Crop Profile for Tomatoes in New York

Prepared: May, 1999

General Production Information

While large-scale production of tomatoes is no longer common in NY, tomatoes are produced by most of the diversified fresh market vegetable producers in NY, and total production is significant. The great majority of tomatoes are grown for fresh market, and most of those are consumed locally, although some are shipped to markets in the eastern US. Field-grown tomatoes predominate, but greenhouse production is increasing. Recent registrations of new insecticides have made Colorado potato beetle a much less serious pest than in the early 1990's, but resistance management programs will need to be followed in order to maintain the effectiveness of these new materials.

Organophosphates such as azinphos-methyl and thiodan play an important role in managing resistance in CPB. Tomatoes are susceptible to a number of serious fungal and bacterial diseases, including new strains of metalaxyl-resistant late blight that are highly virulent on tomatoes. Fungicides are key tools in controlling these diseases. Weeds are also significant pests, and are managed with a combination of cultural practices and herbicides. Without the registration of new effective materials, the loss of chlorothalonil, mancozeb, thiram, metribuzin, or trifluralin would have a significant impact on production and profitability. Tomato producers have critical needs for: an effective curative fungicide for late blight control; and effective controls for bacterial canker, speck and spot. Registrations for fungicides to control powdery mildew and grey mold would greatly aid producers of greenhouse tomatoes.

Registration of new materials by the EPA, even those designated as "low risk", does not guarantee that NY growers will have immediate access to them. The New York State Department of Environmental Conservation conducts its own in-depth reviews before registering new pesticides for use in NY, and may or may not register new materials for portions of or for the entire state.

Basic Commodity Information

State Rank: 15th

% U.S. Production: 1%

Acres Planted: 2800

Acres Harvested: 2600

Cash Value: $9,079,000

Yearly Production Costs: $2000 - $8000, depending on method of production (estimated).

Production Regions: Tomatoes are produced in all the major vegetable growing areas in NY. Leading counties include Erie, Monroe, Niagara, Onondaga, Suffolk, Ulster, Wayne, Orange, Albany, and Dutchess Counties. Greenhouse tomatoes are increasing in importance, with the greatest production in Niagara and Monroe Counties.

Commodity Destination(s):

- **Fresh Market:** 95%
- **Processing:** 5%

Cultural Practices

Field-grown tomatoes are predominantly determinant types, having a restricted branching and fruiting pattern. These varieties are preferred for commercial production because the harvest period is more concentrated and the plants more compact and bush-like, making optimal spacing more predictable and facilitating cultivation. Tomatoes are well adapted to a range of soil types; pH should be in the 6.0-6.8 range. Because tomatoes are sensitive to frost, transplants (greenhouse-grown or less often, shipped from southern states) are placed out in the field after all chance of frost has passed. Raised beds are frequently used, sometimes with plastic mulch. Producers are increasingly staking (using the basket-weave system) and pruning tomatoes in order to hasten early fruit production, improve quality, control diseases, and to ease harvesting. Irrigation is frequently practiced to improve yield and minimize physiological disorders such as blossom end rot brought on by uneven soil moisture availability. Fresh market tomatoes are hand-harvested, primarily between the pink and ripe stages, depending on the distance to market. Very little of the crop is picked as mature greens for shipping long distances. Often they are washed after harvest, sometimes in chlorinated water, then sorted, graded and packed.

Greenhouse tomatoes are grown in glass- or plastic-covered houses. Larger operations use hydroponic systems, while medium to small scale operations either grow plants in soil or in bags of soil-free media. Greenhouse tomato varieties are indeterminate, and plants are pruned and tied to trellis systems. Multiple harvests are done by hand, and harvesting typically lasts from April to August.

Note on Pesticide Use Information: Pesticide use practices vary considerably among tomato producers due to differences in scale, local and yearly pest pressures, and target market. A "typical" use pattern for a particular pest or set of pests rarely exists. To reflect this variability, numbers in tables in the following sections are given as estimated ranges based on grower surveys as well as expert opinion.

Insect Pests

<u>Colorado potato beetle</u> (*Leptinotarsa decemlineata*)

Frequency of Occurrence: Annually.

Damage Caused: Colorado potato beetle adults and larvae feed on leaves, stems and fruit. Damage can be extensive enough to cause plant death, and less severe infestations can weaken plants and cause decreases in yield.

% Acres Affected: 100% at risk; up to 50% affected per year.

Pest Life Cycles: Colorado potato beetles overwinter in soil in fields and field borders. They emerge in the spring and begin feeding on tomatoes, mating and laying bright orange eggs. Nightshade and horse nettle are also hosts. Larvae also feed on foliage and sometimes on fruit. They may have one to three generations per year in NY, depending on the length of the season. In mid-August, most egg laying ceases and adults begin to enter the soil for overwintering.

Timing of Control: All season.

Yield Losses: Can be as high as 80% in severely affected fields; typical losses are <10%.

Regional Differences: None.

