Crop Profile: Peppers in New York

Introduction: Sweet (bell) and hot peppers are produced in NY for both wholesale and direct-to-consumer markets. Most peppers produced are marketed and consumed within the state, but some shipments are made to other states in the eastern US. A number of economically significant pests attack peppers, including European corn borer, aphids, several fungal and bacterial diseases, and a wide spectrum of weed species. Producers use a combination of cultural practices and pesticides to manage these pests. Without the registration of new, effective materials to replace them, the loss of acephate, maneb, and trifluralin would have significant impacts on production and profitability. The industry has critical needs for more herbicide registrations, especially for galinsoga control; and for an effective insecticide for symphylan control.

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.

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II. Basic Commodity Information

State Rank: not ranked
% U.S. Production: Not available.
Acres Planted: Not available.
Acres Harvested: 958 sweet + 102 hot (1997 Census)
Cash Value: Not available.
Yearly Production Costs: Not available.
Commodity Destination(s):
Fresh Market: 100%
Processing: 0%

Production Regions: Peppers are produced in all the major vegetable growing areas in NY. Leading counties include Suffolk, Onondaga, Erie, Niagara, Ulster, Orange, and Orleans.

Cultural Practices: Peppers are warm season crops which produce best during a long growing season. They are very sensitive to temperature extremes, preferring an average daytime temperature of 75^{o} F and an average nighttime temperature of 62^{o} F. Peppers grow well in a loam or sandy loam soil, with a pH between 6.0 and 6.8. Acid soils can lead to calcium and magnesium deficiencies and fruit damaged with blossom end rot. Peppers are planted in New York as transplants. Transplants are set with a starter fertilizer high in phosphorus. Single-row (4-5’ between rows and 12” between plants) or double-row (15” between rows and 14-18” between plants, on 5-6’ center beds) planting systems are used. Many growers in New York use black plastic mulch with trickle irrigation laid under the plastic. This provides uniform moisture and fertility during the growing season. A constant water supply is necessary for adequate production. Bell peppers are harvested when immature and green but have reached full size and maximum wall thickness. Each field is harvested multiple times by hand. Some are picked after they have ripened to red or other colors. Peppers destined for wholesale shipment are usually washed, sorted and graded on a packing line.

Note on Pesticide Use Information: Pesticide use practices vary considerably among pepper 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.

III. Pest Information: Insects

1. Aphids (primarily *Myzus persicae*)

Frequency of Occurrence: Annually.

Damage Caused: Aphids can make pepper fruit unmarketable because of the honeydew that is excreted by the aphid and/or associated sooty mold fungi. Infested plants can be stunted, with deformed foliage. Aphids also vector a number of viruses ("Viruses", below).

% Acres Affected: 100% at risk; up to 75% affected per year.

Pest Life Cycles: Green peach aphids (*Myzus persicae*) are variable in color, and have a wide host range. Aphids overwinter as eggs on crop residue or host plants. Winged forms, less frequently found than wingless forms, enable the insect to move into a field from other areas. Females can reproduce without mating with males. Aphids are generally most abundant from mid-summer through October. Their severity is greatly influenced by weather patterns.

Timing of Control: During transplant production in the greenhouse, and from mid-June through harvest.

Yield Losses: Can be as high as 50% in severely affected fields (including losses from viruses).

Cultural Control Practices: Greenhouse infestations of transplants can be minimized by practicing good greenhouse sanitation. Controlling weed hosts around the edges of fields may help control aphid infestations.

Regional Differences: None.

Biological Control Practices: In the field, various natural enemies often adequately control aphid populations.

Post-Harvest Control Practices: Crop debris should be destroyed as soon as possible after harvest.

Other Issues: In the field, insecticides used to control European corn borer (see section below) often provide adequate control of aphids. However, some insecticides (e.g. permethrin and esfenvalerate) can kill the aphid predators and parasitoids, resulting in secondary aphid problems. Research on aphid control in peppers is ongoing (Gilrein)

Insectides for Aphid and European Corn Borer Control in Peppers:

