New York State
Integrated Pest Management Program

2000 - Fresh Market and Processing Tomato IPM Scouting Procedures

Editors: A.J. Seaman and C.H. Petzoldt

Contributors: R. Bellinder, H. Dillard, M. Hoffmann, W. Kline, C. MacNeil, M. McGrath, M. Mutschler, L. Pedersen, S. Reiners, P. Sutton, T. Zitter

New York State Integrated Pest Management Program

Cornell University • New York State Department of Agriculture and Markets

IPM Bulletin No. 112
May 2000

A. Transplant Production:

A key ingredient for a successful field tomato production season has its beginnings with the production and use of healthy tomato transplants. During the past 10 years, tomato transplants have been implicated in the introduction of the following diseases into the field: Bacterial spot and speck, bacterial canker, Septoria leaf spot, early blight, leaf mold (Fulvia fulva), Botrytis gray mold, and tomato spotted wilt virus (TSWV). The originating sources for these diseases have included infected transplants, tomato seed, tomato crop debris from a previous crop, and perennial plants that serve as a reservoir for the infectious organism. A recent example of a perennial crop serving as a reservoir for a new powdery mildew affecting a greenhouse tomato production operation, was Rosemary herb seedlings grown in the same house.

The standard recommendation for the control of bacterial diseases is the use of clean seed that has been commercially treated with diluted hydrochloric acid, sodium hypochlorite, or a hot water treatment to ensure disinfestation. Additionally, sterilized soil, potting mixes, pots and flats should only be used. Plants should not be topped. Greenhouses should be completely emptied at least once per season and disinfected thoroughly (including the benches, floor, structure, and watering hoses). The greenhouse should be kept weed-free as pathogenic bacteria can live on the leaf surface of non-host plants such as weeds without causing symptoms. Closing up an empty greenhouse for a one to two week period during the summer can reduce pest pressure through the effect of high temperatures.

Sanitation and air movement are important in the avoidance of greenhouse fungal diseases. Greenhouses should be free of plant debris which may serve as an inoculum source. High relative humidity is a major contributor for disease development; for example, tomato leaf mold does not occur if relative humidity is below 85%. Manage gray mold by removing dead plant tissue and by reducing humidity (water plants early in day, don't crowd plants together, increase air circulation by opening vents).

Tomato spotted wilt virus (TSWV) can be a major problem in the field if transplants are infected in the greenhouse. To avoid infection in the greenhouse, grow tomato transplants in a separate house from ornamentals. A number of thrips species can vector TSWV.

B. Field Sanitation

Rotate away from solanaceous crops for a minimum of two years.
If stakes or season extenders are to be re-used, they should be steamed or thoroughly washed with a disinfectant, and allowed to air dry before use. Do not re-use twine.
Prune plants by snapping off suckers at the base. Do not clip.
Do not enter fields if leaves are wet or if guttation droplets have not been withdrawn.
Clean and disinfect all equipment that has entered infested fields, and allow to air dry before use.
Bury infested plant debris in the soil to speed the decline disease inoculum in the soil.

C. General Scouting Information

Transplants should be inspected for symptoms of bacterial diseases (bacterial speck, spot, or canker) before planting. Inspect 5-10% of transplants, distributing your samples across many flats, and concentrating on the lower leaves, or call the NYS Dept. of Ag. and Markets for an inspection. Do not plant transplants with signs of bacterial diseases! Cull out infected transplants, or consider rejecting the shipment if disease levels are unacceptably high. Remember that bacteria can exist on plants as epiphytes (leaf surface inhabitants), meaning that symptoms may not be expressed until several weeks after transplanting to the field. Transplants shipped in from a southern state should be inspected for symptoms of late blight using the procedure described above.

Tomato fields should be scouted in a systematic manner that places sample sites throughout the field. Sampling patterns will vary depending on the shape of the field, but frequently a V-, W-, X-, or diamond shaped pattern adequately covers a field. Sample 5 consecutive plants at each sampling location. Sampling sites should be chosen without bias, except in those cases where specific sites are designated (for example - Anthracnose).

