Cucumber Green Mottle Mosaic Virus (CGMMV) National Management Plan

Version Control		
Version	**Revision Date**	**Amendment**
1.0	22 September 2016	Revised by CGMMV Sub Working Group
2.0	29 October 2016	Endorsed by CGMMV Working Group
3.0	13 December 2018	Revised by Melon Industry Development Manager
4.0	14th September 2023	Revised by CGMMV National Management Plan Working Group

Contents

Acknowledgements

The *Cucumber green mottle mosaic virus* National Management Plan has been produced in consultation with representatives from the Australian Melon Association (AMA), AUSVEG Ltd, Greenlife Industry Australia (GIA), the Northern Territory Farmers Association (NTFA), and the Australian, state and territory governments.

The Plan was correct at the time of current review. Information should be checked with the relevant jurisdiction to ensure 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 infection and prevent its further spread to other growing regions.

This CGMMV National Management Plan (the Management Plan) provides an overarching framework upon which jurisdictional operational plans should be developed. The Management Plan is underpinned by sound scientific risk assessment developed by an expert working group, and a Pest Risk Analysis by the Australian Government (Australian Government 2017).

The Management Plan describes symptoms, and processes for identifying and testing suspect plants, along with precautionary measures and disinfection procedures to prevent disease spread. The Management Plan also outlines best practice approaches to on-farm biosecurity, surveillance and reporting procedures, including decision making support tools for growers. Importantly, the Management Plan articulates agreed roles and responsibilities of governments, industry, and other stakeholders to deal with the disease in Australia.

The Management Plan has been developed in consultation with the Australian Melon Association (AMA), AUSVEG Ltd, Greenlife Industry Australia (GIA), the Northern Territory Farmers Association (NTFA), the Australian, state and territory governments (the Parties). It is intended to provide guidance on the co-ordinated management of CGMMV in Australia, and confidence to interstate and international regulators and stakeholders that the Parties are acting actively and effectively to reduce the impact of CGMMV.

The current version of this plan was reviewed and finalised by the Parties in August 2023.

1.1 Purpose of the Management Plan

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

a. Preventing the spread of CGMMV to new regions within Australia.
b. Reducing the impact of CGMMV in regions where it is already established.
c. Reducing the impacts of CGMMV on interstate 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. Containing CGMMV to currently infected areas.
b. Reducing production losses from CGMMV by encouraging best practice measures to be applied.
c. Limiting the spread of other diseases through application of the same best practice hygiene measures.
d. Supporting continued access to domestic and international markets.
e. Providing a shared framework for disease management and market access considerations.

1.3 Elements of the Management Plan

The key focus areas of the National Management Plan are:

a. Early detection and reporting (when required) through monitoring for CGMMV symptoms in plants.
b. Effective measures to deal with suspect plants.
c. Establishing standard measures to prevent spread of infections.
d. Breaking the cycle of infection between growing cycles.

Growers should consider how they will incorporate these elements in the most efficient and effective manner. Ideally, these measures will fit in with existing management practices and should not add significant cost or inconvenience to usual business practices.

Growers need to document how they will meet the measures, so that all staff can be aware of their roles in dealing with CGMMV. Documented procedures need to identify what actions are to be taken, who is responsible for the

action, when and how it will be done, and what (if any) formal reporting is required. For development of a farm management plan, growers can adopt or modify the guiding documents provided in Appendices 4 and 5.

1.4 Constraints of the Management Plan

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

a. Ease of transmission of CGMMV, due to its very stable virus particles that remain in an infectious state for substantial periods of time on a wide range of substrates (e.g. up to years in soil, months on hard surfaces – such as benches, trellises and other structures, etc).
b. Difficulty of early detection of outbreaks (as there are many other viruses in Australian cucurbit crops that can present with similar symptoms), and government provided testing/identification is limited to suspect infected plants and general state-based surveillance programs.
c. A single program enforcing the same measures to deal with CGMMV in all and states and territories is not feasible due to the differing infection status for each of the jurisdictions.

1.5 Input and Implementation of the Management Plan

The Parties have reviewed the Management Plan and agreed that the content was correct at the time of review.

All Parties have a role and responsibility in building government and industry capability and capacity to manage CGMMV in Australia.

1.6 Roles and responsibilities

To manage CGMMV effectively, each section of the management chain has roles and responsibilities. The management chain includes partners at the national, state/territory, industry, and individual grower level. These roles and responsibilities are outlined in Table 1.

Table 1: Roles and responsibilities for management of CGMMV

Role	Responsibility
Growers	• Be aware of CGMMV symptoms • Survey crops and weeds • Report suspect symptoms (when required) via the Exotic Plant Pest Hotline 1800 084 881 • Provide feedback on effectiveness and currency of awareness material • Implement appropriate on farm biosecurity procedures for control of the pest in accordance with guidelines in the management plan
Peak bodies	• Develop CGMMV awareness material for growers • Encourage grower support for the Management Plan • Coordinate and facilitate grower involvement in surveillance programs • Develop and coordinate awareness and general on-farm biosecurity best practice training • Promote farm biosecurity practices, in accordance with the Management Plan • Melons Australia to take the lead and organise an update of the Management Plan every 3 years unless there is a change that necessitates and update earlier • Maintain updated version on industry websites
State and Territory governments	• Regulate interstate borders • surveillance • Diagnostics

	• Contain infections • Update CCEPP • Identify and contribute to RD&E that would facilitate continued development of diagnostic methods for CGMMV • Provide guidance on development of awareness material for growers
Australian government	• Manage risks at international borders • Screen incoming seeds and propagating materials • Manage exports • Provide guidance on development of awareness material for growers • Identify and contribute to RD&E that would facilitate continued development of diagnostic methods for CGMMV • Report national and regional plant CGMMV status to international community • Advise on minimum requirements to support export market access

1.7 Working group representatives 2022/23

Table 2: List of representations from the Parties who reviewed the Management Plan

Organisation	**Representative**	**Email addresses**
WA Department of Primary Industries and Rural Development (DPIRD)	Roslyn Jettner	Roslyn.Jettner@dpird.wa.gov.au
Department of Agriculture, Fisheries and Forestry (DAFF)	Matt Calverley	Matthew.Calverley@aff.gov.au
Melons Australia	Jo Embry	biosecurity@melonsaustralia.org.au
NSW Department of Primary Industries (DPI)	Shannon Mulholland	shannon.mulholland@dpi.nsw.gov.au
NT Department of Industry, Tourism and Trade (DITT)	Brian Thistleton	Brian.Thistleton@nt.gov.au
NT Farmers Association (NT Farmers)	Greg Owens	Contact via NT Farmers
Greenlife Industry Australia (GIA)	John McDonald	john.mcdonald@greenlifeindustry.com.au
Queensland Department of Agriculture and Fisheries (QDAF)	Gary Artlett and Christine Horlock	Gary.Artlett@daf.qld.gov.au; Christine.Horlock@daf.qld.gov.au
AUSVEG	Zarmeen Hassan	zarmeen.hassan@ausveg.com.au
NT Department of Industry, Tourism and Trade (DITT)	Alexandra Fulton	Alexandra.Fulton@nt.gov.au

2 Background, including history of CGMMV in Australia

Cucumber green mottle mosaic virus was first found in the United Kingdom in 1935 and has since been identified in over 40 countries spanning most global regions including Asia, Europe, the Middle East, North America, and Oceania. Refer to Appendix 1 for a detailed list of the current distribution of CGMMV.

Cucumber green mottle mosaic virus was first reported in Australia in September 2014 from commercial watermelon farms near Katherine and Darwin, Northern Territory (NT). The detection triggered the introduction of emergency measures by the Australian Department of Agriculture, Fisheries and Forestry (DAFF) in October 2014, to reduce the risk of further introductions of CGMMV into Australia through seed.

In March 2015, the National Management Group (NMG) agreed that it was not technically feasible to eradicate CGMMV from the NT. This was largely due to the large number of infected properties across the NT, an isolated detection in north Queensland, and the detection of CGMMV in a broad range of host weed species known to be widely dispersed across northern Australia.

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

Plant Health Committee determined CGMMV to be a pest of national significance in June 2015 and agreed to the development of a national management plan for CGMMV. It also agreed that any future detections of CGMMV would not be considered as an Emergency Plant Pest under the Emergency Plant Pest Response Deed and would be managed in line with the Management Plan.

2.1 Northern Territory

Since the 2014 detection, the NT has established management practices to contain CGMMV to areas of current infection and prevent its spread beyond the NT. The Department of Industry, Tourism and Trade (DITT) has adopted a coordinated management approach with growers.