Pesticide	Target Pest[1]	% Trt.	Type of Appl.	Typical Rates lbs ai/acre	Timing	# of Appl.	PHI days[2]	REI hours
imidacloprid *(Admire, Provado)*	A	1-5	soil or foliar	0.05	at planting or during season	1	90 S[3]; 21 F	12
acephate *(Orthene)*	A ECB	90-95	foliar	0.75	flowering through harvest	2-5	7	24
methomyl *(Lannate)*	A	30-35	foliar	0.45	as needed through season	1	3	48
esfenvalerate *(Asana)*	ECB	10-15	foliar	0.05	flowering through harvest	4-5	7	12
spinosad *(Spintor)*	ECB	15-20	foliar	0.0625	flowering through harvest	1	2	48
carbaryl *(Sevin)*	ECB	1-5	foliar	0.5-1.0	flowering through harvest	1	0	12
dimethoate *(Dimethoate)*	A	25-30	foliar	0.125	as needed through season	1-2	7	48
cyfluthrin *(Baythroid)*	ECB	<1	foliar	0.025-0.044	as needed through season	1	7	12
permethrin *(Ambush)*	ECB	<1	foliar	0.2	flowering through harvest	1	3	12
endosulfan *(Thiodan)*	A	<1	foliar	0.5	as needed through season	1	4	24
oxydemeton-methyl *(Metasystox-R)*	A	<1	foliar	0.5	as needed through season	1	3	48

1. Key to Target Pests: A=aphids, ECB=European corn borers.
2. PHIs on this and all tables indicate the shortest actual number of days between application and harvest, not label PHIs.
3. S=soil applied; F=foliar applied.

Use in IPM Programs: Use of these insecticides on an as-needed basis is consistent with Cornell IPM recommendations. A scouting procedure and thresholds have been established.
Use in Resistance Management: None reported.
Alternatives: Pymetrozine (trade name Fulfill) and thiamethoxam (Adage), two new insecticides developed by Novartis, may be effective aphicides, but trials have yet to be conducted.

2. European Corn Borer (*Ostrinia nubilalis*)

Frequency of Occurrence: Annually.
Damage Caused: Larvae tunnel into and feed on fruit, causing direct damage, premature ripening, and entry points for fruit rotting pathogens. Many infested fruit appear uninjured on the outside but have sustained much damage internally.
% Acres Affected: 100%
Pest Life Cycles: The European corn borer (ECB) is the most important insect pest of pepper fruit in NY. Control of the European corn borer is difficult because of the short time interval between when the eggs hatch and the larvae tunnel into the fruit. Egg masses are laid by the female moth on the underside of leaves, and the eggs hatch in about 4-7 days. Freshly laid eggs are white and gradually darken. Eventually, a black spot becomes visible through the egg shell indicating the eggs are expected to hatch within 24 hours. Mature larvae have small dots on their backs and are ¾ to 1 inch long. After a brief period of feeding on leaves, the larvae tunnel into the fruit usually around the edge of the fruit cap, appearing externally as a pinhole with a small amount of frass. Larvae feed within the fruit for 3 weeks and can cause the injured fruit to ripen prematurely and or allow for the spread of fruit rotting pathogens such as bacterial soft rot. ECB is primarily a pest of corn, and overwinters as pupae in corn and pepper stalks. There are two to three peak flights of ECB in NY, depending on population types.
Timing of Control: mid-July through early August.
Yield Losses: Can be up to 50% in severely infested fields. Typical losses run from 1-10%, even when insecticides are used.
Cultural Control Practices: Locating pepper fields as far away as possible from corn may help lower infestations. Eliminating weeds around field edges may make pepper fields less attractive to ovipositing females.
Regional Differences: None.
Biological Control Practices: A variety of natural enemies can help suppress ECB infestations. Bird predation can also be very important. Alone, these often do not provide commercially acceptable levels of control.
Post-Harvest Control Practices: Destruction of pepper residue and plowing in the fall can destroy a large percentage of overwintering larvae.
Other Issues: Research in ECB control in peppers is ongoing (Gilrein), and focuses on timing and rates of insecticide applications as well as fine-tuning methods of monitoring ECB flights.
Chemical Controls: See "Aphids" section, above.
Use in IPM Programs: Use of labeled insecticides during peak moth activity is consistent with Cornell IPM recommendations. A network of pheromone traps for monitoring ECB activity is maintained throughout most of the production regions in the state. Research has indicated that scouting for egg masses and/or larvae is unreliable.
Use in Resistance Management: None reported.
Efficacy Issues: Acephate is the most effective insecticide against ECB in peppers, and also controls aphids.
Alternatives: Possible alternatives include cryolite (Crymax) and spinosad (Spintor).

3. Symphylans (*Scutigerella immaculata*)

Growers in certain areas in western NY have a continuing problem with garden symphylans, a soil-dwelling arthropod. Symphylans are small, white, centipede-like creatures, and little is known about their biology. No insecticides are currently labeled for their control in peppers, and no known cultural practices are effective.