Although the scouting procedures outlined here are rather rigidly structured, remain alert to possible pest problems that may not be detected by the systematic sampling plan and are noted as you walk from site to site. Keep your eyes on the crop at all times!

For fresh market tomatoes: Inspect 5 groups of 5 plants per field for fields ≤2A. Inspect 5 additional plants for each additional 1/2 acre.
For processing tomatoes: Inspect 10 groups of five plants per field.

While the TOM-CAST disease forecasting system will require monitoring weather at least twice per week, the procedures outlined for other pests should be followed once per week per field. The once per week scouting can be delayed until the second week of June unless the transplants are of poor quality.

D. Field Inspection Procedures

Spray Record: Always check the grower's spray record before entering the field. It is important to check whether or not a pesticide has been applied recently, and if the re-entry interval (REI) has passed. Make sure your growers keep these records up to date.

1. Crop Growth Rating:

Record the stage of growth and plant height on the scouting report form according to the following:

vegetative (no blooms or fruit)
first bloom
first fruit set
fruit size
first ripe fruit

2. Colorado Potato Beetle:

RESISTANCE MANAGEMENT:
The Colorado potato beetle has demonstrated a remarkable ability to develop resistance to new insecticide chemistries. To prolong the life of the currently effective material imidacloprid (Admire and Provado) consider the following resistance management practices:
1) Rotate fields to reduce CPB pressure
2) Never rely exclusively on Admire/Provado for your insect management program. Always use these products in concert with other management tools including non-chemical tactics (see below) and other insecticides.
3) Do not use Provado on a field or part of a field that was treated with Admire at planting.
4) For non-rotated fields, do not use Admire or Provado more than once every two years.
5) Use insecticide only when needed; i.e. when an action threshold is reached.
6) Do not use Provado just prior to dispersal of summer adults to winter hibernation sites.
7) Never use Admire/Provado strictly for control of aphids; other equally effective materials are available.

ALTERNATE MANAGEMENT STRATEGIES:
Distance Rotation: Rotate solanaceous crops attractive to Colorado potato beetle (CPB) (eggplant, potatoes, tomatoes) as a block, and plant as far away from previous year's planting as possible. With enough distance, overwintered adults will colonize the field much later and in much lower numbers.

Trench Traps: (especially useful when long distance rotation not feasible) U or V shaped, **steep-sided** black plastic lined trenches along the edge of the field nearest the source of overwintering adults. Adults disperse mainly by walking early in the season, and are unable to escape from trenches once they fall in. A video tape and bulletin describing the use of trench traps is available from Cornell Cooperative Extension of Suffolk Co., 246 Griffing Ave., Riverhead, NY 11901.

Trap Cropping: (especially useful when long distance rotation is not feasible) Plant eggplant or potatoes in early May along the field border closest to previous season's plantings of tomatoes or potatoes. If using potatoes, plant only sound, unblemished, certified seed potatoes to avoid introducing late blight inoculum or seedborne viruses (especially potato virus Y and potato leafroll virus). Overwintered CPB adults will be preferentially

attracted to the trap crop. Treatment options for trap crop include: propane flaming (potatoes only), or the use of an effective insecticide. If using potatoes, **harvest trap crop as new potatoes or destroy as soon as overwintering adults have disappeared to minimize possibility of late blight infection, or spray with fungicides on an interval sufficient for late blight control on potatoes**.

Border Treatments: Treat border rows with Admire at planting to prevent movement of overwintering adults into field. Tolerate damage from the few adults that manage to get past the border; do not treat with Provado.

SCOUTING:
Early in the season, as overwintering adults are moving into fields, check border areas of fields. If hot spots are found on field borders, applying insecticides only to the borders of the field can delay the necessity for spraying the entire field, resulting in considerable insecticide and economic savings for the grower.

