

# Crop Profile for Pumpkins in New Jersey

Prepared: April 2007

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## Production Facts

- **State rank:** probably in top 15 of production states.
  - **New Jersey's contribution to total US production:** approximately 5% (1).
  - **Yearly fresh market production:** about 2,500 acres with an average yield of 11 tons per acre.
  - **Annual production costs:** approximately \$3,000 per acre.
  - **Percent of crop for processing and fresh market:** 100 percent fresh market.
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## Production Regions

New Jersey is sharply divided into two growing regions: the northern half of the state and the southern half. These growing regions are defined by differences in soil type, elevation, and latitude. Highway US 1, between Trenton and New Brunswick, serves as an approximate geographical border between the two regions.

### *Southern New Jersey*

The soils in this area are coastal plain, generally light soils ranging from sand to sandy loams, but areas of heavier, clay and silt loam soil do exist. Elevations are low with most of the area less than 200 feet. The warmest, seasonal temperatures occur in the extreme southern part of the state with the Salem County area being the warmest. Farms in southern New Jersey tend to be larger in acreage than those in northern New Jersey, but a lower percentage of farmers raise pumpkins in the south.

### *Northern New Jersey*

The northern soils are Piedmont and Appalachian types, heavy silt loams, and shaley soils, respectively. Elevations are generally above 200 feet and reach 1800 feet at High Point in extreme northern New Jersey. The topography is more rugged than that of southern New Jersey, with alternating ridges and valleys running approximately from SW to the NE, ending rather abruptly at the New Jersey–New York state line. The ridges extend southwesterly into eastern Pennsylvania. These ridges are important in influencing both weather conditions and pest infestations for the north. The smaller farms in northern New Jersey cater more to roadside markets and pick-your-own venues.

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## Cultural Practices

Pumpkins are an important cash crop for New Jersey farmers with approximately 2,500 acres grown throughout the state. Both vegetable and row-crop farmers raise them and many farms include pumpkin production as part of their agricultural entertainment in the fall, complementing crop mazes and hay rides. The many varieties of pumpkins can be divided into Jack-o-lantern types and sugar varieties, adding to the importance of the crop, since the fruit can be used for decoration and food.

Fewer farms have pumpkins in southern New Jersey than in the north, largely because the southern farms tend to be larger and geared more towards wholesale marketing than retail (as in the northern part of the

state). Northern New Jersey is more densely populated than the south, which makes for a greater demand for road stand markets where pumpkins can be sold.

Most varieties are planted in early to mid-June, especially those with a longer days to harvest. Shorter season varieties are planted according to a timetable that will have them ripening for October harvests. Pumpkin growth does respond to heat units, so if the summer season records higher-than-normal temperatures, the pumpkins will mature in September, creating a problem of storage and availability of quality fruit in October.

Most pumpkins are planted as seed in conventionally tilled fields with wide row spacing according to the growth habit of the variety. A few are grown on raised beds with plastic mulch and few growers use pumpkin transplants rather than direct seeding.

Varietal selection depends upon market demand and the desire to reduce fungicide use. Some of the varieties popular with customers also are disease resistant, such as Merlin, which has resistance to powdery mildew. Varieties are further divided between jack-o-lanterns and sugar pumpkins, with many varieties available in both groups. Jack-o-lantern: Howden, Howden Biggie, Merlin, Magic Lantern, and Aladdin. Sugar: Ironsides and Baby Pam.

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## **Insect and Mite Pests of Pumpkin in New Jersey**

### ***Primary Insect Pests***

**Striped cucumber beetle** (*Acalymma vittatum*) – A major pest causing damage to seedlings, spreading disease and feeding on maturing fruit. Adults appear similar to the western corn rootworm beetle but are slightly smaller and the yellow and black markings on the elytra are usually more distinct. The beetle has a dark head and antennae with three black stripes down the elytra alternating with two yellow stripes. There are two generations a year in New Jersey.

Adults overwinter, emerging in the spring prior to pumpkin planting. Females begin to lay eggs 8 to 25 days after mating, laying 250 to 800 yellow eggs near the stems in soil cracks. Upon hatching, the larvae descend into the soil to feed on the pumpkin plant roots, allowing for secondary infections by disease pathogens. Larvae are creamy white and slender, about 3/8 long. After about 15 days the larvae pupate as yellowish pupae in the soil. It takes approximately one month from egg hatching to adult emergence.

The most serious damage, which occurs by adults feeding upon pumpkin seedlings at the stem and cotyledons as soon as they emerge, may kill young plants. As the plants mature, cucumber beetles pose less of a threat to the plants except for the spread of bacterial wilt. The pathogenic bacteria reside in the gut of the beetles and plants become infected when the beetles feed on the plants. The bacteria are present in the fecal matter of the beetles and when it comes into contact with wounded tissue the plant becomes infected. Once infected, there is no rescue treatment for the disease with the plant ultimately dies, although pumpkin and winter squash seem to be more resistant to the disease than other cucurbits. The adults also spread pumpkin mosaic disease, which is less of a problem.

Adults continue feeding on the plant throughout the growing season, but once fruit begin to mature, the beetles may feed on the fruit rind, often making the fruit unmarketable because of deep feeding cavities. Additionally, these wounds allow for secondary disease infections, including black rot.

Occasionally, the larvae of the cucumber beetles will come up through the soil to feed on fruit in contact with the soil. These are known as rindworms and are difficult to control. The best option is to reduce the adult levels, which reduces the number of larvae in the field.

### ***Threshold***

Seedlings – 2+ beetles are present in 6 out of 10 sampling sites. On mature fruit – presence of beetles.