Under the NT *Plant Health Regulations 2011*, movement of CGMMV host plants, and plant related material (seeds, seedlings, tissue cultures and beehives) from the NT are not permitted, unless otherwise approved by the Chief Plant Health Officer (CPHO) in the form of a written permit. Under these regulations growers are required to have farm biosecurity plans which may be audited annually by NT Plant Biosecurity Officers. The farm biosecurity plans must identify the risks of transmission of CGMMV on and off the property, and the measures the grower has implemented to address those risks.

From 2019 to 2021, the NT led a research project 'Understanding and managing the role of honey bees in CGMMV epidemiology' (VM18008) to investigate CGMMV transmission by pollinating honey bees. Using laboratory and field trials, the research team demonstrated that when CGMMV is already present in a crop, honey bees visiting flowers within the crop can transmit CGMMV between infected and healthy plants. The virus was found in beehives, but when the hive had been away from CGMMV-positive plants for more than 24 hours transmission to cucurbit plants was not detected. However, the virus could be detected on bees up to one month after the hive had been exposed to CGMMV positive plants, and thus a resting period of one month before movement to a new area is recommended. This does not represent a significantly greater risk than any other mechanical transfer of the virus. Information regarding the research and a project report can be found on the Hort Innovation site: https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/vm18008/.

Further information on management controls for CGMMV in the NT is available on the NT Government website https://nt.gov.au/industry/agriculture/food-crops-plants-and-quarantine/cucumber-green-mottle-mosaic-virus or contact NT Plant Biosecurity on (08) 8999 2118 or plantbiosecurity@nt.gov.au.

2.2 Queensland

CGMMV was confirmed on one property west of Townsville in March 2015. CGMMV was subsequently detected in several protected cropping systems at properties near Bundaberg in 2017. The virus in Queensland is being managed in line with the Management Plan and Biosecurity Queensland, a service of the Department of Agriculture and Fisheries (DAF) continues to work with the affected property owners to manage CGMMV and prevent further spread. Queensland is a large cucurbit producing state and growers can export crops to quarantine sensitive markets under pest free place of production certification arrangements (*CAA-04 PEST FREE PLACE OF PRODUCTION FOR CUCUMBER GREEN MOTTLE MOSAIC VIRUS)* which align with the Management Plan. CGMMV is restricted matter under the *Biosecurity Act 2014,* and all plants with symptoms suspected to be CGMMV must be reported to

Biosecurity Queensland (13 25 23) as soon as possible. Restrictions also apply when moving CGMMV risk carriers (such as cucurbit plants, soil and used cucurbit production equipment and packaging) into Queensland from states and territories where CGMMV has been found, details in the Queensland Biosecurity Manual (https://www.daf.qld.gov.au/__data/assets/pdf_file/0004/379138/qld-biosecurity-manual.pdf).

Additional information on management of CGMMV in Queensland can be found at https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/biosecurity/plants/priority-pest-disease/cucumber-green-mottle-mosaic-virus

2.3 Western Australia

CGMMV was first confirmed in Geraldton in 2016 and delimiting surveillance further detected the virus in Kununurra, Broome, Carnarvon, Geraldton, and Perth. These detections were in cucurbit crops in field and protected cropping facilities and in the native plant *Cucumis variabilis* and the naturalised weed *Cucumis myriocarpus*. The Department of Primary Industries and Regional Development, Western Australia (DPIRD) and Vegetables WA work together to ensure growers are aware of and are implementing 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.

2.4 South Australia

CGMMV was found on three properties in Virginia, South Australia in autumn 2017. These properties had a direct link to infected properties in Geraldton, Western Australia. All three properties were initially placed under regulatory movement controls and a management and eradication plan was in place. Following several detections in the proceeding years, a subsequent assessment of options and consultation with SA industry, resulting in CGMMV being deregulated for active eradication/control in 2020. Condition 24 (entry conditions related to Cucumber Green Mottle Mosaic Virus) was removed from the Plant Quarantine Standard South Australia 17.2 on 26 May 2021, but CGMMV remains a declared pest for notification purposes. As the disease is no longer regulated for import into South Australia, properties that were under a quarantine order for this disease have had their orders revoked.

2.5 New South Wales

CGMMV was first detected on a single farm on the Central Coast in March 2019. It has since been detected on a further two properties in the Sunraysia region and several/three properties in the Sydney Basin. No clear linkages have been identified between the affected New South Wales (NSW) properties or CGMMV-affected properties interstate. The virus is not considered to be technically feasible to eradicate from the NSW affected properties.

The NSW Department of Primary Industries is working with the affected growers to manage the virus, aligned to the Management Plan, and additional engagement is being undertaken with industry to raise awareness of the disease and improve farm biosecurity measures.

Additional information on management of CGMMV in New South Wales can be found at https://www.dpi.nsw.gov.au/biosecurity/plant/insect-pests-and-plant-diseases/cgmmv

2.6 Victoria

Victoria remains area free for CGMMV and accordingly administers a surveillance and compliance program which meets the requirements of ISPM-4 and ISPM-10. Whilst the Victorian melon industry is relatively small, growers can export crops to sensitive markets under pest free place of production certification arrangements which align with the Management Plan. CGMMV remains an exotic disease to Victoria and accordingly any person or business has the responsibility to report a suspect or confirmed detection to the Victorian CPHO.

3 Pest Characteristics

3.1 Hosts

Cucumber green mottle mosaic virus is known to infect all plants in the Cucurbitaceae family (i.e. cucurbits) including commercial crops and weeds, as well as a number of weeds species from other plant families. Known host plants are included in Table 3 below.

Table 3: Known hosts of CGMMV*

Crop		Weed	
Scientific name	**Common name**	**Scientific name**	**Common name**
Benincasa hispida	Ash gourd, Wax gourd, White gourd	*Amaranthus blitoides*	Mat amaranth, Prostrate amaranth
Citrullus lanatus	Watermelon	*Amaranthus graecizans*	Mediterranean amaranth
Cucumis anguria	Bur cucumber, West Indian gherkin	*Amaranthus muricatus*	Rough fruit amaranth
Cucumis melo	Cantaloupe, Melon, Rockmelon	*Amaranthus retroflexus*	Redroot amaranth, Redroot pigweed
Cucumis sativus	Cucumber	*Amaranthus viridis*	Amaranth, Green amaranthus
Cucurbita maxima	Pumpkin	*Chenopodium album*	Fat hen
Cucurbita moschata	Butternut pumpkin, Butternut squash,	*Chrozophora tinctoria*	Turnsole
Cucurbita pepo	Squash, Zucchini	*Citrullus colocynthis*	Bitter apple
Lagenaria siceraria	Bottle gourd, Calabash, Korean native gourd, Long melon	*Ecballium elaterium*	Squirting cucumber
Luffa acutangula	Angled luffa, Chinese okra, Ridged gourd	*Heliotropium europaeum*	Common heliotrope
Luffa cylindrica	Smooth loofah gourd	*Heracleum moellendorffii*	Duan mao du huo, Eosuri
Momordica charantia	Balsam apple, Balsam pear, Bitter gourd, Bitter melon	*Moluccella laevis*	Bells of Ireland
Trichosanthes cucumerina	Serpent gourd, Snake gourd	*Mukia maderaspatana*	Headache bryony vine
Luffa cylindrica	Smooth loofah gourd	*Portulaca oleracea*	Pigweed, Purslane
		Solanum nigrum	Blackberry nightshade, Black nightshade
		Withania somnifera	Indian ginseng

*Abstracted from DAWR (2017) and Dombrovsky et al (2017).

Further information on natural hosts and associations of the virus with host seeds is available from:

https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/biosecurity/risk-analysis/plant-reviews/final-pest-risk-analysis-cgmmv.pdf

Additionally, CGMMV characterisation, improved management and host range was conducted in the national Hort Innovation project led by NT (VG15013) and is available at https://www.horticulture.com.au/globalassets/laserfiche/assets/project-reports/vg15013/vg15013---final-report-completed.pdf

3.2 Symptoms

The symptoms of CGMMV vary with the genus, species and cultivar of the plant and the strain of the virus, ranging 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 discolouration, rotting and necrosis. Asymptomatic leaves and symptomless fruits may also occur in CGMMV-infected cucurbit hosts.

Illustrations of CGMMV infected plants and fruit are provided in Appendix 2.

3.3 Transmission

This section has been updated to reflect research findings as part of the Project 'Understanding and managing the role of honey bees in CGMMV epidemiology' (VM18008). For a full project report refer to: https://www.horticulture.com.au/globalassets/laserfiche/assets/project-reports/vm18008/vm18008-final-report-complete.pdf and for factsheets and management advice developed as part of the project refer to: https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/vm18008/.

Cucumber green mottle mosaic virus is highly transmissible through sap and soil, on clothing, shoes, hands, machinery, and packaging materials, and through infected seeds. Entry into the plant is generally through wounds, however with honey bee transmission introduction is via flowers. CGMMV may remain dormant within the seed coat of infected seeds and remain viable for long periods in infected crop debris, in the soil, on machinery and tools.

