

Insect and Plant Disease Control in Tomato Plug Transplants

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The tomato plug transplant industry is relatively new in Ontario. Its presence and expansion will insure local growers vigorous, healthy, readily available plants with the potential of high yields. The inherent benefits of an industry that uses clean plastic trays, soilless mixes that are renewed each year, the installation of new, well ventilated greenhouses and a grower community focused on producing the highest quality transplants possible lends itself to a favourable situation. However, with any new industry the reality of producing these transplants free of insects and plant diseases must be addressed.

In designing a pest management program for plug production in greenhouses we need to consider all available tools at our disposal. Without question, non-chemical, cultural control measures are encouraged. At times chemical recommendations are necessary but care must be given to both the calibration and application of these products. Protective clothing such as gloves, coveralls, boots and sometimes respirators are a must when handling chemical pesticides.

Pests to Consider

Early in the emergence or seedling phase, fungal diseases caused by Pythium, Rhizoctonia, and Fusarium can cause damping-off symptoms. A green algal or sometimes pink fungal growth often is observed on the surface of the plug soilless mixture but seldom causes any significant problems. Later foliage can be attacked by Alternaria (Early Blight), Septoria and Botrytis. Stem cankers caused by Alternaria and Botrytis leave distinct black spots along the tomato stems ultimately resulting in poor field survival.

Bacterial spot, speck and canker are bacterial diseases, symptoms of which may not always be seen on greenhouse transplants prior to being picked up by the field grower but have the potential to spread throughout the greenhouse if poor watering practices are followed. Characteristic yellow areas with dark centres are foliar symptoms of Bacterial Spot and Speck.

Tomato diseases caused by tomato mosaic (ToMV) and tomato spotted wilt (TSWV) viruses and others are difficult to control without special emphasis given to clean seed and the control insect vectors such as aphids and thrips.

A number of insects can cause considerable damage to seedling tomatoes. Colorado Potato Beetles are of most concern, while aphids, white flies and thrips need to be controlled. Some growers find the black fungus gnats also a nuisance, the larvae of which transmits the Pythium damping-off organism from plant to plant.

A. Plant Disease Control Strategies

Plant disease control strategies are based on two principles; 1) Reduce the initial source of infection and; 2) Reduce the amount of spread once present. If the seeds are clean, the trays are clean, the water is clean and either humans, wind/rain, alternate hosts and/or insect pests do not introduce the disease organisms into the greenhouse, plant diseases are not initiated. If one of the above is violated, there are practices such as ventilation, watering and chemical treatments to retard the spread of the disease. The following are recommendations to accomplish the above.

Plant Disease Control Practices

1. Disease Free Seed

Use only acid or chlorine treated tomato seeds. A 0.1N HCL stock solution is used to clean raw seed once the seed gel has been removed. The stock solution can be made either by using the commercially available 0.1N HCL preparation or by mixing your own 0.1N HCL solution using a 1:100 (vol: water vol) mixture of Muriatic Acid (31.45% HCL).

For dry seed - Use a 1: 9 v/v (1 seed: 9 acid solution) of the 0.1N HCL stock solution, submersing seeds for 1 hour. Make sure the seed mixture is stirred well to separate seeds that often stick together. This process can be conducted at room temperature 20-22 C. Seeds can be dried without being washed. (Dhanvantari, Ag. Canada, Harrow).

If virus is suspected use a 100 g in 1 L of water mixture of Trisodium Phosphate (TSP all purpose heavy duty cleaner) for 15 minutes. This is a very corrosive material and should be handled with great care.

Treat seed with a protectant fungicide (eg. thiram, captan) against damping-off fungi, before sowing.

2. Plastic Plug-Trays

The use of new plastic plug trays eliminates the worry and controversy whether or not reuseable trays act as sources of plant disease inoculum. However, this one time use of trays is not only expensive but the disposal of these hundreds of thousands of plastic containers is environmentally unacceptable. In my opinion we can reuse these trays if we develop effective sanitizing procedures. The best and easiest is to solarize the trays, ie., just stack and cover them with a cloth or plastic and leave them in the greenhouse during the summer. The intense heat will super dry the disease organisms and those non-disease organisms that survive act as biological control agents once trays are re-used. It is important to use trays with as square a cell as possible, to reduce the amount of soilless mixture remaining from the previous year's use and a plastic that is structurally and chemically firm. Often the problem with reusable trays is not a plant disease concern but that of the cells being crushed and trays cracked when handled improperly in the field.

