Priority Pest Review for Vegetables

Report prepared for
Vegetables New Zealand

March 2022

Market Access Solutionz Ltd

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1. Executive Summary

This report reviews the Vegetable NZ priority pests for the period 1 April 2021 to 31 March 2022. Pest information from scientific literature, international databases, MPI's emerging risks system, and the VR&I monitoring risks project is reviewed for relevance of biosecurity risks for the fresh vegetable industry.

As an outcome of this review, the following pests are to be noted by Vegetables NZ because of their establishment in Australia and close proximity to NZ, increased concern overseas, and in the case of Fall armyworm and Pepino mosaic virus, their detection in NZ. These pests are:

- Fall armyworm (*Spodoptera frugiperda*): an egg mass has been found in Tauranga. MPI is undertaking surveillance to determine if there is an established population. Fall armyworm continues to spread worldwide.
- Other *Spodoptera* spp. which are absent in the EU region have been added to the EPPO Alert List.
- Leafminers (*Liriomyza huidobrensis, L. trifolii*): have been detected in Australia and are considered not feasible to eradicate. The fresh produce IHS has been amended with additional phytosanitary measures to manage the risk.
- MPI has set up active monitoring of *Acidovorax citrulli* which affects cucurbits, and *Pantoea ananatis* which has a new host association with tomatoes.
- Pepino mosaic virus: the tomato industry is moving towards long-term management after the virus was first reported one year ago.

2. Introduction

Vegetables New Zealand Inc (VNZI) has engaged Market Access Solutionz Ltd to provide technical expertise on 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 is 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.

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) will be on-going. Although little/no new relevant information was uncovered for some pests, monitoring will continue.

This review of the Vegetable priority pests has considered information from the VR&I Monitoring Biosecurity Risks project, MPI's Emerging Risks System 22nd Stakeholder Report, scientific literature (e.g. Plant Disease journal), and international databases (CAB abstracts, EPPO RSE monthly reports, NAPPO).

This report is a summary of monitoring for the 12-month period from **1 April 2021 to 31 March 2022**.

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 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)

3. Priority Pests

3.1 *Spodoptera frugiperda* – Fall armyworm

Key points:
- Fall armyworm eggs have been found in Tauranga. MPI is undertaking surveillance to determine if a population has established.
- Fall armyworm continues to spread worldwide.
- Research activities continue to focus on resistance and control, including biological control.
- EPPO is directing attention to other *Spodoptera* spp. currently absent in the EU region.

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

New Zealand: A fall armyworm egg mass was found in an Asian gypsy moth trap in Tauranga in March 2022. This indicates a mature female is present and is likely to have arrived via wind-assisted natural flight (MPI. 9 July 2021). Being a tropical species, its establishment is uncertain as the NZ climate is unsuitable for overwintering. In 2021, MPI completed a pest risk assessment and concluded that the overall risk to NZ was very low to low (MPI. April 2021). MPI is currently undertaking surveillance to determine if a population has established.

Distribution: Fall armyworm continues to spread and has been reported in the Solomon Islands (August 2021), Cambodia (May 2019), Brunei (2020) (EPPO 2021/10 2021), and Saudi Arabia (Oct 2021) (EPPO 2022/02 2022). *S. frugiperda* has also been detected on grapevines in Brazil (Bortolotto et al. 2022).

EPPO has also transferred *S. frugiperda* from the A1 list (not present in EPPO region) to the A2 list (localised presence in EPPO region)(EPPO 2021/10 2021). Fall armyworm has been detected in the Canary Islands, Spain (EPPO 2021/03 2021).

Controls and new research: In the USA, the rise of non-GMO crops is causing influxes of fall armyworm into corn growing regions. *Bt* corn has kept fall armyworm numbers low but non-GMO crops are heavily affected. Mild winters may also be contributing to its survival in regions north of the hotter southern USA states where they overwinter (Ward 18 January 2022). In 2021, fall armyworm populations reached their highest numbers in 30 years; influxes are expected to occur every 30 to 50 years.

Studies on pest resistance including resistance development to Bt maize, continue to be published (Porterfield 6 October 2021). *Bt* maize has been engineered to contain toxins created by the bacterium *Bacillus thuringiensis* (*Bt*) that are toxic to fall armyworm. Diagnostic tests have been developed in Australia for early detection and monitoring of insecticide resistance of fall armyworm in Australia (Bird et al. 2022). Treatment of plants with silicon has shown significant negative effects on various biological parameters of fall armyworm and may be a promising strategy for control (Haq 2021).

