Crop Profile for Peppers (Green) in Delaware

Prepared: August, 2000
Revised: July, 2006

General Production Information

Production information for fresh market sweet peppers are combined with other vegetables (asparagus, beets, lima beans, broccoli, cauliflower, green peas, greens, hot peppers, sweet potatoes, squash, and turnips) in Delaware to avoid disclosure of individual producers. From 2000 - 2002, 950 acres of "Other Vegetables" were planted and 910 were harvested in the state. Total production was 32 tons and the value of production of "Other Vegetables" was $2,071,000.

Production information for processing sweet green peppers are combined with other vegetables (carrots, cauliflower, cucumbers, hot peppers, snap beans, spinach, tomatoes and zucchini) in Delaware to avoid disclosure of individual producers. From 2000 - 2002, 8,395 acres of "Other Vegetables" were planted and 7,995 were harvested. Total production was 29,310 tons and the value of production of "Other Vegetables" was $7,003,000.

The 1997 US Census of agricultural data (2) shows that Delaware had 34 sweet pepper growers with 45 acres of peppers in production. Yield is not given.

Production Regions

Most green pepper production takes place in Sussex and counties and most is for fresh market (3).

Cultural Practices

Green peppers are warm-season vegetables that require a long, frost-free season. According to Delaware Cooperative Extension data, Delaware commercial vegetable producers grow several hundred acres of peppers each year for both processing and fresh-market sales. Common varieties are: Keystone Resistant Giant, Yolo, Paladin, and +R3 Camelot. Green peppers are transplanted from greenhouse seedlings. They are planted 1 to 2 feet apart in 36-inch rows no earlier than May 1. Fertilizer should be applied before planting at a rate of 2 to 3 pounds per 100 square feet of 10-10-10 or 5-10-10. Peppers should be sidedressed with a nitrogen fertilizer such as ammonium nitrate when blossoms or small fruit are setting at a rate of 1 cup per 100 feet of row. Peppers need to be maintained as weed-free as possible. Hoeing, cultivating, straw mulches and black plastic mulches can be used. Adequate irrigation will ensure good yields.

Green peppers will produce throughout the summer and into fall until frost. It usually takes 75 days from transplanting until the first peppers are picked. They should be picked when they reach 3-1/2 to 4 inches in size and are still firm and green in color.

Worker Activities (3)
Workers transplant the green pepper plants into the field at the start of the growing season. Because most farms rely on herbicides and black plastic for weed control, workers do minimal hand weeding. Workers may tie plants off later in the season to ensure that plants do not lodge. Irrigation is done by trickle irrigation, thus workers are not required to move irrigation equipment. Workers hand pick green peppers at harvest. The Delaware Department of Agriculture reports that they are not aware of any problems with workers in pepper fields. Possible pesticide exposure would be to hands and arms during tying-off and hand harvesting.

Weeds

Annual and Perennial Broadleaves and Grasses

Frequency of Occurrence: Annually.

Damage Caused: Reduced yields from weed competition, loss due to hindrance with harvesting equipment, and harboring damaging insects and diseases. Crops can become contaminated with weed plant parts (e.g. nightshade berries, Canada thistle buds or daisy buds) during harvesting which can result in reduced selling price or in severe cases, rejection of the crop.

% Acres Affected: 100%

Pest Life Cycles: A wide range of summer and winter annual and perennial weed species is present in pepper fields in DE. Some of the more common weeds include common lambsquarters, pigweed species, common ragweed, morning glory species, and various annual and perennial grasses.

Timing of Control: Preplant, at planting, and postemergence.

Yield Losses: Can be as high as 100% in severely infested fields

Regional Differences: While weed species spectra can vary regionally, they are a serious pepper pest throughout the Delaware.

Cultural Control Practices: Herbicides alone seldom control all weed species. They must be used in conjunction with cultivation to ensure high yields and effective cultural practices in pepper crops. When weed escapes occur, cultivation or postemergence herbicides are preferable to hoeing due to expense and labor. However, since postemergence herbicides are selective, it is unlikely that all weed escapes will be controlled. In plasticulture weeds may be coming from the holes or where soil is covering the plastic preventing cultivation from controlling these plants. Peppers grown with plasticulture have the advantage of the black plastic smothering many weeds and preventing these seedlings from becoming established. However, some weeds species (notably nutsedges) can grow through intact plastic and wherever there are holes or rips in the plastic, this is a spot for weeds to become established. Often times weeds that become established in the plastic (due to holes or rips) will have a faster growth rate than weeds in bare-ground.

Biological Control Practices: None.

Post-Harvest Control Practices: Application of herbicides and/or tillage after harvest can control weeds.
**Other Issues:** Research on pepper weed control is ongoing.