A second method of cleaning reusable trays is to pass each tray individually through a wash water tunnel on an open chain conveyer with the first set of nozzles (top and bottom) with clean water to

first wash the trays of organic matter (deactivates the chlorine) and a second set of nozzles (top and bottom) with a 0.6% solution of sodium hypochlorite (1 part Javex, (6% sodium hypochlorite) into 9 parts of water). Trays can then be piled and stored wet in a room with temperatures kept above 5 C or higher for 2 weeks. The chlorine solution and gas will disinfect the trays and when temperatures are kept warm, will quickly dissipate leaving no harmful residues in the trays. Unfortunately dipping bulk lots of trays into a cleaning solution has not proven successful. Trays are often too compacted with many tray surfaces not exposed to the chemical cleaning agent.

3. Water

It has been reported that organisms causing tomato plant diseases have been found in ditch and well water. If using this source of water, one could be introducing diseases into the greenhouse. Several Ontario greenhouse growers use chlorinated town water. The chlorination or the use of bromine in water of questionable quality is presently being evaluated.

Watering and ventilation practices are key management tools affecting the disease status within a greenhouse. Watering protocols can not be overemphasized. WATER CORRECTLY - REDUCE PLANT DISEASES.

When watering plants use as fine a spray or mist as possible. Do not use pressure as this will damage the delicate plant parts permitting disease infection to occur, and spreading disease organisms, especially bacteria. Water early in the day and under conditions when the foliage will dry within 1-2 hours. Temperature of the water should be relatively warm (15-20 C) to avoid shock to the plants.

Dew should never be allowed to form on the plants: this means avoiding high humidities together with falls in temperature, even by a degree or two. A little heat at night with the vents cracked open should be considered, particularly on clear, radiating nights after warm days.

4. Damping Off Control

Damping-off should not be a problem in tomato plug production. The use of clean, seed and soilless mixtures with seedlings initially grown under warm favourable temperature conditions allows for a fast growing, healthy seedling. Where problems do arise, it is due to poor ventilation, excess watering, low light intensities, excess salts (fertilizers), cool temperatures all of which are under the control of the greenhouse manager. Fungicides applied in the water tunnel at seeding as used by the flower industry for damping-off control are not recommended for tomato plug production.

Most fungicides used at the seedling stage often retard the growth of young seedlings.

Under emergency conditions where a fungicide is required for DAMPING-OFF apply FERBAM 76WDG at 0.13 g/tray (see Chemical Summary Chart) after the 1st true leaves have emerged. Fungus gnats may need to be controlled if populations are high and damping-off persists. The fungus gnat larvae can transmit Pythium spores from root to root.

Determine the number of trays to be treated, calculate the amount of fungicide needed and apply in whatever volume of water normally used when fertilizing.

5. Foliar and Stem Disease Control

A. Fungal - Alternaria, Botrytis, Septoria

Seldom do tomato transplants require a foliar fungicide to be applied during their normal 6-7 week growing cycle in greenhouses. However there are situations where plants are held for longer than normal periods and require additional protection. Under these conditions apply either DYRENE 50WP at 0.04 g/tray or BOTRAN 75W at 0.11 g/tray. (see Chemical Summary Chart).

CAUTION: When using chemicals avoid applying onto tomato foliage under conditions of extreme high temperatures >30 C and high relative humidities. Under these conditions injury to the foliage may occur.