IV. Pest Information: Diseases and Nematodes

1. Anthracnose Fruit Rot (*Colletotrichum gloesporioides, C. capsici, and C. coccodes*)

Frequency of Occurrence: Annually

Damage Caused: Causes fruit to rot.

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

Pest Life Cycles: This fungal disease appears as circular, sunken spots on ripe pepper fruits. In moist conditions, acervuli are formed on the lesion, usually in concentric circles and with pink to yellow masses of spores. The fungus invades the seed cavity and infects seeds and overwinters there and in residue from infected plants. Anthracnose is promoted in wet conditions and relatively high (90^{o}F) temperatures.

Timing of Control: As fruits ripen.

Yield Losses: Up to 15% in severely affected fields. Typical losses are 1-5% even when fungicides are used.

Cultural Control Practices: Two year rotation out of solanaceous crops. Use disease-free seed.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Fungicides and Anti-Bacterials for Pepper Disease Control:

Pesticide	Disease[1]	% Trt.	Typical Rates lbs ai/acre	Application Type and Timing	# of Appl.	PHI days	REI hours
streptomycin[2] *(Agri-Strep)*	BLS	70-75	1 lb product/acre	greenhouse, seedling stage	2-5	--	--
maneb *(Maneb)*	A, BLS[3], P	90-95	1.0	foliar, mid-season to harvest	2-4	7	24
copper compounds	BLS	80-85	varies with formulation	foliar, mid-season to harvest	2-6	1	24
thiram *(Thiram)*	DO	80	label rates	commercial seed treatment	1	--	--
mefenoxam *(Ridomil Gold)*	P	1-5	1 pt product/acre	soil, at planting	1	60	48
metam-sodium *(Vapam)*	DO	<1	--	midseason through harvest	1	60	48

1. Key to diseases: BLS=bacterial leaf spot; A=anthracnose fruit rot; P=phytophthora blight; DO=damping-off.
2. No longer registered for use. Existing stocks may be used.
3. A 2(ee) recommendation calls for the use of copper plus maneb for bacterial leaf spot control.

Use in IPM Programs: Cornell IPM recommendations call for the use of maneb beginning at fruit ripening and continuing on a seven- to ten-day interval.

Use in Resistance Management: None reported.

Alternatives: Azoxystrobin (Quadris) might be a useful fungicide in peppers, but trials would need to be conducted.

2. Bacterial Leaf Spot (*Xanthomonas campestris* pv. *vesicatoria.)*

Frequency of Occurrence: Annually.

Damage Caused: Bacterial leaf spot (BLS) is the most economically significant disease of peppers in NY. The causal bacterium infects both pepper foliage and fruit. Leaf spots first appear on the undersides of leaves as small irregular water-soaked areas. The spots grow larger, become purplish-gray with black centers, and may have a narrow yellow halo. Affected leaves become ragged, turn yellow and drop off. Spots on fruit are like blisters, becoming rough and cankerous and often extending into the seed cavity, predisposing the fruit to secondary pathogens. Loss of foliage also predisposes fruit to sunscald.

% Acres Affected: 100% at risk; up to 30% affected per year.

Pest Life Cycles: The causal bacterium is seed borne. Therefore, the principle sources of inoculum are seed and infected transplants. The bacterium is spread in the field by splashing water and by farm implements and workers in the fields when the foliage is wet. Disease development is promoted by excessive moisture.

Timing of Control: prior to planting and through harvest.

Yield Losses: Can be up to 75% in severely affected fields. Typical losses run from 1-15%.

Cultural Control Practices: An increasing number of resistant varieties with good horticultural characteristics are becoming available to producers. Two year rotation away from tomato and pepper crops is recommended. Seed should be certified and disease-free. A seed treatment using bleach may help provide control. Good field sanitation should be practiced to minimize spread of the disease. Southern transplants should be disease-free and certified. Planting disease-free transplants is a key step in managing this disease in the field. Most growers have switched from overhead irrigation to drip irrigation in part to minimize the spread of BLS.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: Crop debris should be destroyed as soon as possible to remove this source of disease for other plants and to initiate decomposition.

Chemical Controls: The use of thiram seed treatment (either commercial or grower-applied seed treatment) is highly recommended. Foliar copper can help contain an infection, but is not curative (see “Anthracnose” section, above, for pesticide use information).

Use in IPM Programs: Integrated use of cultural controls, fungicides and anti-bacterials is consistent with Cornell IPM recommendations.

Use in Resistance Management: None reported.

Alternatives: Benzothiadazole (trade name Actiguard), a new material from Novartis, may be an effective alternative for BLS control, but efficacy trials would need to be conducted.

