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NEW ZEALAND PLANT PRODUCERS INCORPORATED

COVERED CROPPING NEW ZEALAND

Managing viruses in tomato & capsicum seedlings

GUIDANCE for Plant Producers

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Disclaimer

While this Guidance outlines recommended practices to help producers manage biosecurity risks, it cannot fully eliminate the possibility of pest presence. NZPPI and Covered Cropping NZ accept no liability for pest-related issues in plants produced by nurseries who follow this guidance. Following the recommended measures reduces risk but does not guarantee complete pest exclusion.

Guidance for Plant Producers

With the increasing threat of seed-borne viruses in plants in the Solanum family (tomato, capsicum, eggplant etc), the pressure is on nurseries to be ready. An incursion of a regulated virus in young seedlings could have serious consequences for your business, your customers and the glasshouse cropping industry.

This guideline is for producers of tomato, capsicum and eggplant seedlings for commercial greenhouse crop production. It provides practical steps you and your team can take in your day-to-day operations to manage this risk, helping to protect your reputation, your business and the wider industry.

Using Plant Pass Certification to Demonstrate Good Practice

It is recommended that this guideline is implemented with Plant Pass to reassure customers and regulators that you are aware and prepared to deal with biosecurity risks, such as tomato brown fruit rugose virus (ToBRFV).

- Plant Pass gives your customers & regulators confidence that your business has systems in place that manage serious biosecurity risks.
- Businesses that are part of Plant Pass can use the logo & certification number on business documents, price lists and delivery dockets to demonstrate that they have implemented these standards.

1. Start Clean and Stay Clean

Always begin with clean, tested seed. Obtain a seed testing certificate or test results from your seed supplier and never assume untested or saved seed is safe. Tools and surfaces used for sowing, potting, or pruning should be disinfected at the start of each day and between batches of plants. A simple bleach solution (1 part bleach to 9 parts water) or a commercial disinfectant like Virkon® works well.

Make disinfection a habit:

- Tools (scissors, knives, dibbers): disinfect between uses.
- Benches and trolleys: wipe down and disinfect at the end of each shift.
- Trays and pots: clean and sterilise thoroughly before reuse or use new ones.

Implement measures to keep batches of plants segregated during production and dispatch.

2. Train staff

Train staff who work in tomato and capsicum production areas on hygiene standards and procedures, including the use of PPE, hand washing, equipment and workplace cleaning and sanitation. Train staff to monitor crop health so they know what to look for and how to respond.

If testing is required, train staff how to collect and label samples for diagnostic testing.

3. Clean hands, clothing and footwear

Your hands, clothes, and footwear can carry viruses from one area of the nursery to another. Ensure your team wash their hands before starting work and after handling plants. Disposable gloves help to prevent the spread of plant diseases, but they must be changed frequently – gloves only work if they are clean.

Footbaths or disinfection mats at entry points, along with designated nursery footwear, help reduce contamination from outside. Spend time on the mat, don't just walk through it. Keep personal items out of production areas. If you need a device for nursery operations, make sure you have cleaned and sanitised it before entering the production area.

4. Vectors

Insects such as whiteflies, thrips, and aphids are notorious virus carriers. Keeping them out of your nursery is critical. Use physical barriers like insect screens, maintain a buffer zone around the greenhouse, and check sticky traps regularly.

Good insect control includes:

- Monitoring traps at least weekly.
- Sealing vents and doors properly.
- Managing weeds and alternative host plants around the nursery.

5. Stop the Spread

If a plant shows unusual symptoms – leaf mottling, curling, yellowing, or stunted growth – remove it immediately. Don't wait for confirmation. Assume it's infectious until proven otherwise. Place it in a sealed bag and dispose of it safely (not in compost). Send a sample of leaf material to MPI's Plant Health & Environment Laboratory if you suspect a regulated virus.

Group similar crops together, and don't move plants between bays unnecessarily. Avoid overhead watering that can splash sap between plants.

6. Keep Good Records

Simple notes can save your business. Record your cleaning schedule, pest checks, and any suspicious plant symptoms. This helps identify problems early and shows your commitment to traceability and best practice.

Keep records so that plants can be traced back to the batch of seeds, and onwards to customers.

Segregated Growing Areas for tomato and capsicum seedlings

Biosecurity Layout and Access Guidance

Separate tomato and capsicum production areas in your nursery from other host plants and control the movement of people and plants to help reduce the risk of cross infection between crops and batches of plants.

Ensure the production site is free from host weeds within 1 metre radius of the greenhouse and building.