B. Bacterial - Bacterial Spot, Speck, Canker

Bacterial diseases are currently the major plant disease problems affecting the tomato plant industry. Effective control measures for this complex of bacterial diseases has been discouraging. However clean seed is an essential part of the control process followed by intelligent watering practices. One infected seed in 10,000 can act as a sufficient inoculum source to infect an entire greenhouse. Late evening watering which allows the foliage to remain wet the entire night, provides conditions favourable for bacterial infection and spread. Proper thorough and early watering allowing plant foliage to dry off, coupled with greenhouse structures with the capacity of maintaining good air movement have been shown to reduce the spread of bacterial diseases. Clipping or any other violent physical movement of plant foliage is not recommended.

Bacteria will also survive on "dirty" trays, benches, plant material, etc., that have not been treated. Sanitation practices including solarizing trays, washing greenhouse structures, floors, benches, planting equipment, etc. with soap and water and removing weeds or other vegetation that may harbour bacterial organisms is essential for managing bacterial diseases. A thorough cleaning with a 1:9 Javex solution is recommended if these diseases have been present in the previous year. Chlorination with Javex may not be as effective as many would suppose. Often areas to be cleaned are often covered with organic matter, dust which deactivated the chlorine giving a false sense that control will be achieved using this practice. The hot temperatures during the summer when most greenhouses are left empty along with the freezing temperatures of the winter month prior to using the greenhouses are excellent practical control "agent" for bacterial and fungal disease control. Also sterilizing surfaces using chlorine leaves much to be desired. Often suppressive, antagonistic organisms help limit the spread of disease organisms and would be lost if unrestrained use of chlorine is practiced.

Chemical controls have not proven to be highly effective in the field however if copper/mancozeb combinations have any place at all in the tomato industry it's at this early transplant stage. Unfortunately products containing mancozeb (MANZATE 200, DITHANE M45) cannot be used within a greenhouse structure. Copper alone can be used inside a greenhouse.

Once plants have been moved outside a greenhouse the combination copper/mancozed can be recommended. Apply FIXED COPPER 50WP at 0.04 g/tray plus DITHANE M45 or MANZATE 200 at 0.03 g/tray every 5 days if conditions favour bacterial disease development.

C. Viral - ToMV, TSWV, Streak, Shoestring(CMV)

Methods of controlling plant viruses in greenhouse tomato transplants are - plant disease free seed, treat seed with Trisodium Phosphate (see 1. Disease Free Seed), control both insect vectors and alternate host plants which harbour viruses.

Viruses such as TMV (Tomato Mosaic Virus), Shoestring(Cucumber Mosaic Virus), TSWV (Tomato Spotted Wilt Virus) and Streak (combination of ToMV and Potato Virus X) can be reduced by the following cultural practices (see FACTSHEET 90-054):

1. Provide a complete break in cropping throughout the entire greenhouse complex for at least one month before tomato seedling trays are set out.
2. Commence monitoring for thrips and aphids when the first seeding of tomatoes is complete. Hang blue, sticky insect boards close to the seedling canopy and where practical potted petunia indicator plants (for TSWV) at the ends of the greenhouse.
3. Only plants grown from seed should be produced in greenhouses used for vegetable seedling production.
4. Avoid raising tomato transplants close to greenhouses used for flower and greenhouse cucumber production.
5. Maintain weed free greenhouses. A 3 meter plant free zone should be established around each greenhouse.
6. Restrict visitors to prevent the introduction of thrips and aphids. After smoking or handling tobacco in any form wash hands thoroughly as virus has been known to be introduced into greenhouses by this means and spread throughout the entire greenhouse.
7. Avoid introducing bedding flower plants into the greenhouse, as well as hanging baskets overhead. These plants act as reservoirs for insect vectors and virus diseases..
8. Immediately apply the appropriate insecticide if thrips are found or if feeding scars or virus lesions develop on indicator plants. Aphid populations should be controlled to avoid the spread of TMV and other viruses (see B Insect Control Strategies).
9. Carefully remove infected virus plants from the greenhouse. Burn or bury them. Do not leave plant refuse or trash piles near the greenhouse.

6. Holding Tray Plants in the Field

There are a number of advantages to moving near-ready transplants out of the greenhouse several days prior to transplanting - the primary one being to "harden plants off".