Examine entire plant, including fruit if present, and count the number of adults, small larvae (1st and 2nd instars), and large larvae (3rd and 4th instars), and presence or absence of fruit feeding on each plant. Estimate defoliation to the nearest 10%. Try to distinguish between CPB egg masses (eggs generally larger, more orange, less orderly) and those of the predaceous lady beetle *Coleomagilla maculata* (eggs smaller, lighter yellow, eggs neatly arranged on end). Refer to fact sheet 760.00 and *Natural Enemies of Vegetable Insect Pests* for details of the insects.

Report the mean number of small larvae, large larvae, and adults per plant, presence or absence of egg masses or fruit feeding, and % defoliation on the scouting report form. Indicate any "hotspots" of CPB infestation in the field in comments area.

THE FOLLOWING THRESHOLDS ARE STILL IN THE DEVELOPMENTAL STAGE.
Thresholds are for **established transplants** only. Growers should check plants every other day until transplants are well established and over transplant shock.

PROCESSING FIELDS

Plants up to 10":	Average of 1.5 adults/plant, or defoliation ≥20%
Plants 10" to early fruit set:	If using Bt's: ≥10% of plants infested with egg masses, and ≥30% of egg masses have hatched. If using conventional insecticides: Average of 2 adults or larvae/plant, or defoliation ≥20%
Early Fruit set to fruit maturity:	≥10% defoliation or ≥2% plants with at least one freshly injured fruit

FRESH MARKET FIELDS

Plants up to 10":	Average of 0.75 adults/plant, or defoliation ≥10%
Plants 10" to early fruit set:	If using Bt's: ≥5% of plants infested with egg masses, and ≥30% of egg masses have hatched. If using conventional insecticides: Average of 1 adult or larva/plant, or defoliation ≥10%
Early Fruit set to fruit maturity:	≥10% defoliation or ≥2% plants with at least one freshly injured fruit

3. Flea Beetles:

Scout for flea beetle feeding damage during the first two weeks after transplant. If plants seem stressed by feeding, recommend treatment.

4. Aphids:

Potato aphid is a vector for some tomato viruses. Their importance early in the season is questionable, and therefore no treatment threshold has been developed in New York. However, it will be useful to collect information on the level of aphid infestation.

Sample one lower and one middle compound leaf per plant.
Report the average number of aphids per leaf.
A threshold of 8 aphids per leaf is being used in Massachusetts.

5. Insects that may come with transplants:

During the first scouting trip of the season, inspect transplants for any insects that may have developed in the greenhouse. Report any finding of them on the scouting report form. The following insects could possibly be imported with transplants: leafminers, tomato pinworm, melon aphid, green peach aphid, whiteflies.

6. Other Insects:

Other insect pests which may be observed on tomatoes are tarnished plant bug (TPB), stink bug, tomato hornworm, leafhoppers and tomato fruitworm (corn earworm, late August/early September). Brush/shake foliage to detect presence of stink bug and TPB. During dry seasons stink bug and TPB can cause fruit damage, especially if tomatoes are grown close to other host plants such as strawberries, brambles, or alfalfa (especially right after cutting). Record presence or damage while scouting for other pests. Consider treatment if stink bug or TPB are easily found in a field.

Pay attention to reports of corn earworm from nearby sweet corn fields. If damage or trap catches are reported, then pay particular attention to the possible presence of this pest in tomato fields.

If tomato spotted wilt virus is found in the field it may be important to monitor for thrips, which vector the virus from plant to plant.

7. Early Blight

Refer to Cornell Fact Sheet 735.30 for a brief description of this disease.

Scouting:

If scouting for a demonstration, record disease severity for each group of five plants examined, using the rating system below. This information is to help us evaluate and refine TOM-CAST and should be done relatively quickly. First determine if the plants fall into the low, medium, or high category, then assign a number within the category. Ratings going into category 5 would be reason for concern about potential yield loss. Consult with the area IPM educator if this is the case. Pay particular attention to early maturing varieties (Pilgrim, Vendor, New Yorker, etc.) since they are more susceptible to early blight. Early blight lesions are generally found first on the lower mature leaves.