**Chemical Control Practices:** Herbicide use depends on weed spectrum and cultural practices. For instance, use on seed, bareground peppers is different than transplanted peppers planted under pasticulture. Some herbicide options are restricted by type of pepper grown (bell pepper versus hot pepper). As a result, it is difficult to make generalities for herbicide use in peppers. Also, some herbicides are labeled for applications after the peppers are established, but the herbicide does not control emerged weeds (i.e. Dacthal). Other herbicides can control emerged weeds and provide residual control (Sandea)

**Chemical Controls:**

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Type and Timing of Application</th>
<th>Typical Rates lbs ai/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>bensulide (Prefar)</td>
<td>soil incorporated or soil surface</td>
<td>5.0 - 6.0</td>
</tr>
<tr>
<td>clomazone (Command)</td>
<td>Plasticulture PRE prior to laying plastic (non-incorporated) Bare-ground (seeded and transplants)</td>
<td>0.2 - 0.5 (plastic) 0.25 - 0.75 (bare-ground)</td>
</tr>
<tr>
<td>s-metolachlor (Dual Magnum)</td>
<td>Transplants only: Plasticulture PRE prior to laying plastic (non-incorporated) row middles Bare-ground PRE prior to transplanting post-transplants</td>
<td>0.63 - 0.96</td>
</tr>
<tr>
<td>napropamide Devrinol (Dual Magnum)</td>
<td>Plasticulture PRE prior to laying plastic (non-incorporated) row middles Bare-ground (seeded and transplants)</td>
<td>1.0 - 2.0</td>
</tr>
<tr>
<td>trifluralin (Treflan, many)</td>
<td>Transplants only Bare-ground, pre-plant incorporated</td>
<td>0.5 - 1.0</td>
</tr>
<tr>
<td>DCPA (Dacthal)</td>
<td>Plasticulture row middles Bare-ground (over-the-top) (will not control emerged weeds)</td>
<td>8 - 14</td>
</tr>
<tr>
<td>halosulfuron (Sandea)</td>
<td>Plasticulture row middles</td>
<td>0.023 - 0.047</td>
</tr>
<tr>
<td>clethodim (Select)</td>
<td>Postemergence (over-the-top)</td>
<td>0.094 - 0.125</td>
</tr>
<tr>
<td>sethoxydim Poast)</td>
<td>Postemergence (over-the-top)</td>
<td>0.2 - 0.3</td>
</tr>
<tr>
<td>paraquat (Gramoxon Max)</td>
<td>Plasticulture row middles (shielded sprayer)</td>
<td>0.6</td>
</tr>
</tbody>
</table>
**Use in IPM Programs:** Use of these herbicides is consistent with IPM recommendations. Postemergence herbicides (sethoxydim and paraquat with pepper growth with plastic) support the use of scouting and as-needed applications. Shield paraquat applications to row middles allow for maximum weed seedling emergence prior to treatment and reduce the length of residual weed control needed.

**Use in Resistance Management:** None reported.

**Efficacy Issues:** The listed herbicides have different but overlapping spectra of species control. Bensulide and clomazone are effective on annual grasses and some broadleaf weeds. Ethalfluralin is effective on annual grasses. Emerged grasses are controlled with sethoxydim. Producers have a great need for new herbicide registrations, especially for herbicides, which will help control problem perennial weeds such as Canada thistle or yellow nutsedge.

**Alternatives:** Limited number of herbicides is currently being tested.

<table>
<thead>
<tr>
<th>Pesticide</th>
<th># of Appl.</th>
<th>Maximum Amount</th>
<th>PHI days</th>
<th>REI hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>bensulide (Prefar)</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>12</td>
</tr>
<tr>
<td>clomazone (Command)</td>
<td>1</td>
<td>ns</td>
<td>ns</td>
<td>12</td>
</tr>
<tr>
<td>s- (Dual Magnum)</td>
<td>Ns</td>
<td>ns</td>
<td>7 - 65</td>
<td>12</td>
</tr>
<tr>
<td>napropamide (Devrinol)</td>
<td>Ns</td>
<td>ns</td>
<td>ns</td>
<td>12</td>
</tr>
<tr>
<td>trifluralin (Treflan, many)</td>
<td>ns</td>
<td>ns</td>
<td>ns</td>
<td>12</td>
</tr>
<tr>
<td>DCPA (Dacthal)</td>
<td>Ns</td>
<td>ns</td>
<td>ns</td>
<td>24</td>
</tr>
<tr>
<td>halosulfuron (Sandea)</td>
<td>Ns</td>
<td>2 oz prod/crop cycle</td>
<td>30</td>
<td>12</td>
</tr>
<tr>
<td>clethodim (Select)</td>
<td>Ns</td>
<td>32 fl oz/A/season</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>sethoxydim (Poast)</td>
<td>Ns</td>
<td>4.5 pts/A/season</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>paraquat (Gramoxone)</td>
<td>3</td>
<td>ns</td>
<td>ns</td>
<td>12</td>
</tr>
</tbody>
</table>

ns = not specified on label.

<table>
<thead>
<tr>
<th>Weeds</th>
<th>Treflan</th>
<th>Command</th>
<th>Dual Mag</th>
<th>Devrinol</th>
<th>Prefar</th>
<th>Sandea PRE</th>
<th>Sandea POST</th>
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</thead>
<tbody>
<tr>
<td>Grasses</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Pigweed</td>
<td>F</td>
<td>N/P</td>
<td>G</td>
<td>F/G</td>
<td>F</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Lambsquarters</td>
<td>F/G</td>
<td>G</td>
<td>P</td>
<td>F/G</td>
<td>F/G</td>
<td>G</td>
<td>N</td>
</tr>
<tr>
<td>Ragweed</td>
<td>N</td>
<td>F</td>
<td>N</td>
<td>P/F</td>
<td>N</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>Nightshade</td>
<td>P</td>
<td>P</td>
<td>G</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
</tbody>
</table>
Select and Poast will only control grasses. They have no activity on broadleaf weeds.

**Insect Pests**

In Delaware, the primary insect pests attacking peppers include the European corn borer (ECB), pepper maggot, green peach aphid, corn earworm (CEW), fall armyworm (FAW), beet armyworm (BAW) and thrips. The ECB, pepper maggot, CEW, FAW and BAW all cause direct damage to the fruit. Green peach is the most common and destructive secondary pest. Thrips are important because they vector the tomato spotted wilt virus.