Cultural Control Practices: A number of cultural practices help control of CPB including: rotation away from solanaceous crops, siting plantings at a distance from potatoes, and using trap crops or trench traps to trap overwintering adults as they emerge and move into tomato fields.

Biological Control Practices: Numerous natural control organisms exist in the field. Both parasitoids and predators are useful, however alone they rarely provide commercially acceptable levels of control.

Post-Harvest Control Practices: None.

Other Issues: Research on CPB control in tomatoes and potatoes is ongoing (Tingey), and focuses on screening new insecticides for efficacy, and on resistance management.

Foliar Insecticides for Tomato Insect Control:

Pesticide	% Trt.	Target Pest[1]	Typical Rates lbs ai/acre	Timing	# of Appl.	PHI[2] days	REI hours
abamectin *(AgriMek)*	<1	CPB	0.01	as needed through season	--	14	12
azinphos-methyl *(Guthion)*	25-30	CPB, FB, TFH	0.5	as needed through season	1	2	48
imidacloprid[3] *(Admire, Provado)*	65-70	CPB, FB, A	0.047	as needed through season	1-2	3	12
Bts *(Novador and others)*	<1	CPB, TFH	varies with formulation	as needed through season	1	1	12
carbaryl *(Sevin)*	<5	CPB, SB. TPB	1.0	as needed through season	1	3	12
endosulfan *(Thiodan)*	25-30	CPB, FB, A	0.5	as needed through season	1-2	2	24
esfenvalerate *(Asana)*	<1	CPB, FB, TFH	0.03-0.05	as needed through season	--	1	12
cryolite *(Kryocide)*	<1	FB	8-16	as needed through season	--	14	12
lambda-cyhalothrin *(Warrior)*	<1	SB, TPB, A, TFH, C	0.02-0.03	as needed through season	--	5	24

cyfluthrin *(Baythroid)*	<1	CPB, A, FB, TFH	0.025-0.044	as needed through season	--	1	12
diazinon *(Diazinon)*	<1	A	0.25	as needed through season	--	1	24
dimethoate *(Dimethoate)*	<1	A	0.5	as needed through season	--	7	48

1.Key to pests: CPB=Colorado potato beetle; FB=flea beetle; SB=stink bug; TPB=tarnished plant bug; A=aphid; TFH=tomato fruitworm and hornworm; C=cutworm

2. PHIs in this and all tables represent the shortest actual time between application and harvest, not label PHIs.

3. Soil applications of imidacloprid (Admire) are labeled, but essentially all use of this insecticide is as a foliar application.

Use in IPM Programs: As needed use of insecticides is consistent with Cornell IPM recommendations. Scouting protocols and thresholds have been established for CPB.

Use in Resistance Management: Colorado potato beetles are notorious for developing resistance to insecticides, and CPB in NY are no exception. Before the availability of imidocloprid, CPB were resistant to many available organophosphates. After several years of imidocloprid use, it is not known if organophosphate resistance has been maintained in these populations.

Efficacy Issues: Imidocloprid has been so effective in controlling CPB that overwintering populations have fallen dramatically, making the pest much less significant than previously. Bts are only effective on small larval stages, not adult stages. Since CPB are usually present in all stages in tomato fields, Bts may not be as effectiveas other materials.

Alternatives: Possible alternatives include Mycotrol (*Beauvaria bassiana*) or spinosad. Efficacy trials need to be conducted.

Cutworms

Frequency of Occurrence: Sporadic.

Damage Caused: Cutworms can cut young plants off at the surface.

% Acres Affected: 100 at risk; typically 2% affected per year.

Pest Life Cycles: Cutworms overwinter either as large larvae or as eggs in the soil. They tend to be most abundant in weedy areas in a field or adjacent to cover crop strips after the cover crops are killed or tilled down. They pupate in the soil and adult moths emerge in June or July. They may have from 1-3 generations per year, but typical cutworm injury occurs only when plants are small.

Timing of Control: When plants are small.

Yield Losses: Yield loss can be as high as 50% in heavily infested fields due to stand loss.

Regional Differences: None.

Cultural Control Practices: Avoid following sod or pasture with tomatoes. If fields contain significant amounts of weeds before field preparation, allow at least two weeks between disking and planting.

Biological Control Practices: Naturally-occuring predators, parasitoids, and pathogens help suppress infestations.

Post-Harvest Control Practices: None.

Chemical Controls: See "Colorado Potato Beetle" section, above, for pesticide use information.

Use in IPM Programs: As needed use of insecticides is consistent with Cornell IPM recommendations.

Use in Resistance Management: None reported.

Flea beetle (*Epitrix cucumeris*)

Frequency of Occurrence: Annually.

Damage Caused: Flea beetles chew small holes in foliage. They can severely injure transplants and blemish fruits. Feeding sites provide entry points for diseases.

% Acres Affected: 100% at risk; usually up to 25% affected per year.

Pest Life Cycles: Adult flea beetles overwinter in the soil and emerge early in the spring to feed and lay eggs. Larvae feed on plant roots but do not cause significant damage at this stage.

Timing of Control: Seedlings and early transplants.

Yield Losses: Up to 20% in severely affected fields.