**Spotted cucumber beetle** (*Diabrotica undecimpunctata howardii*) – The spotted cucumber is similar to the striped cucumber beetle in that it will also feed on the cotyledons and seedlings of emerging plants and will also feed on maturing fruit. This beetle is also capable of vectoring the bacteria for bacterial wilt in pumpkins and other cucurbits. The adults are larger (5/16 inch long) than the striped cucumber beetles and are green with black spots on the back. Of the two cucumber beetles the spotted is the more general feeder with a larger number of host plants that it will feed on and is not as severe a pest as the striped species. The larvae of the spotted cucumber beetle are yellow to greenish white in color and feed on the roots of host plants. The larvae are sometimes pests of other crops because of their root feeding habits.

### ***Threshold***

Seedlings – 2+ beetles are present in 6 out of 10 sampling sites. On mature fruit – presence of beetles

**Squash bug** (*Anasa tristis*) – A member of the insect family Coreidae, the squash bug is a common pest with the general appearance of a narrow-bodied stink bug. Adult squash bugs are rather large, about 5/8 inch long and approximately 1/3 as wide. Adults are winged, brownish black, sometimes mottled with gray or light brown, flat-backed, and give off a disagreeable odor when crushed. Adults are occasionally attracted to blacklights. Newly hatched nymphs have red legs and antennae with a green abdomen. As the nymphs age the red parts become black and take on an overall dark, greenish-gray appearance. Eggs are yellowish brown to brick red laid in loose groups or clusters. The older the eggs the darker they become.

The squash bug is one of the most common and troublesome pests attacking melons and squash, but does not seem to be a significant pest of pumpkin plants in New Jersey. However, it is now known that the squash bug vectors a disease pathogen which causes yellow vine, which has been found in mid-western states. Both nymphs and adults suck sap from the leaves and stems injecting a toxin into the plant, which may lead to wilting known as Anasa wilt of cucurbits. After wilting, vines and leaves turn black and become brittle. Occasionally small plants, especially those that are having difficulty in growing are killed entirely, while larger plants may have affected runners. Squash bugs often congregate in dense clusters on vines and unripe fruits. Rarely, feeding damage is severe enough to prevent fruit formation.

Unmated adult squash bugs overwinter in the shelter of dead leaves, vines, boards or buildings and fly to cucurbits when vines start to grow. Following feeding and mating, egg-laying soon begins. Masses of eggs, each containing about a dozen or more, are usually deposited on the undersides of leaves in angles formed by the veins. Egg-laying by the overwintering females continues until midsummer. Eggs hatch in about 7 to 10 days and the nymphs pass through 5 instars requiring 4-6 weeks to reach adulthood. Only one generation develops each year and new adults do not mate until the following spring. Squash bugs are secretive in habit. Both adults and nymphs are found clustered near the plant crown, beneath damaged leaves, under clods or in any protective groundcover. They move quickly for cover when disturbed. Because of the protracted egg laying period, all life stages occur throughout the summer months.

### ***Threshold***

In younger plants before the vines have become intertwined, the NJ Commercial Vegetable Production Recommendation book recommends a threshold of one egg mass per plant. Once the rows are closed, insecticide applications are generally not recommended unless it is apparent that economic damage is

occurring. Non-chemical management such as destroying egg masses is feasible in some instances. Adults search out protected areas under boards and other debris on the ground to overwinter. In the spring, check these areas for the presence of adults and destroy those found.

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## ***Secondary Insect Pests***

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**Green Peach Aphids** (*Myzus persicae*) – Green peach aphids are small (1/8 inch or less), pastel green and usually occur in colonies, though individual aphids may be found. They feed on the plant sap and may cause stunting or leaf curl if large numbers exist. Usually little plant damage is seen from their direct feeding; however, aphids can transmit watermelon mosaic and other viral diseases. Usually these viral diseases are not a significant problem and seldom reduce yields, but this depends upon the virus strain. Unfortunately it is very difficult to keep aphids out of pumpkins or to stop the viral transmissions. A single aphid may infect plants and entirely escape notice.

Green peach aphids overwinter in the egg stage on peaches and other *Prunus* trees and after hatching in the spring develop into stem mothers, which begin producing live young that are all female. Multiple generations occur through the growing season where the individuals are all female allowing aphid populations to flare up rapidly if conditions are right. A generation of males is produced in the fall when mating occurs and females then lay eggs on *Prunus*.

### ***Threshold***

None established.

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**Melon Aphid** (*Aphis gossypii*) – Melon aphids are smaller and more varied in coloration than the green peach aphid. The color variants seem to depend upon the temperature with the color varying from dark green to green to yellow. Winged forms may be yellow or black. Like the green peach aphid, melon aphids feed on the plant sap and while large numbers may reduce plant vigor and even stunt plant growth, they are more likely to cause damage through viral disease transmission. Their life cycle is similar to the green peach aphid.

### ***Threshold***

None established.

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**Two-spotted spider mites** (*Tetranychus urticae*) - Two-spotted spider mites are very small, up to 1/16 inch; eggs and immatures are much smaller. Adult mites usually have dark reddish areas on either side of the body, hence their name. As numbers of mites increase, fine, spidery webbing will become noticeable on the underside of leaves or on vine terminals.

Spider mites are sap feeders, feeding directly on plant cells with their stylets (usually on the undersides of leaves). Once damaged, the cell or leaf tissue does not recover, resulting in yellow speckling (chlorosis) on the upper leaf surface. Damaged leaf tissue allows for more rapid water loss and in heavily damaged plants, wilting may occur. If the mites are not controlled, under favorable conditions they can severely stunt or kill plants.