Efficacy Issues: Resistant varieties are very effective in managing this disease, especially when used in conjunction with good sanitation and other cultural practices. However, not all commercial varieties are resistant at this time.

3. Bacterial Soft Rot (*Erwinia carotovora*)

Frequency of Occurrence: Annually.

Damage Caused: Causes a soft rot of fruit, rendering peppers unmarketable. Rots can become apparent before harvest or during transit.

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

Pest Life Cycles: The causal bacteria can infect pepper fruits through a wound in the skin while the peppers are still in the field. The area around the wound become sunken, and the internal tissue softens quickly. The tissue fluid collects in the lower portion of the fruit, which expands and eventually ruptures. Soft rot is often spread when pepper fruits are washed before packing. Entry at the stem end is common. European corn borer damage frequently provides the pathogen an entry point for infection.

Timing of Control: pre-plant and post-harvest.

Yield Losses: Up to 15% in severely affected fields.
Cultural Control Practices: Southern transplants should be disease-free and certified.
Regional Differences: None.
Biological Control Practices: None.
Post-Harvest Control Practices: The addition of chlorine in postharvest wash treatments can prevent the spread of decaying bacteria during shipment. Producers have found that vacuum cooling after harvest slows stem end decay due to bacterial soft rot in transit.
Chemical Controls: None.

4. Phytophthora Blight (*Phytophthora capsici*)

Frequency of Occurrence: Annually.
Damage Caused: All parts of the pepper plant can be infected with the causal fungus. Infected seedlings can develop damping-off. The symptoms on older plants include root rot, stem canker, leaf blight and fruit rot. A white mold growth often appears inside and on the surface of infected fruit.
% Acres Affected: 100% at risk; typically up to 20% affected per year.
Pest Life Cycles: The causal fungus, *Phytophthora capsici*, has a wide host range, including eggplant, tomato, cucumber, pumpkin, squash, and melons. The fungus can survive on and in seed and in soil. Wind-borne sporangia can be blown long distances in a viable condition and can result in widespread dissemination and rapid spread of the disease.
Timing of Control: at planting, and during the growing season.
Yield Losses: Can be as high as 75% in severely affected fields. Typical losses range from 1-20%.
Cultural Control Practices: Low-lying or poorly drained areas should be avoided. Overhead irrigation should be curtailed in favor of drip irrigation. A rotation away from all solanaceous crops for three years is recommended. Planting on raised beds to improve drainage can help control the disease. Only disease-free seed should be used. A few resistant varieties are available.
Regional Differences: None
Biological Control Practices: None.
Post-Harvest Control Practices: None.
Chemical Controls: See “Anthracnose” section, above, for fungicide use information.
Use in IPM Programs: Use of fungicides is consistent with Cornell IPM recommendations.
Use in Resistance Management: None reported.
Alternatives: Unknown.

5. Damping-off and Seed Rots (*Phytophthora* spp., *Pythium* spp., and *Rhizoctonia solani)*

Frequency of Occurrence: Sporadic.
Damage Caused: Seedlings fail to emerge or collapse in the small seedling stage.
% Acres Affected: 100% at risk; typically only 1-5% affected.
Pest Life Cycles: *Phythophthora*, *Pythium*, and *Rhizoctonia* are common soil pathogenic fungi. They have wide host ranges and can survive in soil for many years. They are commonly enhanced by undecomposed organic matter in soil and high soil moisture. High humidity conditions, created when plants are crowded, or in poorly vented greenhouses, also enhance these diseases.
Timing of Control: at planting
Yield Losses: Usually minimal since peppers are mostly transplanted. Losses can occur in greenhouse transplant production.
Cultural Control Practices: Use soil-free planting mix in transplant production.
Regional Differences: None.
Biological Control Practices: Trichoderma (Rootshield) and Mycostop used preventatively in the greenhouse.
Post-Harvest Control Practices: None.
Chemical Controls: Metam-sodium (Vapam) is labeled for use, but is used on <1% of the acres in NY.

6. Viruses (several types)

Frequency of Occurrence: Annually.

Damage Caused: Viruses can stunt plants and reduce fruit set, lowering yield. Virus-infected fruits are often malformed, discolored, and/or spotted, rendering them unmarketable.

% Acres Affected: 100% at risk; typically 1-15% affected per year.

