*.

3	<p>Replanting</p> <p>There is nothing to stop growers from re-planting in previously infected areas. However proving absence is very difficult. Points which growers need to consider.</p> <ol style="list-style-type: none"> (1) Current scientific information from overseas suggests that the virus can persist in the soil for up to 2 years. Whilst research is being performed in Australia to test this under Australian conditions, especially under tropical conditions some caution is needed. Growers are encouraged to collect soil from infected areas and plant some indicator species to test for infection (bioassay). Whilst this may provide an indication of the soils status it is not foolproof. Similarly testing of the soil using molecular methods may also not provide a guarantee. The best advice at this stage is that should testing using bioassay and molecular methods show no evidence then this is a strong indication of virus absence but not a guarantee. (2) Should virus be present at very low levels (below detection) then planting a host crop will only prolong the virus's existence. (3) Should the virus re-appear there will be ramifications for sale of infected fruit. <p>Planting is a business decision and is done at one's own risk.</p>
4	<p>Indicator Species*</p>
5	<p>Virus Lifespan*</p>
6	<p>On Farm Biosecurity</p> <p>Refer to the Farm Biosecurity Action Planner and Checklist for Management of CGMMV. This document can be found in the National CGMMV Management Plan.</p>
<p>*Represent gaps in our current knowledge of CGMMV. As this is a live document the relevant information will be inserted as it is received by the Working Group.</p>	
<p>Considerations</p>	
<p>What Do I Need to Know?</p> <ul style="list-style-type: none"> ○ Spread by infected seed, and contact with many materials including human skin and clothing. ○ All seed that entered Australia prior to November 4 2014 must be tested for virus, contact your State Biosecurity personnel for lab details. ○ Will persist for long periods of time. ○ Currently no Resistant Cultivars. ○ It cannot be cured. ○ Not all varieties or species show symptoms. ○ Many weeds and native species can harbour the virus. ○ Infected plants and all materials that come into contact with the virus need to be either destroyed or disinfected. ○ Vehicle and people movements need to be controlled in infected areas and between properties. ○ Do a thorough check to see if there are any potential linkages between your property and those that are or maybe infected, include all potential forms of movement and materials. 	

*Accompanying notes will be updated in line with advances in R&D.

Appendix 4 - Major Risk Pathways for Transmission

Risk	Action
<p>Vehicles and equipment Virus can remain viable on</p> <ul style="list-style-type: none"> • Organic material • Vehicle surfaces 	<p>Clean vehicles and machinery are stored at dedicated facilities on site away from growing areas.</p> <p>Equipment and dedicated farm vehicles do not move off the property and are cleaned and disinfected between use in different growing areas.</p> <p>Visitor vehicles park at designated areas and on site vehicles travel on designated pathways between growing areas to minimise interaction with farm equipment.</p> <p>Gate signs direct traffic and inform visitors about property access points, and who to contact for queries.</p>
<p>Packaging and pallets Virus can remain viable on</p> <ul style="list-style-type: none"> • Organic material • Conveyance surfaces 	<p>Packaging materials are new and never recycled. Unused boxes and bins are stored on clean hard floors in a covered area.</p> <p>Pallets are clean of organic material and soil. Dirty pallets are cleaned in the wash down area.</p>
<p>Staff and Farm Visitors Virus can remain viable on</p> <ul style="list-style-type: none"> • Hands • Clothes, especially footwear • Vehicles including tyres 	<p>Visitor clothing, footwear and tools are checked for organic matter and soil, and cleaned down before entering the farm.</p> <p>Cleaning facilities including footbaths and brushes are maintained and accessible for visitors and staff.</p> <p>Staff are trained about on-farm biosecurity practices and visitors inducted in biosecurity expectations prior to moving past the farm office.</p> <p>All visitors report to management, sign a visitor register and report previous movements in other growing regions upon entering the property.</p> <p>Gate signs direct traffic and inform visitors about property access points, designated visitor parking and restricted areas (growing areas).</p>
<p>Waste and weeds Virus can remain viable for long periods within/on</p> <ul style="list-style-type: none"> • Plant based waste • Weeds 	<p>Waste is disposed of as soon as possible and stored away from growing areas and water. Growing areas are surrounded by weed-free buffer zones.</p>
<p>Planting materials Virus can remain viable within/on</p> <ul style="list-style-type: none"> • Seed/seedlings • Fertiliser/ organic amendments where no there has been no heating involved in production 	<p>Planting material is sourced from reputable suppliers.</p> <p>Follow seed testing requirements for imported cucurbit seed as listed in BICON – Australian Biosecurity Import Conditions Database.</p> <p>Arrange testing of seed if imported into the country before November 2014.</p>