Like aphids, spider mites have multiple generations each year. They overwinter as dormant adult females in plant debris and begin feeding in the spring on plant tissue. Spider mite numbers can explode under favorable conditions of high temperatures and dry conditions and are more difficult to control once they are abundant.

### ***Threshold***

Presence, especially in hot, dry weather.

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**Pickleworm** (*Diaphania nitidalis*) (5) is a southern moth (family Pyralidae) that sometimes migrates into the area, feeding on pumpkins later in the season. The female moth lays eggs on or near flowers where the larvae feed initially. If fruit are present, the caterpillars will begin feeding on these, causing holes in the rinds. Sometimes the caterpillars penetrate into the rind, making only a shallow hole, and then move on to another location and begin additional holes. The mature caterpillars may remain inside in the rind finishing their larval development. Damaged fruit become cosmetically disfigured and the damage often leads to secondary infections by bacterial and fungal pathogens.

The larvae are readily identified because of their coloration. The early instars are white or yellowish white with brown or black spots. In the last instar the caterpillar becomes a pastel green with brown head.

### ***Threshold***

None established, but considering that the larvae will feed on the fruit, direct loss ensues. Probably growers should adopt a zero threshold and initiate insecticide applications when the pickleworm is first detected.

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**Potato leafhopper** (*Empoasca fabae*), **squash vine borer** (*Melittia satyriniformis*), **thrips** (various species), **white flies** (Aleyrodidae) and **leaf miners** (Agromyzid fly) are minor pests that rarely cause economic damage in commercial plantings. Squash vine borer is a more frequent pest of backyard or homeowners' plantings where a few pumpkin plants are being grown. It isn't clear why this insect is not more of a problem in commercial plantings.

### ***Thresholds***

None established.

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## **Chemical Controls Used in New Jersey Pumpkins for Insects**

There are no state records for insecticide use in pumpkins.

There is a marked difference in the typical use of insecticides between growers in our Vegetable IPM Program and those who aren't. Those in the IPM Program use 1 or 2 insecticides upon emergence for control of striped cucumber beetles and 1 or 2 insecticide applications as the fruit mature, for the purpose of protecting the fruit from striped cucumber beetles (2,3).

In non-scouted fields growers are more prone to applying more insecticides, often tank-mixing with fungicide treatments. Esfenvalerate, methomyl, and endosulfan are the primary materials used. Growers most often use labeled rates of insecticides.

Imidacloprid or carbofuran may be applied at seeding to protect against cucumber beetles but most growers seem to apply insecticides directly to the plants for control of these beetles. Pymetrozine is sometimes used when necessary for aphid control.

**Table 1: Current (2006) Pesticide Recommendations  
for Insect Pests, Product Rates Per Acre and Use** <sup>(4)</sup> Key: G=general, R=restricted

**Striped and Spotted Cucumber Beetle**

<b>imidacloprid</b> (Admire) 16-24 fl oz 2F/A (soil application)	G
<b>esfenvalerate</b> (Asana XL) 5.8-9.6 fl oz 0.66EC/A	R
<b>fenproprathrin</b> (Danitol) 10.66-16 fl oz 2.4 EC/A	R
<b>carbofuran</b> (Furadan – special local needs label 24(c)) 3.8 fl oz 4F/1000 row ft	R
<b>permethrin</b> (Ambush, Pounce) 4-8 fl oz 3.2/A	R
<b>thiomethoxam</b> (Platinum) 5-8 oz 2SG/A	G
<b>carbaryl</b> (Sevin) 1.25 lb 80S/A	G
<b>endosulfan</b> (Thionex) 0.67-1.33 qts 3EC/A	R (in NJ)

**Squash bug**

<b>esfenvalerate</b> (Asana XL) 5.8-9.6 fl oz 0.66EC/A	R
<b>permethrin</b> (Ambush, Pounce) 4-8 fl oz 3.2/A	R
<b>azadirachtin</b> (Azatin, Ecozin, Neemix) 11-21 fl oz EC/A	G
<b>bifenthrin</b> (Capture, Brigade, others) 2.6-6.4 fl oz 2EC/A	R
<b>carbaryl</b> (Sevin) 1.25 lb 80S/A	G
<b>endosulfan</b> (Thionex) 0.67-1.33 qts 3EC/A	R (in NJ)

**Aphids – Green Peach and Melon Aphids**

<b>imidacloprid</b> (Admire) 10 -24 fl oz 2FS/A (soil application)	G
<b>pymetrozine</b> (Fulfill) 2.75 oz 50WDG/A	G
<b>oxydemeton methyl</b> (Metasystox-R) 1.5-2 pt 2SC/A	R
<b>thiomethoxam</b> (Platinum) 5-8 oz 2SG/A	G
<b>endosulfan</b> (Thionex) 0.67-1.33 qts 3EC/A	R (in NJ)

**Two-spotted spider mites**

<b>bifentate</b> (Acramite) 0.75-1.0 lb 50WS/A	G
<b>abamectin</b> (Agri-mek) 8-16 fl oz 0.15EC/A	R
<b>bifenthrin</b> (Capture, Brigade, others) 5.12-6.4 fl oz 2EC/A	R
<b>fenproprathrin</b> (Danitol) 10.66-16 fl oz 2.4EC/A	R
<b>dicofol</b> (Kelthane) 1.6 lb 35 WP/A	G
<b>spiromesifen</b> (Oberon) 7.0-8.5 fl oz 2SC/A	G

**Pickleworm**

<b>esfenvalerate</b> (Asana XL) 5.8-9.6 fl oz 0.66EC/A	R
<b>bifenthrin</b> (Capture) 2.6-6.4 fl oz 2EC/A	R
<b>permethrin</b> (Pounce) 4-8 fl oz 3.2EC/A	R
<b>carbaryl</b> (Sevin) 1.25 lb 80S/A	G
<b>spinosad</b> (SpinTor) 4-8 fl oz 2SC/A	G
<b>endosulfan</b> (Thionex) 0.67-1.33 qt 3EC/A	R (in NJ)

## **Chemical Use in IPM Programs**

There is a tendency for growers to over-apply insecticides. In a two year demonstration of pumpkin IPM in southern New Jersey, growers typically applied at least 2 or more unneeded insecticides.

