Priority Pest Review for Vegetables

Report prepared for
Vegetables New Zealand

September 2023

Market Access Solutionz Ltd

Table of Contents

1. Executive Summary 3
2. Introduction 4
3. Priority Pests 6
3.1 *Spodoptera frugiperda* – Fall armyworm 6
3.2 *Meloidogyne enterolobii* – Guava root knot nematode 7
3.3 Leafminers - *Liriomyza huidobrensis* (serpentine leafminer), *L. trifolii* (American serpentine leafminer), *L. sativae* (vegetable leafminer) 8
3.4 *Aphis fabae* - Black bean aphid 8
3.5 Capsicum chlorosis virus (CaCV) 9
3.6 *Contarinia nasturtii* - swede midge 9
3.7 Cucumber green mottle mosaic virus (CGMMV) 9
3.8 Cucurbit yellow stunting disorder virus (CYSDV) 9
3.9 *Cylas formicarius, Euscepes postfasciatus* - Sweet potato weevils 9
3.10 *Diabrotica virgifera virgifera* - Western corn rootworm 10
3.11 *Epitrix* spp. - Flea beetle 10
3.12 *Lygus lineolaris* - Tarnished plant bug 10
3.13 *Tetranychus evansi* - Tomato red spider mite 10
3.14 Viroids 11
4. Pests of concern 11
4.1 *Leptinotarsa decemlineata* – Colorado beetle 11
4.2 Pepino mosaic virus (PepMV) 12
4.3 *Scirtothrips dorsalis* - Chilli thrips 12
4.4 *Phaedon brassicae* – Brassica leaf beetle 12
4.5 *Leucinodes orbonalis* – Eggplant fruit borer 12
4.6 Tomato brown rugose fruit virus (ToBRFV) 13
4.7 Tomato leaf curl New Delhi virus (ToLCNDV) 13
4.8 *Pantoea ananatis* – centre rot 13
4.9 Other pests of concern 14
5. New and emerging pests of concern 14
5.1 Watermelon crinkle leaf-associated virus 1 and 2 (WCLaV-1, WCLaV-2) 14
6. References 15

1. Executive Summary

This report reviews the Vegetable NZ priority pests for the period **1 March 2023 to 30 September 2023**. The frequency of these reports has been increased to six-monthly so that information can be provided to Vegetables NZ in a timely manner. Pest information from the scientific literature, international databases, and the VR&I monitoring risks project has been reviewed in relation to being a biosecurity risk for the fresh vegetable industry, and to inform on the latest research findings. The lack of reporting from MPI's emerging risks system means information from the Emerging Risks System is not included in this report.

As an outcome of this review, the following pests are highlighted to Vegetables NZ because of their detection in Australia and close proximity to New Zealand, or increased concern overseas. These pests are:

- ***Meloidogyne enterolobii*** (guava root knot nematode): has been detected in Northern Territories and Queensland, Australia, at multiple sites infecting a variety of vegetable crops. Its regulatory status has been updated by MPI from 'Not assessed' to 'Regulated'.
- **Watermelon crinkle leaf-associated virus 1 and 2** (WCLaV-1, WCLaV-2): were added to the EPPO Alert List following recent concerns due to new detections emerging from different parts of the world, including WCLaV-1 being detected in Australia. These viruses are new, generally mechanically transmitted, and associated with seeds, plants for planting, and potential seed and fruit. To date, damage is reported on watermelon, squash and zucchini. MPI are undertaking monitoring of these pathogens.
- ***Spodoptera frugiperda*** (fall armyworm): the fall armyworm response in New Zealand has ended and transition to long-term management, led by industry, is underway. Its unwanted organism status has been revoked, however it remains a regulated organism and as such presents an ongoing concern to the vegetable sector.

2. Introduction

Vegetables New Zealand Inc (VNZI) has engaged Market Access Solutionz Ltd to provide technical assessment of priority pests. Some of these pests are, or may become, Sector Risk Organisms under GIA Operational Agreements. Others are identified as pests of concern to VNZI, with their changing distribution and impact monitored to determine whether their significance is increasing.

The purpose of the priority pest review is to identify any changes in the risk posed by these priority pests and to identify any new pests that should be added to the priority pest list. In the 2023-24 workplan, the frequency of this report was increased to six-monthly so that new information could be provided to VNZI in a timely manner.

New developments of interest, in particular studies on chemical control and resistance, biocontrol, and other related topics, are highlighted. Key points and recommendations may be noted for some pests. Monitoring of priority pests, and pests of concern (Table 1) is on-going. Although little/no new relevant information was uncovered for some pests, monitoring will continue for these. Little/no new information can also be a reflection of research investment and publication rates, and the lack of publications is not necessarily an indication of a reduction in biosecurity risk.

This review of Vegetable priority pests has considered information from the VR&I Monitoring Biosecurity Risks project, scientific literature (e.g., Plant Disease journal), and international databases (CAB abstracts, EPPO RSE monthly reports, NAPPO).

MPI Emerging Risks System
A key source of information has been MPI's Emerging Risks System. A Stakeholder report has not been released since November 2021. A recent enquiry to MPI indicated that the 23rd Stakeholder report (covering 22 September 2021 to 21 September 2022) is due in the week of 9 October 2023; and the 24th Stakeholder report (covering 22 September 2022 to 21 August 2023) should be released approximately six weeks later (late November 2023). Thereafter, reports are planned to be released quarterly. The significant delay in MPI releasing these reports reinforces the importance for VNZI to continue with its own independent monitoring for priority pests and emerging biosecurity risks.

This report is a summary for the 7-month period from **1 March 2023 to 30 September 2023**.

Table 1: Priority pests for Vegetables NZ

Priority Pests	*Aphis fabae* (black bean aphid) Capsicum chlorosis virus (CaCV) *Contarinia nasturtii* (swede midge) Cucumber green mottle mosaic virus (CGMMV) Cucurbit yellow stunting disorder virus (CYSDV) *Cylas formicarius, Euscepes postfasciatus* (sweet potato weevils) *Diabrotica balteata* (banded cucumber beetle) *Diabrotica speciosa* (cucurbit beetle) *Diabrotica virgifera virgifera* (western corn rootworm) *Epitrix similaris* (flea beetle) *Lygus lineolaris* (tarnished plant bug) *Liriomyza* spp., *Chromatomyia horticola, Phytomyza* gymnostoma (leafminers) *Meloidogyne enterolobii* (root knot nematode) *Spodoptera frugiperda* (fall armyworm) *Tetranychus evansi* (red spider mite) Tomato apical stunt pospiviroid (TASVd)
Other pests of concern	*Candidatus Lineribacter solanacearum* (CLso) Potato spindle tuber viroid (PSTVd) *Scirtothrips dorsalis* (chilli thrips) *Diaprepes abbreviates* (citrus weevil) *Empoasca fabae* (potato leafhopper) *Epitrix* spp. (flea beetles) *Frankliniella ewarti/fusca* (thrips) *Halyomorpha halys* (brown marmorated stink bug, BMSB) *Hauptidia maroccana, Austroasca viridigrisea, Sibovia occatoria* (leafhoppers) *Leptinotarsa decemlineata* (Colorado beetle) *Leucinodes orbonalis* (eggplant fruit borer) Physostegia chlorotic mottle virus (PhCMoV) Pea early browning virus Pea enation mosaic virus *Phaedon brassicae* (brassica leaf beetle) Tomato brown rugose fruit virus (ToBRFV) Tomato leaf curl New Delhi virus (ToLCNDV) Tomato leaf curl purple vein virus (ToLCPVV) Tomato torrado virus (ToTV) *Tuta absoluta* (tomato leafminer) *Xiphinema, Longidorus* and *Meloidogyne* spp. (nematodes)

Regulatory status

Regulatory status is obtained from the Official New Zealand Pest Register (ONZPR) (MPI 2021b). The following terms are used to describe the regulatory status:

Regulated	Organisms of potential importance to NZ and not yet present, present but not widely distributed and officially controlled, or a vector for another regulated organism.
Non-regulated	Organisms assessed to be present in NZ, unlikely to ever establish, or unlikely to cause significant harm if it becomes established.
Not assessed	Not assessed organisms intercepted at the border will be either subject to a rapid risk assessment to determine regulatory status, or provisional measures will be applied to manage risk until a risk assessment is performed.