**European Corn Borer (ECB)**

**Biology and Life History**: Two to three generations occur each year in the Mid Atlantic region. Corn borers overwinter as fully grown larvae; pupate in late April to early May, emerging as adults in May to early June and again in late July through September. Eggs are laid in masses on the undersides of leaves. Larvae hatch in 4-7 days. The young larvae generally feed on the foliage for a week before boring into stems and developing pepper fruit.

**Damage**: The European corn borer is the major pest of peppers in Delaware causing losses from direct damage to fruit and stems as well as contamination problems. Larvae generally bore into the fruit under the cap. If corn is planted late or there is no corn in the area, first generation damage can cause significant plant lodging and stem breakage. Initially, damage is difficult to detect because the only external sign is a pinhole and some sawdust-like excrement near the cap. Once inside the fruit, larvae feed on the seed core and become fully developed inside the fruit. Damaged fruit ripens prematurely. The most significant damage occurs when diseases enter the feeding holes causing the fruit to rot.

**Monitoring and Decision Making**: Once peppers are infested with ECB, no controls measures can be taken to reduce the problem. Direct sampling for eggs and larvae is impractical due to the low damage tolerance. Therefore, sampling must be done with the use of blacklight or pheromone traps. If using blacklight traps, sprays should be applied within 5-7 days after the first corn borer moth is captured and fruit are at least 1/2 inch in diameter. If a pheromone trap is used, applications should be made within one week after trap catches reach seven per week.

**Controls:**

**Biological**: Although there are many general predators that feed on corn borer eggs and small larvae, the low damage tolerance makes it impractical to rely on these predators. Recent research in New York and Virginia indicates that the use of Trichogramma nubilalie may provide good corn borer control in peppers. Evaluation of the economics and effectiveness in commercial situations is still needed.

**Cultural**: A number of cultural practices have been used in field corn to reduce corn borer infestations including plowing under corn stalks, keeping fields free of weeds to ensure better spray coverage and keeping a good mineral balance in the soil. However, none of these practices have been evaluated in a pepper system.
Chemical:

(I) Pyrethroids

- Permethrin 3.2EC - Applied at a rate of 8 oz (0.2 pound active) /acre; Provides good ECB control; Applied to less than 5% of the acreage; PHI - 3 days; REI - 12 hours
- Asana XL - Applied at a rate 9.6 oz/acre; Fair corn borer control; Applied to less than 2% of the acreage; PHI - 7 days; REI - 12 hours
- Baythroid 2E- Applied at a rate of 1.6 - 2.8 oz/acre; Provides very good control; Applied to 50% of the acreage; one-three applications; use high rate when worm pressure is high; PHI - 7 days; REI - 24 hours
- Capture 2EC- Applied at a rate 2.1-6.4 oz/acre; Provides very good control; Applied to 30% of the acreage; one-two applications; use high rate when worm pressure is high; PHI - 7 days; REI - 12 hours
- Mustang MAX - Applied at a rate of 4.0 oz/acre; Provides good control; Applied to 10% of the acreage; PHI - 1 day; REI - 12 hours
- Warrior 1EC - Applied at a rate of 2.56 - 3.84 oz/acre; Provides very good control; Applied to 30% of the acreage; PHI - 5 days; REI - 24 hours

(II) Organophosphates

- Acephate (Address, Lancer, Orthene) - Applied at rate of 1.33 lb per acre; Excellent control; only 2 applications allowed at this rate; Applied to 100% of the acreage; PHI - 7 days; REI - 24 hours

(III) Carbamates

- Lannate LV - Applied at a rate of 3 pt/acre; Provides good control; Applied to 20% of the acreage; PHI - 3 days; REI - 48 hours

(IV) New Labeled Chemistry

- Avaunt 30WDG - Applied at rate of 3.5 oz/acres; Provides very good control but must be ingested; Applied to 30% of the acreage; PHI - 3 days; REI - 12 hours
- Intreprid 2F - Applied at a rate of 8 - 16 oz/acre; Provides very good control but must be ingested; Applied to 10% of the acreage; PHI - 1 day; REI - 12 hours
- Spintor 2SC - Applied at a rate of 8 oz/acre; Provides good control by contact and ingestion; Applied to 50% of the acreage; PHI - 1 days; REI - 4 hours

Pepper Maggot

**Biology and Life History:** This insect overwinters in the soil in the pupal stage. Flies begin to emerge in mid- late June, emerging over a 10-14 day period and surviving less than one month. Female flies insert eggs under the skin and into the flesh of the pepper. The eggs hatch in 8 to 14 days and the maggots mature in 2-3 weeks. There is one generation per year.

**Damage:** The elliptical egg punctures are the first sign of an infestation. Maggots feed within the core of the fruit but generally emerge and drop to the ground to pupate before peppers are harvested.

As infested peppers enlarge, the egg punctures become shallow depressions in the fruit. If the fruit is green, damage is hard to detect. Damaged peppers turn red prematurely and rot.
**Monitoring and Decision Making:** Although pepper maggot flies can be baited with yellow sticky-traps baited with ammonia, they must be suspended at a height of 20 feet within the canopy of a maple tree. This is the only reliable method to detect low population levels. A perimeter of indicator cherry-pepper plants can be used to monitor flies by examining fruit for feeding scars every 3-4 days for a 3 week period. If using traps to monitor populations, two-three sprays will be needed at 5-day intervals as soon as the first fly is caught. If using indicator plants, sprays should be applied as soon as scars are observed on indicator plants.