The origins and migration paths of fall armyworm invasion into Australia most likely originated from Indonesia's southern/eastern islands to the Torres Strait Islands and to Bamaga on the mainland. Favourable monsoon winds helped their flight across the Timor Sea to Australia (Qi 2021a). Another publication concluded that fall armyworm invasion into China originated from Myanmar into Yunnan Province, which is often the first arrival point for many pests that migrate from Myanmar (Sun 2021).

Other *Spodoptera* spp.

EPPO has recently been directing its attention to other *Spodoptera* spp. which are currently absent from the EU region.

Spodoptera eridania (Southern armyworm)**:** is possibly present in Maharashtra, India after larvae, determined to be *S. eridania*, were seen causing damage to soybeans, although adults had not been seen to confirm identification (EPPO 2021/10 2021). *S. eridania* is a polyphagous pest native to the Americas, and present in Southern USA to Argentina. It was first recorded in Africa in 2018 and in India in 2019.

Spodoptera ornithogalli (Yellow striped armyworm): was added to the EPPO Alert list in January 2021 at the recommendation of the Netherlands, as there were repeated interceptions in 2020, particularly on asparagus consignments from the Americas (EPPO Alert List 2021).

Spodoptera praefica (Western yellow striped armyworm): was added to the EPPO Alert list in September 2021 (EPPO 2021/09 2021). *S. praefica* is native to North America and is present in the western USA, and southern Alberta and British Columbia. *S. praefica* is polyphagous and can feed on forage crops, fruit and vegetables, ornamentals, and weeds. Recorded hosts include: onion, beet, melon, *Cucurbita* spp., carrot, bean, peas, *Solanum* spp., tomato and maize. Damage is caused by larvae feeding on many broad-leaved plant species. Within a crop, larvae often aggregate on a few plants causing complete defoliation. Moths can fly, possibly over long distances similar to other *Spodoptera* species, but no specific data is available on the flying characteristics of *S. praefica*. Over long distances, *S. praefica* could be spread on host plants or, in soil as pupae. Pathways are fresh produce, plants for planting, cut flowers of host plants, and in soil from countries where *S. praefica* is present.

MPI update: MPI and GIA partners have prepared a report 'Lepidoptera Readiness Stock-take', that highlights key information, opportunities and knowledge gaps that would contribute to New Zealand's readiness for a Lepidoptera incursion. The report includes *S. frugiperda*. There is currently no readiness plan to prepare for its arrival.

Regulatory status: *Spodoptera frugiperda* is a regulated organism. NZ has country freedom status for *S. frugiperda.*

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

Liriomyza sativae: was found on two separate occasions in Kununurra (northern Western Australia) in March 2021, and in Torres Strait (Queensland) in May 2021 and near Bamaga (Queensland). Eradication was considered unlikely to be feasible. *L. sativae* is currently under regional official control in Queensland and Western Australia (EPPO 2021/10 2021). The NSW Dept of Primary Industries is developing new surveillance tools to monitor insecticide resistance in *L. sativae* as part of a sustainable IPM approach to reduce pest impact on horticultural crops (Ausveg Weekly Update, 23Mar22).

Liriomyza huidobrensis: Following recent outbreaks, DNA barcoding has been used to characterise Diptera leafminer species in Australia so that their spread and new incursions can easily be tracked (Xu 2021).

Controls and new research: Over a 25 year period, changes in insecticide susceptibility were seen in indoor and field populations of *L. trifolii* (Matsuda 2022). Findings from this study, where susceptibility was found to be insecticide-dependent will help inform the management of insecticide susceptibility in successive generations of insect pests. In a study to determine if there are positive or negative interactions between *L. sativae* and *Bemisia t*abaci (whitefly) under field conditions, both pests have been found to co-exist in melon crops (Lemos 2021); *L. sativae* feeding on the leaf, and *Bemisia tabaci* on the phloem sap.

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

MPI update: In July 2021, Australia's Department of Agriculture, Water and Environment (DAWE) informed MPI that there were outbreaks of *L. huidobrensis* and *L. trifolii* in Australia. Fresh produce from Australia was identified as a potential pathway into New Zealand. In October 2021, MPI issued an urgent amendment to the fresh produce IHS to include additional phytosanitary measures to manage the pathway and prevent their arrival. The measures include pest control measures, pest-free area of production, and post-harvest treatment such as fumigation and irradiation. The relevant imported vegetables are celery, broccoflower, broccoli, Brussel sprouts, cabbage, cauliflower, lettuce, basil, parsley, and peas (Alert #s 8504 and 8541)(MPI 2021).