Regional Differences: None.

Cultural Control Practices: Maintain good plant health, so plants can outgrow damage. Weed control may help because they can act as alternate hosts for flea beetles.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: See "Colorado Potato Beetle" section, above, for pesticide use information.

Use in IPM Programs: As needed use of insecticides is consistent with Cornell IPM recommendations.

Use in Resistance Management: None reported.

Potato aphid (*Macrosiphum euphorbiae*)

Frequency of Occurrence: Annually.

Damage Caused: Aphids cause damage by sucking plant juices and excreting a sticky honeydew which may reduce fruit quality. Aphids weaken plants and result in smaller fruit. Aphids can also vector viruses.

% Acres Affected: 100 at risk; usually 25-50% affected per year.

Pest Life Cycles: Aphids overwinter as eggs on a variety of crops and weeds. The eggs hatch in the spring, and after one or more generations on the overwintering host, winged aphids are produced and migrate to a variety of other hosts, including tomatoes. Females can reproduce without mating with males. Each aphid can give birth to 50-100 live young, all females. There may be 5-10 generations per season. In the fall, a generation with winged males and females is produced. These migrate back to overwintering hosts, mate and lay eggs.

Timing of Control: Planting through harvest.

Yield Losses: Up to 50% in severely affected fields.

Regional Differences: None.

Cultural Control Practices: None.

Biological Control Practices: Naturally occurring predators, parasitoids, and pathogens help suppress infestions.

Post-Harvest Control Practices: None.

Chemical Controls: See "Colorado Potato Beetle" section, above, for pesticide use information.

Use in IPM Programs: As needed use of insecticides is consistent with Cornell IPM recommendations. A scouting procedure and economic thresholds have been established.

Use in Resistance Management: None reported.

Alternatives: Pymetrozine (trade name Fulfil) and thiamethoxam (trade name Adage), two new insecticides developed by Novartis, may be effective aphicides, but trials have yet to be conducted.

Stink bug (*Eushchistus* spp.)

Frequency of Occurrence: Sporadic.

Damage Caused: Stink bugs can feed directly on the fruit resulting in blemishes or cloudy spots on the surface, and shallow, corky areas in the flesh. Damage renders tomatoes unmarketable. Damage is sometimes limited to field edges.

% Acres Affected: 100% at risk; typically up to 15% affected.

Pest Life Cycles: A number of species of stink bugs can attack tomatoes. Little is known about their biology in New York. Because of their secretive nature, they frequently hide on the back side of fruit, and can be difficult to scout for. Populations can build up in brambles around field edges.

Timing of Control: From fruit formation through harvest.

Yield Losses: Up to 25% in severely affected fields. Typical losses run 1-5%.

Regional Differences: None.

Cultural Control Practices: Avoid planting near brambles. Eliminate weed areas near the field as these can serve as breeding sites.

Biological Control Practices: Several natural control organisms, including egg parasitoids, are important in controlling stink bugs.

Post-Harvest Control Practices: None.

Chemical Controls: See "Colorado Potato Beetle" section, above, for pesticide use information.

Use in IPM Programs: As needed use of insecticides is consistent with Cornell IPM recommendations.

Use in Resistance Management: None reported.

Tarnished plant bug (*Lygus lineolaris*)

Frequency of Occurrence: Occurs in most years.

Damage Caused: Tarnished plant bugs damage tomato fruit with their piercing and sucking mouth parts. Direct feeding results in blemishes on the surface. The area below the feeding site dries out causing the surface of the fruit to crack. These blemishes render the fruit unmarketable.

% Acres Affected: 100% at risk; typically up to 15% affected.

Pest Life Cycles: The tarnished plant bug feeds on a wide variety of crop and weed plants. Overwintering adults are found under debris or in other protected places. They become active in early spring and deposit their eggs in the stems, petioles, midribs and blossoms of host plants. Hatching takes place abut a week or more later, and the green-to-yellow nymphs molt five time, reaching the adult stage in approximately 30 days. There are usually 2-3 generations in NY.

Timing of Control: When fruit is present.

Yield Losses: Can be up to 25% in severely affected fields.

Regional Differences: None.

Cultural Control Practices: Minimize weeds in the vicinity of the field.

Biological Control Practices: Numerous natural control organisms exist in the field.

Post-Harvest Control Practices: None.

Chemical Controls: See "Colorado Potato Beetle" section, above, for pesticide use information.

Use in IPM Programs: As needed use of insecticides is consistent with Cornell IPM recommendations.

Use in Resistance Management: None reported.

Tomato fruitworm (*Heliocoverpa zea*)and **hornworm** (*Manduca* spp.)

Frequency of Occurrence: Sporadic.

Damage Caused: Tomato fruitworm larvae bore into the fruit, typically at the calyx, resulting in contamination and loss of fruit. Hormworms feed on leaves and fruit of tomatoes, weakening the plant and causing direct damage to the fruit.

% Acres Affected: 100% at risk; typically up to 5% affected.