Growers are warned about the overuse of pyrethroids, as this practice may lead to increased spider mite and aphid populations. The use of carbofuran at planting may lead to additional mite problems later in the season. Field scouting helps to greatly reduce insecticide applications.

## **Chemical Use in Resistance Management**

Rotate chemical classes and/or groups with similar modes of action to reduce the odds of resistance development.

## **Alternatives**

No alternative controls, although the use of thresholds could reduce insecticide applications considerably in pumpkin production. A pumpkin IPM demonstration project at Rutgers showed that insecticide applications made by several participating growers were excessive and unwarranted.

## **Cultural Control Practices**

None demonstrated currently; however, companion plantings may be tried in the 2007 growing season for developing trap crops for cucumber beetles.

## **Biological Controls**

Parasitic flies of squash bugs can sometimes be found in pumpkin fields. It is not clear how much these flies influence the squash bug population.

## **Post Harvest Control Practices**

Tillage immediately after harvest is encouraged to reduce insect pest populations.

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## **Weed Pests in New Jersey Pumpkins**

All weeds are pests in pumpkins because they will compete with pumpkins for nutrients, water, and space and may serve as reservoirs for plant pathogens. The presence of weeds will also lead to reduced air flow through the crop, which would favor disease development. Generally, weeds are considered to be at threshold when they occur at the rate of 1 weed per square yard prior to row closure. Unlike insecticide use, the pattern of herbicide use between scouted and non-scouted fields is essentially the same.

### ***Winter Annuals***

These weeds are not usually a problem since most pumpkins are planted after winter annuals have gone to seed and died.

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### ***Summer Annuals***

All broadleaf and grass annuals are pests and especially zero tolerance weeds, including nightshades, morningglory, jimson weed, and common cocklebur.

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### **Perennials**

Zero tolerance weeds—including horsenettle, yellow nutsedge, Canada thistle, common milkweed, hemp dogbane, field bindweed, johnsongrass, bermudagrass, and quackgrass—can be problematic. These weeds especially should not be allowed to become established because they can compete with the crop, enhance disease presence by reducing pesticide application effectiveness, and interfere with harvesting.

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### **Chemical Controls Used in New Jersey Pumpkins for Weeds**

There are no state records for herbicide use in pumpkins.

Typically, most New Jersey growers use a pre-emergent herbicide shortly after planting, followed by a post-emergent herbicide after the seedlings have reached the 2 to 5 leaf stage. Strategy (jug mix of ethalfluralin and clomazone) is the primary pre-emergent herbicide used and halosulfuron is the favored post-emergent material. Broadleaf weeds, especially cocklebur in southern and central New Jersey, and nutsedge are the primary concerns for control. *See Table 2 which follows for the Current (2006) Pesticide Recommendations for Weed Pests, Product Rates Per Acre and Use (4)*

### **Chemical Use in IPM Programs**

In weed control the same regimen of herbicide use generally occurs whether the fields are scouted or not.

### **Chemical Use in Resistance Management**

Growers are urged to use different chemical classes for spraying for weeds.

### **Alternatives**

Depending upon circumstances and the weeds involved, hand weeding may be done to make sure that the weeds are removed.

### **Cultural Control Practices**

Crop rotation is recommended to assist in weed management.

### **Biological Controls**

None.

### **Post Harvest Control Practices**

None. Post-harvest tillage does little to discourage weed pests for the next growing season.

**Table 2: Current (2006) Pesticide Recommendations for Weed Pests,  
Product Rates Per Acre and Use <sup>(4)</sup>** (Key: G=general, R=restricted)

**Conventional Tillage:**

**1. For Transplants**

- a. **Herbicide under plastic mulch**  
bensulide (Prefar) 5-6 lb 4E/A G
- b. **Pre-emergence – Including strips between rows of plastic mulch**  
bensulide (Prefar) 5-6 lb 4E/A G  
ethalfluralin (Curbit) 1-2 pts 3E/A G  
ethalfluralin plus clomazone (Strategy – jug mix of Curbit and Command)  
1.5-6 pts 2.1 SC/A G
- c. **Post-emergence**  
halosulfuron (Sanda) 0.5-0.66 dry ounce 75WG/A G  
paraquat (Grammoxone – Special local need 24 (c)) 1.5 Max 3SC/A, or,  
2.4 pts Inteon 2SC/A R  
clethodim (Select) 6-8 oz 2EC/A G  
sethoxydim (Poast) 1-1.5 pts 1.5EC/A G

**2. Direct Seeded – without plastic mulch**

- a. **Preplant Incorporated**  
bensulide (Prefar) 5-6 lb 4E/A G
- b. **Pre-emergence**  
bensulide (Prefar) 5-6 lb 4E/A G  
ethalfluralin plus clomazone  
(Strategy – jug mix of Curbit and Command) 1.5-6 pts 2.1 SC/A G
- c. **Post-emergence**  
paraquat (Grammoxone – Special local needs 24 (c)) 1.5 Max 3SC/A, or,  
2.4 pts Inteon 2SC/A  
clethodim (Select) 6-8 oz 2EC/A G  
halosulfuron (Sanda) 0.5-0.66 dry ounce 75WG/A G  
sethoxydim (Poast) 1-1.5 pts 1.5EC/A G
- d. **Postharvest – with or without plastic mulch**  
paraquat (Grammoxone – Special local needs 24 (c)) 1.5 Max 3SC/A, or,  
2.4 pts Inteon 2SC/A R