Introduction of CGMMV through contaminated seed and soil are among the most common means of infection. Infection of roots can occur in soil that is contaminated with infected plant debris. The virus can then spread through root-to-root contact. In addition, transmission frequency can be 20% or more in seed harvested from infected plants. CGMMV can be transmitted by several means, including:

- in water or in nutrient solutions in soil-less culture;
- by mechanical transfer (especially in protected or high-input culture systems where plants are pruned, staked, handled or touched frequently);
- on machinery used for cultivation or weed control;
- in infected rootstock if plants are grafted;
- through weed species that act as asymptomatic alternative hosts/reservoirs; and
- by vector transmission through foraging honey bees.

3.4 Cucumber green mottle mosaic virus research in Australia

There have been a range of research activities undertaken in Australia to better understand the biology, epidemiology, host range and transmission of CGMMV in Australia. These have resulted in a number of publications including the Northern Territory Department of Industry, Tourism and Trade led, and Horticulture Innovation Australia funded projects:

- Tran-Nguyen LTT. (2019) Improved Management Options for Cucumber green mottle mosaic virus – VG15013. https://www.horticulture.com.au/globalassets/laserfiche/assets/project-reports/vg15013/vg15013---final-report-completed.pdf
- Donaldson M. (2022) Understanding and managing the role of honey bees in CGMMV epidemiology - VM18008. https://www.horticulture.com.au/globalassets/laserfiche/assets/project-reports/vm18008/vm18008-final-report-complete.pdf

4 Managing CGMMV in Australia

4.1 Principles for Managing CGMMV

The following principles underpin the management of CGMMV in Australia:

a. CGMMV is a notifiable plant disease in Australian states and territories (see Section 4.2). For Australia as a whole, CGMMV remains a quarantine pest under official control.
b. The risk of further spread of CGMMV is best dealt with by growers through preventative on-farm biosecurity practices including surveillance, early reporting, and post-detection management practices.
c. Government will assess the need and feasibility of implementing regulatory measures to mitigate and minimise the risk of spreading the virus further (see section 4.2).
d. Industry, growers, governments, and the public will work together to monitor and reduce the impacts of CGMMV in Australia.

4.2 CGMMV is a Notifiable plant disease in most Australian states and territories

Growers are required to report any suspected detections of CGMMV to the Chief Plant Health Manager (CPHM)/CPHO in their jurisdiction. If a report is made in an area or jurisdiction that is not recognised as infected with CGMMV, the CPHM may request the grower to provide symptomatic plant material for testing.

The CPHM/CPHO will notify the Australian Chief Plant Protection Officer (ACPPO) and affected industries if there is a confirmed positive diagnosis when the detection is from an area in which the virus is not known to occur, or where the virus is detected on a previously unrecognised host.

Northern Territory Legislation

Following detection of the virus in 2014, CGMMV was declared as a both a pest, and a notifiable pest under the NT Plant Health Act 2008 (https://legislation.nt.gov.au/en/Legislation/PLANT-HEALTH-ACT-2008). Download - "Northern Territory Government gazette: no. S94". Northern Territory Government, Darwin. 3 Oct. 2014 Web. 9 May. 2022. (https://hdl.handle.net/10070/544127), for a copy of the legal instrument. Initially watermelon was declared as a host plant, and the list of host plants was broadened to include additional hosts as more information became available. For a list of declared host plants download - "Northern Territory Government gazette: no. S34". Northern Territory Government, Darwin. 16 Apr. 2015 Web. 10 May. 2022. (https://hdl.handle.net/10070/524695).

Under NT legislation section 15(1), a person must notify an inspector of the presence of a pest at a place within 24 hours after becoming aware of the presence of the pest at the place. There are other requirements under the legislation regarding declared pests and prevention of infestation, prevention of spread and dealing with affected plants and plant materials.

Initially various quarantine areas were declared as to control the spread of the virus. In 2016, these quarantine place declarations were revoked, with new regulations to manage the virus introduced (as it became apparent that it was not technically feasible to eradicate the virus from the NT). These regulations prohibit the export of seeds, seedlings, and bee hives from the NT (unless otherwise approved by the NT Chief Inspector of Plant Health) and require growers to have an auditable farm biosecurity plan for the purpose of controlling CGMMV. To view the Regulations in full refer to Part 2B 'Control of Cucumber Green Mottle Mosaic Virus', sections 26E-H, 26L-K – (https://legislation.nt.gov.au/Legislation/PLANT-HEALTH-REGULATIONS-2011).

CGMMV still remains both a declared and notifiable pest under NT legislation as to allow for the Regulations and ongoing management of the virus. The list of declared host plants also remains in force.

Queensland Legislation

Under Queensland legislation schedule 2 of the *Biosecurity Act 2014* (https://www.legislation.qld.gov.au/view/html/inforce/current/act-2014-007#sch.2) CGMMV is restricted matter and suspect detections must be reported to Biosecurity Queensland (13 25 23), as soon as possible. In the meantime, restrict access to symptomatic plants and wait further instructions.

Western Australia Legislation

Section 26 of the Biosecurity and Agriculture Management Act creates a Duty to report a declared pest. Declared pests are listed on the Western Australian Organism List (https://www.agric.wa.gov.au/organisms?search_string=CGMMV). Search under 'CGMMV'.

South Australia Legislation

By notice of the South Australian Government Gazette (No. 26 - Thursday, 5 May 2022 (pp. 1019–1116) CGMMV has been declared a pest pursuant to section 4 of the Plant Health Act 2009. https://governmentgazette.sa.gov.au/2022/May/2022_026.pdf

New South Wales Legislation

CGMMV is no longer listed as a 'disease required to be notified' in New South Wales.

Victoria Legislation

https://agriculture.vic.gov.au/biosecurity/moving-plants-and-plant-products/plant-biosecurity-legislation

4.3 Risk Pathways for CGMMV movement

The Management Plan applies a Hazard Analysis Critical Control Point (HACCP) based approach for reducing the risk of CGMMV movement (spread). Pathways for transmission of CGMMV and the points at which regulatory or other control measures are required have been identified in Table 4 and Appendix 3.

Table 4: HACCP analysis of key points at which controls are to be applied to reduce transmission of *Cucumber green mottle mosaic virus* in Australia

Risk Pathway	Import into Australia	State or Territory Borders	CGMMV-infected Region	CGMMV-infected Property within a Region	Uninfected Property	Supply Chain
1. Soil						
Control Required:	**Y**	**Y**	**Y**	**Y**	**N**	**N**
Action:	Control on soil that may have come into contact with infected plants. Nursery stock cannot be imported in soil. If soil is present on goods, then requirements are mandatory irradiation or cleaning to remove soil. Appropriate certification required.	Control on soil that may have come into contact with infected plants. Certification required from CPHM.	Control on soil that may have come into contact with infected plants. Jurisdiction to manage on a situational basis. Grower to manage movement of soil onto and off property.	Control on soil that may have come into contact with infected plants. Jurisdiction to manage on a situational basis. Grower to manage movement of soil onto and off property.	If outside infected region. Supported by proof of area freedom or individual property freedom.	
2. Seed						
Control Required:	**Y**	**N**	**N**	**Y**	**Y**	**N**
Action:	All cucurbit seeds associated with CGMMV to be tested (off-shore or on-shore) by ISTA validated ELISA (ISTA 7-026) or a PCR method approved by the department on a			All cucurbit seeds associated with CGMMV to be tested in accordance with ISTA 7-026 method of ELISA on a sample of 9,400 seeds and national seed testing	All cucurbit seeds associated with CGMMV to be tested in accordance with ISTA 7-026 method of ELISA on a sample of 9,400 seeds and national seed testing	

Risk Pathway	Import into Australia	State or Territory Borders	CGMMV-infected Region	CGMMV-infected Property within a Region	Uninfected Property	Supply Chain
	sample size of 9,400 seeds (or 20 per cent for small seed lots) to verify freedom from CGMMV. Seed lots tested off-shore must be accompanied by an official government Phytosanitary Certificate with an appropriate declaration.				guidelines for CGMMV.	
3. Nursery Stock (tissue culture and seedlings)						
Control Required:	**Y**	**Y**	**Y**	**Y**	**N**	**N**
Action:	Controls on nursery stock of host plants. Imports of nursery stock for host plants currently suspended.	Controls on nursery stock of host plants from infected states. CPHM certification required.	Controls on nursery stock of host plants from infected areas. Jurisdiction to manage on a situational basis.	Controls on nursery stock of host plants from infected properties. Jurisdiction to manage on a situational basis	If outside of infected region. Supported by proof of area freedom or individual property freedom.	
4. Fruit*						
Control Required:	**N**	**N**	**N**	**N**	**N**	**N**
Action:	**N/A** The risk of CGMMV transmission through commercially produced fruit for human consumption is regarded as low.	**N/A** The risk of CGMMV transmission through commercially produced fruit for human consumption is regarded as low.	**N/A** The risk of CGMMV transmission through commercially produced fruit for human consumption is regarded as low.	**N/A** The risk of CGMMV transmission through commercially produced fruit for human consumption is regarded as low.	**N/A**	**N/A**