**Controls:**

**Biological:** Although general predators can reduce adult and pupal populations, they will not provide commercial control.

**Cultural:** The elimination of alternative hosts, like horsenettle, can help reduce populations but will not eliminate the problem. The use of a cherry-pepper trap crop can help with bell peppers only.

**Chemical:**

(I) **Organophosphates**

- Acephate (Address, Lancer, Orthene) - Applied at rate of 1.33 lb per acre; Not specifically labeled for pepper maggot but use for corn borer control will help reduce pepper maggot problems only 2 applications allowed at this rate; Applied to 100% of the acreage; PHI - 7 days; REI - 24 hours
- Dimethoate 4EC - Applied at a rate of 0.5 - 0.67 pt/acre; Provide very good control; Applied to 100% of the acreage; PHI - 0 days; REI - 48 hours

(II) **Organochlorines**

* Thionex 50WP - Applied at a rate of 1-2 lb/acre; Poor-fair control; Applied to less than 2% of the acreage.

**Green Peach Aphid (GPA)**

**Biology and Life History:** There are a number of aphids that can be found on peppers; however, the green peach aphid is the most common and important one. GPA can attack plants throughout the season; however, the greatest injury occurs late summer through early fall. During most of the season, aphids give birth to live young, usually wingless females. Under warm conditions, the young mature in less than 9 days. Many generations occur in one season.

**Damage:** Aphids can cause cosmetic problems on peppers as a result of the "honeydew" left on leaves and fruit. At extreme populations, aphids can feed on plant sap resulting in plant chlorosis, curling and distortion which may reduce yields. At low levels, aphids can also transmit viruses

**Monitoring and Decision Making:** Monitor for aphids by checking the undersides of leaves in late June. Check for aphids on two upper and two lower leaves on 25 plants per field to determine the number of aphids per leaf. A treatment is needed prior to fruit set if you find 5-10 aphids per week for 2 consecutive weeks. After fruit set, a spray should be applied if the population averages 1-2 per leaf and beneficial activity is low.

**Controls:**

**Biological:** Naturally occurring predators and parasites usually provide season long suppression. If continuous pyrethroid programs are used, the can kill beneficials as well as repel certain parasites resulting in an aphid explosion.
Cultural: The use of reflective mulches has been shown to delay or reduce aphid colonization of pepper fields but does not eliminate the damage. Other strategies that can lower aphid populations include weed control, removal of perennial hosts and avoiding excessive nitrogen fertilization.

Chemical:

(1) Carbamate

- Lannate LV - Applied at a rate of 1.5 - 3 pt/acre; Provides fair to good control - some pockets of resistance exits; Applied to 20% of the acreage; PHI - 3 days; REI - 48 hours

(II) Neonicotinoid

- Assail 70WP - Applied at a rate of 0.8 -1.2 oz/acre; Provides good control; New label so used on less than 2% of the acreage; PHI - 7 days; REI - 12 hours
- Actara 25WDG - Applied at a rate of 2-3 oz/acre; Provides good control; Used on less than 5% of the acreage; PHI - 0 days; REI 12 hours
- Provado 1.6F - Applied at a rate of 3.75 oz/acre; Provides good control; Used on 20% of the acreage; PHI - 0 days; REI - 12 hours

(III) Other Chemistry

* Fulfill 50WDG - Applied at a rate of 2.75 oz/acre; Selective aphicide providing good control and very safe on beneficials; Used on less than 5% of the acreage; PHI - 0 days; REI - 12 hours

Corn Earworm (CEW)

Biology and Life History: This insect overwinters in Delaware; however, moth activity (overwintering and migratory ) is heaviest from mid-August to early October as corn is mature and moths are attracted to peppers. Eggs are laid singly on buds and terminal leaflets close to flowers and small fruit. Eggs hatch in 3-4 days and small larvae move directly to fruit at egg hatch. Individual larvae complete their development inside the fruit before pupating. Complete larval development can take place in 14 days at temperatures of 82 degrees.

Damage: Larvae begin feeding near the stem end of fruit. They feed inside the fruit and create a watery cavity filled with caste skins and excrement. As larvae mature, they often leave the fruit and move into another fruit. Older larvae enter the fruit anywhere, leaving a large hole in the side of the fruit. Damaged fruit becomes infected with diseases and injured fruit often rots before harvest. Contamination is a serious problem for processing peppers because one small hole may be the only evidence of an infestation.

Monitoring and Decision Making: Once small green pepper fruit are present, sampling should begin for corn earworm. Examine the foliage and at least 20 fruit from randomly picked plants in at least 5 locations per field for the presence of small larvae. Although blacklight and pheromone traps are not reliable for timing insecticide applications, moth catches greater than 20 per night indicate the potential for problems.