Under these conditions they can be treated as field plants allowing growers to use any of the appropriate recommended fungicides listed in Publication 363 - Vegetable Production Recommendations. Although it is often not necessary, for those growers wishing to apply foliar fungicides at this stage the following products can be used:

PRODUCT	RATES/tray	/rack (16 trays)
BRAVO 500	0.04 ml	0.6 ml
DYRENE 50WP	0.04 g	0.6 g
DITHANE M-45	0.04 g	0.7 g
MANZATE 200	0.04 g	0.7 g
BENLATE 50W	0.01 g	0.2 g
FIXED COPPER 50WP + mancozeb	0.04 g + 0.03 g	0.6 g + 0.4 g

When weather conditions favour the development of plant diseases, and especially if longer storage of plug plants is anticipated begin a spray program 1 week after the removal of trays from the greenhouse, and repeat applications every 5 days. Do not apply any of the recommended pesticides within 3 days of transplanting.

CALIBRATION: see **CHEMICAL SUMMARY CHART**

Determine the number of racks to be treated, multiply this number by the amount of chemical recommended per rack (16 trays) and apply in whatever volume of water normally used when fertilizing.

EXAMPLE:

If the fertilizer injector being used delivers a 1:16 ratio and it has been determined that 400 ml of water is to be applied per tray, add the recommended rate per rack into a 400 ml stock solution to be feed through the injector.

eg. 0.3 ml of THIODAN 4EC should be mixed into 400 ml of stock solution and applied through the injector onto a single rack.

To treat 10 racks add $10 \times 0.3 \text{ ml} = 3 \text{ ml}$ THIODAN 4EC into $10 \times 400 = 4000 \text{ ml}$ water = 4 L of stock solution.

It is advisable to mix up slightly more stock solution than absolutely needed to allow for proper priming of hose and injector.

B. Insect Control Strategies

Seldom are insect pressures high enough to warrant insect control measures. Recently however there has been interest in controlling aphids and thrips to reduce virus transmitted diseases and recommendations to control Colorado potato beetles.

The following is a list of insecticides that are registered for use on tomato greenhouse plug transplants within a greenhouse structure:

AMBUSH 500EC	POUNCE 384EC
DIPEL WP	THURICIDE-HPC
THIODAN 4EC	THIODAN 50WP
ENDOSULFAN 400EC	ENDOSULFAN 50W
DIAZON 50EC	DIBROM INSECTICIDE

Examples of products used for the control of:

APHIDS	THIODAN, ENDOSULFAN, DIAZON
THRIPS	THIODAN/ENDOSULFAN plus AMBUSH
COLORADO POTATO BEETLES	THIODAN, ENDOSULFAN

(see Chemical Summary Chart)

CHEMICAL SUMMARY CHART

PRODUCTS	/ha	PRODUCT RATES	
		/tray	/rack(16 trays)
<u>GREENHOUSE USE:</u>			
FERBAM 76WDG	10.0 kg	0.13 g	2.1 g
FIXED COPPER 50WP	3.0 kg	0.04 g	0.6 g
DYRENE 50WP	3.0 kg	0.04 g	0.6 g
BOTRAN 75W	-	0.11 g	1.8 g
AMBUSH 500EC	200.0 ml	0.003ml	0.04 ml
POUNCE 384EC	250.0 ml	0.004ml	0.06 ml
THIODAN 4EC	1.4 L	0.02 ml	0.3 ml
THIODAN 50WP	1.1 kg	0.01 ml	0.2 ml
ENDOSULFAN 400EC	2.75 L	0.04 ml	0.6 ml
DIAZON 50EC	1.5 L	0.02 ml	0.3 ml
<u>FIELD USE:</u>			
all of the above plus			
BRAVO 500	2.8 L	0.04 ml	0.6 ml
DITHANE M45	3.25 kg	0.04 g	0.7 g
MANZATE 200	3.25kg	0.04 g	0.7 g
BENLATE 50W	0.84 kg	0.01 g	0.2 g
DIAZINON 500EC	1.5 L	0.02 ml	0.3 ml
CONVERSIONS:	g/1000 = kg	kg X 2.2	= lbs