Risk Pathway	Import into Australia	State or Territory Borders	CGMMV-infected Region	CGMMV-infected Property within a Region	Uninfected Property	Supply Chain
5. Host plant material including crop and weed debris and waste from previous crops						
Control Required:	**N/A**	**Y**	**Y**	**Y**	**N**	**N**
Action:		Controls on movement and destruction of host plant material including drop and weed debris and waste from previous crops. CPHM certification required to move out of infected state.	Controls on movement and destruction of host plant materials. Jurisdiction to manage on a situational basis.	Controls on movement and destruction of host plant materials. Jurisdiction to manage on a situational basis.	Supported by proof of area freedom or individual property freedom.	
6. Conveyances (includes crates, boxes, bins, pallets)						
Control Required:	**N**	**Y**	**Y**	**Y**	**N**	**N**
Action:		Controls on conveyances that may have come into contact with infected plants and/or other CGMMV risk carriers.	Controls on conveyances that may have come into contact with infected plants and/or other CGMMV risk carriers. Jurisdiction to manage on a situational basis. May be managed by on-farm biosecurity /auditable HACCP.	Controls on conveyances that may have come into contact with infected plants and/or other CGMMV risk carriers. Jurisdiction to manage on a situational basis. May be managed by on-farm biosecurity /auditable HACCP.	Supported by proof of area freedom or individual property freedom. May be managed by on-farm biosecurity /auditable HACCP.	May be managed by on-farm biosecurity /auditable HACCP.

Risk Pathway	Import into Australia	State or Territory Borders	CGMMV-infected Region	CGMMV-infected Property within a Region	Uninfected Property	Supply Chain
7. Tools, equipment, machinery used on farm						
Control Required:	**Y**	**Y**	**Y**	**Y**	**N**	**N**
Action:	Used tools, equipment and machinery must be clean and free of soil.	Controls on tools, equipment and machinery used on farm that may have come into contact with infected plants or soil. CPHM certification required.	Controls on tools, equipment and machinery used on farm that may have come into contact with infected plants or soil. Jurisdiction to manage on a situational basis. May be managed by on-farm biosecurity/auditable HACCP.	Controls on Tools, equipment and machinery used on farm that may have come into contact with infected plants or soil. Jurisdiction to manage on a situational basis. May be managed by on-farm biosecurity/auditable HACCP.	Supported by proof of area freedom or individual property freedom. May be managed by on-farm biosecurity/auditable HACCP.	
8. Transport vehicles						
Control Required:	**N**	**N** To be managed at property level.	**N** To be managed at property level.	**N** To be managed at property level.	**N** To be managed at property level.	**N** To be managed at property level.
9. Personnel						
Control Required:	**N**	**N**	**N**	**N**	**N**	**N**
10. Domestic livestock, pest animals (feral)						
Control Required:	**N/A**	**N** To be managed at property level.	**N** To be managed at property level.	**N** To be managed at property level.	**N** To be managed at property level.	**N/A**
11. Weeds						
Control Required:	**N/A**	**N** To be managed at property level.	**N** To be managed at property level.	**N** To be managed at property level.	**N** To be managed at property level.	**N/A**

Risk Pathway	Import into Australia	State or Territory Borders	CGMMV-infected Region	CGMMV-infected Property within a Region	Uninfected Property	Supply Chain
12. Bees						
Control Required:	**Y**	**Y**	**Y**	**Y**	**N**	**N**
Action:	Post-entry quarantine is required for any imported bees.	Controls on bee hives that have been used to pollinate infected plants.	Controls on bee hives that have been used to pollinate infected plants. If a hive has been exposed to CGMMV it is recommended to not conduct hive maintenance on that hive in a cucurbit production area. Recommend 4 week resting period at a cucurbit/CGMMV free site if pollinating cucurbit crops at separate sites. Jurisdiction to manage on a situational basis.	Controls on bee hives that have been used to pollinate infected plants. If a hive has been exposed to CGMMV it is recommended to not conduct hive maintenance on that hive in a cucurbit production area. Recommend 4 week resting period at a cucurbit/CGMMV free site if pollinating cucurbit crops at separate sites. Jurisdiction to manage on a situational basis.	If outside of infected region. Supported by proof of area freedom or individual property freedom.	

*Controls on fruit may change subject to international trading requirements.

4.4 Importation of Seed into Australia

- Pathogen testing—mandatory off-shore or on-shore testing by International Seed Testing Association (ISTA) validated Enzyme-Linked Immunosorbent Assay (ELISA) on a sample size of 9,400 seeds (or for small seed lots, 20 per cent of the seed lot by weight up to a maximum of 9,400 seeds) to verify freedom from CGMMV (and other target pathogens where applicable).

- Certification of testing— Seed lots tested off-shore must be accompanied by an official government Phytosanitary Certificate endorsed with an additional declaration confirming that the seed had been tested in accordance with Australia's requirements and found free from CGMMV (and other target pathogens where applicable). Consignments must be accompanied by the relevant laboratory testing report.

- Pathogen treatment – mandatory off-shore or on-shore treatment of seed lots of *Cucumis melo* and *Cucumis sativus* with a broad-spectrum fungicidal treatment to manage to biosecurity risks associated with the fungal pathogen *Diaporthe cucubitae*.

- Certification of treatment— For seed species *Cucumis melo* and *Cucumis sativus* that are also hosts of fungal pathogen *Diaporthe cucurbitae,* the seed lots treated off-shore must be accompanied by an official government Phytosanitary Certificate confirming the seed lot was treated with a broad-spectrum fungicide for *Diaporthe cucurbitae*.

Standard conditions

- On-arrival inspection—seed lots must be inspected on arrival to verify freedom from live insects, soil, disease symptoms, prohibited seeds, other plant material (for example, leaf, stem material, fruit pulp and pod material), animal material (for example, animal faeces and feathers) and any other extraneous contamination of biosecurity concern.

- Purity testing – Where the seed lot is greater than 10 kg in weight and contains seed less than 8 mm in diameter, sampling for International Seed Testing Association (ISTA) testing must also occur to confirm freedom from contaminants such as soil and weed seeds. This testing must be performed at a department approved ISTA laboratory off-shore or on-arrival.

- Packing and labelling – Cucurbit seeds are subject to the standard seeds for sowing import conditions, which include packed in clean and new packaging, and clearly labelled with the full botanical name.

In addition to mandatory virus testing for *Cucumber green mottle mosaic virus* (CGMMV), some cucurbit seed species also require testing and/or treatment for other seed-borne pathogens. A summary of the testing and treatment requirements applicable to each seed species is summarised below:

Citrullus lanatus (and synonyms) requires mandatory testing for CGMMV, *Kyuri green mottle mosaic virus* (KGMMV), *Zucchini green mottle mosaic virus* (ZGMMV) and *Melon necrotic spot virus* (MNSV).

Cucurbita pepo (and synonyms) requires mandatory testing for CGMMV, KGMMV and ZGMMV.

Cucumis melo (and synonyms) requires mandatory testing for CGMMV and MNSV, as well as treatment for the fungus that causes black rot (*Diaporthe cucurbitae*).

Cucumis sativus (and synonyms) requires mandatory testing for CGMMV and KGMMV, as well as treatment for the fungus that causes black rot (*Diaporthe cucurbitae).*

Cucurbita maxima, Cucurbita moschata, Lagenaria siceraria, Trichosanthes cucumerina requires mandatory testing for CGMMV.

Luffa spp. 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 https://bicon.agriculture.gov.au/BiconWeb4.0 for current standards and testing requirements for each species/variety before submitting samples.

4.5 Importation of Cucurbitaceae Tissue Culture Material into Australia

Known hosts of CGMMV are *Benincasa hispida*, *Citrullus lanatus*, *Cucumis anguria*, *Cucumis sativus*, *Cucumis melo*, *Cucurbita moschata*, *Cucurbita pepo*, *Lagenaria siceraria*, *Luffa acutangular*, *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 Export of Host Material

All cucurbits exported to New Zealand must be sourced from a property certified as free from CGMMV based on a state-issued freedom certificate, to support a DAWE issued phytosanitary certificate. Property freedom from CGMMV must be confirmed by the relevant state department prior to exports being permitted. Information regarding registration can be obtained through contacting the Horticulture Exports Program at Horticultureexports@agriculture.gov.au.