**No-Till Pumpkins (managing cover crop plants and weed escapes):**

- paraquat (Grammoxone – Special local needs 24 (c)) 1.5 Max 3SC/A, or,  
2.4 pts Inteon 2SC/A, 1 or more applications R
- glyphosate (Roundup Ultra or Glyphomax Plus or Touchdown IQ) 3 pts/A,  
or, (Roundup Ultra Max) 2.4 pts/A, 1 or 2 applications G
- bensulide (Prefar) 5-6 lb 4E/A G
- ethalfluralin plus clomazone (Strategy – jug mix of Curbit and Command)  
1.5-6 pts 2.1 SC/A G

Although some growers raise pumpkins in no-till, it is not recommended because of:

- 1) risk of herbicide injury to seedling pumpkins because of poor closure of the seeding furrow;
- 2) lack of post-emergent herbicides to kill lambsquarter or deal with morning glory and nightshade;
- 3) possible increased reliance on Sandea (halosulfuron), which would probably increase weed resistance to ALS inhibitor herbicides.

## Disease Pests of Pumpkin in New Jersey

### Primary Disease Pests

**Powdery Mildew** (*Podosphaera xanthii*) Cucurbit powdery mildew (PM) is an important fungal disease of pumpkin in the northeast. The pathogen may overwinter on infested crop debris, and is largely wind dispersed from southern states into the northeast each year. Powdery mildew lesions first appear as white, dime-sized areas of powdery growth on either the top or bottom sides of infected leaves. As the infections progress, entire leaves and stems may be covered with the powdery-white growth (made up of asexual spores) giving an infected field an overall grayish look. Powdery mildew does not require free moisture for spore germination, and may be more severe under dry, hot conditions



**Powdery mildew on pumpkin leaves.**

which may otherwise stress the pumpkin crop. Initial infections usually begin to show up at vine run in mid-summer. Fungicide applications should not begin until the threshold of 1 lesion per 50 leaves is reached. By using this threshold, one or more applications of fungicides can be eliminated without sacrificing yield<sup>2</sup> when compared to typical spray schedules. Preventive control measures should be made early as dense foliage and warm weather favors disease development. Powdery mildew infections kill foliar tissue slowly, weakening the plant and resulting in poor fruit size, color, and weak stems (handles). Primary losses come from sunscald injury or from fruit not being marketable because infected handles turn brittle and break off easily, greatly reducing the quality of the fruit. Making a profit on the crop requires high quality fruit. For this reason in non-scouted fields, fungicides should begin with a 7-day spray schedule beginning at vine run, and continuing until the crop is fully mature.



**Pumpkin stem (handle) infected with powdery mildew** – photo Andy Wyenandt

Powdery mildew infections often reach extremely high levels in fields, and resistance to commonly-used fungicides has been reported in the northeast. To prevent resistance development, vegetable pathologists recommend that classes of fungicides (FRAC groups) be rotated to provide adequate control and reduce the chances for fungicide resistance development. Otherwise, there is the risk of the pathogen may develop resistance to one or more fungicides. Currently, growers are advised to begin the fungicide programs at the onset of vine run with protectant

fungicides such as chlorothalonil or sulfur and rotate at 7 to 10 day intervals with a demethylation inhibitor (DMI) type fungicide (Nova, Procure, FRAC group 3) mixed with a broad spectrum protectant such as chlorothalonil (FRAC group M5). Strobilurin and DMI class fungicides are systemic and provide control on plant parts not directly contact with the fungicide. Powdery mildew resistance to DMI fungicides is known as quantitative resistance (such that, a higher rate of active ingredient may be more effective than a lower rate), and therefore, only the highest rates of the DMI's should be used. Recently, resistance to the strobilurin fungicides (FRAC group 11) has been documented in parts of the U.S., including New York and New Jersey. This resistance is known as qualitative resistance (where once the fungus becomes resistant to the chemistry, the fungus becomes completely resistant to all rates and formulations), and therefore, strobilurin fungicides should be used judiciously. Scouting the field early in the growing season for PM lesions is helpful in initiating a fungicide program when infection levels are initially low. In general, systemic fungicides should be used earlier in the growing season when PM populations are lower which helps to reduce the risk of resistance development. As the crop matures, the

emphasis should be put on broad spectrum protectant fungicides such as chlorothalonil, sulfur, or mineral oil because resistance to these materials does not occur.

Some varieties of both jack-o-lantern and sugar types are tolerant to PM. In these varieties, the disease may appear later than in susceptible types and may progress more slowly. These varieties may permit later initiation of fungicide programs, thus saving money on fungicide applications.

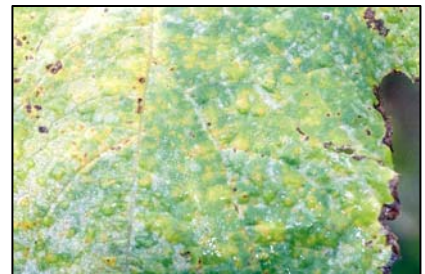
Beginning with vine-run, scout fields at least once a week, checking five consecutive plants each in ten random locations throughout the field. Observe two mature leaves per plant for the presence of powdery mildew lesions. Initiate the protectant fungicide program when more than one lesion per fifty mature leaves is found.

**Threshold**

1 lesion per 50 leaves.