Pest Life Cycles: Cucumber Mosaic Virus (CMV) is spread by the green peach aphid that migrates from diseased perennial weeds and crops. The virus causes severe mosaic on pepper foliage, malformation of fruits and conspicuous yellow concentric rings and/or spots on infected green fruit. Tomato Spotted Wilt Virus(TSWV) is spread by thrips but usually comes in on transplants. If young plants are infected, a severe crop loss can result. Infected plants develop numerous small grayish brown thin dead spots on the leaves. Growing tips of the plant are usually severely affected. Pepper fruit develop numerous characteristic spots that are about ½ inch wide and have concentric rings. The rings may be alternately red and yellow and the center of the spot may be raised, giving the fruit a rough appearance. Other viruses infecting peppers include tomato mosaic virus, tobacco mosaic virus, alfalfa mosaic virus, tobacco etch virus, and potato Y virus.

Timing of Control: seeding in greenhouse and following transplanting to field.

Yield Losses: Can be up to 75% in severely affected fields; typical losses are 1-5%.

Cultural Control Practices: No resistant varieties are available. Elimination of weed hosts around the perimeter of the field can help minimize the risk of CMV and TSWV infection. TSWV is commonly found in greenhouses where ornamentals and potted plants are grown. Pepper transplants should not be produced in the same greenhouse as ornamentals.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: No pesticides are registered to directly manage viral diseases of peppers.

7. Nematodes (*Pratylenchus, Ditylenchus* and others)

Frequency of Occurrence: Sporadic.

Damage Caused: Nematodes cause plant stunting and subsequent yield reduction.

% Acres Affected: up to 25% but difficult to monitor.

Pest Life Cycles: Nematodes are tiny worm-like invertebrates that live in soil. They overwinter in a dormant stage, and often have multiple crop and weed hosts. Nematodes attack roots of plants and feed off of plant fluids. They can be spread by the movement of infected soil or water.

Timing of Control: at planting

Yield Losses: Usually <5%.

Cultural Control Practices: Long rotations with cereals, grasses, and other non-hosts are the most practical means of control.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: While oxamyl (Vydate) is labeled for use, it is very infrequently (<1%) used in NY.

V. Pest Information: Weeds

1. Broadleaf and Grass Weeds

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. Weeds growing up through the planting holes of plastic mulch can be a particular problem.
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: Planting on plastic-mulched beds can aid in weed control. Many growers use handweeding to clean up weed escapes. Some cultivation is practiced between the beds, but aggressive cultivation can pull up the edges of the plastic mulch.
Regional Differences: None.
Biological Control Practices: None.
Post-Harvest Control Practices: Cultivation. Post-harvest application of herbicides to control perennial weeds.

Chemical Controls:

Pesticide	% Trt.	Type of Appl.	Typical Rates lbs ai/acre	Timing	# of Appl.	PHI days	REI hours
clomazone *(Command)*	35-40	soil incorporated	0.375	pre-transplant	1	65	12
paraquat *(Gramoxone)*	55-60	directed-shielded spray	0.2	mid-season	1	20	12
bensulide *(Prefar)*	<1	soil surface or incorporated	--	pre- or post-transplant	1	60	?
trifluralin *(Treflan)*	60-65	soil incorporated	0.5	pre- or post-transplant	1	65	12
napropamide *(Devrinol)*	20-25	soil incorporated	1.0	pre-transplant	1	65	12
metolachlor[1] *(Dual)*	25-30	soil surface	1.5	pre-transplant or immediately post-transplant	1	60	12
sethoxydim *(Poast)*	<1	soil surface	0.28	post-transplant	1	45	12

1. Available (except for in Long Island) through a 3rd party label held by the NYS Vegetable Growers Association.

Use in IPM Programs: Use of registered herbicides is consistent with Cornell IPM recommendations.
Use in Resistance Management: None reported.
Efficacy Issues: Registered herbicides vary in their weed spectrum of control (see Reference #2 for more information). Producers have a real need for an herbicide to control galinsoga in peppers grown on plastic mulch. While metolachlor can control galinsoga, its use as a postemergence application on plastic-grown peppers can cause significant crop injury when rain or irrigation washes the product into the holes around transplants.
Alternatives: Approval of the 3ME formulation of clomazone (Command) would help growers tremendously. This new formulation is less volatile and will not require incorporation, making it much easier to use than the current formulation.

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VII. References

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2. *Pest Management Recommendations for Commercial Vegetable and Potato Prodution, 1999*. Cornell Cooperative Extension, Cornell University. http://www.nysaes.cornell.edu/recommends/

3. *Vegetable Production Handbook*. 1994. Cornell Cooperative Extension, Cornell University.

5. 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 eleven pepper growers in the state.

6. M.F. Huelsman, December 1998. *Crop Profile for Sweet Peppers in Ohio*. USDA OPMP. http://ipmwww.ncsu.edu/opmppiap/proindex.htm