Exporters must provide evidence attesting to the endorsement to the DAFF Authorised Officer at time of inspection.

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

Restrictions on 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 should check with local biosecurity officers or refer to the following websites:

Tasmania

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

Northern Territory

https://nt.gov.au/industry/agriculture/food-crops-plants-and-quarantine/plants-and-quarantine/plant-quarantine-contacts-and-plant-inspectors

https://industry.nt.gov.au/__data/assets/pdf_file/0011/396587/Plant-Quarantine-Manual.pdf

New South Wales

https://www.dpi.nsw.gov.au/biosecurity/plant

Queensland

https://www.daf.qld.gov.au/__data/assets/pdf_file/0004/379138/qld-biosecurity-manual.pdf

Victoria

https://agriculture.vic.gov.au/biosecurity/moving-plants-and-plant-products/plant-quarantine-manual

Western Australia

https://www.agric.wa.gov.au/iaquarantine/

South Australia

http://www.pir.sa.gov.au/biosecurity/plant_health

5 Surveillance

5.1 Grower led surveillance

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

Should growers suspect a CGMMV infection they should immediately notify their state biosecurity agency (refer to section 4.2) and apply strict biosecurity protocols to limit the potential for further spread. Plants/crops should be cordoned off and access restricted. Growers or consultants should not attempt to sample suspect infected plants themselves, unless specifically directed to do so by their state or territory biosecurity agency. Example procedures for grower undertaken CGMMV surveillance in fields are provided in Appendix 6.

5.2 Government led surveillance

Cucumber green mottle mosaic virus is present in Australia but is limited in distribution. Australian state or territory-based regulators may mitigate the risks associated with the entry or further spread of CGMMV to pest free locations using phytosanitary measures. Specific surveillance for CGMMV is undertaken to agreed export protocols as required. General surveillance activities targeting CGMMV are also undertaken as appropriate.

6 On-Farm management for farms where CGMMV is not established

All growers are strongly encouraged to implement these simple procedures to prevent the movement of CGMMV onto their properties:

a. Use seed from a reputable supplier that has been tested and certified as free from CGMMV.
b. If transplants are used, ensure that they are inspected prior to planting. Do not plant seedlings that look unhealthy or have any pest or disease symptoms.
c. Follow good field sanitation and cultural practices that include controlling weeds, especially cucurbit species that border fields, and chewing insects.
d. Inspect fields (crops and weeds) for symptoms at regular intervals.
e. Take action if host plants (either crops or weeds) show symptoms of CGMMV. Report suspected infections your biosecurity agency as soon as possible.
f. Restrict farm visitor access.
g. Clean and disinfect tools, clothing, and machinery on entry, and prior to leaving the property.

7 On-Farm management for farms where CGMMV is established

This advice only applies to farms where CGMMV has been found.

Once a crop is infected with CGMMV, the risk of spread through the rest of the crop is high; the virus may also remain viable in the soil for many years even after the crop has been destroyed. Infected crops should be carefully managed to limit the further spread of CGMMV.

When managing CGMMV:

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

8 References

Australian Department of Agriculture and Water Resources; DAWR. (2017) *Final pest risk analysis for* Cucumber green mottle mosaic virus *(CGMMV).* CC BY 3.0. https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/biosecurity/risk-analysis/plant-reviews/final-pest-risk-analysis-cgmmv.pdf

CGMMV Risk Assessment Working Group (2016). Scientific advice relating to *Cucumber Green Mottle Mosaic Virus* (CGMMV).

Dombrovsky A, LTT Tran-Nguyen, and RAC Jones. (2017) Cucumber green mottle mosaic virus: Rapidly Increasing Global Distribution, Etiology, Epidemiology, and Management Annual Review of Phytopathology. 55:231–56.

9 Further reading

Fact sheet links

https://nt.gov.au/industry/agriculture/food-crops-plants-and-quarantine/cucumber-green-mottle-mosaic-virus

https://industry.nt.gov.au/__data/assets/pdf_file/0012/387696/FS-CGMMV-general-info.pdf

https://industry.nt.gov.au/__data/assets/pdf_file/0005/387698/FS-CGMMV-symptoms-damage.pdf

https://industry.nt.gov.au/__data/assets/pdf_file/0004/387697/FS-CGMMV-research.pdf

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

https://www.agric.wa.gov.au/sites/gateway/files/CGMMV%20farm%20biosecurity%20information%20sheet%20PDF.pdf

https://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/vg15013-cgmmv-symptoms-fact-sheet.pdf

Reports

Other useful literature

American Seed Trade Association (2014). *Cucumber green mottle mosaic virus*: A Seed Production and Commercial Growers Guide.

Vegfed's PSTVd Technical Advisory Group (2003). New Zealand Code of Practice for the Management of Potato Spindle Tuber Viroid (PSTVd) in Greenhouse Tomato & Capsicum Crops.

Lovelock, D.; Mintoff, S.; Kurz, N.; Neilsen, M.; Patel, S.; Constable, F.; Tran-Nguyen, L. Investigating the Longevity and Infectivity of Cucumber green mottle mosaic virus in Soils of the Northern Territory, Australia. Plants 2022, 11, 883. https://doi.org/10.3390/ plants11070883 (https://pdfs.semanticscholar.org/ab74/78ebd502fe1fee1391e370c6c104e1659a0b.pdf)

Mackie J, Kinoti WM, Chahal SI, Lovelock DA, Campbell PR, Tran-Nguyen LTT, Rodoni BC, Constable FE. Targeted Whole Genome Sequencing (TWG-Seq) of Cucumber Green Mottle Mosaic Virus Using Tiled Amplicon Multiplex PCR and Nanopore Sequencing. Plants (Basel). 2022 Oct 14;11(20):2716. doi: 10.3390/plants11202716. PMID: 36297740; PMCID: PMC9607580. (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9607580/)

10 Appendices

Appendix 1 – Current distribution of Cucumber green mottle mosaic virus (CGMMV)

(Abstracted from the CABI Compendium)

(https://www.cabidigitallibrary.org/doi/full/10.1079/cabicompendium.16951)

Africa	**Europe**	**Oceania**
Nigeria	Austria	Australia
Asia	Bulgaria	- Northern Territory
China	Federal Republic of Yugoslavia	- Queensland
Georgia	Denmark	- Western Australia
India	Finland	- South Australia
Japan	France	- New South Wales
Myanmar	Germany	
Pakistan	Greece	
South Korea	Hungary	
Sri Lanka	Latvia	
Taiwan	Lithuania	
Thailand	Moldova	
Middle East	Netherlands	
Iran	North Macedonia	
Israel	Norway	
Jordan	Poland	
Lebanon	Romania	
Saudi Arabia	Russia	
Syria	Spain	
North America	Sweden	
Canada	Turkey	
United States	Ukraine	
	United Kingdom	

Appendix 2 - Symptoms of CGMMV infection on cucurbit host plants

Images were sourced from a range of agencies including state and territory governments.

Watermelon

Melon

Pumpkin

Bottle gourd

Cucumber

Appendix 3 - Pathways for Transmission of CGMMV

Pathway	Action
Vehicles and equipment CGMMV particles can remain viable * • within organic materials (years) • on vehicle surfaces (months)	Clean vehicles and machinery are stored at dedicated facilities in locations away from growing areas. Equipment and dedicated farm vehicles do not move off the property and are cleaned and disinfected between use in different growing areas. Visitor vehicles park at designated areas and on-site vehicles travel on designated pathways between growing areas to minimise interaction with farm equipment. Gate signs direct traffic and inform visitors about property access points, and whom to contact for enquiries.
Packaging and pallets CGMMV particles can remain viable* • within organic materials • on pallets • on or in used packaging	New packaging materials should be used for each batch of product crop and never recycled. Unused boxes and bins are stored on clean hard floors in a covered area, well away from potentially infected plants and objects. Pallets are clean of organic material and soil. Dirty pallets are thoroughly cleaned in a wash-down area.
Staff and Farm Visitors CGMMV particles can remain viable* on • Hands and gloves • Tools and equipment • Clothes, especially footwear • Vehicles, including tyres and in mud/plant debris in interior footwells	Visitor vehicles, clothing, footwear and tools are checked for organic matter and soil and cleaned down before entering and again before leaving the farm. Cleaning facilities including footbaths and brushes are maintained and accessible for visitors and staff. Staff are trained about hygiene measures and visitors are inducted in biosecurity expectations prior to moving past the farm office. All visitors report to management, sign a visitor register and report previous movements in other growing regions upon entering the property. Gate signs direct traffic and inform visitors about property access points, designated visitor parking and restricted areas (growing areas).
Waste and weeds CGMMV particles can remain viable* for long periods (months to years) within/on • Plant debris or waste • Weeds	Plant debris or waste is disposed of as soon as possible and stored away from growing areas and water sources or overground flows. Growing areas are surrounded by weed-free buffer zones.
Planting materials CGMMV particles can remain viable* within/on • Seed/seedlings • Fertiliser/ organic amendments where there has been no heating involved in production	Planting material is sourced from reputable suppliers. Follow seed testing requirements for imported cucurbit seed as listed in BICON – Australian Biosecurity Import Conditions Database. Arrange testing of seed if imported into the country before November 2014.