Pests or diseases uncovered as a result of the monitoring activities that are not listed in the ONZPR are noted as **Not listed**.

3. Priority Pests

3.1 *Spodoptera frugiperda* – Fall armyworm

Key points:
- Fall armyworm response has ended and transition to long-term management is underway.
- The unwanted organism status of fall armyworm has been revoked but it remains a regulated organism.
- The publication of scientific articles on fall armyworm continues at a high rate indicating the significant resources being directed to combat the impact of this pest.

S. frugiperda larvae damage to corn. Photo: University of Georgia, Bugwood.org. Creative Commons 3.0

New Zealand: The fall armyworm response ended on 21 April 2023, and transition to long-term management began to get underway. Transition to long-term management is industry-led. The unwanted organism status of fall armyworm was also revoked, and statutory reporting is no longer required. In June, low numbers of fall armyworm moths were still appearing in traps in Northland, and winter surveillance was being initiated (FAR 2 June 2023). A large number of tropical armyworm (*Spodoptera litura*) were also observed in Northland. This species can be confused with fall armyworm (EPPO datasheet 2023).

Distribution: The global distribution of fall armyworm is largely unchanged over the last six months, with few new reports. Fall armyworm has almost global distribution and remains absent in northern Asia, Russia, northern Canada or continental Europe. In southwestern China, fall armyworm has displaced the Asiatic corn borer, *Ostrinia furnacalis*, as the dominant maize pest in the area (Song et al. 2023).

EPPO region: In June 2023, the EU revised its emergency measures for fall armyworm to include the additional host fruits for Capsicum, Momordica (Cucurbitaceae), and eggplant species (*Solanum aethiopicum, S. macrocarpon, S. melongena*); and for plants of asparagus, Chrysanthemum, Dianthus, Pelargonium and maize.

Australia: Plant Health Australia have published three reports on fall armyworm; (i) Genetic insights of fall armyworm; (ii) Understanding key market drivers for resistance management, and (iii) Survey of local insect viruses for FAW management (Plant Health Australia 2023). A national programme that will benefit the Australian vegetable industry will be bringing the latest science-based management tools and best practice guidelines to vegetable growers to reduce fall armyworm and its impact. The programme is led by DAFF and funded by Hort Innovation (Hort Innovation July 2023).

New research: The publication of articles on fall armyworm has not diminished. Publications continue to discuss; pest biology and genetics, management, chemical and biological control. In a review of biological control, larval parasitoids may provide the best prospects for classical biological control (Kenis 2023). Strategies for biocontrol with egg parasitoids are also being investigated (Li et al. 2023a).

The addition of nonanal, a component of perfume, to a pheromone mixture was shown to increase its effectiveness to lure male moths, and should be used to improve surveillance, monitoring and control of fall armyworm populations (Saveer et al. 2023).

Regulatory status: *Spodoptera frugiperda* is a regulated organism. Country freedom status has been revoked as *S. frugiperda* is 'Known to be present in NZ'.

3.2 *Meloidogyne enterolobii* – Guava root knot nematode

Galling in sweet potato caused by *M. enterolobii*. Image: Camilo Parada (Ausveg)

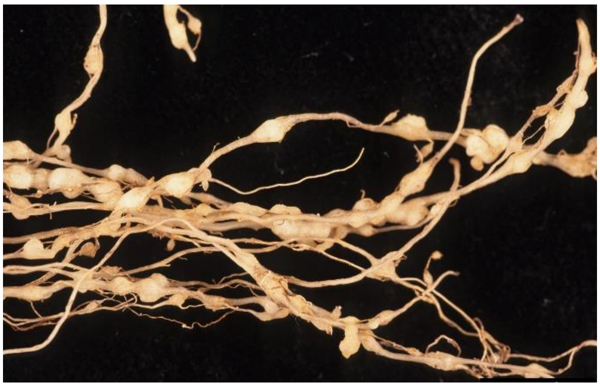
Key points:

- *Meloidogyne enterolobii* continues to be reported from new regions of the world, affecting many hosts including a variety of vegetable crops.
- The regulatory status of *M. enterolobii* was updated from 'Not assessed' to 'Regulated'.

Distribution and hosts: Reporting of new detections of *Meloidogyne enterolobii* (guava root knot nematode) affecting different hosts continue to emerge in the literature. There has been no significant change in global distribution over the last six months. Guava root knot nematode has recently been reported: (i) on sweet potato in **Georgia, USA** (EPPO 2023/03 2023) (Hajihassani et al. 2023), (ii) in **Italy** on *Ficus microcarpa* plants imported from China to the Netherland and re-exported (EPPO 2023/04 2023; EPPO 2023/06 2023), (iii) on plantain in **Nigeria** (EPPO 2023/05 2023), (iv) on guava in **Egypt** (EPPO 2023/06 2023), (v) on eggplant in **Mexico** (Salazar-Mesta et al. 2022), (vi) on the tropical fruit pitaya in **China** (Wu et al. 2023), and (vii) on black nightshade (*Solanum nigrum*) in **China** (Chen et al. 2023).

Australia: Guava root knot nematode was reported in Northen territory and Queensland in late 2022, and it has been determined that eradication from Australia is not possible (EPPO 2023/01 2023). In June 2023, Ausveg held a webinar on guava root knot nematode. Presentations from speakers from Northern Territory, Queensland and Florida, and a Q&A session, are available to view on YouTube (Ausveg June 2023).

New research: Two studies on Capsicum hosts have been investigating (i) the defence mechanisms involved in resistance of Capsicum spp. to guava root knot nematode (Long et al. 2023), and (ii) the distribution, resistance, and biochemical response to guava root knot nematode of capsicums with resistant and susceptible genotypes (Marques et al. 2023).



Root galling on cucumber.
Image: Gerard Holmes, California Polytechnic State University at San Luis Obispo, Bugwood.org

Other root knot nematodes and other nematodes: ***Meloidogyne arenaria*** (peanut root knot nematode, not assessed) is reported infecting maize in Guizhou Province, southeastern China. *M. arenaria* is one of the most damaging plant-parasitic nematodes, infecting many crops worldwide, resulting in large losses in crop quality and yield (Cao et al. 2023). ***Meloidogyne luci*** (not listed) is now reported on tomato from Serbia (Bačić et al. 2023), after previously being reported from Brazil, Chile, Iran, Slovenia, Italy, Greece, Portugal, Turkey, and Guatemala; the authors hypothesized that climate change, and in particular higher temperatures, could lead to further spread and greater damage by *M. luci* to various field crops in the future. ***Heterodera zeae*** (corn cyst nematode, regulated), now reported from Spain infecting corn, is an important disease of corn in several areas of the world, including the Indian subcontinent, Egypt, Thailand, United States, Greece, and Portugal (Palomares-Rius et al. 2023).

Regulatory status: *Melodogyne enterolobii* is a regulated organism.

3.3 Leafminers - *Liriomyza huidobrensis* (serpentine leafminer), *L. trifolii* (American serpentine leafminer), *L. sativae* (vegetable leafminer)

Publications on *Liriomyza* spp. continue to discuss pest biology and genetics, chemical and biological control with parasitoids (Mugala et al. 2023; Seal et al. 2023; Xu et al. 2023) and biopesticides (Prayogo et al. 2022), resistance in plants (Mou 2023), and pest management practices.