Severity Class	Range of Disease Percentages
0	no disease present
1 2 3	Low
4 5 6	Medium
7 8 9	High

Early Blight Forecasting:

The TOM-CAST system can be used to schedule protectant fungicide sprays for controlling early blight where weather data is available. Daily data on temperature and hours of leaf wetness will be needed to determine DSV's (daily severity values) using the table below. Begin recording DSV's as soon as tomatoes are transplanted. The first fungicide application should occur when **25 DSV's** have accumulated since transplanting. If 25 DSV's have not accumulated before July 11, apply the first fungicide at that time*. Subsequent applications should occur when **18-22 DSV's** have accumulated since the previous application if Bravo or Quadris are used, or **15 DSV's** if mancozeb fungicides are used. If spray intervals extend more than 14 days using TOM-CAST, and the weather forecast calls for rain, apply a fungicide and allow it time to dry before the onset of rain.

*The July 11 date may not make sense for very late transplanted fields. Use your best judgement to determine the best time for the first fungicide application if DSV's are accumulating very slowly. Rapidly enlarging fruit or any early blight symptoms would be reasons to initiate the first fungicide application**.**

CAUTION: Where bacterial canker is a perennial problem, do not attempt to use TOM-CAST to schedule fungicide applications. The spray intervals recommended by TOM-CAST are not sufficient to manage bacterial canker. See the section on bacterial diseases for additional management information.

	Leaf wetness periods (hr.) required to produce Daily Disease Severity Values of:				
Mean Temp. (°F) (during wetting period)	**0**	**1**	**2**	**3**	**4**
55-63	**0-6**	**7-15**	**16-20**	**21+**	
64-68	**0-3**	**4-8**	**9-15**	**16-22**	**23+**
69-77	**0-2**	**3-5**	**6-12**	**13-20**	**21+**
78-84	**0-3**	**4-8**	**9-15**	**16-22**	**23+**

Madden, L., S.P. Pennypacker, and A.A. MacNab. Phytopathology 68:1354-1358

Guidelines for determining length of wetting periods:

2 or more hours that do not register leaf wetness are required to end a wetting period.

Never break a wetting period at an arbitrary time point. For example, if a wetting period starts at 10 PM and continues until 8 AM the following day, you have one 10-hour wetting period, not 2 hours for the first day and 8 hours for the second.

8. Late Blight

Refer to Cornell Fact Sheet 725.40 for a brief description of this disease.

Keep an eye open for possible late blight symptoms as you walk between scouting locations. Late blight may first appear in areas of the field with poor air circulation, such as wooded edges or low areas. Inspect stems, green and red fruit, and growing points at the top of plants carefully. If the humidity is not high enough for sporulation when the field is scouted, suspect lesions may be held in moist chambers and checked for sporulation after 12-24 hours. **Scouts: if late blight is found, highlight the report on the scouting form and indicate that immediate action is needed.**

Monitor late blight incidence in potatoes via the late blight network listserv. (Contact local Extension or Area IPM Specialist for information about access). If late blight infected potato or tomato fields are reported in your county or adjacent counties, switch to a late blight forecast for fungicide scheduling:

0-2 SV over previous 7 days: Use TOM-CAST recommended intervals
3-5 SV over previous 7 days: 7 day spray interval
6+ SV over previous 7 days: 5 day spray interval

If rain is forecast and 7 or more days have passed since the last fungicide application, apply a fungicide before the leaves get wet if possible. If late blight is found in the field, destroy infected plants if the infection is localized, and maintain a 5-day fungicide schedule. Disk down plants as soon as harvest is complete or if the field is abandoned because of late blight infection.