Pest Life Cycles: Tomato fruitworms are also called corn earworms. They do not overwinter in New York. The moths migrate in from the south usually in July and August. Eggs are light green and laid singly on the underside of foliage. Larvae feed for 3-4 weeks before entering the soil to pupate. There may be 2-3 generations per year.

Timing of Control: When fruit are present.

Yield Losses: Usually minor; can be up to 15% in severely affected fields.

Regional Differences: Pressure tends to be higher on Long Island than in upstate NY.

Cultural Control Practices: None.

Biological Control Practices: Several parasitoids and predators help suppress both pests in the field.

Post-Harvest Control Practices: None.

Chemical Controls: See "Colorado Potato Beetle" section, above, for pesticide use information.

Use in IPM Programs: As needed use of insecticides is consistent with Cornell IPM recommendations.

Diseases

Anthracnose (*Colletotrichum coccodes*)

Frequency of Occurrence: Annually.

Damage Caused: Anthracnose causes rotting of ripe fruit, reducing yield and quality. There is a strict limit on the amount of anthracnose acceptable on processing tomatoes. Roots may also be infected, resulting in black dot disease.

% Acres Affected: 100% at risk; up to 25% affected per year.

Pest Life Cycles: The fungus survives the winter as seedlike structures called sclerotia and as threadlike strands called hyphae in infested tomato debris. In late spring the lower leaves and fruit may become infected by germinating sclerotia and spores in the soil debris. Infections of the lower leaves are important sources of spores for secondary infections throughout the growing season. Leaves injured by early blight or flea beetles can also become infected and provide sources of secondary spores.

Timing of Control: At planting, and when fruit begin to form.

Yield Losses: Can be up to 50% in severely affected fields. Typical losses run from 1-10%, even when fungicides are used.

Regional Differences: None.

Cultural Control Practices: Minimum 3-4 year rotation away from solanaceous crops. Tomatoes should be planted in fields with good soil and air drainage. Trellising and mulching can reduce disease severity. Seed should be certified disease-free. No resistant varieties are available. Susceptible weeds such as velvetleaf should be removed from the field.

Biological Control Practices: None.

Post-Harvest Control Practices: Plow under crop residue to initiate decomposition.

Chemical Fungicides and Antibacterials for Tomato Disease Control:

Pesticide	% Trt.	Target Disease[1]	Type of Appl.	Typical Rates lbs ai/acre	Timing	# of Appl.[3]	PHI days	REI hours
copper compounds *(Many)*	95	BCSS, EB, An, BPR, LB	foliar	varies with formulation	as needed through the season	2-8	1	24

chlorothalonil *(Bravo)*	99	BCSS, EB, An, LB	foliar	1.5	all season	2-6	2	48
mancozeb *(Manzate)*	99	BSCC, EB, BLW, LB	foliar	1.125-2.25	all season	1-4	5	24
streptomycin *(Agri-Strep)*	40-50	BCSS	foliar to seedlings	1 lb product/acre	only while in greenhouse	2-4	45	--
thiram *(Thiram)*	80-90	BCSS, DO, An	seed treatment	label rates	before planting	1	60	--
mefenoxam *(Ridomil Gold)*	<1	DO, BPR	soil	1-2 pts product/acre	at planting	1	45	48
maneb *(Maneb)*	30-35	EB, An, BLW, LB	foliar	1.0	all season	2-4	5	24
ziram *(Ziram)*	<1	EB, An	foliar	3.0	all season	--	7	48
azoxystrobin[4] *(Quadris)*	15-20	EB, An, LB	foliar	0.975	all season	1-2	1	12
fosetyl-Al *(Aliette_)*	<1	BPR	foliar	2-4	all season	--	14	12
benomyl *(Benlate)*	30-35	BLW	foliar	0.25-0.5	all season	1-2	1	24

propamocarb[2] *(Tattoo-C)*	0-5	LB	foliar	0.9 propamocarb; ? chlorothalonil	as needed once late blight is found in field	--	7	?

1. Key to target disease: BCSS=Bacterial canker, speck and spot; DO=Damping-off; EB=Early blight; An=Anthracnose; SLS=Septoria leaf spot; BPR=Buckeye and phytophthora rots; BLW=Botrytis gray mold, leaf spot, and Sclerotinia white mold; LB=Late blight.

2. Available under a Section 18 emergency exemption.

3. Total number of fungicide applications per farm or per field varies considerably depending on weather and other conditions. Not all fungicides are used on all fields. In general, growers make in the range on 4 to 8 fungicide applications per field per season. The material chosen (e.g. chlorothalonil, mancozeb, copper) also varies considerably.

4. Not labeled for use in Long Island (Suffolk and Nassau counties).

Use in IPM Programs: As-needed use of fungicides is consistent with Cornell IPM recommendations. The TOM-CAST disease forecasting program provides weather-based information for scheduling fungicide applications for control of anthracnose and other diseases.

Use in Resistance Management: None reported.

Alternatives: None at this time.