Appendix 5 - Farm Biosecurity Action Planner

<h3>Farm Biosecurity Action Planner</h3> <p>This Action Planner is a template with which you can address the risk factors in Appendix 10.4. It is designed such that you can put in your individual management action in the blank column.</p>			
Risk	Estimated risk rating* (0 = no risk, 10 = high risk)	Mitigation practices	Action
<p>Vehicle movement With multiple entry sites, vehicle access cannot be controlled, making it difficult to stop visitors moving into growing regions.</p> <p>These risks are increased when the vehicles have been exposed to different growing areas.</p>		<p>Visitor vehicles are restricted to parking only at designated areas and on site vehicles travel on designated pathways between growing areas.</p> <p>Gate signs direct traffic and inform visitors about property access points, and who to contact for queries.</p>	
<p>Vehicle hygiene Areas where organic matter can become lodged, such as tyre treads and grilles, can incubate CGMMV.</p> <p>Runoff from clean down areas can carry CGMMV.</p>		<p>Clean vehicles and equipment at dedicated on site facilities that are well maintained and away from growing areas.</p> <p>Keep dedicated equipment and vehicles for on farm use.</p>	
<p>Staff and Farm Visitors on farm Visitors and staff can carry CGMMV from other areas on the farm or other growing regions.</p> <p>Staff that are untrained in good biosecurity practices can spread diseases, pests and degrade biosecurity systems in place.</p>		<p>Visitor clothing, footwear and tools are checked for organic matter and soil, and are cleaned down before entering the farm.</p> <p>Cleaning facilities including footbaths and brushes are maintained and accessible for visitors and staff.</p> <p>Staff are inducted in on farm biosecurity practices and visitors are made aware of biosecurity expectations prior to moving around the farm.</p> <p>All visitors report to the farm office and sign a visitor register upon entering the property.</p>	

Risk	Estimated risk rating* (0 = no risk, 10 = high risk)	Mitigation practices	Action
<p>Waste Farm waste can become a breeding ground and incubation source for CGMMV.</p>		<p>Waste is disposed of as soon as possible, stored away from growing areas and water sources.</p>	
<p>Planting and packaging materials Seed, seedlings, packing materials, soil, compost and fertilizer can be a source of CGMMV.</p>		<p>Planting material is sourced from reputable suppliers and treated for pests as required.</p> <p>Any tests for the virus, eg. seed diagnostics, are kept on record.</p> <p>Packaging materials are new and never recycled. Unused boxes and bins are stored on clean hard floors in a covered area.</p> <p>Pallets are clean of organic material and soil. Dirty pallets are cleaned in the wash down area.</p>	
<p>Monitoring Lack of monitoring can lead to virus symptoms going unnoticed, allowing the virus to go unmanaged, during which time they may establish in growing regions and spread to other properties.</p> <p>Recording a <i>lack of observation</i> during regular monitoring is essential for proving property freedom.</p>		<p>Regular monitoring is carried out in crops and surrounding vegetation.</p> <p>Staff are trained to be aware of CGMMV infection symptoms.</p> <p>Posters, information pages and fact sheets are available on property to help staff identify symptoms.</p> <p>Monitoring results are documented.</p>	

<p>Growing Area regulation Unnecessary movement in growing areas can increase the risk of CGMMV transmission.</p> <p>Neighbouring properties could harbour CGMMV.</p> <p>Weeds can be an incubation source for the virus. Animals have the potential to spread the virus.</p>		<p>Gate signs direct traffic and inform visitors about property access points. There is a designated visitor parking area.</p> <p>Regular communication is maintained with neighbours regarding biosecurity procedures.</p> <p>Feral animal and weed populations are controlled.</p>	
<p>Biosecurity planning Not implementing biosecurity strategies can increase the risk of CGMMV infection, lead to higher long-term costs for managing CGMMV, and place market access at risk.</p>		<p>A biosecurity plan with prioritised actions is maintained for each growing area on your property.</p> <p>This plan is updated as goals are achieved and is integrated into the overall Farm Management Plan.</p>	
<p>Extra risk:</p>			
<p>Extra risk:</p>			

***Estimated risk rating**

The risk rating is a qualitative estimate that aims to indicate high priority areas of farm biosecurity for CGMMV. It is important to note that individual properties may face different levels of risk for each aspect of biosecurity. For this reason farm biosecurity plans should be tailored accordingly to be most effective. Attributing a value to the risk rating should be based on current knowledge of farm traffic, farm management practices, and professional advice.