The current and future distribution of *Liriomyza* spp. in Australia continues to be investigated. Information from the global distribution of *L. sativae, L. trifolii* and *L. huidobrensis* is being used to forecast their potential distribution in Australia (Maino et al. 2023). Based on environmental variables, the model is being used to predict the suitability of unoccupied ranges, and to highlight where vegetable production regions are at risk. This study also highlighted there are many regions in the world where these species have the potential for future spread.

A review by Mugala et al. discussed the biology and morphological identification of *L. huidobrensis*, its host range and the potential of associated biocontrol agents such as entomopathogenic nematodes, entomopathogenic fungi, and parasitoids as future control options (Mugala et al. 2022). Integrated pest management (IPM) programmes for *L. huidobrensis* have also been evaluated (Monica and Vinothkumar 2023). A study of the pea leafminer, *Chromatomyia horticola* (regulated), showed that different pea cultivars did not have an effect on the reproduction (mean generation time and doubling time) of this leafminer (Dengta et al. 2023).

L. huidobrensis is a priority pest for all vegetable product groups, and Biosecurity New Zealand (MPI November 2020).

Liromyza sativae, L. huidobrensis, and *L. trifolii* (left to right). Photo credits: D. M. Firake and G. T. Behere (left), Central Science Laboratory, York (GB) - British Crown (middle and right). https://gd.eppo.int

Regulatory status: *Liriomyza huidobrensis, L. sativae,* and *L. trifolii* are regulated organisms. NZ has country freedom status for *L. huidobrensis*, which is listed as a priority pest by Biosecurity NZ.

3.4 *Aphis fabae* - Black bean aphid

Publications focussed on Aphis fabae have centred on chemical and biological control, discussing; (i) design, synthesis and insecticidal activity of pyrimidine derivatives (Kayahan 2023) (Nie et al.) (Lan et al. 2023); (ii) the efficacy of essential oils (Abdelmaksoud et al. 2023; Boukabache et al. 2023; Gospodarek et al. 2023; Perumal et al. 2023); (iii) entomopathogenic fungi (Qubbaj and Samara 2022), and (iv) biocontrol using parasitoids in organic production (Ismail et al. 2023).

Regulatory status: *Aphis fabae* is a regulated organism.

Aphis fabae adults and nymphs. Photo: Jack Kelly Clark, courtesy University of California Statewide IPM Program. Copyrighted by the Regents of the University of California.

3.5 Capsicum chlorosis virus (CaCV)

As viruses often occur in co-infections, a PCR test has been developed for in-field diagnosis of CaCV (Devi et al. 2023), and to distinguish it from four other RNA viruses that infect chillis: chilli veinal mottle virus (ChiVMV), large cardamom chirke virus (LCCV), cucumber mosaic virus (CMV), and pepper mild mottle virus (PMMoV), and a DNA virus, chilli leaf curl virus (ChiLCV).

Regulatory status: CaCV is a regulated organism. CaCV is also a Priority pest for TomatoesNZ.

3.6 *Contarinia nasturtii* - swede midge

A publication has discussed the use of pheromone traps for detection and monitoring programmes for swede midge along the edges of canola fields in regions where it is found in the USA and Canada (Vankosky et al. 2023). Pheromone traps are continuing to be used to maintain monitoring programmes to support early detection if it does continue to disperse towards the northwest of North America.

Regulatory status: *Contarinia nasturtii* is a regulated organism.

3.7 Cucumber green mottle mosaic virus (CGMMV)

Understanding the resistance mechanisms of CGMMV has been the topic of recent studies (Liu et al. 2023; Yang et al. 2023). Genetically characterising CGMMV from detections in Australia continue to infer that the CGMMV population was from a single virus source, and via multiple introductions (Mackie et al. 2023). It is also noted that non-host and cucurbitaceous weeds may be potential hosts or reservoirs of CGMMV, so weed management is important (Lovelock et al. 2023).

A rapid and specific CGMMV detection method using specific monoclonal antibodies and an immunochromatographic strip has been developed that is specific for CGMMV, and does not cross-react to tobacco mosaic virus (TMV) and cucumber mosaic virus (CMV) (Zhao et al. 2023). A real-time-droplet digital PCR test has also been developed for quantitative detection of CGMMV (Tian et al. 2023).

Regulatory status: CGMMV is a regulated organism.

3.8 Cucurbit yellow stunting disorder virus (CYSDV)

Cucurbit yellow stunting disorder virus has been detected in India together with Curburbit chlorotic yellows virus (CCYV) (EPPO 2023/09 2023). There have been no other new relevant publications on CYSDV, however EPPO have released a new datasheet (EPPO Datasheet. 19 June 2023).

Regulatory status: CYSDV is Not assessed.

3.9 *Cylas formicarius, Euscepes postfasciatus* - Sweet potato weevils

Cylas formicarius is an important pest of sweet potato. There have been studies into (i) sweet potato defence responses to *Cylas formicarius*, investigating the formation, regulation, and signal transduction mechanisms of defensive volatiles in sweet potato (Xiao et al. 2023), and (ii) the volatiles that influence insect behaviour e.g., oviposition. Studies on control have investigated entomopathogenic fungi (Márquez-Gutiérrez et al. 2022); females, mating, oviposition related female reproduction (Hiroyoshi et al. 2023), and male mating behaviour (Ouyang et al. 2023). Studies on biocontrol continue, as do genomic analyses of the sweet potato weevils which are providing insights into their genetic diversity, population structure, and dispersal (Andreason et al. 2023). These studies are also providing information to support management strategies, and the development of IPM programmes for *Cylas formicarius* also continues (Jackson et al. 2002). There have been no new publications on *Euscepes postfasciatus*.

Regulatory status: *Cylas formicarius* and *Euscepes postfasciatus* are regulated organisms.

3.10 *Diabrotica virgifera virgifera* - Western corn rootworm

The level of susceptibility of *Diabrotica virgifera virgifera* to the pyrethroids, deltamethrin and tau-fluvalinate was studied with populations which exhibited 'high susceptibility', 'susceptibility', 'low resistance' and 'medium resistance' to these agrichemicals, and concluded that the susceptibility needs to be taken into account when developing a strategy to prevent resistance development in this pest species (Dworzanska et al. 2023). EPPO have release a new datasheet for *D. virgifera virgifera* (EPPO Datasheet. 18 April 2023).

Western corn rootworm adult. Photo: Winston Beck, Iowa State University, Bugwood.org.

Regulatory status: *Diabrotica* spp. are regulated organisms.
Diabrotica spp. are Priority pests for many of the vegetable product groups.

3.11 *Epitrix* spp. - Flea beetle

There have been no relevant publications specifically for the VNZI priority pest, *Epitrix similaris*.

Regulatory status: *Epitrix similaris* is not assessed.

3.12 *Lygus lineolaris* - Tarnished plant bug

Publications related to *Lygus lineolaris* have focussed on insecticides and resistance, and biological control.

Tarnished plant bug. Photo: Ross Ottens, University of Georgia, Bugwood.org.

The capture of *L. lineolaris* in the field was found to be significantly increased by combining visual cues (red coloured sticky traps) with olfactory cues (pheromone blends) in a trap/lure combination. The authors suggested that this device, or a future iteration, could contribute towards sustainable and environmentally appropriate early-season monitoring and management of *L. lineolaris* in the field (George et al. 2023). The efficacy and chemical concentrations of commonly used insecticides was evaluated on cotton host plants (Smith et al. 2023). Few studies of *L. lineolaris* are conducted on vegetable hosts.

In studies of resistance mechanisms (Du et al. 2023), mechanisms of metabolic resistance to pyrethroids and neonicotinoids were found to fade away when there was no selection pressure on populations of *L. lineolaris*.

Biological control in strawberries (Dumont et al. 2023) and beans (Li et al. 2023b) has also been the topic of publications.

Regulatory status: *Lygus lineolaris* is a regulated organism.