*The viability of CGMMV particles on/in different substrates can be variable, depending on the substrate and how it is treated (temperature, exposure to chemicals). Generally speaking, CGMMV particles will remain infectious (viable) within plant material for longer (months to years) periods than on inert surfaces (weeks to months).

Appendix 4 - Farm Biosecurity Action Planner

Farm Biosecurity Action Planner

This Action Planner is a template you can use to address CGMMV risk factors on your farm. It is designed for you to put your individual management actions in the blank column.

Risk	Estimated risk rating* (0 = none, 10 = high risk)	Mitigation practices	Action
Vehicle movement With multiple entry sites, vehicle access cannot be controlled, making it difficult to stop visitors moving into growing regions. These risks are increased when the vehicles have been exposed to different growing areas.		Visitor vehicles are restricted to parking at designated areas and on-site vehicles travel on designated pathways between growing areas. Gate signs direct traffic and inform visitors about property access points, and whom to contact for enquiries.	
Vehicle hygiene Areas where organic matter can become lodged, such as tyre treads and grills, can become reservoirs of CGMMV infected material. Runoff from clean-down areas can carry CGMMV particles.		Clean vehicles and equipment at dedicated on-site facilities that are well maintained and away from growing areas. Keep dedicated equipment and vehicles for on-farm use.	
Staff and Farm Visitors on farm Visitors and staff can carry CGMMV from other areas on the farm, other farms, or other growing regions. Staff that are untrained in good biosecurity practices can spread diseases, pests and degrade biosecurity systems that are already in place.		Visitor clothing, footwear and tools are checked for organic matter and soil and are cleaned down before entering the farm. Cleaning facilities including footbaths and brushes are maintained and accessible for visitors and staff. Staff are inducted in on-farm biosecurity practices and visitors are made aware of biosecurity expectations prior to moving around the farm. All visitors report to the farm office and sign a visitor register upon entering the property.	

Risk	Estimated risk rating* (0 = none, 10 = high risk)	Mitigation practices	Action
Waste Farm waste can be a source of CGMMV.		Waste is disposed of as soon as possible and stored away from growing areas and water sources.	
Planting / propagating material Seed, seedlings		Planting / propagating material is sourced from reputable suppliers. Planting / propagating material should be checked for pests and diseases on arrival – unhealthy plants should not be planted. Any information relating to CGMMV status (e.g. seed tests, batch numbers, dates of receipt and sources) are kept on record.	
Soil and compost made from infected plants can be a source of CGMMV.		Do not reuse soil or growing media from infected plants. Do not use infected plant debris in compost.	

Packaging materials Used packaging or pallets that have come into contact with infected plants can be a source of CGMMV.		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.	
Monitoring Lack of monitoring can lead to virus symptoms going unnoticed, allowing the virus to go unmanaged, during which time it may establish in growing regions and spread to other properties. Recording a *lack of symptoms* during regular monitoring is essential for proving property freedom.		Regular monitoring is carried out in crops and surrounding vegetation. Staff are trained to be aware of CGMMV infection symptoms. Posters, information pages and fact sheets are available on the property to help staff identify symptoms. Monitoring results are documented.	
Growing Area regulation Unnecessary movement in growing areas can increase the risk of CGMMV transmission. Neighbouring properties could harbour CGMMV. Weeds can be a source for the virus. Animals have the potential to spread the virus.		Gate signs direct traffic and inform visitors about property access points. There is a designated visitor parking area. Regular communication is maintained with neighbours regarding biosecurity procedures. Feral animal and weed populations are controlled.	

Farm biosecurity plans Writing a biosecurity plan for a specific farm or area of land, helps to identify gaps and risks in biosecurity. Not implementing biosecurity strategies can increase the risk of CGMMV infection, and lead to higher long-term costs for managing CGMMV.		A specific farm biosecurity plan with prioritised actions is maintained for each growing area on your property. This plan is updated as goals are achieved and is integrated into the overall Farm Management Plan.	
Extra risk:			
Extra risk:			

***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 5 – 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 (e.g. 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 on 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 materials 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 free of organic material and soil				
Dirty pallets are cleaned in the wash-down area				

Appendix 6 – Example CGMMV and MNSV Surveillance Instructions

1. Purpose

The purpose of this document is to instruct Australian cucurbit growers how to survey cucurbit paddocks for the presence of *Cucumber green mottle mosaic virus* (CGMMV) and *Melon necrotic spot virus* (MNSV).

2. Scope

These instructions are to be used by Australian cucurbit growers or their delegates to conduct surveys for CGMMV and MNSV in paddocks planted to cucurbits (watermelon, rockmelon, honeydew melon, cucumber, zucchini, squash).

3. Type of surveys

- **Comprehensive surveys (visual inspection supported by sampling of symptomless plants)** involve taking samples evenly across the whole paddock irrespective of plants' appearance or other factors. The advantage of this style of sampling is that it detects infection at very early stages and does not rely on the person undertaking the survey to recognise CGMMV or MNSV symptoms. Comprehensive surveillance provides a higher level of confidence that CGMMV and/or MNSV will be detected if present. Plants are selected according to the sampling pattern, and young leaves from those plants are sampled.
- **Targeted surveys (only sampling when symptoms are seen)** surveys involve visually examining plants across paddocks but only sampling from plants with symptoms that indicate virus infection. Note that this could also mean sampling from plants with *Papaya ringspot virus* – type W (PRSV-W), *Zucchini yellow mosaic virus* (ZYMV), *Watermelon mosaic virus* (WMV), *Squash mosaic virus* (SqMV) or other virus-like mottling or distortion symptoms. Only sample the one type of symptom once, from each type of cucurbit. Again, young leaves should be sampled from symptomatic plants.

4. Equipment required

- Press seal plastic storage bags
- Pen to label sample bags
- Paper towel
- Spray bottle filled with water (to wet paper towel)
- Gloves (for symptoms seen sampling)
- Hand wipes (to clean up bags, hands and equipment if symptoms are seen)
- Rubbish bag
- Field marker – spray paint, flags, tagging tape
- Kit bag
- Knife (for cutting fruit)
- Cooler with freezer blocks
- Bubble wrap or layers of newspaper (to put between samples and freezer blocks to prevent freezing the samples)

<u>Optional extras:</u>

- GPS (mobile device)
- Step counter with alarm

5. Glossary

For the purpose of this survey the following terms mean:

- a '**mature**' plant is one that has had fruit set, noting that plants can be surveyed after harvest if needed.
- a '**symptom**' is a visual trait or collection of traits observed on cucurbit plants that indicate it may be infected with a plant virus, including CGMMV or MNSV. See Attachment 1 and Section 8 for example symptoms.
- a '**planting**' consists of the same variety (or multiple varieties if seedless and pollinator watermelons) planted at the same time, from the same seed lot/s and managed in the sameway. A '**planting'** may be comprised of several '**blocks'**.
- a '**block**' is defined as a group of plants of one or more varieties managed as a single unit within a property. A '**block**' is often bounded by permanent structures or natural features such as roads, fences, irrigation channels or creeks.
- where a number of plants of the same or different varieties are planted sequentially over time in one area, the area is still considered one '**block**' as long as the area is managed as a single unit. As such a '**block'** can continue across roads/tracks or contour banks/creeks/irrigation channels.
- a '**sampling frame**' is the collection of blocks and plantings that are the subject of the survey activity at a particular time, out of which a selection of plants will be surveyed and sampled. A '**sampling frame**' is often a whole property or farm.
- a '**survey walking path**' is the pattern you will use to walk through the sampling frame to visually examine plants and sample from them.

6. Pre-survey planning

Ideally surveying and sampling will be conducted when at least ¾ of the plants that will be planted over the season either have fruit set or have been harvested (NB: crops can still be surveyed and sampled after all fruit has been harvested).

Requirements for visual survey and leaf sampling:

- 1000 plants for visual examination.
- 150 samples (one leaf each) for **comprehensive (visual inspection supported by sampling of symptomless plants)** surveys on a roughly proportional basis (e.g. 20 ha rockmelon and 10 ha watermelon equals 100 and 50 samples from each crop respectively).
- For **targeted (only sampling when symptoms are seen)** sampling, one sample (of up to five individual leaves) should be taken for each symptom seen on each host plant type.
- Sample bags – for **comprehensive** surveys up to 10 leaves of the same cucurbit type can be stored in each sample bag.
- Sample bags – for **targeted** surveys each sample (of up to 5 individual leaves) should be stored in a single sample bag.