Controls:

Biological: Although there are many general predators that feed on corn earworm eggs and small larvae , the low damage tolerance makes it impractical to rely on these predators.
Cultural: None available

Chemical:

(I) Pyrethroids

- Permethrin 3.2EC - Applied at a rate of 4-8 oz (0.1- 0.2 pound active)/acre; Provides good CEW control; Applied to less than 2% of the acreage; PHI - 3 days; REI - 12 hours
- Asana XL - Applied at a rate 9.6 oz/acre; Provides good CEW control; Applied to less than 2% of the acreage; PHI - 7 days; REI - 12 hours
- Baythroid 2E- Applied at a rate of 1.6 - 2.8 oz/acre; Provides very good control; Applied to 50% of the acreage; one-three applications; use high rate when worm pressure is high; PHI - 7 days; REI - 24 hours
- Capture 2EC- Applied at a rate 2.1-6.4 oz/acre; Provides very good control; Applied to 30% of the acreage; one-two applications; use high rate when worm pressure is high; PHI - 7 days; REI - 24 hours
- Mustang MAX - Applied at a rate of 4.0 oz/acre; Provides good control; Applied to 10% of the acreage; PHI - 1 day; REI - 12 hours
- Warrior 1EC - Applied at a rate of 2.56 - 3.84 oz/acre; Provides very good control; Applied to 30% of the acreage; PHI - 5 days; REI - 24 hours

(II) Organophosphates

- Acephate (Address, Lancer, Orthene) - Applied at rate of 1.33 lb per acre; Poor CEW control; only 2 applications allowed at this rate; Applied to 0% acreage for CEW control; PHI - 7 days; REI - 24 hours

(III) Carbamates

- Lannate LV - Applied at a rate of 1/5 pt/acre; Provides good control; Applied to 20% of the acreage; PHI - 3 days; REI - 48 hours

(IV) New Labeled Chemistry

- Avaunt 30WDG - Applied at rate of 3.5 oz/acres; Provides fair to good control but must be ingested; Applied to 30% of the acreage; PHI - 3 days; REI - 12 hours
- Intrepid 2F - Applied at a rate of 8 - 16 oz/acre; Provides fair-good control but must be ingested; Applied to 10% of the acreage; PHI - 1 day; REI - 12 hours
- Spintor 2SC - Applied at a rate of 8 oz/acre; Provides fair-good control by contact and ingestion; Applied to 50% of the acreage; PHI - 1 days; REI - 4 hours

Fall Armyworm (FAW)

Biology and Life History: This insect migrates to Delaware in late June to early July. Moth activity in peppers is heaviest from late August to early October. Eggs are laid in a mass on the undersides of leaves. Eggs hatch in 2- 10 days and larvae mature in approximately 20-28 days.

Damage: Young larvae enter the fruit under the cap, similar to corn borer; however, the damage is more extensive as larvae mature. Older larvae move from fruit to fruit destroying more than they consume. Injury is easier to detect compared to CEW so contamination is rarely a problem. Damage fruit often drop or rot. Unlike CEW, they also feed extensively on the foliage.
**Monitoring and Decision Making:** Pheromone traps can be used to monitor moth activity and to determine when moths are actively laying eggs. A green unitrap should be placed within the plant canopy. Field should also be examined for the presence of egg masses. Pheromone trap catches of greater than 10-20 per night in combination with the presence of egg masses indicates the potential for a problem.

**Controls:**

**Biological:** None available.

**Cultural:** None available

**Chemical:**

(I) **Pyrethroids**

- Permethrin 3.2EC - Applied at a rate of 4-8 oz (0.1 – 0.2 pound active)/acre; Provides poor control; Applied to less than 2% of the acreage; PHI - 3 days; REI - 12 hours
- Asana XL - Applied at a rate 9.6 oz/acre; Provides poor FAW control; Applied to less than 2% of the acreage; PHI - 7 days; REI - 12 hours
- Baythroid 2E - Applied at a rate of 1.6 - 2.8 oz/acre; Provides fair-good control; Applied to 10% of the acreage; one-three applications; use high rate when worm pressure is high; PHI - 7 days; REI - 24 hours
- Capture 2EC - Applied at a rate 2.1-6.4 oz/acre; Provides fair-good control; Applied to 10% of the acreage; one-two applications; use high rate when worm pressure is high; PHI - 7 days; REI - 12 hours
- Mustang MAX - Applied at a rate of 4.0 oz/acre; Provides fair-good control; Applied to less than 2% of the acreage; PHI - 1 day; REI - 12 hours
- Warrior 1EC - Applied at a rate of 2.56 - 3.84 oz/acre; Provides fair-good control; Applied to 30% of the acreage; PHI - 5 days; REI - 24 hours

(II) **Organophosphates**

- Acephate (Address, Lancer, Orthene) - Applied at rate of 1.33 lb per acre; Good FAW control; only 2 applications allowed at this rate; Applied to 10% acreage for FAW control; PHI - 7 days; REI - 24 hours

(III) **Carbamates**

- Lannate LV - Applied at a rate of 1/5 pt/acre; Provides good control; Applied to 20% of the acreage; PHI - 3 days; REI - 48 hours

(IV) **New LabeledChemistry**

- Avaunt 30WDG - Applied at rate of 3.5 oz/acres; Provides good to very good control but must be ingested; Applied to 30% of the acreage; PHI - 3 days; REI - 12 hours
- Intrepid 2F - Applied at a rate of 8 - 16 oz/acre; Provides good - very good control but must be ingested; Applied to 10% of the acreage; PHI - 1 day; REI - 12 hours
- Spintor 2SC - Applied at a rate of 8 oz/acre; Provides -good control by contact and ingestion; Applied to 50% of the acreage; PHI - 1 days; REI - 4 hours

**Beet Armyworm (BAW)**
**Biology and Life History:** This insect migrates to Delaware in mid-late July. Moth activity in peppers is heaviest from mid-August to early October. Eggs are laid in a mass on the undersides of leaves. Eggs hatch in 3-4 days and larvae mature in approximately 2-3 weeks. One generation can be produced in 3 weeks.