Botrytis gray mold, leaf mold, and white mold (*Botrytis cinerea*, *Fulvia fulvum*,and *Sclerotinia sclerotiorum*)

Frequency of Occurrence: Sporadic in field tomatoes, but an annual, and frequently severe, problem in greenhouse tomatoes.

Damage Caused: This group of related diseases causes molds on leaves, stems, and/or fruits of tomato plants. Infected plants are weakened, affecting yield. Gray mold may attack fruits directly, rendering them unmarketable.

% Acres Affected: 100 at risk; typically 5-10% affected in field tomatoes. In greenhouse tomatoes, typically 50-75% affected.

Pest Life Cycles: *Botrytis cinerea*, the fungus causing gray mold, is ubiquitous, and has a very wide host range. The first sites of infection are leaves in contact with infested soil, leaves wounded by handling or weather damage, senescent leaves, or flowers. Tomatoes are very susceptible when the flowers are still attached or if the calyx is infected. Stem lesions can be caused by the fungus traveling through the petiole from other infected sites. Stem lesions may girdle and kill the plant. The fungus overwinters as small, black sclerotia in plant debris. White mold, caused by *Sclerotinia sclerotiorum*, another widespread fungal pathogen, begins during bloom, causing water-soaked areas on stem joints or leaf axils. The stems become soft and bleached or light gray. During cool, moist weather, cottony growth is seen on the stems. Black, hard sclerotia may be found on the surface or within the stem. Leaf mold is usually a greenhouse disease.

Timing of Control: From seedling stage up to when fruit reaches cherry size.

Yield Losses: In field tomatoes, losses are usually low (1-5%), but gray mold can cause significant losses in greenhouse-grown tomato crops.

Regional Differences: None.

Cultural Control Practices: No resistant varieties are available. Select fields with good air circulation. In the greenhouse, provide venting and air circulation, and provide adequate space for each plant to encourage good air movement.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: See "Anthracnose" section, above, for pesticide use information.

Use in IPM Programs: As needed use of fungicides is consistent with Cornell IPM recommendations.

Use in Resistance Management: None reported.

Damping-off (*Pythium* spp. and *Rhizoctonia solani*)

Frequency of Occurrence: Annually.

Damage Caused: Seeds may rot, and infected plants may fail to emerge following germination. Older seedlings may wilt, turn brown and die, resulting in poor stands.

% Acres Affected: 100 at risk; typically 1-5% affected per year.

Pest Life Cycles: Damping-off can be caused by *Pythium* or *Rhizoctonia* species, both very common soil-borne pathogens with wide host ranges. *Pythium* grows as white mycelium which branch and form reproduction structures. The spores move in water to a host. They survive best on dead plant and animal matter, but can do well on living plants particularly in wet soils. The fungus enters and kills plant cells, especially if the plant is young.

Timing of Control: During transplant production.

Yield Losses: Usually minimal.

Regional Differences: None.

Cultural Control Practices: Use high quality seed in transplant production. Seed should be treated by seed suppliers with a fungicide. Plants should be grown under optimal conditions in a soil-free media. If reusing flats, sterilize properly.

Biological Control Practices: Trichoderma (Rootshield) and Mycostop, used as preventatives, may provide some control of damping-off.

Post-Harvest Control Practices: None.

Chemical Controls: See "Anthracnose" section, above, for pesticide use information.

Use in IPM Programs: As needed use of fungicides is consistent with Cornell IPM recommendations.

Use in Resistance Management: None reported.

Early Blight (*Alternaria solani*)

Frequency of Occurrence: Annually.

Damage Caused: Early blight causes leaf defoliation and fruit rot.

% Acres Affected: 100%

Pest Life Cycles: The fungus overwinters in plant debris and seed. Leaf symptoms begin around flowering, and appear as target or bulls-eye lesions on older leaves. These lesions coalesce to form large dead areas in the leaf, which subsequently drops off. Spore production and lesion enlargement are greatest during cool weather, infection is greatest in warm weather. Heavy dews, humid weather and abundant rainfall are essential for heavy disease pressure.

Timing of Control: All stages of plant development.

Yield Losses: Can be up to 100% in severely affected fields. Typical losses, even in fields treated with fungicides, run 1-10%

Regional Differences: None.

Cultural Control Practices: A minimum rotation of two year away from tomato and potato crops is recommended. Weedy fields or fields with volunteer tomato plants should be avoided. Seed should be disease-free.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: See "Anthracnose" section, above, for pesticide use information.

Use in IPM Programs: Cornell IPM recommendations call for the use of the disease forecasting system TOM-CAST to time fungicide applications according to infection pressure, where local weather information is available. A scouting procedure and thresholds have also been established.

Use in Resistance Management: None reported.

Alternatives: Trifloxystrobin, a new strobilurin fungicide similar to azoxystrobin, may be an effective alternative, but trials need to be conducted.

Fusarium and Verticillium wilts (*Fusarium oxysporum* and *Verticillium albo-atrum*)

Frequency of Occurrence: Infrequent.

Damage Caused: Several fungi, including *Fusarium* and *Verticillium* spp., cause wilting of the plant due to blockage of the water-conducting vessels. Infected plants usually die.