Appendix 6 - Farm Biosecurity Checklist

Farm Biosecurity Checklist				
Biosecurity Practice	In place	In progress	No	N/A
Vehicle Cleaning				
Wash down facilities are provided on site for machinery, equipment and vehicles				
Run-off water from wash down facilities is collected for disposal				
Clean down facilities are located near farm entrances and away from growing areas				
A hard pad is provided in vehicle wash down area				
High pressure water and air hoses are available for removal of plant and soil from machinery, equipment and vehicles				
Wash-down facility and surrounds are inspected frequently for potential sources of contamination (eg. organic matter and host weeds)				
Records of wash down facility inspections are logged				
Machinery is inspected and disinfected before entering growing areas				
Vehicle Movement				
Visitor vehicle access is restricted to designated parking areas				
Only on-site vehicles are used to transport equipment and visitors around the farm				
Vehicle movement is kept to a minimum in growing areas				
Designated tracks are used to limit vehicle movement on growing areas				
Machinery and vehicles are cleaned before moving off property				
Staff and Farm Visitors				
Footbaths and brushes are easily accessible and used				
Visitor clothing, footwear and tools are checked for soil and organic matter before entering the farm				
Staff are trained in biosecurity and farm hygiene practices				
Visitors are inducted in biosecurity expectations prior to moving around the farm				
Visitors sign a register to monitor movements between farms				
Appropriate hygiene supplies are available to staff and visitors (hand sanitiser, gloves, foot baths)				

Contractor entry is conditional to a biosecurity induction and hygiene protocols				
Growing Areas and Controlled Access				
Signs requesting phone check in and providing farm contacts are visible at main entrances				
Farm is divided into 'zones' with restricted/ minimised people, machinery and equipment movement between zones				
A sanitation procedure is in place where there is regular movement of people, machinery or equipment between zones				
There is regular communication with neighbours regarding minimising CGMMV transmission				
Boundary fences are regularly inspected and maintained				
Vermin, feral animal, weed and wildlife populations are managed in line with regulations				
Plants and Materials				
Records of planting material are maintained				
Planting material are sourced from reputable suppliers				
Imported seed has been tested as per BICON conditions				
Seed imported before November 2014 is tested as per BICON conditions for CGMMV prior to planting				
Records of seed or seedling tests are logged				
Monitoring				
Symptom monitoring is regularly conducted in crops				
Symptom monitoring is regularly conducted in neighbouring vegetation				
Staff are trained to recognise symptoms of CGMMV infection				
Staff know how and where to report suspect plant disease symptoms				
Activities and results of CGMMV monitoring are recorded, including lack of observations				
Monitoring records are well organised and maintained				
A farm management plan is maintained for CGMMV				
Packaging and pallets				
Packaging materials are new and never recycled.				
Unused boxes and bins are stored on clean hard floors in a covered area.				
Pallets are clean of organic material and soil.				
Dirty pallets are cleaned in the wash down area.				

Appendix 7 - On-Farm Risk Mitigation Summary Guide

General Information

Do not use untested seed.

Be aware of what CGMMV looks like in crops that you grow.

Conduct visual surveillance for these symptoms.

If you see suspect symptoms get the affected plant tested.

If you have CGMMV you may be able to manage your property to eradicate it.