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**Downy mildew** (*Pseudoperonospora cubensis*) Downy mildew (DM) has become an important disease in cucurbit crops in recent years. The pathogen does not overwinter in northern climates, but can be found year round in parts of southern Gulf states and Florida. Once established DM produces spores that are easily spread in the field by wind and splashing rain. Downy mildew infections result in rapid defoliation, and will greatly reduce yield if infections occur early in the production season. Initially, DM appears as yellow (chlorotic) spots on the upper leaf surface.



**Downy mildew infection, showing chlorotic spots on upper leaf surface** – photo Kris Holmstrom



**Downy mildew sporulation on lower leaf surface** – photo Kris Holmstrom

Under moist conditions, purplish-black spores will develop profusely on the underside of leaves. Unlike powdery mildew, downy mildew will only sporulate on the undersides of leaves.

Control of Downy mildew, like control of Powdery mildew, begins with early scouting and preventative fungicide applications. Scout fields early in the production season, especially during periods of cool, wet weather.



**Severe downy mildew infestation, showing dead, wilted leaves** – photo Kris Holmstrom

Growers can anticipate with some accuracy the probability of DM appearing in their region by regularly monitoring the Downy Mildew Forecast Center provided by North Carolina State University. See [www.ces.ncsu.edu/depts/pp/cucurbit/](http://www.ces.ncsu.edu/depts/pp/cucurbit/).

The website publishes confirmed reports of DM from areas around the US, and provides wind trajectories and weather reports for its predicted pathways. The forecast predicts the likelihood of DM infection in areas downwind of affected fields. When DM has been detected in a region, cucurbit growers should switch from protectant programs to fungicides labeled specifically for Downy mildew control, even if their fields show no symptoms.

**Threshold**

Presence of the disease in region.

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**Phytophthora blight** – Phytophthora blight (*Phytophthora capsici*) is one of the most destructive soil-borne diseases of cucurbits in the US. Without proper control measures, losses to Phytophthora blight can



**Phytophthora fungal growth on underside of fruit** – photo Andy Wyendant

be extremely high. Heavy rains often lead to conditions that favor Phytophthora blight development; in low, poorly drained areas of fields the disease can progress to the crown and stem rot phases. Infections often occur where water is slow to drain from the soil surface and/or where rainwater remains pooled for short periods of time after heavy rainfall.

Infected plants show signs of wilting in the early stages of the disease. Black lesions develop on stems near the soil line. In favorable conditions, the fungus sporulates on infected stem tissue producing white, fungal growth. During periods of heavy wind and rain, spores are splashed to surrounding healthy vines, resulting in the aerial phase of the disease with symptoms similar to crown infections. Infected vines develop blackish-brown

lesions and produce spores that are then carried by wind and rain to fruit and vines of surrounding healthy plants. Infected fruit often become soft while still attached to the plant, and in disease-favorable conditions, the fungus will sporulate on fruit, producing a white, mildew-like appearance. Spores from infected fruit can be splashed to other fruit and surrounding plants, leading to further disease development.

Phytophthora blight epidemics can occur in a relatively short period of time, especially following a few days of warm weather with periods of heavy rain. Control of Phytophthora blight begins with recognizing the factors which predispose cucurbit crops to potential disease development and using best management practices to mitigate potential disease development.

- 1. Proper crop rotation.** Tomato, cucurbit crops, pepper and eggplant are all susceptible to Phytophthora blight. Therefore, it is critical that a proper crop rotation be followed. Rotate away from these crops for 2 years minimum. Four years or more is preferred. Never plant susceptible crops in the same field, or area of field, during the same season if multi-cropping, or in consecutive years. Inoculum (spores) produced from one crop can survive in the soil between crops from year to year. Use a subsoiler to break up any hardpans in the field. Subsoiling should help to improve drainage during the production season.
- 2. Avoid planting in fields with history of Phytophthora blight or in low-lying or poorly drained areas of a field with a history of Phytophthora blight.** If possible, avoid planting in fields with a known history of Phytophthora blight. Use these fields to produce other non-susceptible vegetable crops. If you must plant in a field that has a history of Phytophthora blight, avoid planting susceptible crops in areas that you have designated as low-lying or poorly drained. Planting susceptible crops in low-lying areas of a field with a history of Phytophthora blight will greatly increase the potential for Phytophthora development.
- 3. Always allow water to drain away from field.** Do not allow water to pool at ends of rows. Discing (cut harrowing) and cleaning up alleyways often creates soil dams at the ends of rows. If this occurs, remove excess soil. If “ponds” develop on corners or edges of field, dig trenches to allow water to run out of field.
- 4. Take measures to reduce chances for further Phytophthora development in field during growing season.** If symptoms of Phytophthora blight develop, take appropriate measures to reduce the chances for further spread of the disease. This can be accomplished a number of ways.

First, always rogue out infected plants during the production season sooner than later. Removing infected plants early in the growing season may help to reduce disease later in the season. Leaving infected plants in the field during the growing season will allow them to serve as an inoculum source. If growing on black plastic mulch, remove the mulch in areas where the soil remains wet or waterlogged between rows, or, in areas where plants are starting to show early disease symptoms. This may help to the dry soil, thereby reducing conditions favorable to the pathogen. Avoid overhead irrigation, if possible, especially if the aerial phase is present.

- 5. Proper control with chemical applications.** In recent years, *P. capsici* has developed resistance to mefenoxam in many areas throughout the US. Fungicide resistance such as this occurs when a small proportion a fungal population mutates in order to avoid fungicide toxicity. Over time, resistant fungal populations build in the field as susceptible populations are killed. Once resistance develops, fungicide applications against resistant fungal populations are no longer effective. In order to reduce the chances of fungicide resistance developing, always follow and apply fungicides according to label recommendations.