If late blight is found in the field, collect a sample and send it to the Cornell disease diagnostic lab for isolate identification. The US 7 and 17 isolates are more aggressive on tomato than other isolates, and will require especially close adherence to the spray intervals recommended above. To send a sample for diagnosis, place one infected compound leaf in a plastic bag and blow air into the bag to inflate it before sealing it. It's best to place each leaf into a separate bag. Box and ship via overnight service to: Karen Snover, Plant Disease Diagnostic Lab, 321 Plant Science, Ithaca, NY 14853. Include your name and phone number, the name of the grower, and location of the field. **NOTE: Late blight diagnosis is no longer free but is essential!**

9. Anthracnose

See the fact sheet 735.70 for a picture of an anthracnose lesion on tomato fruit.

Scheduling fungicide applications according to TOM-CAST should provide good anthracnose control.

Anthracnose will only be monitored on fruit. It is most severe in red fruit in the first cluster (the cluster closest to the ground) and most often tends to be found on the surface facing the ground. **Anthracnose will not be observed in the field if tomatoes are picked before they are red in color.** Anthracnose symptoms are generally not randomly scattered throughout a tomato field. Looking in certain moist areas of the field such as low spots, shady spots or areas next to woods will enable the scout to more efficiently find the disease if it is present in the field. Therefore at least 1-2 of the sites that are chosen for sampling pests in tomatoes should be in low spots or areas bordering woods if tomatoes are ripened in the field.

On each plant sampled, look on the underside of the first fruit cluster for sunken, circular lesions. There is no need to count the lesions on individual fruit. Report the percent plants with one or more fruit with any lesion(s) on the scouting report form.

10. Buckeye Rot:

See Fact Sheet 736.24 for a description of Phythophthora blight of tomato and other crops.

Only fruit are affected. It is more likely to occur on fruit near the ground and on plants in disease-prone areas (fields with a history of the pathogen (Phytophthora) on tomato, pepper, cucurbits, eggplant; low areas; plants grown on the ground or without mulch). Look at fruit near the ground on plants in low areas for firm, smooth, brown spots. Lesions can cover entire fruit. Concentric zones within the lesions are characteristic. Note presence in the comment section of the scouting report form. Collect affected fruit for diagnosis confirmation. In fields with confirmed buckeye rot, recommend Ridomil fungicides.

11. Septoria leaf spot

See Fact sheet 735.80 for descriptions of Septoria leaf spot.

Scheduling fungicides using TOM-CAST should provide good control of Septoria leaf spot. Inspect those leaves sampled for the presence of Septoria lesions on leaves and stems. Look for the presence of small dark brown pimple-like structures called pycnidia on the lesion to aid in distinguishing this disease from early blight. This disease is most commonly associated with infected transplants although if annual rotation is not practiced the organism survives on plant debris. The fungus prefers cool, wet springs for early disease spread. Report the presence or absence of infected plants on the scouting report form.

12. Viruses:

Fact sheets 735.40 (General viruses) and 735.90 (Tomato spotted wilt) describe several virus diseases that may be seen on tomato plants. Although the scout will not systematically sample for any of these diseases it is important to note the presence of virus diseases in the field in the comments section of the scouting report form.

Distinguishing between the diseases in the field may be difficult. If the problem is widespread it may be necessary to submit a sample for diagnosis to the county agent and the Disease Diagnostic Lab at Cornell. Tomato spotted wilt virus (TSWV) is transmitted from plant to plant by thrips. If tomato spotted wilt is found in the field, monitor for thrips by tapping flowers to dislodge the thrips, and if they are present, they may need to be controlled to avoid further plant to plant transmission.

13. Bacterial diseases:

Fact sheet 735.50 describes the important bacterial diseases (bacterial speck, spot, and canker) which occur on tomatoes in New York. The best management strategy for bacterial diseases is prevention. Always use disease free or hot water treated seed and practice a 2-3 year rotation away from tomatoes and peppers. Scan leaves and fruit ≤1 1/4 inches in diameter for symptoms of any of the three bacterial diseases. If found in the field collect a sample for diagnosis. In fields with confirmed bacterial disease infections, discontinue the use of TOM-CAST for scheduling fungicides and recommend copper be included in fungicide applications. To avoid spreading bacterial pathogens, do not scout or work in infected fields when foliage is wet.