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.

3.3 *Aphis fabae* - Black bean aphid

Recent publications on *Aphis fabae* continue to discuss control with: biocontrol (Cuatlayotl-Cottier 2021; Nordey 2021), aphid parasitoids, natural repellents, insecticides and its implications in IPM (Skouras 2021), and the timing of insecticides on populations of *A. fabae* to determine susceptible cultivars and the effect of different spray regimes (Almogdad 2021). The components of the essential oil (*Salvia officinalis*) and its activity against *A. fabae* have been studied as they have strong repellent properties, and cause high mortality (Harizia 2021). Natural pest regulation for small farming operations have been studied in sub-Saharan Africa (Ndakidemi 2021). Studies into pest biology also continue to be undertaken (Srisakrapikoop 2021; Ulrich 2021).

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.

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

3.4 Capsicum chlorosis virus (CaCV)

Recent publications have discussed environmental effects (temperature) on capsicum resistance to CaCV infection (Tsai), characterising CaCV genetic diversity (Kumari 2022), and coinfection occurring with other viruses, cucumber mosaic virus (CMV) and groundnut bud necrosis virus (GBNV) (Vinodhini 2021).

Regulatory status: CaCV is a regulated organism.

3.5 *Contarinia nasturtii* - swede midge

Recent publications on *Contarinia nasturtii* have discussed plant protection using garlic extracts, selenium and silicon compounds (Golubkina et al. 2022). Genetic studies have also been undertaken (Mori et al. 2021).

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

3.6 Cucumber green mottle mosaic virus (CGMMV)

CGMMV is a seed-borne virus and has been found in seeds sent to Australia via online mail orders (Constable 2021). Another Australian study determined that there is limited genetic diversity of CGMMV within Western Australia suggesting a single incursion event to the region (Kehoe 2022). Other studies have been on biology, genetics and resistance (Ruiz 2021), and pathogen transmission (Qi 2021b).

There were no interceptions of CGMMV on cucurbits imported from Australia in 2021 (MAS 2022).

Regulatory status: CGMMV is a regulated organism.

3.7 Cucurbit yellow stunting disorder virus (CYSDV)

CYSDV and Cucurbit chlorotic yellow virus (CCYV) are co-infecting greenhouse cucumber and melons in the Mediterranean region of Turkey (Arslan 2020). There have been reports of co-infection of cucurbits by CYSDV and CCYV (Mondal et al. 2021), and with Cucurbit aphid-borne yellows virus (CABYV) which causes yellowing disease on pumpkin and cucumber, and the effect on co-infection on vector transmission (Orfanidou 2021). The natural resistance of cucurbits to viruses has also been reviewed (Martín-Hernández and Picó 2021).

Regulatory status: CYSDV has not been assessed.

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

Recent publications have focussed on the biology and genetic variation of *Cylas formicarius* and *Euscepes postfasciatus* (Hiraku 2021; Hua et al. 2021). A small number of other studies have been undertaken to better understand pest biology.

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

3.9 *Diabrotica virgifera virgifera* - Western corn rootworm

Diabrotica virgifera virgifera (Western corn rootworm) has been reported on maize in Spain for the first time (EPPO 2021/11 2021). It is a known vector of maize chlorotic mottle virus but could also be a potential vector the pathogen, *Pantoea ananatis* (Krawczyk et al. 2021). The pest is widely distributed in the EU, and is no longer regulated in the EU territory. *D. virgifera virgifera* is a Priority pest for many of the vegetable product groups.

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

D. balteata (banded cucumber beetle) and *D. speciosa* (cucurbit beetle) are also VNZI priority pests.

Regulatory status: *Diabrotica* spp. are regulated organisms.

3.10 *Epitrix* spp. - Flea beetle

Digital image processing (DIP) has been used to facilitate identification, classification, and counting of insect pests. This study showed that DIP is useful for in characterising selected species of potato flea beetles (*Epitrix cucumeris*), psyllids, thrips, whiteflies, pepper weevils, and aphids, to help classify insects. Results were up to 90% precision when compared to an entomologist undertaking identifications (Moreno-Lucio et al. 2021).

Epitrix similaris is a Vegetable NZ priority pest.

Regulatory status: *Epitrix similaris* is not assessed.