Information needed to calculate how to conduct visual survey and leaf sample collection across the sampling frame (farm):

- Use Attachment 2: CGMMV Surveillance Property Description – to calculate how many plants to survey and sample – take note that numbers are calculated as a proportion of mature plants available to survey/sample (the total number of mature plants across the

farm).

- Ideally you need to know sizes of blocks and numbers of rows in each block to figure out the survey walking path to be used through the sampling frame (farm).
- Can also be helpful to know how long your average step size is (for counting steps between samples / visual examination points). A step counter with alarm can also assist.
- Divide up the sampling frame (farm) within and between blocks based on the proportion of the total number of plants needed to be surveyed.
- Develop the survey walking path based on individual situations.
  - If your farm is small, "W" shaped walking paths through the blocks is preferred.
  - If your farm is very large, create a "H" shape by walking across the tops of rows, and then down one relatively central row, and across the bottom of rows of each paddock, to proportionately cover all plants in the sampling frame (farm).
- Figure out how many sample bags to take – using the method described above. Pre-labelling sample bags can make things much easier in the field.

7. Paperwork

If you are collecting samples, you will need to submit paperwork with the samples collected. Keeping records of when you survey and what the results are, including negative results, is good biosecurity practice.

- A '*CGMMV Surveillance Property Description Form'* (Attachment 2) records when and where surveys were performed and helps to calculate how many plants to inspect.
- A '*Surveillance and Sampling Record*' (Attachment 3) is used to record details of the samples collected.

Forms should be completed fully – all sections, in legible handwriting please. Block / planting names should match those in usual use by the farm.

8. Symptoms

Look closely at individual cucurbit plant leaves, stems, and fruit for:

8.1 CGMMV

- Leaves - mottling and mosaic (Attachment 1, Figure 1).
- Stems and peduncles - necrotic lesions (Attachment 1, Figure 2).
- Fruit (external) - shape deformity (Attachment 1, Figure 3), skin lesions, general discolouration and/or mottling.
- Fruit (internal) – 'yellow patches' in the pink fruit flesh of watermelons (Attachment 1, Figure 4) and/or mushy flesh (Attachment 1, Figure 5).

CGMMV symptoms are often more distinct on younger leaves. Early symptoms include vein clearing and crumpling, while older leaves may have chlorosis (yellowing). If symptoms are observed, the plant should be selected for sampling.

If external fruit symptoms such as fruit deformity (Attachment 1, Figure 3) or lesions are observed, fruit should be cut open to look for internal symptoms.

8.2 MNSV

- Fruit - The most distinctive feature of MNSV infection is the brown stains/patches that develop in watermelon fruit rind and throughout rockmelon fruit flesh and seed cavities (Attachment 1, Figures 6 and 7).
- Petioles and stems - brown necrotic spots may also develop on leaf petioles and plant stems (Attachment 1, Figure 8).
- Leaves - Small greasy-looking to transparent spots appear on new leaves of both rockmelon and watermelon that turn brown and grow as the leaf matures (Attachment 1, Figure 9). Leaves also curl and wilt and may die.

Note:

- Leaf discolouration, mottling and distortion and fruit skin lesions, can also be caused by endemic viruses, such as PRSV-W, SqMV, WMV or ZYMV.
- Stem lesions caused by MNSV are always associated with leaf or fruit symptoms, and do not occur on their own.
- Stem lesions can also be caused by gummy stem blight.

8.3 Detailed descriptions of CGMMV and MNSV

CGMMV:

- https://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/vg15013-cgmmv- symptoms-fact-sheet.pdf
- https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/crop-growing/priority-pest-disease/cucumber-green-mottle-mosaic-virus

MNSV:

- https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/crop-growing/priority-pest-disease/melon-necrotic-spot-virus
- https://www.planthealthaustralia.com.au/wp-content/uploads/2015/11/Necrotic-spot-virus-FS.pdf

9. Procedure

9.1 Comprehensive surveys (visual inspection supported by sampling of symptomless plants):

The sampling frame will be mature cucurbit plants on the farm.

1. Walk the perimeter of each block to be surveyed – do not touch plants yet – and look for any obvious signs of disease or damage. If diseased plants are seen, mark the spot to come back to later (these will be sampled at the end of the process).
   a) Using your previous calculations and taking your kit bag of equipment, walk your planned survey path through the block stopping every ‘x’ steps (or metres as per your calculations) to visually examine a plant (see symptoms list in Section 8 and images in Attachment 1 for images). If no symptoms are seen, continue with survey.
   b) Every ‘y’ steps take a ‘no symptom’ sample of one leaf from one plant into your pre-labelled sample bag(s). Remember each sample bag can only contain 10 sampled leaves.
   c) When selecting leaves to sample, note that young fresh leaves will travel to the laboratory in much better condition than older, damaged leaves. Viruses if present in the plant will also be present in young leaves, even if you can’t see symptoms on them yet.

2. When sampling, collect a fully expanded leaf from each of ten plants of the same variety into a press seal plastic storage bag (samples from different varieties must not be mixed including pollinator varieties). If the leaf is large, only collect a 7 cm X 14 cm piece of the leaf (about the size of a mobile phone) in order to reduce the bulk in the sample. No more than 10 leaves to be collected in each bag and where practical do not mix samples from different plantings.
    a) Label the bag with the property name, date, variety, planting/block name, collector and number of leaves. When starting a new bag, record the latitude and longitude of the first sample collected and record the details on the survey sample form for the property (Attachment 3).
    b) Each bag should contain a moist, but not wet, paper towel, to keep the leaves from dehydrating during transport to the laboratory. Each bag should be sequentially numbered according to the sample form running sheet in Attachment 3.
    c) Bags are to be kept cool in an esky while surveying, but not in direct contact with freezer bricks (bubble wrap between freezer bricks and bags works well). Frozen leaf tissue is not useful for laboratory testing.

3. If you see symptoms, that you are really concerned might be CGMMV or MNSV (especially fruit symptoms for MNSV) – **do not continue the survey.** Instead, take some images on your phone. Collect a symptomatic leaf sample (up to five leaves). Put some slices of the symptomatic fruit (mobile phone sized including rind if possible) into a separate bag and exit the field. Put the samples in a secure location and contact your local state-based biosecurity officer (i.e. QDAF, NSW DPI or Agriculture Victoria through the exotic plant pest hotline 1800 084 881) or AMA biosecurity officer (Joanna Embry, biosecurity@melonsaustralia.org.au) as soon as possible. While waiting for further instructions restrict access to the suspect plants, and thoroughly clean yourself, your clothing and equipment before entering any other cucurbit crops.

4. If you see symptoms typical of viruses (like PRSV, ZYMV, WMV, etc.) that you are used to seeing on your property, then take a 'targeted survey' sample (as described below, Section 9.2) and then continue.

9.2 Targeted survey (only sampling when symptoms are seen):

If you have observed symptomatic plants , that you think is something other than CGMMV or MNSV ,during the initial perimeter walk, or whilst walking through the crop, you will need to go back and take a 'symptoms seen' sample.

1. Take five new growth, but fully expanded leaves from one plant or a number of plants next to each other displaying the same symptoms. Take up to 5 leaves per symptom per host plant type with a **maximum** of 10 samples taken (i.e. 50 leaves in 10 bags, with 5 leaves per bag). Again, note that young fresh leaves will travel to the laboratory in much better condition than older, damaged leaves. Viruses spread throughout plants, and will also be present in young leaves of plants with symptoms on older leaves.

2. The sample for each symptom must be collected into a separate bag for submission to the laboratory as a separate sample.

3. Record the location of any suspect plants (GPS, flagging tape, spray paint, row number etc).

4. Write details for all symptoms seen samples on the *Surveillance and Sampling Record* (Attachment 3).

NB: If you see symptoms, that you are really concerned might be CGMMV or MNSV (especially fruit symptoms for MNSV) – **do not continue the survey.** Instead, take some images on your phone. Collect a symptomatic leaf sample (up to five leaves). Put some slices of the symptomatic fruit (mobile phone sized including rind if possible) into a separate bag and exit the field. Put the samples in a secure location and contact your local state-based biosecurity officer (eg. QDAF, NSW DPI or Agriculture Victoria through the exotic plant pest hotline 1800 084 881) or AMA biosecurity officer (Joanna Embry, biosecurity@melonsaustralia.org.au) as soon as possible. While waiting for further instructions restrict access to the suspect plants, and thoroughly clean yourself, your clothing and equipment before entering any other cucurbit crops.