% Acres Affected: Usually <1%.

Pest Life Cycles: The causal fungi are soil-borne and persist for many years in infected soil. They can also be carried on seed.

Timing of Control: Before planting.

Yield Losses: Usually minimal, since almost all commercial varieties are resistant to both types of wilts.

Regional Differences: None.

Cultural Control Practices: Use of resistant varieties have made these potentially devastating diseases minor problems in commercial production. Older, heirloom varieties are often very susceptible to these wilts. Maintaining soil pH near 7.0, and the use of nitrate rather than ammonia fertilizer can slow Fusarium wilt.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: No pesticides are registered to manage these diseases.

Late Blight (*Phytophthora infestans*)

Frequency of Occurrence: In recent years, annually.

Damage Caused: Late blight infections can devastate fields of both potatoes and tomatoes if not controlled. Under the right weather conditions, infections can spread extraordinarily quickly. Stem lesions can girdle plants and kill them. Infected fruit rot either before harvest or very soon after harvest.

% Acres Affected: 100% at risk; over last six years, typically 1-5% affected.

Pest Life Cycles: Late blight is caused by a fungus that grows most actively in warm wet weather. Spores are disseminated by water and wind movement. Under favorable weather conditions, the pathogen can blight the foliage so rapidly that it appears the plants were hit by frost. Decaying vines may be recognized by a foul odor. The fungus overwinters in live crop tissue such as potato tubers (culls and volunteer potatoes), but is not thought to overwinter in the soil. Infected transplants or inoculum from potatoes may serve as primary sources of the disease. In recent years, several new strains of the disease have spread throughout the US, Mexico and Europe. These new strains are resistant to metalaxyl, previously an effective curative fungicide, so the disease has become of much greater economic significance than in the previous decade. Some of the new strains are more virulent on tomatoes than older strains.

Timing of Control: Mid- to late season.

Yield Losses: Can be as high as 100%.

Regional Differences: Recent late blight outbreaks have been regional in nature, but all regions are at risk.

Cultural Control Practices: No resistant varieties are available. Recommended practices for reducing the risk of the disease include: do not plant near potato cull piles; destroy any volunteer potato plants; disk down plants as soon as harvest is complete or if the field is abandoned because of late blight infection.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Other Issues: Because of the serious nature of this disease, research on its control is ongoing (Zitter).

Chemical Controls: See "Anthracnose" section, above, for pesticide use information.

Use in IPM Programs: In response to actual and potential devastating losses to late blight in tomatoes and potatoes, Cornell Cooperative Extension maintains a late blight network of weather instruments and experts monitoring late blight incidence during the growing season. Recommendations for fungicide use (time of first application, application schedule through growing season, and choice of fungicides) are made available to many producers and consultants. These recommendations include the use of protectant fungicides (chlorothalonil, maneb, or mancozeb) or other labeled fungicides such as azoxystrobin (not labeled for use on Long Island), and propamocarb (Tattoo-C).

Use in Resistance Management: In recent years, several new strains of the disease have spread throughout North America and Europe. These new strains are resistant to metalaxyl, previously an effective curative fungicide, so the disease has become of much greater economic significance than in the previous decade.

Efficacy Issues: Even with the availability of Tattoo-C, controlling an outbreak of late blight is very difficult. Controlling an outbreak in one field is exceptionally critical, since spores from infected plants move readily via wind to non-infected fields within the same geographical region. Azoxystrobin (not labeled for use on Long Island) is useful as a protectant, but is not an effective curative. The industry has a critical need for a fungicide that could completely cure an infected field, as metalaxyl once did. If such a material were available, the use of protectant fungicides could decrease substantially.

Alternatives: Cymoxanil (Curzate) and dimethomorph (Acrobat) have been used with some success in potatoes for eradicating late blight. They may be possible alternatives for tomatoes, but trials would need to be conducted. Trifloxistrobin, a strobilurin fungicide like azoxystrobin, could be a useful protectant in tomatoes.

Phytophthora fruit and root rots (*Phytophthora parasitica* and *P. capsici*)

Frequency of Occurrence: Sporadic.

Damage Caused: The fungi *Phythophthora parasitica* and *P. capsici* can cause a serious fruit rot, known as buckeye rot, as well as a root rot which usually kills infected plants.

% Acres Affected: 100% at risk; typically 5-15% affected per year.

Pest Life Cycles: The disease is most common during periods of prolonged warm, wet weather. The pathogens are spread by surface water and spattering rain. Rot is usually confined to fruit in contact with the soil.

Timing of Control: at planting and during July and August.

Yield Losses: Usually minimal.

Regional Differences: None.

Cultural Control Practices: The following are recommended practices: minimum three years away from tomatoes, eggplants, cucurbits and peppers; avoid poorly drained fields; reduce soil compaction; use raised beds; stake and mulch plants to limit contact with soil; avoid overirrigation.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: See "Anthracnose" section above for pesticide use information.

Use in IPM Programs: As-needed use of fungicides is consistent with Cornell IPM recommendations.

Use in Resistance Management: None reported.