3.13 *Tetranychus evansi* - Tomato red spider mite

Publications on *Tetranychus evansi* have largely focussed on its control achieved using chemical and biocontrol tools. A study tested the efficacy of neem oil against the chemicals, Acarius and Sunpyrifos, where under laboratory conditions, neem oil was found to seldom induce resistance (Azandémè-Hounmalon et al. 2022). In biological control studies, the foraging behaviour of the predatory mite, *Amblyseius swirskii* on *T. evansi* indicated that the predatory mite may not be a direct recommendation for the biological control of *T. evansi* on tomato, but may be better for inundative release in the early stages of infestation to help improve the success of biological control (Shirvani et al. 2023). The performance of the predatory mite, *Phytoseiulus persimilis*, was found to be reduced when its diet choice was imperfect, or low quality prey (Lemos et al. 2023).

Regulatory status: *Tetranychus evansi* is a regulated organism.

3.14 Viroids

New Zealand: PSTVd was detected in greenhouse tomatoes in the Nelson-Tasman region in mid-late November 2022, and a response initiated by Biosecurity NZ. Plants in three greenhouses were removed and destroyed. As of June 2023, testing for presence of the viroid was on-going, as eradication cannot be declared until a series of negative tests has been returned.

New research: A universal probe, based on a long and highly conserved sequence of nucleotides shared among six members of the genus Pospiviroids has been developed to enable simultaneous detection and large-scale survey in tomato plantings in China, where only PSTVd was detected in a few greenhouse plants (Zhang et al. 2023). The six pospiviroids are: Columnea latent viroid (CLVd), Pepper chat fruit viroid (PCFVd), Potato spindle tuber viroid (PSTVd), Tomato apical stunt viroid (TASVd), Tomato chlorotic dwarf viroid (TCDVd), and Tomato plant macho viroid (TPMVd).

A severe strain of PSTVd was shown to have been attenuated and to cause very mild symptoms in potatoes after three cycles of continuous propagation in tomato which has been suggested that attenuated viroid strains could have potential as a biocontrol agent or vaccine (Kochetov et al. 2023).

Regulatory status: CLVd, PepMV, PSTVd, TCDVd, ToBRFV, TASVd, TPMVd, and PCFVd are all regulated organisms. CLVd, PSTVd, TASVd are Biosecurity NZ priority pests.

4. Pests of concern

4.1 *Leptinotarsa decemlineata* – Colorado beetle

Colorado beetle. https://gd.eppo.int

Leptinotarsa decemlineata has been reported in potato fields in Finland during summer 2021, and is under eradication (EPPO 2023/05 2023). In the UK, *L. decemlineata* larvae were found in a potato field in Kent, and containment and eradication measures were undertaken. Two outbreaks have previously occurred in Kent, and both were promptly eradicated.

A small number of publications have discussed natural enemies (Akcin and Kacar 2023), the effect of irrigation water and nitrogen applications on *L. decemlineata* and natural enemy populations (Daşcı and Aslan 2023), and the susceptibility of the beetle to pyrethroid (Dworzanska et al. 2023). *Leptinotarsa decemlineata* is a VNZI pest of concern.

Regulatory status: *Leptinotarsa decemlineata* is a regulated organism.

4.2 Pepino mosaic virus (PepMV)

Pepino mosaic virus was reported for the first time from South Korea in 2020 in greenhouse tomatoes (EPPO 2023/05 2023).

A publication describing the detection of PepMV in greenhouse tomatoes (Vabishchevich et al. 2023), found that symptoms were from mono-infection or complex co-infections with other viruses (Cucumber mosaic virus, Tobacco mosaic virus, Tomato mosaic virus, and Potato virus X) . During the growing season, possible PepMV symptoms include interveinal chlorosis, deformations, mosaic and yellow spots on leaves and also blotchy ripening fruit.

Tomato fruit symptoms of PepMV showing uneven ripening and surface 'marbling' (left), healthy with normal appearance (right). Image from DPV411 Fig. 6

Plant genetics have been the topic of the majority of recent publications on PepMV.

PepMV is under long-term management after being detected in greenhouse tomatoes in April/May 2021, and a response was initiated. PepMV remains a regulated organism.

Regulatory status: PepMV is a regulated organism.

4.3 *Scirtothrips dorsalis* - Chilli thrips

Scirtothrips dorsalis has been reported from Northern and Southern Peru for the first time with adult thrips collected from blueberry plants and identified by morphology and molecular tests (EPPO 2023/07 2023). *S. dorsalis* is also reported causing damage to grapevines in Mexico (Zamora-Landa et al. 2023).

A study is being conducted to predict the global distribution of *S. dorsalis*. Although largely focussed on the Americas, its distribution in the USA is being used to determine reproductive and feeding hosts of the insect which will provide insights into its increasing host range and expanded geographical distribution (de Aguiar et al. 2023). The study outcomes will be used to develop species-specific monitoring and management programmes (Kumar et al. 2023). The effect of seasonal incidence (Zamora-Landa et al. 2023) and weather parameters on pest abundance (Waluniba et al. 2023) are also being studied. Biocontrol studies have focussed on entomopathogenic fungi (Francis and Manchegowda 2023), predators (Tsuchida and Masui 2023), and control studies on insecticides continue (Choudhary et al. 2022).

EPPO have updated the datasheet for *Scirtothrips dorsalis* (EPPO Datasheet. 13 September 2023).

Regulatory status: *Scirtothrips dorsalis* is a regulated organism.

4.4 *Phaedon brassicae* – Brassica leaf beetle

Preliminary experiments with halofenozide, a new class of insect growth-regulating insecticide, has revealed outstanding larval toxicity against *Phaedon brassicae*, however, its metabolic degradation in insects remains unclear, requiring more research (Ma et al. 2023).

Regulatory status: *Phaedon brassicae* is a regulated organism.

4.5 *Leucinodes orbonalis* – Eggplant fruit borer

Topics of publications on *L. orbonalis* have focussed on control. An evaluation of microbial insecticides for *L. orbonalis* management were found to be effective for reducing *L. orbonalis* infestation in both the shoot and fruit. There was an increase in marketable fruit yield resulting from increased healthy fruit weight and decreased infested fruit weight (Mahi Imam et al. 2022).

An evaluation of bioefficacy, phytotoxicity and insecticide residue dynamics of chlorantraniliprole in eggplants growing under field conditions concluded that it was an effective alternative to conventional insecticides (Halder et al. 2022).

Regulatory status: *Leucinodes orbonalis* is a regulated organism.

4.6 Tomato brown rugose fruit virus (ToBRFV)

ToBRFV has been reported in Argentina for the first time in greenhouses in a major tomato growing area (EPPO 2023/07 2023). In the EU, emergency measures have been revised for ToBRFV establishing measures to prevent the introduction and spread of ToBRFV in the EU (EPPO 2023). A review by van Damme et al (van Damme et al. 2023), presents strategies for halting ToBRFV disease outbreaks based on research of various tobamovirus-plant interactions.

In Mexico, a study was undertaken to determine the environmental suitability of ToBRFV in Guanajuato State by creating a database of vegetative material and geographic locations of positive cases to analyse climatic conditions that favour the incidence and severity of ToBRFV (Nolasco-García et al. 2022). The climatic variables that favour disease incidence were: precipitation of the warmest four-month period (28%), humidity regime (26%) and average minimum temperature of the coldest year (17.0%).

Evidence on how and where ToBRFV can be spread by humans has been provided in a study of the infectivity of ToBRFV-contaminated surfaces where samples were taken from various surfaces in greenhouses, packhouses, and shared and private accommodation, and from various fabrics such as outer clothing, bed linen, and items used by greenhouse workers (Ehlers et al. 2023). Clothing and protective items were highly contaminated with ToBRFV, and in a few apartments ToBRFV was detected around the sleeping area. These findings indicate that strict hygiene protocols are required to interrupt transmission and avoid further dissemination,

Typical fruit symptoms of ToBRFV. Photo: https://gd.eppo.int. Courtesy: Dr Aviv Dombrovsky

The importance of Solanaceae weed hosts continues to be a topic of publications as their distribution and abundance increases the risks of virus transmission (Matzrafi et al. 2023). Roots of infected plants may be the source of ToBFRV detected in wastewater, river and irrigation water, which may have implications on the role of water-mediated transmission, and provide a critical point for monitoring and control, and aid in risk assessment (Mehle et al. 2023).