Plan Your Layout with Biosecurity in Mind

Segregated production means physically separating tomato and capsicum seedlings into distinct zones – ideally with their own entry points, tools, cleaning equipment and staff where possible. Treat each crop area like its own quarantine zone:

- Tomato and capsicum bays may be in separate greenhouses, on separate tables, or separated within the site.
- Use signage to communicate key hygiene procedures, entry and exit points, and any restricted areas (e.g. “TOMATO ONLY – NO ENTRY”).
- Be clear about who can enter the restricted area.

Manage Entry and Exit

Ideally, each segregated zone should have a dedicated entry point. This helps control what – and who – moves in and out.

Set up an access control point at each entrance:

- Footbath with disinfectant.
- Hand sanitiser station.
- Storage for clean tools, gloves, and protective clothing.

Workers should move from lower-risk to higher-risk areas (e.g. from younger to older and grafted plants), not the other way around.

Control the movement of people and their gear

Pathogens can hitch a ride on hands, tools, trays, clothing – even your phone. Once inside, viruses are hard to contain.

- Use separate tools, trays & equipment etc in restricted areas.
- Avoid moving seedlings or equipment out of restricted areas.
- No visitors or deliveries without prior approval and hygiene checks.
- Leave personal bags outside the area. Staff must not have tomatoes or capsicums in their packed lunch.
- Leave mobile phones, watches and jewellery outside the area, or sanitise them prior to entry.
- Use PPE clothing or workplace-only clothing and launder it fresh every day.

Rules for Segregated Production Areas

1. No cross-over of staff or tools between restricted zones during the same day.
2. Everyone should sanitise hands and footwear before entering and upon leaving a restricted area.
3. No plant material should move between zones.
4. Dedicated tools and PPE (gloves etc) should be available at the entrance and used only in that zone.
5. Ensure regular cleaning and sanitation, including cleaning tools and changing gloves between different batches.
6. Tools should be stored in the zone.
7. Signage should mark restricted areas and entry protocols.
8. Regular checks to ensure the rules are being followed.

Batches & Traceability

Plant Pass – Seed-to-Dispatch Tracking Guide

Having a system in place to track plant batches is critical for early detection and containment. If a virus or viroid appears, knowing exactly where each batch came from – and where it went – saves time, reduces losses, and protects your customers.

Track the Batches

A **batch** is a group of seedlings grown from a single seed lot, treated as a unit for tracking and management.

At sowing:

- Assign a **unique batch code** (e.g. T25-01-06 for Tomato, 2025, Batch 1, June).
- Record seed source details: supplier, variety, seed lot number.
- Label trays and / or propagation areas with the batch code – clearly and permanently.

Keep each batch physically separate from others:

- Separate benches or bays for each batch.
- No mixing of leftover seed or seedlings between batches.

As seedlings move through different stages – sowing, pricking out, spacing, pinching and grafting – track every step.

Visitors, Customers and Contractors

Visitors should check in at the office reception, or meet the manager / supervisor upon arrival – this includes common visitors like customers, suppliers, maintenance contractors, etc.

At the office, they should sign in and receive a quick biosecurity briefing outlining any restrictions on where they can go and what they can do.

Visitors should be informed about any restricted areas and should not be allowed entry to these areas if they have visited other nurseries or tomato greenhouses in the past few days.

Appendix 1 – Symptoms

Symptoms of virus and viroid infection includes a range of colour changes, malformations, necrosis and stunting and dwarfing. Symptoms are often first visible in the top leaves under the flowering truss and may be difficult to detect in young plants.

In young plants, keep an eye out for leaf mosaic patterning, chlorosis and necrosis spots, yellowing, stripes or streaks, vein clearing and banding. Leaves can also appear narrowed, puckered, and deformed by leaf rolling and curling.

In older plants, flower symptoms include deformation and changes in colour, while fruits and vegetables can include mosaics, stunting, discoloration, malformation, and chlorotic ring spots. Stem expression includes pitting, grooving and tumour formation.

Leaf symptoms

Bubbled leaves

Vein Yellowing

Combined leaf symptoms

Symptoms vary tremendously and many of the above symptoms can be mistaken for effects of poor nutrition, adverse environmental conditions, or attack by pathogens, so correct diagnosis of virus attack relies on laboratory tests.

Specific symptoms for different virus and viral pathogens is included in Appendices 4 and 5.

Appendix 2 – Testing Procedures

If your customer requires batch test certification for tomato or capsicum, the available testing methods include irrigation wastewater testing and plant material testing.

Any testing method for exotic pathogens should be approved by MPI's Plant Health & Environment Laboratory (PHEL) prior to use.