**Damage:** Small larvae spin webs and feed in groups on the foliage, often skeletonizing the plants. As larvae develop, they encounter fruit and take bites on the surface, bore under the cap or enter the side of the fruit.

**Monitoring and Decision Making:** Pheromone traps can be used to monitor moth activity and to estimate population levels. A green unitrap should be placed within the plant canopy. Use one trap per field and position lures at the top of the plant canopy. Intensify field scouting when catches reach 20 moths per night. Fields should also be checked twice a week for egg masses and small larvae. Fields should be treated if 5% of the plants are infested with small larvae or you find one egg mass per 100 leaves.

**Controls:**

**Biological:** None available.

**Cultural:** None available

**Chemical:**

(I) **Pyrethroids (significant pyrethroid resistance exists in BAW)**

- Permethrin 3.2EC - Applied at a rate of 4-8 oz (0.1 – 0.2 pound active)/acre; Provides poor control; Applied to less than 2% of the acreage; PHI - 3 days; REI - 12 hours
- Asana XL - Applied at a rate 9.6 oz/acre; Provides poor BAW control; Applied to less than 2% of the acreage; PHI - 7 days; REI - 12 hours
- Baythroid 2E - Applied at a rate of 1.6 - 2.8 oz/acre; Provides poor BAW control; Applied to less than 2% of the acreage; PHI - 7 days; REI - 24 hours
- Capture 2EC - Applied at a rate 2.1-6.4 oz/acre; Provides poor control; Applied to less than 2% of the acreage; PHI - 7 days; REI - 12 hours
- Mustang MAX - Applied at a rate of 4.0 oz/acre; Provides poor control; Applied to less than 2% of the acreage; PHI - 1 day; REI - 12 hours
- Warrior 1EC - Applied at a rate of 2.56 - 3.84 oz/acre; Provides poor control; Applied to 30% of the acreage; PHI - 5 days; REI - 24 hours

(II) **Organophosphates**

- Acephate (Address, Lancer, Orthene) - Applied at rate of 1.33 lb per acre; poor-fair BAW control; only 2 applications allowed at this rate; Applied to 10% of the acreage; PHI - 7 days; REI - 24 hours

(III) **Carbamates**

- Lannate LV - Applied at a rate of 1/5 pt/acre; Provides poor control; Applied to less than 2% of the acreage; PHI - 3 days; REI - 48 hours

(IV) **New Labeled Chemistry**
Avaunt 30WDG - Applied at rate of 3.5 oz/acre; Provides very good control but must be ingested; Applied to 30% of the acreage; PHI - 3 days; REI - 12 hours

Intrepid 2F - Applied at a rate of 8 - 16 oz/acre; Provides very good control but must be ingested; Applied to 10% of the acreage; PHI - 1 day; REI - 12 hours

Spintor 2SC - Applied at a rate of 8 oz/acre; Provides good control by contact and ingestion; Applied to 50% of the acreage; PHI - 1 days; REI - 4 hours

Thrips

**Biology and Life History:** This insect overwinters as adults on weed hosts. Adults move to host plants and eggs are produced sexually or asexually. Wingless nymphs can develop into winged adults in 2 weeks. Populations explode under warm, dry weather. In some cases, thrips can be brought north on southern transplants.

**Damage:** The most significant damage occurs when thrips vector the Tomato Spotted Wilt virus. Transmission can occur in the greenhouse or on transplants outside the greenhouse just before transplanting in the field. Thrips can also directly damage peppers by extracting sap from leaves and fruit. This results in distorted leaves and fruit with silver or brown lesions on the surface. Damage occurs near the cap or where two or more fruit contact each other.

**Monitoring and Decision Making:** Examine 5 plants in 10 locations for the presence of thrips on leaves and fruit. Although no exact thresholds have been established, a treatment may be needed if 10% of the leaves or fruit are infested with thrips. Plants showing virus symptoms should be rogued out of the field to prevent virus spread.

**Controls:**

**Biological:** None available.

**Cultural:** None available

**Chemical:**

(I) Pyrethroids

- Baythroid 2E- Applied at a rate of 1.6 - 2.8 oz/acre; Provides good thrips control; Applied to 20% of the acreage; PHI - 7 days; REI - 24 hours
- Capture 2EC- Applied at a rate 2.1-6.4 oz/acre; Provides fair-good control; Applied to 10% of the acreage; PHI - 7 days; REI - 12 hours
- Warrior 1EC - Applied at a rate of 2.56 - 3.84 oz/acre; Provides good control; Applied to 30% of the acreage; PHI - 5 days; REI - 24 hours

(II) Other Chemistry

- Spintor 2SC - Applied at a rate of 8 oz/acre; Provides good control by contact and ingestion; Applied to 30% of the acreage; PHI - 1 days; REI - 4 hours

Spider Mites

**Biology and Life History:** This arthropod pest overwinters as females on debris and is capable of reproducing sexually or asexually. Eggs are laid on the undersurface of leaves or on protected plant parts. Under hot, dry conditions, eggs hatch in 3 days. Immature mites molt 3 times and can reach adulthood in less than one week
**Damage:** Nymphs and adults puncture leaf tissue and extract plant juices. Leaf injury first appears as white stippling or small white blotches which fuse together into larger yellow patches. Under heavy infestations, leaves dry out, turn brown and are tied together by webbing. Mites can develop quickly and severely stunt the growth of plants. Mites can also feed on the fruit causing a roughened appearance of the fruit and rendering it unmarketable.