**For control of the crown rot phase of Phytophthora blight, apply:**  
**mefenoxam**--1-2 pt Ridomil Gold 4E/A or 2-4 pt Ultra Flourish 2E/A

**For suppression of the fruit rot phase of the disease, apply the following when conditions favor disease development:**

**Forum**--6.0 fl oz 4.18SC/A (must be tank mixed with another fungicide active against Phytophthora blight on pumpkins and winter squash such as fixed copper), or  
**Ranman**--2.75 fl oz 400 SC/A (*plus* an adjuvant, no not tank mix with copper), or  
**Tanos**--8-10 oz 50 WDG/A

**Threshold:**

Infested fields with known Phytophthora problems.

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## **Secondary Disease Pests**

**Gummy Stem Blight or Black Rot** - Gummy stem blight (GSB) or black rot (BR) of cucurbits is caused by the soil-borne fungus, *Didymella bryoniae*. Gummy stem blight is the phase of the disease which affects foliage and stems, and black rot is associated with fruit rot. In pumpkin, GSB is often evident as a marginal necrosis that proceeds inward toward the center of the leaf in a wedge-shaped pattern. As the tissue dries and turns tan, it may be possible to see small black fruiting bodies (the spore producing structures) within the affected tissue. Ultimately, entire leaves will die. Infected stems will turn tannish-brown with black fruiting bodies developing in lesions. Black rot will cause brown to black lesions anywhere on the surface of a fruit. As lesions enlarge, it penetrates into the seed cavity, and develops black and white fungal growth on the surface. Wounds to the fruit surface will increase the likelihood of fruit infection. The disease is favored by temperatures near 75°F, with high relative humidity and periods of leaf wetness. Spores are dispersed by splashing water. In pumpkins, GSB and BR are often not apparent until vines are older, due to the resistance of immature tissue to infection. Foliar symptoms will appear on older leaves, and fruit symptoms will develop on maturing fruit. The fungus may reside on infected seed, or overwinter in infected debris. It is important that seed be treated, and certified to be free of the pathogen. If a field is suspected to have GSB or BR, the crop residue should be plowed under as soon as possible to hasten decomposition. Practice a 2-year minimum rotation between cucurbit crops. Mature fruit can become infected by injury during harvest. In New Jersey, both forms of this disease have been largely controlled in the past by fungicide schedules



required for PM control. It is important to note, however, that current chemical control recommendations rely heavily on the use of strobilurin-class fungicides (Quadris, Flint, and Cabrio). GSB and BR resistance to strobilurin fungicides has been documented, and is spreading. In New Jersey, strobilurin resistant GSB was suspected on watermelons in several areas during the 2003 season. As with PM resistance to strobilurin class fungicides, the resistance is not affected by rate, and switching from Quadris to Flint or Cabrio will not improve control. The strobilurins should always be tank mixed and rotated with another class of fungicide. If resistance is suspected, they should be dropped from the program. Broad spectrum protectants such as chlorothalonil will provide adequate control, and are not likely to result in resistant strains.

### **Threshold**

Presence of the disease.

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**Bacterial leaf spot** and **Angular leaf spot** - Bacterial leaf spot (BLS) and angular leaf spot (ALS) are bacterial diseases that cause damage to foliage and injury to fruit. Although serious infections do not occur annually, in some years, infections may lead to economic loss if not controlled properly. The bacteria (*Xanthomonas* and *Pseudomonas* spp.) are seed-borne, and may overwinter in infested debris. Both diseases are favored by warm temperatures with high humidity. Prolonged leaf wetness contributes to infections, and both diseases are dispersed with splashing water. Symptoms first appear as small, water-soaked lesions on fully expanded leaves. The lesions turn dry and tan, and may fall out causing 'shotholes'. Fruit lesions begin as water soaked-spots, which turn brown and become sunken causing a 'scabby' appearance on infected fruit. The lesions act as entry points allowing soft rotting organisms to enter, causing further collapse of fruit.



**Angular leaf spot infection, showing whitish residue.** Photo from Ohio St. Veg Net.

Use of certified disease-free seed is recommended. Seed treatments may not prevent all infections if bacteria are located within infested seed coats. Both bacterial infections may be spread by field workers coming in contact with infected plants during periods of leaf wetness. Trickle irrigation is favorable over sprinkler or overhead, as the latter may disperse bacteria within the field. Because both bacteria can overwinter on infected debris, it is important to fully incorporate all debris as soon as possible after harvest. This will enhance decomposition and lessen the likelihood of overwintering. Foliar symptoms are often present prior to fruit infection. If foliar symptoms appear, commence 7-10 day applications of a fixed copper at labeled rates. If a regular foliar fungicide program is already in place for fungal diseases, add fixed copper at labeled rates to the schedule.

### **Threshold**

Presence of the disease.

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**Bacterial wilt** (*Erwinia tracheiphila*) of cucurbits is a bacterium vectored by cucumber beetles (see primary insect pests section), and although more serious in muskmelons and cucumbers, bacterial wilt is capable of causing significant losses in pumpkin if not controlled properly. The bacterium survives the winter in infected beetles. Infected beetles feed on emerging seedlings or on new transplants, and transmit the bacteria during feeding. Plants in the 0-4 true leaf stage are most vulnerable. Plants infected at this early stage will continue to grow, and during the late summer will begin to wilt during the heat of the day. Plants



often appear to “recover” at night for a few days.