3.11 *Lygus lineolaris* - Tarnished plant bug

Lygus lineolaris is polyphagous, affects many vegetable crops, and is a major pest of cotton in the USA. A review of research into *L. lineolaris* over the last 20 years was undertaken by George (George et al. 2021) who noted that since 2000, new studies have focussed on host range changes, population dynamics, resistance, chemical and biological control (Gómez-Domínguez et al. 2021), the development of new IPM tools, and pest biology and behaviour to inform these areas of research. *L. lineolaris* has developed resistance to most insecticides used for control (Graham et al. 2021).

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

3.12 *Tetranychus evansi* - Tomato red spider mite

Rapid and accurate diagnostic tools have been developed in NZ to identify *Tetranychus evansi* from other *Tetranychus* species in the field and the laboratory. Diagnosis is based on damage symptoms, morphological characters, DNA sequences, and DNA barcoding enabling *T. evansi* to be differentiated from closely related species (Fan 2021).

Biopesticides against *T. evansi* have been investigated for IPM use, in the presence of the predatory mite *Phytoseiulus longipes* (Savi 2021b). One publication has noted that tomato genotype has less influence on *T. evansi* than previously hypothesised (Savi 2021a).

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

3.13 *Meloidogyne enterolobii* - root knot nematode

In the USA, *Meloidogyne enterolobii* has been observed causing plant stunting and galled root symptoms on Thai basil which is shown to be a good host (Gu et al. 2021). *M. enterolobii* is known to break down the root-knot resistance of crops including soybean, sweet potatoes, and tomatoes, and is considered a major emerging threat in the southeastern USA. There is limited information on its distribution in the USA. *M. enterolobii* is also reported to be affecting sweet potato in China (Jia et al. 2021; EPPO 2022/02 2022) and Brazil (Silva et al. 2021).

Topics covered in recent publications include: screening studies for resistance and susceptibility in grain crops (Rezende 2021), crop susceptibility to *M. enterolobii* (Khanal and Harshman 2022), in-furrow treatments (Rivera 2021), and management strategies.

Regulatory status: *Meloidogyne enterolobii* has not been assessed.

3.14 Viroids – including Tomato apical stunt viroid, a VNZI priority pest

A review of global plant viral diseases indicates that long-distance dispersal by international trade in seed or planting material is a feature of their changing distribution, and are a threat to food production. Examples of viruses affecting vegetable production discussed in this review include potato tuber necrotic ringspot, faba bean necrotic yellows, pepino mosaic, tomato brown rugose fruit, and cucumber green mottle mosaic (Jones 2021).

Pospiviroids were shown to produce different disease symptoms in capsicum, and that there is a lack of seed transmission after capsicums were inoculated with columnea latent viroid (CLVd), pepper chat fruit viroid (PCFVd), potato spindle tuber viroid (PSTVd) and **tomato apical stunt viroid** (TASVd) (Verhoeven et al. 2020). Seed to seedling transmission was also not recorded, irrespective of viroid species. Verhoeven's research group have developed a RT-PCR test, called Pospisense, to screen for pospiviroids in tomato and capsicum seeds (Botermans et al. 2020).

Natural infection of tomato by PSTVd has been demonstrated in India (Natarajamurthy 2021). Tolerance to PSTVd was found to be a dominant trait observed in wild species, and is being used to develop PSTVd-tolerance varieties of tomato (Naoi 2021). Other publications have investigated genetic diversity and pathogenicity (Matsushita et al. 2021), and mechanisms of infection (Fujibayashi et al. 2021).

Tomato chlorotic dwarf viroid (TCDVd) has been reported to have been isolated from symptomless *Petunia* plants in Japan. MPI will consider measures at the next IHS review (Alert 6156-1, 2021) (MPI 2021).

The seed for sowing IHS has been amended to manage a number of viruses and viroids requiring seeds to be sourced from a pest free area or a pest free place of production, or to undergo testing. Capsicum seed require testing for: PCFVd, PSTVd, ToMMV, and ToBRFV, and eggplant seed require testing for PSTVd. Tomato seed are tested for: CLVd, TCDVd, TASVd, Tomato plant macho viroid (TPMVd), PepMV, PSTVd, Tomato mottle mosaic virus (ToMMV), and ToBRFV.

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

4. Other pests of concern

4.1 *Acidovorax citrulli* (fruit blotch)

Cucurbits are the major hosts of *Acidovorax citrulli*, particularly watermelon and melons. Its distribution is increasing in Europe. *A. citrulli* has been reported affecting tomato seedlings. MPI is actively monitoring this organism, and noted changes to the IHS at the next review (MPI 2021).