10. Sample storage and dispatch

Once back in the office, check samples again to ensure that paper towel is moist, but bags are not dripping with water; and leaves are mostly flat within the bag and in good condition.

If you are not sending samples the same day, keep them cool in a cool room or fridge, being careful that they do not become frozen (4 - 15 ^{o}C is ideal).

Double check paperwork is complete, and handwriting is legible.

Send the samples in a plastic express post bag or courier to:

Victoria:

Crop Health Services Agribio
Specimen Reception
Main Loading Dock
5 Ring Rd
BUNDOORA VIC 3083
Please inform Crop Health Services (CHS) when they are on the way:
Telephone: (03) 9032 7515
Email: chs.reception@depi.vic.gov.au

Queensland:

Attn: Grow Help Australia
Department of Agriculture and Fisheries (DAF)
Loading Dock, Basement 3
Joe Baker Street
DUTTON PARK QLD 4102

NSW:

NSW Plant Health Diagnostic Service
Send samples to:
Sample Submissions
Elizabeth Macarthur Agricultural Institute
Woodbridge Rd
MENANGLE NSW 2568
https://www.dpi.nsw.gov.au/about-us/services/laboratory-services/plant-health/collecting-and-submitting-plant-or-insect-samples

WA:

https://www.agric.wa.gov.au/livestock-biosecurity/sending-specimens-identification

NT:

https://industry.nt.gov.au/industries/primary-industry/laboratory-services/plant-pathology

Delivery to the appropriate laboratory within 48 hours of collection is recommended. Samples do not need to be sent as cold consignments. Overnight courier or express post (24-48 hours) at room temperature is fine.

Attachment 1:

Images of CGMMV symptoms

Figure 1: **Leaf mottling/mosaic symptoms.**

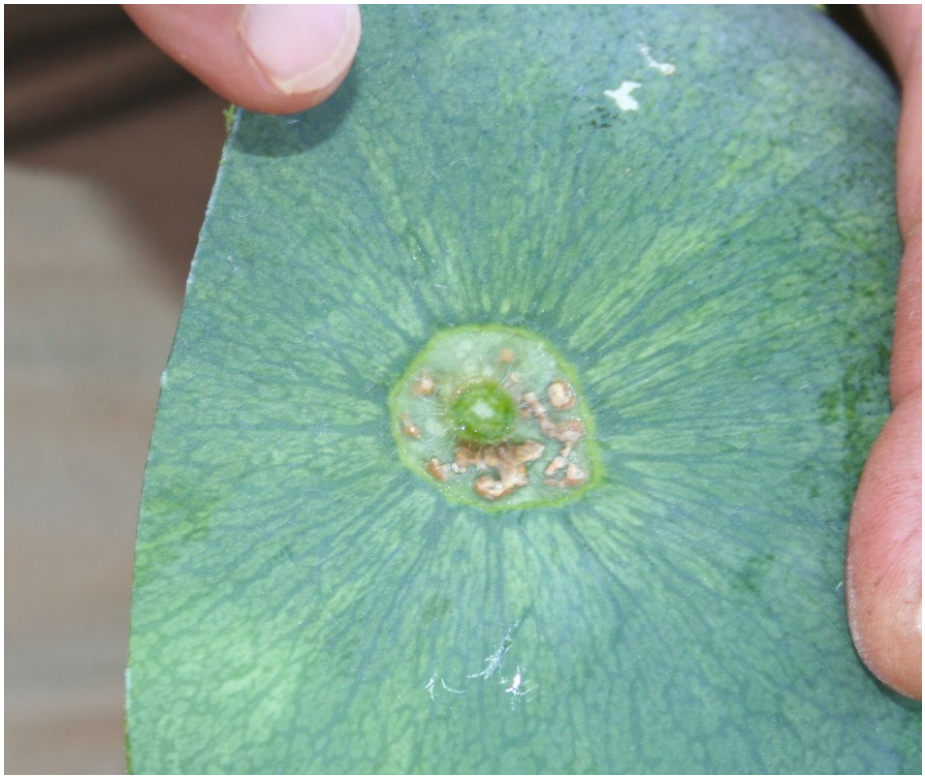

Figure 2: **Necrotic spot on fruit peduncle, this symptom can extend onto the stalk.**

Figure 3: **Unripened areas extending from the rind into the centre of otherwise ripe fruit. This was the most commonly observed fruit symptom in the Northern Territory.**

Figure 4: **Mature fruit with yellow patches in otherwise ripe fruit flesh. This is the most severe fruit symptom.**

Figure 5: **Mature fruit with patches of rotten or mushy flesh or cavities, whilst the rest of the fruit flesh is still quite firm.**

MNSV symptoms

Figure 6: Brown MNSV lesions inside watermelon fruit rind and flesh (left) and inside rockmelon fruit (right).

Figure 7: Necrotic spots caused by MNSV on the exterior of watermelon fruit.

Figure 8: Necrotic lesions on cucurbit stems (left) and watermelon fruit peduncle (right). Remember that stem and peduncle lesions on their own (i.e. without leaf spots or fruit symptoms) are not strong indicators of MNSV.

Figure 9: Leaf spots on watermelon caused by MNSV.

Images courtesy of the Northern Territory Department of Industry, Tourism and Trade and the New South Wales Department of Primary Industries

Attachment 2: EXAMPLE
CGMMV Surveillance Property Description (where possible, attach farm map with block plan)

Property name:

Address:

Surveillance date: Approved person:

Latitude: Longitude: NB: Record latitude and longitude at property entrance

Expected cucurbit area for the property for season (ha):

EXAMPLE: Cucurbit Planting Description

Block Name	Planting Name	Variety	Number Planted	Mature	Expected Visual	Calc for visual	Expected Sample 1	Calc for sample	Actual Visual
House	1	Javelin (seedless)	20,000	Y	417	(20,000/ 48,000)*1000	63	(20,000/ 48000)*150	
House	1	SP-6 (pollinator)	5,000	Y	104	(5,000/ 48,000)*1000	16	(5,000/ 48000)*150	
House	2	Sucro	5,000	Y	104	(5,000/ 48,000)*1000	16	(5,000/ 48000)*150	
Block 2	1	Sucro	3,000	Y	63	(3,000/ 48,000)*1000	9	(3,000/ 48000)*150	
Block 3	1	Silverock	5,000	N	0	(0/ 48,000)*1000	0	(0/ 48000)*150	
Block 3	2	Sweet Trick	10,000	Y	208	(20,000/ 48,000)*1000	31	(20,000/ 48000)*150	
Block 3	3	Sweet Trick	10,000	N	0	(0/ 48,000)*1000	0	(0/ 48000)*150	
Nursery	1	Silverock	5,000	Y	104	(20,000/ 48,000)*1000	16	(20,000/ 48000)*150	
Total			63,000	48,000	1000		150		

CGMMV Surveillance Property Description (where possible, attach farm map with block plan)

Property name:

Address:

Surveillance date: Approved person:

Latitude: Longitude: NB: Record latitude and longitude at property entrance

Expected cucurbit area for the property for season (ha):

Cucurbit Planting Description

Block Name	Planting Name	Variety	Number Planted	Mature	Expected Visual	Expected Sample 1	Actual Visual

Attachment 3: EXAMPLE

Sample Form

Property name:

Sample Date:

EXAMPLE: Sample Form

Sample name	Block	Planting - (p) pollinator	Number leaves	Symptomatic	Latitude (1stsample)	Longitude
1	House	1	5	Y	-19.123456	143.123456
2	Block 3	2	5	Y	-19.12356	143.12456
3	House	1	10		-19.1236	143.1245
4	House	1	10		-19.xxxxx	143.xxx
5	House	1	10		-19.xxxxx	143.xxx
6	House	1	10		-19.xxxxx	143.xxx
7	House	1	10		-19.xxxxx	143.xxx
8	House	1	10		-19.xxxxx	143.xxx
9	House	1 (p)	10		-19.xxxxx	143.xxx
10	House	1 (p)	6		-19.xxxxx	143.xxx
11	House	2	10		-19.xxxxx	143.xxx
12	House	2	10		-19.xxxxx	143.xxx
13	Block 2	1	10		-19.xxxxx	143.xxx
14	Block 3	2	10		-19.xxxxx	143.xxx
15	Block 3	2	10		-19.xxxxx	143.xxx
16	Block 3	2	10		-19.xxxxx	143.xxx
17	Nursery	1	10		-19.xxxxx	143.xxx
18	Nursery	1	10		-19.xxxxx	143.xxx
Total			166		-19.xxxxx	143.xxx

Sample Form

Property name:

Sample Date:

Sample name	Block	Planting - (p) pollinator	Number leaves	Symptomatic	Latitude (1stsample)	Longitude
Total						