Regulatory status: ToBRFV is a regulated organism. NZ has country freedom for ToBRFV.

4.7 Tomato leaf curl New Delhi virus (ToLCNDV)

ToLCNDV has been reported causing significant damage in tomato in Nepal (EPPO 2023/05 2023). It has been reported from Turkey, where it is under eradication (EPPO 2023/05 2023). First reported in China on tomato in 2021, ToLCNDV has now been detected in melon, cucumber and luffa in greenhouses in Shanghai (EPPO 2023/05 2023). Damage has also occurred on various melons, pumpkin, luffa, and squash. An in-field assay using real-time LAMP has been developed for rapid detection of ToLCNDV using zucchini, squash, tomato, and pepper samples (Caruso et al. 2023).

Regulatory status: ToLCNDV is a regulated organism.

4.8 *Pantoea ananatis* – centre rot

MPI is actively monitoring *Pantoea ananatis* (MPI 2021a). EFSA (European Food Safety Authority) has undertaken a Pest categorisation of *P. ananatis* and has determined that its pathogenic nature is not well defined, there are non-pathogenic strains, and that it particularly affects onions, maize, rice and eucalyptus. Tomatoes were not listed as a host. Insect vectors were noted to be *Frankliniella fusca* (tobacco thrips) and *Diabrotica virgifera virgifera* (western corn rootworm) (EFSA Panel on Plant Health. 2023).

Regulatory status: *Pantoea ananatis* is a regulated organism.

4.9 Other pests of concern

There have been no relevant publications for other pests of concern: *Hauptidia maroccana* (leafhopper), *Austroasca viridigrisea* (leafhopper), *Sibovia occatoria* (leafhopper), Tomato torrado virus (ToTV), *Empoasca fabae* (potato leafhopper), *Frankliniella fusca* or *F. ewarti* (thrips).

5. New and emerging pests of concern

5.1 Watermelon crinkle leaf-associated virus 1 and 2 (WCLaV-1, WCLaV-2)

WCLaV-1 and WCLaV-2 were added to the EPPO Alert List in May 2023 because little is known about their biology, there have been recent reports from different parts of the world affecting watermelon and other cucurbits (EPPO 2023/05 2023).
WCLaV-1 and WCLaV-2 were first described in China in 2017, and their current distributions are:
WCLaV-1: China (Henan), USA (Florida, Georgia, Texas), (Bahia, Piaui, Rio Grande do Norte), and Australia (New South Wales).
WCLaV-2: China (Henan), (Florida, Oklahoma, Texas), and Brazil (Bahia, Rio Grande do Norte).

These viruses cause damage on watermelon, and more recently on squash and zucchini (*Cucurbita pepo*), however their host range may be wider. Symptoms on leaves include mild leaf crinkling and yellow mosaic patterns, yellow mottling and chlorosis, and wrinkling with thickened, bunchy, and upward curling; and on fruit include circular lesions, and deformations. Symptoms may be severe and disease incidence up to 50% has been reported in commercial fields.

WCLaV-1 and WCLaV-2 have been experimentally shown to be mechanically transmissible, however more research into the mode of transmission is required. Both viruses can be found in mixed infections. No vectors have yet been identified but many viruses of the order Bunyavirales are vectored by arthropods. Suggestions are that WCLaV-1 and WCLaV-2 may be associated with seeds, and pathways are plants for planting, and potential seed and fruits.

The MPI Emerging Risks team was notified, and responded: "none of these hosts can be imported as nursery stock, and although they can be imported as seeds for sowing and fresh produce, we found no reliable evidence of these viruses being seed transmitted. Although the genus is quite new, viruses in the genus Coguvirus are generally mechanically transmitted. Therefore, given the lack of information on transmission, we concluded that there is currently no open pathway for these viruses to enter New Zealand. The ERS will monitor the literature for new information regarding the biology, hosts, and transmission of WCLaV-1 and WCLaV-2."

Regulatory status: WCLaV-1 and WCLaV-2 are not listed in the ONZPR.

6. References

Abdelmaksoud, N. M., El-Bakry, A. M., et al. (2023). "Comparative toxicity of essential oils, their emulsifiable concentrates and nanoemulsion formulations against the bean aphid, Aphis fabae." Archives of Phytopathology and Plant Protection 56(3): 187-208.https://doi.org/10.1080/03235408.2023.2178065

Akcin, S. and Kacar, G. (2023). "Determination of Natural Enemies and Overwintering of Colorado Potato Bettle Leptinotarsa decemlineata Say (Coleoptera: Chrysomelidae) in Bolu." International Journal of Agriculture and Wildlife Sciences 9(2): 153-161.https://doi.org/10.24180/ijaws.1265774

Andreason, S. A., Lahey, Z., et al. (2023). "Mitochondrial genome datasets for the sweetpotato weevil, Cylas formicarius elegantulus (Coleoptera: Brentidae), collected in the United States." Data in Brief 49: 109432.https://doi.org/10.1016/j.dib.2023.109432

Ausveg. (June 2023). "Guava root knot nematode industry webinar (YouTube)."   Retrieved 25 September 2023, from https://www.youtube.com/watch?v=wBmR49KuHuM https://www.youtube.com/watch?v=NVsS5cpNf6A https://www.youtube.com/watch?v=1rNqDlutjD0 https://www.youtube.com/watch?v=LFtUuEa7KwM

Azandémè-Hounmalon, G. Y., Toutopa, D., et al. (2022). "Comparative efficacy of three pesticides against the tomato red spider mite Tetranychus evansi Baker & Pritchard under laboratory conditions." International Journal of Tropical Insect Science 43: 267-275

Bačić, J., Pavlović, M., et al. (2023). "First Report of the Root-Knot Nematode Meloidogyne luci on Tomato in Serbia." Plant Disease 107(8): 2554. https://doi.org/10.1094/PDIS-01-23-0164-PDN

Boukabache, M., Chibani, S., et al. (2023). "Chemical composition and insecticidal activity of Aloysia citrodora essential oil against Aphis fabae (Hemiptera: Aphididae), Rhopalosiphum maidis (Hemiptera: Aphididae) and Tribolium castaneum (Coleoptera: Tenebrionidae)." International Journal of Tropical Insect Science 43(2): 455-461.10.1007/s42690-023-00949-0 https://doi.org/10.1007/s42690-023-00949-0

Cao, Y., Li, C., et al. (2023). "First Report of Meloidogyne arenaria Infecting Maize in Guizhou Province of China." Plant Disease.10.1094/PDIS-10-22-2420-PDN https://doi.org/10.1094/PDIS-10-22-2420-PDN

Caruso, A. G., Ragona, A., et al. (2023). "Development of an In-Field Real-Time LAMP Assay for Rapid Detection of Tomato Leaf Curl New Delhi Virus." Plants 12(7): 1487https://www.mdpi.com/2223-7747/12/7/1487

Chen, J., Gao, F., et al. (2023). "First Report of Meloidogyne enterolobii Infecting Solanum nigrum in China." Plant Disease.10.1094/PDIS-07-23-1316-PDN https://doi.org/10.1094/PDIS-07-23-1316-PDN

Choudhary, J. S., Monobrullah, M. D., et al. (2022). "Field efficacy of insecticides against chilli thrips (Scirtothrips dorsalis) and their effect on coccinellids." The Indian Journal of Agricultural Sciences 92(10): 1196-1201.10.56093/ijas.v92i10.121815 https://epubs.icar.org.in/index.php/IJAgS/article/view/121815