Regulatory status: *Acidovorax citrulli* is a regulated organism.

4.2 '*Candidatus* liberibacter solanacearum'

'*Candidatus* liberibacter solanacearum' (CLso) has been reported on carrots in Serbia for first time (Trkulja et al. 2020); the authors of this study suggest that CLso has a wider distribution in Europe than previously reported. Studies on CLso have focussed on seed transmission in peppers and its impact on plant emergence (Workneh et al. 2022), biology and environment effects (Keshet-Sitton et al. 2021), control tools such as bactericides (García-Sánchez et al. 2021), and control strategies (Mora et al. 2021).

Regulatory status: '*Candidatus* liberibacter solanacearum' Haplotype A is not assessed. Haplotypes B-E are regulated organisms. Haplotype H is not listed in the ONZPR.

4.3 *Frankliniella fusca, F. ewarti* – thrips vectors of *Pantoea anantis*

Thrips (*Thrips tabaci* and *Frankliniella fusca*) are vectors of *Pantoea ananatis* (centre rot of onion, leaf spot of maize), and their feeding is understood to compromise the effectiveness of foliar bactericides against *P. ananatis*. Thrips feeding on onion foliage and the resulting feeding scars could facilitate the entry of *P. ananatis*, and compromise the efficacy of protective chemical treatments indicating that effective management should also include thrips management at susceptible stages of onion growth (Stumpf et al. 2021).

P. ananatis causes leaf spot of maize. At tassel initiation, infected plants show localized chlorotic streaks on leaves that expand over time, which turn necrotic. Severely affected plants wilt and die. Symptoms first appear in lower leaves, then in upper leaves as the disease progresses. Disease incidence was 20 to 30%, with approx. 30% of infected plants wilting and dying, resulting in 20 to 25% yield losses (Toaza et al. 2021).

An alert was submitted to the MPI Emerging Risks System of a new host association of *P. ananatis* with tomato. MPI will continue active monitoring of the organism (MPI 2021).

Regulatory status: *F. fusca* and *Pantoea ananatis* are regulated organisms, *F. ewarti* is not listed.

4.4 *Leptinotarsa decemlineata* – Colorado beetle

In addition to studies on genetics, biology, insecticide resistance, biological and chemical control and resistance, a non-chemical method has been developed that pneumatically removes the Colorado beetles from the foliage, deposits them on the ground between the rows before being crushed. Results were comparable to using insecticide (Almady and Khelifi 2021).

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

4.5 *Leucinodes orbonalis* – Eggplant fruit borer

EFSA have performed a pest categorisation of *Leucinodes orbonalis* as it is absent from the EU (EFSA Panel on Plant Health 2021). *L. orbonalis* is a tropical and sub-tropical species native to Asia and Australia, and a major pest of eggplant. *L. orbonalis* has recently emerged as a potato pest in south-west India.

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

4.6 Pepino mosaic virus (PepMV)

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

In April/May 2021, PepMV was detected in four commercial glasshouses in Auckland, and is under official control (EPPO 2021/138 (EPPO 2019/06 2019)). The tomato industry is now moving towards long-term management of the disease.

Distribution: In the EU, PepMV was reported in Serbia for the first time (July 2019) on tomatoes growing in plastic tunnels (EPPO 2021/03 2021), and also detected in commercial tomatoes in Israel (Alert 6544-2) (MPI 2021).

Research: An EFSA review of PepMV EU strain, mild isolate Abp1 and PepMV CH2 strain, mild isolate Abp2, for use as active substances/pesticides, concluded they have sufficient efficacy against more aggressive PepMV strains and are low-risk for use in greenhouses (Anastassiadou 2021). Studies on mixed infections of PepMV strains have investigated virus-virus interactions (Alcaide 2021c), disease epidemiology (Alcaide 2021a), and genetic variability (Alcaide 2021b). An approach using RNA interference (RNAi) is being used to generate broad spectrum resistance to PepMV strains US1, LP, CH2 in tomatoes (Leibman 2021).

The presence of PepMV in the Mediterranean, as well as the tomato pathogens, *Fusarium oxysporum* f. sp. *lycopersici*, *Verticillium dahliae*, and Tomato mosaic virus is preventing the introduction of the pepino as multi-resistant cultivars require development (Pacheco 2021).

MPI Update: An amendment has been made to the fresh produce IHS for testing. Bioassays are an unacceptable method of PepMV detection, PCR and ELISA are accepted methods.

Regulatory status: PepMV is a regulated organism.