Septoria leaf spot (*Septoria lycopersici*)

Frequency of Occurrence: Annually.

Damage Caused: Septoria can cause severe defoliation of plants, thus reducing yields. Symptoms occur only rarely on fruit.

% Acres Affected: 100%

Pest Life Cycles: The fungus that causes septoria leaf spot is not a soil inhabitant, but it can persist from one season to the next on debris of diseased plants incorporated in the soil. The pathogen can also overwinter on solanaceous weeds. Tomato seed has been shown to carry spores and produce infected seedlings, but whether the pathogen is truly seedborne is unknown. Under wet conditions, spores are produced and spread by windblown water, splashing rain, hands and clothing of pickers, insects, and cultivation equipment. Following spread, spores germinate and leaf spots appear within five days. Heavy dews and high humidity favor disease development.

Timing of Control: All stages of plant development.

Yield Losses: Can be up to 50% in severely infected fields.

Regional Differences: None.

Cultural Control Practices: No resistant varieties are available. A minimum of one year rotation away from tomatoes is recommended. Fields should have good air drainage. Weed hosts should be controlled. Movement through fields when plants are wet should be minimized. Staking and mulching may reduce severity. Disease-free and hot-water treated seed should be used. Infected transplants should be rogued before transplanting.

Biological Control Practices: None.

Post-Harvest Control Practices: Remove or destry tomato debris by deep plowing immediately after harvest.

Chemical Controls: See "Anthracnose" section above for pesticide use information.

Use in IPM Programs: Cornell IPM recommendations call for the use the disease forecasting system TOM-CAST to time fungicide applications according to infection pressure.

Use in Resistance Management: None reported.

Alternatives: None at this time.

Bacterial canker, speck and spot (*Clavibacter michiganenesis* subsp. *michiganensis*, *Pseudomonas syringae* pv. *tomato*, *Xanthomonas campestris* pv. *vesicatoria*)

Frequency of Occurrence: Annually.

Damage Caused: These bacterial diseases cause wilting and blighting of leaves and spotting and decay of fruits. Leaves of infected plants may tatter and fall off, predisposing the fruit to sunscald. These diseases are difficult to control and have caused significant losses in recent years.

% Acres Affected: 100%

Pest Life Cycles: Bacterial canker is caused by the bacterium *Clavibacter michiganensis* subsp. *michiganensis*, bacterial speck by *Pseudomonas syringae* pv. *tomato*, and bacterial spot by *Xanthomonas campestris* pv. *vesicatoria*. The causal bacterium of bacterial canker is known to persist in the soil for up to three years and survives in or on seed, in tomato debris and possibly in solanaceous weed hosts. Although the disease may develop over a wide range of temperatures, it is most severe in warmer years when temperatures consistently range in the 80s and there is frequent high humidity and rainfall. The bacterium is spread by wind-driven rain and enters the plant through wounds and natural openings. The bacteria that causes spot can be carried as a contaminant on the surface of seed and overwinter in the soil in association with roots of various non-hosts. The optimum temperature for bacterial growth is between 75-86^{o} F. Abundant rainfall and high humidity are needed for maximum spread and infection. The bacteria that causes speck can survive on seed, in plant debris in the soil and on many nonhost plants. It is thought that it survives overwinter in NY. Bacterial population build-up and spread are greater under wet cool conditions. The organism enters the plant through wounds and natural openings.

Timing of Control: Canker: plant emergence through harvest. Speck: planting until first-formed fruits. Spot: early flowering and fruit setting period.

Yield Losses: Can be as high as 100% in severely affected fields. Even when recommended control measures are taken, typical losses range from 5-40%.

Regional Differences: None.

Cultural Control Practices: Cultural control practices are critical for controlling bacterial diseases in tomatoes. These include: rotation away from tomatoes and peppers for 2-3 years; eliminating volunteers; siting fields away from cull piles; planting disease-free seed and transplants; treating seed with hot water or a bleach solution; and practicing good field and greenhouse sanitation including disinfecting wooden stakes used for staking tomatoes. No resistant varieties exist.

Biological Control Practices: None.

Post-Harvest Control Practices: The addition of chlorine in postharvest wash treatments can prevent the spread of decaying bacteria. Crop debris should be incorporated after final harvest to speed decomposition.

Chemical Controls: See "Anthracnose" section above for pesticide use information. Growers use a combination of mancozeb and copper to manage outbreaks of these diseases.

Efficacy Issues: Even when chemical and cultural controls are combined, growers still sustain significant losses from bacterial diseases of tomatoes. Producers have a critical need for more effective control measures for managing this disease.

Use in Resistance Management: None reported.

Alternatives: None at this time.

Viruses (several)

Frequency of Occurrence: Sporadic.

Damage Caused: Virus infections can cause distorted growth, stunting, distortions in leaf coloration, and small, misshapen and poorly ripening fruit.

% Acres Affected: 100% at risk; typically 1-2% affected per year.