Daşcı, E. and Aslan, İ. (2023). "The effect of irrigation water and nitrogen applications on potato beetle (Leptinotarsa decemlineata Say) and natural enemy populations. ." Research in Agricultural Sciences 54(1): 15-21.DOI: 10.5152/AUAF.2023.220404

de Aguiar, C. V. S., Alencar, J. B. R., et al. (2023). "Predicting the Potential Global Distribution of Scirtothrips dorsalis (Hood) (Thysanoptera: Thripidae) with Emphasis on the Americas Using an Ecological Niche Model." Neotropical Entomology 52(3): 512-520.10.1007/s13744-023-01038-0 https://doi.org/10.1007/s13744-023-01038-0

Dengta, G., Banshtu, T., et al. (2023). "Effect of different cultivars of garden pea on population growth parameters of pea leafminer, Chromatomyia horticola (Goureau) (Diptera: Agromyzidae)." Phytoparasitica 51(3): 415-424.10.1007/s12600-023-01075-w https://doi.org/10.1007/s12600-023-01075-w

Devi, O. P., Sharma, S. K., et al. (2023) "A Simplified Multiplex PCR Assay for Simultaneous Detection of Six Viruses Infecting Diverse Chilli Species in India and Its Application in Field Diagnosis." Pathogens 12 DOI: 10.3390/pathogens12010006.

Du, Y., Zhu, Y.-C., et al. (2023). "The mechanisms of metabolic resistance to pyrethroids and neonicotinoids fade away without selection pressure in the tarnished plant bug Lygus lineolaris." Pest Management Science 79(10): 3893-3902.https://doi.org/10.1002/ps.7570 https://doi.org/10.1002/ps.7570

Dumont, F., Solà, M., et al. (2023) "The Potential of Nabis americoferus and Orius insidiosus as Biological Control Agents of Lygus lineolaris in Strawberry Fields." Insects 14 DOI: 10.3390/insects14040385.

Dworzanska, D., Zamojska, J., et al. (2023). "Pyrethroid susceptibility and oxidative detoxification mechanism in Colorado potato beetle and western corn rootworm." Plant Protection Science 59(2): 174-184 https://pps.agriculturejournals.cz/artkey/pps-202302-0006.php http://dx.doi.org/10.17221/53/2022-PPS

EFSA Panel on Plant Health. (2023). "Pest categorisation of Pantoea ananatis." EFSA Journal 21(3): e07849.https://doi.org/10.2903/j.efsa.2023.7849 https://doi.org/10.2903/j.efsa.2023.7849

Ehlers, J., Nourinejhad Zarghani, S., et al. (2023) "Analysis of the Spatial Dispersion of Tomato Brown Rugose Fruit Virus on Surfaces in a Commercial Tomato Production Site." Horticulturae 9 DOI: 10.3390/horticulturae9050611.

EPPO 2023/01 (2023). EPPO Reporting Service No. 1. Paris, EPPO. 2023-01

EPPO 2023/03 (2023). EPPO Reporting Service No. 3. Paris, EPPO. 2023-03

EPPO 2023/04 (2023). EPPO Reporting Service No. 4. Paris, EPPO. 2023-04
EPPO 2023/05 (2023). EPPO Reporting Service No. 5. Paris, EPPO. 2023-05
EPPO 2023/06 (2023). EPPO Reporting Service No. 6. Paris, EPPO. 2023-06
EPPO 2023/07 (2023). EPPO Reporting Service No. 7. Paris, EPPO. 2023-07
EPPO 2023/09 (2023). EPPO Reporting Service No. 9. Paris, EPPO. 2023-09
EPPO (2023). "EPPO Reporting Service. Number Article: 2023/130. EU emergency measures for Spodoptera frugipreda and tomato brown rugose fruit virus. ." https://gd.eppo.int/reporting/article-7612
EPPO datasheet. (2023). "Spodoptera litura (PRODLI) EPPO datasheet."   Retrieved 25 September 2023, from https://gd.eppo.int/taxon/PRODLI/datasheet.
EPPO Datasheet. (13 September 2023). "EPPO datasheet: Scirtothrips dorsalis (SCITDO)."   Retrieved 3 October 2023, from https://gd.eppo.int/taxon/SCITDO/datasheet.
EPPO Datasheet. (18 April 2023). "EPPO datasheet: Diabrotica virgifera virgifera (DIABVI)."   Retrieved 25 September 2023, from https://gd.eppo.int/taxon/DIABVI/datasheet.
EPPO Datasheet. (19 June 2023). "EPPO datasheet: Cucurbit yellow stunting disorder virus (CYSDV)."   Retrieved 25 September 2023, from https://gd.eppo.int/taxon/CYSDV0/datasheet.
FAR. (2 June 2023). "Fall armyworm update 2 June 2023."   Retrieved 25 September 2023, from https://www.far.org.nz/articles/1821/fall-armyworm-update-2-june-2023.
Francis, J. R. and Manchegowda, H. K. (2023). "Molecular phylogenetic identification of Metarhizium and Beauveria and their bio-efficacy against chilli thrips, Scirtothrips dorsalis." International Journal of Tropical Insect Science 43(3): 909-918. https://doi.org/10.1007/s42690-023-01002-w
George, J., Reddy, G. V. P., et al. (2023). "Combining visual cues and pheromone blends for monitoring and management of the tarnished plant bug Lygus lineolaris (Hemiptera: Miridae)." Pest Management Science 79(6): 2163-2171.https://doi.org/10.1002/ps.7395 https://doi.org/10.1002/ps.7395
Gospodarek, J., Krajewska, A. and Paśmionka, I. B. (2023) "Contact and Gastric Effect of Peppermint Oil on Selected Pests and Aphid Predator Harmonia axyridis Pallas." Molecules 28 DOI: 10.3390/molecules28124647.
Hajihassani, A., Nugraha, G. T. and Tyson, C. (2023). "First Report of the Root-Knot Nematode Meloidogyne enterolobii on Sweet Potato in Georgia, United States." Plant Disease 107(9): 2890.10.1094/PDIS-11-22-2692-PDN https://doi.org/10.1094/PDIS-11-22-2692-PDN
Halder, J., Adak, T. and Majumder, S. (2022). "Bioefficacy, phytotoxicity and insecticide residue dynamics of chlorantraniliprole in brinjal (Solanum melongena) under field condition." The Indian Journal of Agricultural Sciences 92(10): 1219–1224.10.56093/ijas.v92i10.124925 https://epubs.icar.org.in/index.php/IJAgS/article/view/124925
Hiroyoshi, S., Mitsunaga, T., et al. (2023). "Effects of ejaculate size on remating, attractiveness, and oviposition in females of the sweetpotato weevil, Cylas formicarius." Entomologia Experimentalis et Applicata 171(4): 268-276.https://doi.org/10.1111/eea.13275 https://doi.org/10.1111/eea.13275
Hort Innovation. (July 2023). "National fall armyworm innovation system for the Australian vegetable industry (VG22006)."   Retrieved 25 September 2023, from https://www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/vg22006/.
Ismail, M., Visser, B., et al. (2023). "Phenology of the black bean aphid, Aphis fabae, on organic crops and effect of parasitoid communities." Agricultural and Forest Entomology 25(2): 323-335.https://doi.org/10.1111/afe.12554 https://doi.org/10.1111/afe.12554
Jackson, D., Bohac, J., et al. (2002). "Integrated Pest Management of Sweetpotato in the Caribbean." Acta horticulturae 583: 143-154.10.17660/ActaHortic.2002.583.16
Kayahan, A. (2023). "Lethal and sublethal effects of lambda-cyhalothrin on Aphis fabae (Scopoli, 1763), Myzus persicae (Sulzer, 1776) and Acyrthosiphon pisum (Harris, 1776) (Hemiptera: Aphididae). ." Turkish Journal of Entomology. 2023; 47(2): 175-188. 47(2): 175-188.https://doi.org/10.16970/entoted.1228330 https://dergipark.org.tr/en/pub/entoted/issue/77923/1228330#article_cite
Kenis, M. (2023). "Prospects for classical biological control of Spodoptera frugiperda (Lepidoptera: Noctuidae) in invaded areas using parasitoids from the Americas." Journal of Economic Entomology 116(2): 331-341.10.1093/jee/toad029 https://doi.org/10.1093/jee/toad029
Kochetov, A. V., Shmakov, N., et al. (2023) "Three Cycles of Continuous Propagation of a Severe PSTVd Strain NicTr-3 in Solanum lycopersicum cv. Rutgers Resulted in Its Attenuation and Very Mild Disease Symptoms in Potato." Agronomy 13 DOI: 10.3390/agronomy13030684.
Kumar, V., Xiao, Y., et al. (2023). "Distribution of Scirtothrips dorsalis (Thysanoptera: Thripidae) cryptic species complex in the United States and reproductive host assessment of its dominant member." Journal of Economic Entomology: toad138.10.1093/jee/toad138 https://doi.org/10.1093/jee/toad138
Lan, S., Xiao, T., et al. (2023). "Design, synthesis, and insecticidal activity of pyrimidinamine derivatives containing 2-pyridinyloxy moiety." Journal of Heterocyclic Chemistry 60(6): 1058-1069.https://doi.org/10.1002/jhet.4651 https://doi.org/10.1002/jhet.4651
Lemos, F., Bajda, S., et al. (2023). "Imperfect diet choice reduces the performance of a predatory mite." Oecologia 201(4): 929-939.10.1007/s00442-023-05359-0 https://doi.org/10.1007/s00442-023-05359-0
Li, T.-H., de Freitas Bueno, A., et al. (2023a). "Current status of the biological control of the fall armyworm Spodoptera frugiperda by egg parasitoids." Journal of Pest Science 96(4): 1345-1363.10.1007/s10340-023-01639-z https://doi.org/10.1007/s10340-023-01639-z