Timing of testing:

Immature plants are likely to have a very low concentration of virus if it is present, so time the sampling as late as possible while still allowing 7 to 10 working days for diagnostic results prior to dispatching seedlings.

It is recommended that plant material testing is done on older seedlings (8 weeks or older), while irrigation wastewater sampling can be done at any time.

Irrigation Wastewater

Testing irrigation wastewater (runoff) samples is available for virus surveillance testing of tomato brown rugose fruit virus (ToBRFV) and pepino mosaic virus (PepMV).

Irrigation wastewater can be collected from a sump, collection tank, pipe, bench etc. Irrigation wastewater collected from a small area where tomato seedlings are grown will be more concentrated than that collected from a larger area of mixed crops or covering the whole nursery.

Before collecting your first sample, seek advice from MPI's Plant Health & Environment Laboratory on the best method for collecting water from your seedling production area.

Sampling irrigation wastewater:

Use a separate container for each water sample, ideally a 50ml sampling container to collect a sample of 40ml.

- Label it with a permanent marker, noting the location of the sample (e.g. greenhouse bench 1), date, and business name.
- Wash and sanitise hands, put on disposable gloves.
- Collect the water sample. Do not fill to the brim, especially if the sample is to be stored in the freezer.

Place the labelled sample in a zip lock bag and wrap in bubble wrap.

Wash, sanitise and change gloves between each sample if more than one sample is being taken. If using a collecting device, wash and sanitise this between samples as well.

Complete a laboratory submission form and include this in a courier bag with the sample(s). Notify the diagnostic laboratory a sample is being couriered. Keep the courier bag in a fridge or freezer if not being couriered same day.

If a positive result is obtained from irrigation water testing, this should be followed up by testing plant material to confirm or rule out viral infection.

Plant Material

Plant material testing is generally not recommended for batch certification because of the high costs of testing. It is the best option for correctly diagnosing plants showing symptoms, and to follow up a positive irrigation water test result.

Plant testing uses the first fully expanded leaf from the apex, or a flower calyx if the plants are in flower.

For plants showing symptoms – select up to three young leaflets collected from the top of the plants or shoots, or the calyx.

For asymptomatic plants (not showing symptoms) nearly 100% of the batch needs to be tested to give a high confidence in a negative test result.

- For example, 990 plants in a batch size of 1000 plants must be sampled to achieve 99% confidence in being able to detect an infected plant (ISPM 31: Methodologies for sampling of consignments).

This can be very costly unless in-house diagnostics are available.

Wash and sanitise hands and use disposable gloves for sampling, changing gloves between each sample batch.

Remove the whole leaf by pinching off at the leaf petiole, as cut leaves deteriorate quickly.

Use a separate plastic bag for each set of plant samples and label with a permanent marker, noting the sample group (e.g. greenhouse bench 1), date, and business name.

Once the samples have been collected, keep them cool until they can be sent by same day courier to the diagnostic laboratory or tested in-house. Do not freeze the sample as this destroys the plant cells.

Appendix 3 – Sanitation processes and agents

Unlike many human viruses, plant viruses are 'non-enveloped' and are not destroyed by alcohols such as ethanol or 2-propanol. Unenveloped viruses have a higher resistance to chemical substances, so effective disinfectants must be selected with this in mind.

Some viruses are persistent. For example, Tobamoviruses can persist for more than a year in organic material and soil, and longer than six months on surfaces.

Effective disinfectants against non-enveloped viruses on different materials are included below:

Material	Active ingredient / method	Dose, temp	Contact time
Surfaces (metal, glass), knives, scissors	Hyperclean X	1%	5 min
	Virkon S	1%	10 min
	SYN-Formaline 37%, fog	2%	24 hours
	Jet 5 (hydro-peroxide/peracid). Note: surface must be cleaned first.	1.5%	30min
	Menno Florades (benzoic acid)	2%	5 min
	Sodium hypochlorite (12.5 - 15%)	4% 3%	16 hours 5 min
Shoes	Potassium soda[1]		
	Brushing + water, then Virkon S		
Hands / gloves	Alkaline soap	5%	Washing + water
	Protein (e.g. milk)		Dip and go, between every plant
Washing clothing	Professional and household	60 – 65°C	
Drain water	Ozone	Agrozone	
	UV-c	250mJ/cm2	

From Ines van Marrewijk, Delft Research Group (Normec Group). IPS presentation, 2021.
https://www.grodan.com/about/events/international-propagation-seminar/ips-presentation-2021/