**Monitoring and Decision Making:** Examine 5 plants in 10 locations for the presence of mites on 2 leaves and 2 fruit per plant. Although no exact thresholds have been established, a treatment may be needed if 10% of the leaves or fruit are infested with mites.

**Controls:**

**Biological:** Although natural enemies and fungal pathogens can help to crash populations, they often cannot be relied upon to provide economic control.

**Cultural:** None available

**Chemical:**

(I) Pyrethroids *(excessive use for other insects can cause spider mite outbreaks)*

(II) Other Chemistry

- Kelthane MF - Applied at a rate of 0.75 - 1.5 pt/acre; Provides good control; Applied to 10% of the acreage; PHI - 2 days; REI - 24 hours
- Agri-Mek 0.15EC - Applied at a rate of 8-16 oz/A; Provides good control; Applied to less than 10% of the acreage; PHI - 7 days; REI - 12 hours

**Pepper Weevil**

This insect can come north on southern transplants; however, it has not been a problem in Delaware. Last seen in NJ in 1992. The small reddish-brown to black beetle with a curved beak can be transported on plants with well developed flowers and flower buds. Larvae are a white legless grub with a brown head and can complete their lifecycle in 3 weeks. Larvae cause damage by chewing holes in leaves as well as buds and small fruit. Damage can be detected by puncture wounds on the buds and/or premature dropping of flowers, bud and small pods.

Best management practice is to avoid southern transplants, especially ones with well developed flowers and buds. If you suspect pepper weevil, check for puncture wounds on 25-50 bud clusters once a week and count cluster damaged if one or more flower buds have holes. A treatment is recommended if 5% of the clusters are damaged. Two-three weekly pyrethroid sprays needed for control.

**Diseases**

Diseases of green pepper in Delaware are: Rhizoctonia (damping off or root rot), Pythium (damping off or root rot), Bacterial leaf spot, Anthracnose, Phytophthora Blight, Bacterial soft rot, Nematodes, and various virus diseases, such as AMV, TEV, TMV, CMV, PVY, and TSWV. Sclerotinia blight is a rare disease in Delaware. Some diseases can be
present during the entire time that green peppers are in the field, such as bacterial leaf spot, and some diseases are limited to post harvest (bacterial soft spot). Other diseases are more prevalent during certain months as shown in the following tables.

## DISEASE CONTROL OPTIONS

<table>
<thead>
<tr>
<th>MONTH</th>
<th>DISEASE</th>
<th>BIOLOGY</th>
<th>SYMPTOMS</th>
<th>SCOUTING</th>
<th>CULTURAL</th>
<th>CHEMICAL</th>
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</thead>
<tbody>
<tr>
<td>May - June</td>
<td>Rhizoctonia damping-off or root rot</td>
<td>Rhizoctonia is a common soil-borne fungus that is more aggressive on young plants</td>
<td>Stem is constricted near the soil line. Roots may appear decayed. Damage occurs first in patches. Fine web-like growth may be present near lesion.</td>
<td>Seedlings damaged in patchy or circular areas in flats. Look for symptoms on stems and roots.</td>
<td>Use rigorous sanitation in green house (clean soil-less medium, disinfected trays, benches and tools). Avoid planting too deeply.</td>
<td>Biocontrol such as SoilGard (incorporated into potting soil) has limited efficacy as does Thiram seed treatment. Field application of Ridomil Gold or Ultra Flourish (Pythium only), Vapam or Terraclor (Rhizoctonia only), are effective but rarely economically justified for damping-off alone.</td>
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<tr>
<td>May - June</td>
<td>Pythium damping-off and root rot</td>
<td>Soil-borne fungus with broad host range. In seedlings, high soil moisture, excess fertility and crowding (in greenhouse) can exacerbate the problem</td>
<td>Emergence of seedlings may be reduced. Roots and stems become tan to brown and water soaked.</td>
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<td>May - September (until night temperatures are below 60°F)</td>
<td>Bacterial leaf spot</td>
<td>Causal bacterium is Xanthomonas campestris pv. vesicatoria. Three races occur in the region. The bacteria is typically seed-borne. Disease is favored by high nighttime temperatures and moisture.</td>
<td>Initially water-soaked irregular spots (often delimited by veins) may have yellow border. Lesions turn brown to black. Infected leaves often turn yellow and prematurely drop off the plant. Fruit spots, initially</td>
<td></td>
<td>Several cultivars resistant to local races are available. Buy transplants grown from treated seed. Keep fertility moderately high. Use rigorous sanitation in greenhouse, crop rotation and weed management.</td>
<td>Apply streptomycin-based spray in greenhouse. In field, apply copper (1 lb. active ingredient per acre) plus maneb at 1.5 lb. 80 WP per acre.</td>
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<td>June through harvest</td>
<td>Sclerotinia blight</td>
<td>Hard black structures (sclerotia) survive many years. Sclerotia germinate and initiate disease when soil is moist for several (6 or more) days. Fungus becomes established on senescent tissue such as old flowers or leaves. Disease is favored by cool temperatures</td>
<td>Symptoms are fluffy white mycelia and presence of sclerotia (1/16 to ½ inch hard black structures) on diseased tissue. Tiny salmon colored mushroom like structures may be present on the soil surface.</td>
<td>When cool, damp weather occurs look for tiny mushroom-like structures on soil and black sclerotia.</td>
<td>Long rotation with corn and small grain reduces disease.</td>
<td>Terraclor in transplant water (3 lb. 75WP/100 gal. Of water applied at 0.5 pint/plant).</td>
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</table>

**MONTH**
- **DISEASE**
  - Anthracnose

**BIOLOGY**
- Typically a disease of mature fruit, however, a new strain in our area infects immature fruit.

**SYMPTOMS**
- Sunken lesions form on fruit. The center of lesions may have gray to black fungal growth. Following periods of high humidity or rain, salmon colored spore masses develop on lesions.