Li, Y., Mbata, G. N. and Simmons, A. M. (2023b) "Population Dynamics of Insect Pests and Beneficials on Different Snap Bean Cultivars." Insects 14 DOI: 10.3390/insects14030230.
Liu, M., Kang, B., et al. (2023). "Transcriptomic and metabolic profiling of watermelon uncovers the role of salicylic acid and flavonoids in the resistance to cucumber green mottle mosaic virus." Journal of Experimental Botany 74(17): 5218-5235.10.1093/jxb/erad197 https://doi.org/10.1093/jxb/erad197
Long, H., Sun, Y., et al. (2023). "Occurrence of root-knot nematodes (Meloidogyne spp.) on peppers in Hainan, China, and resistance of field cultivars to M. enterolobii and M. incognita." Plant Disease.10.1094/PDIS-02-23-0281-RE https://doi.org/10.1094/PDIS-02-23-0281-RE
Lovelock, D. A., Mintoff, S. J. L., et al. (2023) "Ability of Non-Hosts and Cucurbitaceous Weeds to Transmit Cucumber Green Mottle Mosaic Virus." Viruses 15 DOI: 10.3390/v15030683.
Ma, L., Xu, C., et al. (2023). "Sublethal effects of halofenozide on larval development and detoxification in Phaedon brassicae (Coleoptera: Chrysomelidae)." Journal of Economic Entomology 116(4): 1286-1295.10.1093/jee/toad113 https://doi.org/10.1093/jee/toad113
Mackie, J., Campbell, P. R., et al. (2023) "Genome Characterisation of the CGMMV Virus Population in Australia—Informing Plant Biosecurity Policy." Viruses 15 DOI: 10.3390/v15030743.
Mahi Imam, M., Nayem, H. and Soyema, K. (2022). "Evaluation of Microbial Insecticides for the Management of Eggplant Shoot and Fruit Borer, Leucinodes orbonalis Guenee." Entomology and Applied Science Letters 9(4): 9-18.10.51847/H7euMM1RAx https://easletters.com/article/evaluation-of-microbial-insecticides-for-the-management-of-eggplant-shoot-and-fruit-borer-leucinode-pvolr4l28mhsj1r
Maino, J. L., Pirtle, E. I., et al. (2023). "Forecasting the potential distribution of invasive leafminer pests, Liriomyza spp. (Diptera: Agromyzidae), and their natural enemies." Austral Entomology 62(1): 118-130.https://doi.org/10.1111/aen.12632 https://doi.org/10.1111/aen.12632
Marques, M. L. d. S., de Jesus, J. M. I., et al. (2023). "Biochemical response of resistant and susceptible Capsicum spp. to Meloidogyne enterolobii." Journal of Phytopathology 171(9): 430-441.https://doi.org/10.1111/jph.13200 https://doi.org/10.1111/jph.13200
Márquez-Gutiérrez, M. E., Pérez-Lezcano, E., et al. (2022). "Effect of temperature and ultraviolet radiation on growth and pathogenicity of Metarhizium anisopliae. ." Agrociencia.https://doi.org/ 10.47163/agrociencia.v56i8.2477
Matzrafi, M., Abu-Nassar, J., et al. (2023). "Solanum elaeagnifolium and S. rostratum as potential hosts of the tomato brown rugose fruit virus." PLOS ONE 18(3): e0282441.10.1371/journal.pone.0282441 https://doi.org/10.1371/journal.pone.0282441
Mehle, N., Bačnik, K., et al. (2023). "Tomato brown rugose fruit virus in aqueous environments – survival and significance of water-mediated transmission." Frontiers in Plant Science 14.10.3389/fpls.2023.1187920 https://www.frontiersin.org/articles/10.3389/fpls.2023.1187920
Monica, S., . and Vinothkumar, B. (2023). "Evaluation and Validation of IPM Modules in Potato Against Invasive Leaf Miner, Liriomyza huidobrensis." Potato Research.10.1007/s11540-023-09630-y https://doi.org/10.1007/s11540-023-09630-y
Mou, B. (2023). "Green Leaf, Red Leaf, and Romaine Lettuce Breeding Lines with Resistance to Leafminer, Corky Root, and Downy Mildew." HortScience 58(4): 436-441.10.21273/HORTSCI17069-22 https://journals.ashs.org/hortsci/view/journals/hortsci/58/4/article-p436.xml
MPI (2021a). MPI Emerging Risks System for Biosecurity. 22nd Stakeholder Report. 20 March to 20 September 2021. Wellington, Ministry of Primary Industries. 22nd
MPI. (2021b). "Official New Zealand Pest Register (ONZPR). ." Retrieved March 2021, from https://pierpestregister.mpi.govt.nz/Home/.
MPI. (November 2020). "Serpentine leafminer Liriomyza huidobrensis." Retrieved November 2020, from https://www.mpi.govt.nz/biosecurity/priority-pests-diseases/horticultural-pests/serpentine-leaf-miner/.
Mugala, T., Visser, D., et al. (2023). "Occurrence of the potato leaf miner, Liriomyza huidobrensis (Diptera: Agromyzidae), and parasitoids in potato fields and natural vegetation of the Western Cape province, South Africa." African Entomology 31(1): 1-8.10.17159/2254-8854/2023/a10672
Mugala, T., Visser, D., et al. (2022). "Review of Liriomyza huidobrensis (Blanchard, 1926) (Diptera: Agromyzidae) on potatoes in South Africa, with special reference to biological control using entomopathogens and parasitoids. ." African Entomology [online] 30: 1-10.http://dx.doi.org/10.17159/2254-8854/2022/a11455
Nie, H., He, L., et al. "Design, synthesis, and biological activity of new 8-decylthio-10-methylthio-pyrimido[5,4-e][1,2,4]triazolo[1,5-c]pyrimidine derivatives." Phosphorus, Sulfur, and Silicon and the Related Elements: 1-8.10.1080/10426507.2023.2245528 https://doi.org/10.1080/10426507.2023.2245528
Nolasco-García, L. I., Marín-León, J. L., et al. (2022). "Geographic areas susceptible to Tomato brown rugose fruit virus (ToBRFV) in Guanajuato, Mexico." Bioagro 35(1): 13-20.10.51372/bioagro351.2 https://revistas.uclave.org/index.php/bioagro/article/view/4286
Ouyang, H., Zhang, R. and Haseeb, M. (2023) "Investment Trade-Off between Mating Behavior and Tonic Immobility in the Sweetpotato Weevil Cylas formicarius (Coleoptera: Brentidae)." Insects 14 DOI: 10.3390/insects14010073.
Palomares-Rius, J. E., Clavero-Camacho, I., et al. (2023). "First Report of Heterodera zeae (Corn Cyst Nematode) Infecting Corn (Zea mays) in Spain." Plant Disease 107(8): 2557.10.1094/PDIS-02-23-0362-PDN https://doi.org/10.1094/PDIS-02-23-0362-PDN