4.7 *Scirtothrips dorsalis* - Chilli thrips

Scirtothrips dorsalis was reported in Turkey for the first time (Oct 2020) on blueberries, believed to have been introduced with imported plant material (Atakan and Pehlivan 2021; EPPO 2021/07 2021). It is now considered eradicated after the application of insecticides. *S. dorsalis* is also widely distributed in southern Iran, where it is considered a citrus pest (EPPO 2021/06 2021).

S. dorsalis has been found on celery (*Apium graveolens*) plants being grown under plastic tunnels in Karnataka, India. All stages of the pest were seen on celery leaves, suggesting that *S. dorsalis* can breed on celery. Affected plants had discoloured and distorted leaves (EPPO 2022/01 2022). New Zealand continues to import roses from India, and *S. dorsalis* is often intercepted (MAS 2022).

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

4.8 Tomato brown rugose fruit virus (ToBRFV)

Key points:

- ToBRFV continues to steadily spread mainly in the European region.
- Real-time RT-PCR is the recommended method for detecting ToBRFV in seed.
- ELISA testing for ToBRFV has been removed from the seed for sowing IHS as it is no longer an acceptable method of testing.

Distribution: ToBRFV continues to spread and has been detected in Uzbekistan (EPPO 2021/10 2021), Iran (Aug 2021), Saudi Arabia (Jan 2021) (EPPO 2021/11 2021), Albania, Lebanon on capsicum (EPPO 2022/02 2022), Syria (EPPO 2021/09 2021), Norway (Hamborg and Blystad 2021), Portugal, Yunnan Province, China (EPPO 2021/09 2021); and has been eradicated in the UK

(EPPO 2022/01 2022). ToBRFV was eradicated in Bretagne, France but detected again in commercial greenhouses in Southern France (EPPO 2021/09 2021).

Research: An investigation of seed transmission characteristics concluded that ToBRFV is a seedborne virus located externally on the seed coat and transmitted mechanically from contaminated seeds to seedlings, which would become a disease foci and eventually cause spread to a new growing area (Salem et al. 2021).

In a study of disinfectants effective against the tobamoviruses CGMMV and ToBRFV, 0.5% Lactoferrin, 2% Virocid, 10% Clorox, and 3% Virkon were 90-100% effective against ToBRFV (Chanda et al. 2021).

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

EPPO update: New anti-ToBRFV regulations and controls have been put in place for all seed from China. The legislation provides for new eradication methods and mandatory phytosanitary analysis on all Chinese propagation material, on half the material arriving from Israel, and some material from other countries (EUR-Lex. 2021).

A report from Euphresco (European Phytosanitary Research Coordination) recommends the use of real-time RT-PCR testing for the detection of ToBRFV in seeds (Giesbers et al. 2021). The study showed that real-time RT-PCR testing diagnosed ToBRFV in all samples with only a small percentage of false negative and false positive results, in contrast to end-point RT-PCR and isothermal amplification testing were unsuitable because of their lack of sensitivity.

MPI update: ELISA testing has been removed as an acceptable testing method for ToBRFV from the seed for sowing IHS for tomato seed (Import Health Standard seeds for sowing (155.02.05)).

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

4.9 Tomato leaf curl New Delhi virus (ToLCNDV)

Key points:

- Becoming a potato pest in India
- Nursery stock IHS has been amended to manage ToLCNDV on ornamental plant species

Distribution: ToLCNDV has been reported on capsicum in Tunisia (EPPO 2022/01 2022).
Hosts: ToLCNDV is becoming a potato pest in India (EPPO 2022/01 2022). New host associations with *Chrysanthemum indicum* and *Crossandra infundibuliformis* (firecracker flower) have been identified in India. Risk management by MPI is underway and the Nursery stock IHS will be amended (MPI 2021).

Control and new research: A method, based on controlling the vector, *Bemisia tabaci*, combining the use of Horiver traps and *Amblyseius swirskii* was proposed by Koppert for the biological control of ToLCNDV infection of zucchini (Freshplaza. 21 December 2021). A study of Southeast Asian and Mediterranean isolates of ToLCNDV has shown that the Southeast Asian isolate isolated from tomato and cucurbit crops has higher pathogenicity than the Mediterranean isolate (Yamamoto 2021).

MPI update: The nursery stock IHS was amended urgently to manage ToLCNDV on 19 newly identified ornamental plant host species, imported from all countries. Additional risk management options include: pest-free area; pest-free place of production; pest-free production site; and mother plant testing.

Regulatory status: ToLCNDV is a regulated organism.

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