**SCOUTING**
- Scout for presence of lesions and initiate sprays at first sign of disease. Apply fungicide preventatively where there is a history of disease.

**CULTURAL**
- Rotate away from solanaceous plants for two years.

**CHEMICAL**
- Alternate applications of 1.5 to 2 lb. 80 WP/A and Quadris 6.4 to 15.4 fl. oz/A
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<td>June to harvest</td>
<td>Phytophthora Blight</td>
<td>Devastating disease spread rapidly when conditions are favorable.</td>
<td>Crown rot phase: Plants wilt and dark lesion girdles the base of the stem or just below the soil surface. Symptoms appear first in low-lying areas of field. Aerial phase: Black girdling lesions, 2-3 inches long, form in the axils of pepper branches. Fruit phase: Large soft water soaked lesions form on fruit. White sporulation may occur in humid conditions. Fruit symptoms coincide with presence of aerial phase. Use cultural practices even in absence of disease.</td>
<td>Use resistant cultivars when possible. Rotate away from peppers, eggplants, tomatoes and all cucurbits for at least 3 years. Plant only in well-drained fields. Produce peppers on raised beds that have a central crown. Following transplanting, mound soil at the plant base. Remove diseased plants.</td>
<td>Note: Application of chemicals alone cannot control this disease. Apply 1 pt Ridomil Gold 4 E or 1 qt. Ultra Flourish 2 E/A broadcast prior to planting or in a 12-16 inch band over the row before or after transplanting. Make two additional directed applications (6-10 inches) on either side of row at 30-day intervals. Applications may be through drip. Stem and fruit rot phase: Apply fixed copper at 2 lb. 77 WP/A, or equivalent, or Ridomil Gold Copper 2.5 lb. 65 WP/A at 10-14 day intervals. If Ridomil Gold Copper is used for stem and fruit rot phase, the third application of Ridomil Gold 4 E cannot be made.</td>
<td>Use chlorinated water to wash fruit, if necessary.</td>
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<td>Post-harvest</td>
<td>Bacterial soft rot</td>
<td>Pathogen population is high in fields previously cropped to potato or cabbage. Excessive nitrogen levels and high moisture predisposes fruit to damage.</td>
<td>Initial lesions are usually small and on the stem end of fruit. Large lesions are soft and slimy, enlarge quickly and the entire fruit collapses. Management measures are preventative.</td>
<td>Avoid wounding fruit during harvest and washing. Do not pick during rain. Do not place in cold water, if washed.</td>
<td>Use resistant cultivars when possible. Rotate away from peppers, eggplants, tomatoes and all cucurbits for at least 3 years. Plant only in well-drained fields. Produce peppers on raised beds that have a central crown. Following transplanting, mound soil at the plant base. Remove diseased plants.</td>
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<td>June - September</td>
<td>Virus Diseases</td>
<td>Seed borne inoculum is rare. TSWV, and to a lesser extent TMV, may start initially in greenhouses. AMV, CMV, PVY and TEV are aphid transmitted. TSWV is thrip transmitted and TMV is spread mechanically.</td>
<td>Symptoms of each virus vary from a blotchy white or yellow mosaic (AMV, TEV, TMV), slight necrosis with ringspot or soakleaf pattern (CMV) vein banding (PVY) mild to intense mottling (PVY, TEV, TMV), wilting (TEV), systemic necrosis, brown spots, necrotic streaks or rings of line patterns (TSWV). Fruit develops mosaic, ringspors, necrotic spots and may be deformed.</td>
<td>Look for stunted plants with leaf symptoms.</td>
<td>Avoid planting near alfalfa, birdsfoot trefoil or potatoes. Do not grow ornamentals in same greenhouse as peppers.</td>
<td>Because aphid transmitted viruses can be vectored within 60 seconds, insecticides are generally not helpful. Insecticides to reduce thrips populations maybe helpful in reducing TSWV spread. Manage insects using IPM principles.</td>
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<tr>
<td>July -</td>
<td>Nematodes</td>
<td>Southern root knot, lesion, and stubby</td>
<td>Above-ground symptoms are stunted and wilted plants that occur in patchy or circular areas. Wilted plants may recover in morning. Below ground symptoms are root galls, 1/16 inch to 1/4 inch</td>
<td>In fields that exhibit aboveground symptoms that are not attributed to other factors, perform soil and root assay. Routine assays should be conducted in the fall in fields cropped</td>
<td>Avoid planting peppers after potatoes or strawberries. Rotate with corn, wheat, barley, or rye.</td>
<td>Pre-plant fumigation is effective, if economical.</td>
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</tbody>
</table>
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References

3. H. Grier Stayton, Administrator, and David Pyne, Pesticide Inspector, Delaware Department of Agriculture Pesticide Compliance Section.

[1] FOOTNOTES:
Entries for Ambush 2E and Pounce 3.2EC were changed to Permethrin 3.2EC for ECB, CEW, FAW, AND BAW. All listed herbicides and fungicides are currently labeled for green pepper.