General Surveillance

- Be aware of what the symptoms of CGMMV are on crops that you are growing
- Visually inspect your crops throughout the growing period for these symptoms
- If you observe symptoms take a sample for diagnostic testing – you can test by
 - a. Diagnostic strip (if you get a positive it is advised that you send a sample to a lab for confirmation)
 - b. Send a sample to a lab for confirmation – check with your agronomist or government on the process for submitting samples. See the section below on sample preparation.
- If you suspect you have CGMMV isolate the infected area of the crop until diagnostic results are known because CGMMV can be easily moved mechanically

Sampling Preparation

- Submit samples that have a range of symptoms, from light to severe, representative of the field symptoms. Do not send dead plants.
- Submit whole plants with roots and soil, where practical.
- Where it is not practical to submit the entire plant, send damaged/infected parts of plants.
- Wrap plant samples in slightly damp newspaper to help maintain freshness. Do not package plant material in plastic bags over the summer months.

Testing Agencies

Crop Health Services (03) 9032 7515 Send samples to: AgriBio Specimen Reception Main Loading Dock, 5 Ring Road, La Trobe University Bundoora VIC 3083	NSW Plant Health Diagnostic Service (02) 4640 6327 Send samples to: Sample Submissions Elizabeth Macarthur Agricultural Institute Woodbridge Rd MENANGLE NSW 2568
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Actions Following Detection

It is encouraged that detections are reported to aid in delimiting the pest and effective management of CGMMV. Following a positive detection the presence of the virus must be reported to the appropriate state or territory Department of Primary Industry. Call the Exotic Plant Pest Hotline (1800 084 881) to be directed to your relevant agency. Do not send plant samples or soil interstate without checking state or territory regulations.

Re-planting

Whilst there is no regulation to prevent re-planting it must be remembered that if virus is present then planting of new host crops will aid continued survival of the virus as the virus can persist in the soil for up to 2 years.

Reappearance of the virus may lead to impacts on productivity and marketability of produce due to virus symptoms. It is recommended that the affected site is left fallow for at least two years following detection or planted with non-host species. A non-host planting will assist in restricting soil movement provide care is taken to prevent movement of infected soil.

Restrict movement of people and farm vehicles on the site.

Destroy and remove any infected plants and neighbouring plants. If harvesting proceeds care should be taken to not spread the virus. Remember the virus can be spread by contact.

Once harvesting is complete destroy the crop – re-check before destruction and remove any additional plants and neighbouring plants that are showing symptoms.

Continue to monitor other host plants on your property, and on linked properties.

Maintain farm zoning and biosecurity best practices. Complete the biosecurity checklist and action planner provided in this Plan to aid in developing appropriate protocols for managing the virus.

Sample Shipping Guidelines

Quality of diagnosis is dependent on the quality of the submitted sample.

The plant tissues containing the highest concentrations of Melon necrotic spot virus particles are the symptomatic fruit, the roots and the growing tips of runners. Samples of this material can be sent to the PHDS Laboratory for testing.

1. **SAMPLE COLLECTION-** Vines with suspect symptoms are the best candidates for confirmation of Melon necrotic spot virus. A sample should consist of: a minimum of 3-4 runners about a metre long, with growing tip and leaves attached; the root systems including fine roots, and any symptomatic fruit from the same symptomatic plant. Wrap, in newspaper, vine pieces and root systems separately. Place in sealed plastic bag– DO NOT add water to sample. Following collection of the sample in the field, they should be stored in a cooler with ice brick until placed into the container for shipping. Please ensure that specimen does not get crushed.
2. **SAMPLE LABELING -** If submitting more than one sample, please LABEL the outside each bag clearly with a permanent marker. Please state the variety (and rootstock if grafted).
3. **COMPLETE FORM –** Complete the submission form. Please state the variety (and rootstock if grafted). Make sure that sample labels are consistent with information describe on form. Place submission form in a plastic bag/envelope and keep separate from samples.
4. **SHIPPING SAMPLES –** Postal Service or our Preferred Courier (cost of courier is included in our testing fee), but same day or next day service is recommended (Don't send samples on a Friday). Store the sample in a refrigerator until being shipped. Place samples and submission sheet in the same container (a freezer brick may also be included) for collection by a courier or post.

Courier Details

Metrostate Security Couriers

Phone: 02 96459700

Inform Metrostate that package is being sent to E.M.A.I

No account number required, just address sample to E.M.A.I

TNT Couriers

Phone: 13 11 50

Account Number: 218 576 35 (to EMAI Plant Pathology)

Please put a cross (X) overnight first class box

<http://www.tnt.com.au>

Please try to send samples early in the week, to avoid weekend delays.