1 Caution: Potassium soda is known to erode concrete with continuous use on footwear.

Appendix 4 – Seed-transmitted viruses & viroids

Name	Main hosts	Spread	Early symptoms
Pepino mosaic virus (PepMV)	Tomato, eggplant, pepino, potatoes, also weeds and other wild hosts.	Transmitted by mechanical contact, including contaminated tools, hands, clothing, direct plant-to-plant contact, and propagation. Can be seed transmitted and insect vectored.	Include small yellow spots
Tomato brown rugose fruit virus (ToBRFV)	Capsicum[2], Tomato, (also *Petunia, Nicotiana, Impatiens, Cyclamen*).	Easily transmitted from plant to plant by mechanical means, soil, and infected plants. Can be seed transmitted and insect vectored.	Leaf mosaics, spots and yellowing. Leaves can also appear narrowed, puckered and deformed.
Tomato mottle mosaic virus (ToMMV)	Tomato, Capsicum, *Nicotiana, Petunia x hybrida, Physalis* spp., *Brassica* spp., *Pisum sativum.*	Mechanically transmitted. Might also be spread by insects and bumblebees.	Leaf distortion, mosaic, mottle and necrosis.
Tomato infectious chlorosis virus (TICV)	Tomato, lettuce, artichokes.	Can be seed transmitted. Transmitted by whiteflies.	Curling and yellowing of young leaves, upward and inward rolling of the leaf margins, interveinal yellowing of leaflets and severe stunting.
Potato spindle tuber viroid (PSTVd)	Wide range of Solanaceae incl. tomatoes, potatoes and many ornamentals and weed species.	Mechanically transmitted. Aphids may be a vector, and PSTVd can survive and be spread in dried plant sap and leaf debris.	Growth reduction and chlorosis in the top of the plant.
Other viroids: PCFVd, TCDVd, TASVd, TPMVd.	Capsicum, Tomato.	All can be transmitted mechanically and via seed. TPMVd can be spread by aphids.	Stunting and shortening of internodes. Also leaf discolouration, distortion, necrotic or chlorotic lesion on plants or leaves, yellowing of leaves and epinasty (bending outwards and downwards.

2 ToBRFV can cause local infection but is non-systemic in commercial varieties of Capsicum with TMV resistance. Ines van Marrewijk, IPS, 2021.

Appendix 5 – Other Solanaceous viruses & viroids

The following viruses and viroids may also be spread within plant production but are not thought to be seed transmitted. They are not present in New Zealand and are not likely to enter on imported seed.

Name	Main hosts	Spread	Early symptoms
Capsicum chlorosis virus (CaCV)	Capsicum, Tomato[3]	Transmitted by thrips. Not spread by other insects, mechanically, in soil or in seed.	Chlorosis or yellowing on leaf margins and between the veins, leaves often become narrow and curled.
Columnea latent viroid (CLVd)	Tomato, eggplant, chili pepper, potato, *Petunia x hybrid*a and a range of ornamentals	Mainly spread via plants and could possibly be seed transmitted	Distorted and discoloured leaves.
Tomato yellow leaf curl virus (TYLCV)	Tomato[4], capsicum, cotton	Transmitted by whiteflies.	Curling and yellowing of young leaves, upward and inward rolling of the leaf margins, interveinal yellowing of leaflets and severe stunting.
Lisianthus enation leaf curl virus (LELCV)	Tomato, capsicum, *Lisianthus*, pumpkin	Transmission agent not yet understood.	Curling and yellowing of young leaves, upward and inward rolling of the leaf margins, interveinal yellowing of leaflets and severe stunting.
Tomato leaf curl New Delhi virus (ToLCNDV)	Tomato, capsicum, melon, zucchini, cucumber	Transmitted by whiteflies.	Curling and crinkling of leaves, vein clearing, yellow mottling, leaf puckering and blistering of leaves.
Tomato torrado virus (ToTV)	Tomato[5]	Transmitted by whiteflies.	Affected plants show necrotic (burn-like) lesions in the upper parts of the plants.
Tomato marchitez virus (ToMarV)	Tomato	Transmitted by whiteflies.	Severe leaf necrosis, beginning at the base of the leaflets.
Tomato yellow mottle-associated virus (TYMaV)	Tomato, Capsicum, eggplant	Transmission agent not yet understood.	Chlorosis, mosaic, epinasty of leaflet blades, yellow spots, puckering, and mottling symptoms.

3 Tomatoes NZ Exotic-Pest-Fact-Sheet-7-Capsicum-Chlorosis-Virus-CaCV, 2023.

4 TYLCV is not known to be seed transmitted. DEECA, Australia, 2023.

5 ToTV is not known to be seed transmitted. MPI, 2023.