Pest Life Cycles: A number of viruses infect tomato plants. These include tomato/tobacco mosaic virus (TMV; transmitted by seed, tobacco products, and equipment); double virus streak (TMV plus Potato virus X; transmitted by seed and equipment); cucumber mosaic virus (CMV; transmitted by aphids); and tomato spotted wilt virus (TSWV; transmitted by thrips).

Timing of Control: All season.

Yield Losses: Usually minimal.

Regional Differences: None.

Cultural Control Practices: Practices recommended to control viruses include: use of disease-free seed, controlling weed hosts, checking transplants carefully and roguing infected plants, separating tomato seedlings from ornamentals and bedding plants in the greenhouse. Trying to control insect vectors is usually not effective. Many commercial varieties have multiple virus resistance or tolerance.

Biological Control Practices: None.

Post-Harvest Control Practices: Crop debris should be destroyed as soon as possible to help control TMV and double virus streak.

Chemical Controls: No pesticides are registered to manage viruses.

Powdery Mildew (*Oidium lycopersicum*)

Frequency of Occurrence: This disease is an emerging problem in the eastern US, including NY, and in Europe.

Damage Caused: The fungus can cause severe leaf blighting. Symptoms include mycelial growth on leaves and stems, followed by desiccation, necrosis, and defoliation.

% Acres Affected: 100% at risk; incidence, particularly in greenhouse tomatoes, is increasing.

Pest Life Cycles: Powdery mildew of tomatoes may be caused by at least three different pathogens worldwide, but recent outbreaks appear to be due to the morphologically distinct powdery mildew fungus *Oidium lycopersicum*. Once a greenhouse is infected, it is extremely difficult to control.

Timing of Control: under hot and humid conditions

Yield Losses: Can be severe in greenhouse tomatoes.

Regional Differences: None.

Cultural Control Practices: Unknown.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: No fungicides are currently registered for use against this disease.

Alternatives: Greenhouse tomato growers have a critical need for control measures for powdery mildew.

Weeds

Annual and Perennial Broadleaves and Grasses

Frequency of Occurrence: Annually.

Damage Caused: Reduced yields from weed competition.

% Acres Affected: 100%

Pest Life Cycles: Annual and perennial weeds such as ragweed, lambsquarters, redroot pigweed, galinsoga, nightshade species, yellow nutsedge, annual and perennial grasses, mustards and others, are a problem throughout the growing season.

Timing of Control: Preplant, preemergence, and postemergence.

Yield Losses: Losses can run as high as 75% in untreated fields. Typical losses are 1-5%.

Regional Differences: None.

Cultural Control Practices: Cultivation is an important cultural practice used to control weeds. Many growers rely on handweeding to clean up weed escapes. Planting on plastic-mulched beds can aid in weed control, but this is practiced on limited acreage. Recent research indicates that tomatoes can be transplanted into a killed rye mulch with reasonably effective weed control. However, this can result in increased slug damage and in delayed maturity of fruit.

Biological Control Practices: None.

Post-Harvest Control Practices: Cultivation. Post-harvest application of herbicides to control perennial weeds.

Other Issues: Research on weed control in tomatoes is ongoing (Bellinder). The focus of this research is screening new herbicides for efficacy and crop tolerance, and testing methods to lower herbicide use rates. The use of living mulches, suppressed by low rates of herbicides, has shown some promising results.

Chemical Controls:

Pesticide	% Trt.	Type of Appl.	Typical Rates lbs ai/acre	Timing	# of Appl.	PHI days	REI hours
metribuzin *(Sencor, Lexone)*	75-80	soil incorporated or surface	0.125-0.5	preplant or postemergence	1-2	60	12
trifluralin *(Treflan)*	75-80	soil incorporated	0.5	preplant	1	75	12
pebulate *(Tillam)*	<1	soil incorporated	6.0	preplant	1	75	12
napropamide *(Devrinol)*	10-15	soil incorporated or surface	1.0-2.0	preplant or preemergence	1	75	12
sethoxydim *(Poast)*	1-5	soil surface	0.28	postemergence, early to mid season	1	45	12
paraquat *(Gramoxone)*	<1	directed-shielded spray	0.94	as needed through season	1	30	12

Use in IPM Programs: Use of herbicides is consistent with Cornell IPM recommendations.

Use in Resistance Management: None reported.

Alternatives: A number of herbicides are potential alternatives to currently registered materials. Metolachlor (Dual Magnum) may receive a federal label by 2000, and perhaps a NY label soon thereafter, although restrictions have been put on this herbicide by NYS Department of Environmental Conservation in the past. IR-4 is scheduled to run residue trials on halosulfuron in 2000. Flufenacet + metribuzin (Axiom) has looked very promising in research trials. IR-4 completed residue trials on pendimethalin (Prowl) and a registration packet is in preparation. Finally, rimsulfuron has been registered for use in California, and that label could potentially be expanded to include other states including NY.

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6. Information for and review of this Crop Profile were provided by producers, consultants, researchers and Extension Educators. Pesticide use information was gathered through a survey of twenty-one tomato growers in the state, as well as information from on-farm IPM demonstrations in tomatoes.