Perumal, V., Kannan, S., et al. (2023). "Essential oils from Acacia nilotica (Fabales: Fabaceae) seeds: May have insecticidal effects?" Heliyon 9(4): E14808.DOI:https://doi.org/10.1016/j.heliyon.2023.e14808
Plant Health Australia (2023). Fall armyworm final technical reports. Australia, P. H. Canberrahttps://www.planthealthaustralia.com.au/fall-armyworm-final-technical-reports/
Prayogo, Y., Bayu, M. S. Y. I., et al. (2022). "Innovation of main pest and disease control technology using biopecticdes on soybean (*Glycine max* L.)." Applied Ecology and Environmental Research 21: 589-608.DOI: http://dx.doi.org/10.15666/aeer/2101_589608
Qubbaj, T. and Samara, R. (2022). "Efficacy of Three Entomopathogenic Fungi Beauveria bassiana, Metarhizium anisopliae and Lecanicillium lecanii Isolates against Black Bean Aphid, Aphis fabae (Scop.) (Hemiptera: Aphididae) on Faba bean (Vicia faba L.). ." Legume Research 45: 1572-1579.doi: 10.18805/LRF-706.
Salazar-Mesta, R. J., Carrillo-Fasio, J. A., et al. (2022). "First Report of the Root-Knot Nematode Meloidogyne enterolobii Parasitizing Eggplant in Mexico." Plant Disease 107(5): 1638.10.1094/PDIS-08-22-1846-PDN https://doi.org/10.1094/PDIS-08-22-1846-PDN
Saveer, A. M., Hatano, E., et al. (2023). "Nonanal, a new fall armyworm sex pheromone component, significantly increases the efficacy of pheromone lures." Pest Management Science 79(8): 2831-2839.https://doi.org/10.1002/ps.7460 https://doi.org/10.1002/ps.7460
Seal, D. R., Liburd, O. and Li, J. (2023) "Seasonal Abundance of Various Hymenopteran Parasitoids of Leafminers in Beans and Comparative Abundance in Bean, Tomato, and Squash." Agriculture 13 DOI: 10.3390/agriculture13071460.
Shirvani, Z., Döker, I., et al. (2023). "Foraging behavior of Amblyseius swirskii (Acari: Phytoseiidae) feed on the invasive pest Tetranychus evansi (Acari: Tetranychidae) on tomato." Systematic and Applied Acarology 28(2): 223-235.10.11158/saa.28.2.6 https://doi.org/10.11158/saa.28.2.6
Smith, J., Crow, W. D., et al. (2023). "Evaluating Efficacy and Chemical Concentrations of Commonly Used Insecticides Targeting Tarnished Plant Bug in Mid-South Cotton." Journal of Cotton Science 27: 74-80
Song, Y., Yang, X., et al. (2023). "The invasive Spodoptera frugiperda (J.E. Smith) has displaced Ostrinia furnacalis (Guenée) as the dominant maize pest in the border area of southwestern China." Pest Management Science 79(9): 3354-3363.https://doi.org/10.1002/ps.7524 https://doi.org/10.1002/ps.7524
Tian, Y., Fei, J., et al. (2023). "Development of a reverse-transcription droplet digital PCR method for quantitative detection of Cucumber green mottle mosaic virus." Heliyon 9(2): e12643.10.1016/j.heliyon.2022.e12643
Tsuchida, Y. and Masui, S. (2023). "Efficacy of biocontrol of the yellow tea thrips and the Kanzawa spider mite with the generalist phytoseiid mite Euseius sojaensis differs between grape cultivars with different leaf morphological traits." BioControl 68(4): 425-434.10.1007/s10526-023-10201-w https://doi.org/10.1007/s10526-023-10201-w
Vabishchevich, V. V., Volchkevich, I. G. and Kanapatskaya, M. V. (2023). "Symptoms of Pepino mosaic virus in greenhouse tomatoes and reactions of test plants on infection." Proceedings of the National Academy of Sciences of Belarus. Agrarian series 61(2): 133-140. 10.29235/1817-7204-2023-61-2-133-140
van Damme, M., Zois, R., et al. (2023) "Directions from Nature: How to Halt the Tomato Brown Rugose Fruit Virus." Agronomy 13 DOI: 10.3390/agronomy13051300.
Vankosky, M. A., Hladun, S., et al. (2023). "Pheromone trap monitoring reveals the continued absence of swede midge in the Northern Great Plains." The Canadian Entomologist 155: e7.10.4039/tce.2022.38
Waluniba, A. N., Neog, P., et al. (2023). "Effects of Different Abiotic and Biotic factors on Abundance of Sucking Pests of Chilli (Capsicum annuum L.)." Environment and Ecology 41(1C): 679-683
Wu, C., Chen, D., et al. (2023). "First Report of the guava root-knot nematode (Meloidogyne enterolobii) on Selenicereus costaricensis in Guangxi, China." Plant Disease.10.1094/PDIS-04-23-0736-PDN https://doi.org/10.1094/PDIS-04-23-0736-PDN
Xiao, Y.-y., Qian, J.-j., et al. (2023). "Diurnal emission of herbivore-induced (Z)-3-hexenyl acetate and allo-ocimene activates sweet potato defense responses to sweet potato weevils." Journal of Integrative Agriculture 22(6): 1782-1796.https://doi.org/10.1016/j.jia.2023.02.020 https://www.sciencedirect.com/science/article/pii/S2095311923000321
Xu, X., Hoffmann, A. A., et al. (2023). "Molecular identification of hymenopteran parasitoids and their endosymbionts from agromyzids." Bulletin of Entomological Research 113(4): 481-496.10.1017/S0007485323000160
Yang, L. L., Li, Q. L., et al. (2023). "A cysteine-rich secretory protein involves in phytohormone melatonin mediated plant resistance to CGMMV." BMC Plant Biol 23(1): 215.10.1186/s12870-023-04226-7
Zamora-Landa, Á. I., Estrada-Virgen, M. O., et al. (2023). "The first report of Scirtothrips dorsalis causing damage to vines at Jalisco, México." Southwestern Entomologist 48(1): 283-286.10.3958/059.048.0129 https://doi.org/10.3958/059.048.0129
Zhang, Y.-h., Li, Z.-x., et al. (2023). "A universal probe for simultaneous detection of six pospiviroids and natural infection of potato spindle tuber viroid (PSTVd) in tomato in China." Journal of Integrative Agriculture 22(3): 790-798.https://doi.org/10.1016/j.jia.2022.08.119
Zhao, Z., Tian, Y., et al. (2023) "A Monoclonal Antibody-Based Immunochromatographic Test Strip and Its Application in the Rapid Detection of Cucumber Green Mottle Mosaic Virus." Biosensors 13 DOI: 10.3390/bios13020199.