For staked fields: Always disinfect stakes between seasons, and do not re-use string or other hardware. Include copper in fungicide applications made after staking and pruning operations. When pruning, growers can place buckets of disinfectant with towels at regular intervals throughout field and have workers wash off gloves when they reach a bucket, to minimize spread of pathogens.

14. Powdery Mildew:

Powdery mildew is a new foliar disease with potential to cause extensive premature leaf death in non-fungicide-treated plants. White powdery fungal growth develops on both upper and under leaf surfaces. Fortunately, control has been achieved with Bravo applied following a TOM-CAST forecast.

14. Other diseases:

Other diseases which are unlikely to cause serious problems but which may be observed in tomato fields during the scouting season are Botrytis (refer to fact sheet 735.60), white mold (*Sclerotinia*), and *Rhizoctonia*. Severe cases of Botrytis can cause signs (sclerotia) and symptoms (stems turn beige to white in color) which may mimic white mold (figure 3 in fact sheet 735.60) Note any occurrence of these diseases. A specific fungicide application(s) may be required for Botrytis control as considerable green fruit in a cluster can be lost. This is especially true during periods of frequent summer rains and extended periods of heavy dews.

15. Weeds:

Making a Weed Map

Weeds or weed species may not be evenly distributed over a field. Where localized areas of severe infestations are found or atypical conditions exist (poorly drained area, high spots, field edges), weed infestations may be recorded on a weed map. A weed map illustrates problem areas and provides information for future control decisions. When weed maps are kept over a period of years for a given field, changes in location and population can be noted and control decisions adjusted accordingly. Areas of severe infestations can be targeted for specific control practices, rather than treating a larger area needlessly or failing to control problems at all.

First, make a rough sketch of the field, including landmarks, boundaries, crop row direction, compass directions, roads, planting date, date of map preparation, and any other important details. Then the following information should be indicated on the map:

Weed species, or if this is unknown, some effort should be made to distinguish annual from perennial, and broadleaf species from grasses and from yellow nutsedge. Make a special effort to identify hard to control weeds such as nightshades.

Abundance of each species estimated according to the following system:

0 = None; 1 = Scattered, few weeds; 2 = Slight, 1 weed/6 row feet;
3 = Moderate, 1 weed/3 row feet; 4 = Severe, > 1 weed/3 row feet

Distribution of weeds in the field is important and can be rated as follows:

SPOTTY - found in a few places around the field;
LOCAL - found in a small portion of the field;
GENERAL - found throughout the field

Weed size - The following size ratings can be used:

WHITE SPROUTS - seeds are just germinating or emerging;
TINY - weeds show only cotyledons or first true leaf;
SMALL - weeds less than 1" tall or less than the diameter of a quarter
LARGE - weeds more than 1" tall or more than the diameter of a quarter

Throughout the season, at least two weed maps should be prepared. Timing should be as follows:

1. Early - shortly after transplanting. Purpose: to evaluate the success of the current season weed control program.

2. Late - Near harvest. Purpose: to plan for next season's weed control needs.

Weed management in Tomatoes:

Herbicide chemistries for as needed, post emergent weed control are available for tomatoes grown in fields in which the weed populations are primarily annual broadleaves and grasses. For annual broadleaf weeds, use the low rate application of Sencor (refer to Cornell Recommends for details) just as weeds are emerging. Up to 3 applications may be necessary, and will be most effective when used in combination with cultivation. The higher label rate may be used if weeds get too big. If annual grasses are also present, one postemergent application of Poast should provide sufficient control.

Cornell University
Vegetable IPM Program
5/00