Symptoms of bacterial wilt may be confused with *Phytophthora* crown rot or with damage caused by squash vine borer (the larva of a moth) as both of these pests will also cause plants to rapidly collapse and die. The stems of infected plants will often have a coppery-tan appearance if cut longitudinally at the base of the stem. Control of bacterial wilt begins with controlling cucumber beetles during the 0-4 true leaf stage. Beetles may be controlled with foliar applied insecticides, or with a systemic insecticide at planting or in the transplant water. Systemic insecticides will limit feeding more effectively than the use foliar applied insecticides.

**Threshold**

Two or more striped cucumber beetles per site at six or more sites in the field.

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**Plectosporium blight** (6), caused by the fungus, (*Plectosporium tabacinum*) is a relatively new disease that was first identified in the eastern US in 1988 and now occurs in New Jersey, as well as most of the eastern states. *Plectosporium* blight development is favored by cool, wet, rainy weather. The fungus can overwinter in plant debris and can persist in the soil for several years. Fungal spores are spread by splashing rain or by overhead irrigation. *Plectosporium* blight infects both vines and fruit causing spindle-shaped white ‘diamond’ lesions on vines and fruit. Early vine death may occur on severely infected plants. The white russetting on fruit may make fruit cosmetically unmarketable and may lead to further decay caused by secondary pathogens during post harvest. Along with the use of preventative fungicide applications, a 3 year crop rotation is recommended between cucurbit crops. Choosing fields with good drainage and air circulation and practicing good field sanitation practices at the end of the season will help reduce the disease incidence. Reducing or eliminating overhead irrigation will also reduce the spread of the disease.

**Threshold**

Presence of the disease.

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**Fusarium diseases** (7, 8) Several species of *Fusarium* may cause injury to pumpkin vines and fruit. *Fusarium solani* f. sp. *cucurbitae* race 1 is a common soil-borne fungus that can be difficult to control once established in a field. Once the soil in a field is infested with *Fusarium* it may be years before susceptible crops can be safely planted in the field again. Fields in which pumpkin crops are planted continually or in short rotations are extremely susceptible to *Fusarium* fruit rot. In cucurbits, *Fusarium oxysporum* may attack root systems of plants disrupting the conductive tissue causing a progressive wilt over the course of the growing season. Weather conditions and other factors determine how rapidly wilt progresses. Fruit lesions, caused by *Fusarium solani* and few other species, may occur on fruit during any stage of development in direct contact with the soil. Management of the disease depends upon crop rotation and other cultural practices. Recently, research conducted at Ohio State University indicated that cover crops such as winter rye and/or winter rye + hairy vetch and/or small grains may reduce the incidence of *Fusarium* in pumpkins by preventing fruit from coming into direct contact with the soil. Infected fruit should be removed from the field immediately.

**Threshold**

None

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**White mold** is caused by the fungus *Sclerotinia sclerotiorum* is a common soil-borne fungus. The pathogen can infect many different crops including bean and tomato. Cool, wet conditions favor disease development. Lesions initially appear as water-soaked lesions on fruit that later develops into a white

fluffy mold as fruit tissue breaks down. White masses of the fungus and black sclerotia may develop either on vines and fruit. Sclerotia can persist in the soil for several years and act as a source of inoculum in following production seasons. Fungicides are seldom useful and crop rotation with other non-susceptible crops is necessary for control. Where pumpkins are grown on small farms with a number of other vegetable crops it may be difficult for proper crop rotation to prevent development and spread of the fungus. Rouging out infected plant material may help in reducing the incidence of the disease. Fruit left in field for curing for long periods prior to sale are extremely susceptible to white mold.

### **Threshold**

None established.

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**Virus diseases** - There are a number of aphid-vectored mosaic viruses common on pumpkin in New Jersey. In general, virus symptoms are more severe the earlier the plants become infected in the growing season. **Both fruit and foliage will show symptoms of virus-infection.** Plants that are infected prior to flowering may show symptoms of leaf mottling, wrinkling, and distortion



**Note yellow rings from viral infection**  
- photo Joe Ingerson-Mahar

that resemble 2-4 D herbicide injury. Fruit produced by plants infected at an early stage are likely to have very rough skins and ringspots (ring-shaped areas of discoloration) on ripe fruit. Often, no fruit are produced if infection occurs early in the production season. When plants are infected after fruit set, damage may be minimal or absent. Wild cucurbits and several other weeds, including common lambsquarters act as reservoirs for viruses of cucurbit crops. Aphids feeding on these alternate hosts can transmit the virus to cucurbits. Even small within field aphid populations can spread viruses



**Virus infected leaf** - photo  
Andy Wyenandt

between plants. It is critical to prevent aphid feeding on transplants and significant injury can occur when aphid infested transplants are planted into the field.

Scouting and treating foliage with insecticides if aphids approach threshold levels may not provide adequate protection against virus if aphids move into newly emerged or planted fields quickly. A number of pumpkin cultivars have resistance/tolerance packages to one or more important viruses. Another practical control method is the use of systemic insecticides at planting or transplanting. Neo-nicotinoid insecticides (Admire, Actara) at seeding or transplanting are very effective in reducing aphid populations and provide excellent protection for small plants.

### **Threshold**

The action threshold for preventing large aphid populations is twenty or more leaves per fifty leaves with more than five aphids.

There is no threshold for the prevention of aphids vectoring viruses. The use of resistant varieties or systemic insecticides for either transplants or in field seed planting, are the best means of reducing early viral problems.

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## **Chemical Controls for Diseases of Pumpkins in New Jersey**

There are no state records for fungicide use in pumpkins.

The need to manage disease pests necessitates the use of fungicides, which comprise the bulk of pesticide applications to pumpkins. Typically, the first application is recommended at vine run and continues at 7 to 10 day intervals until the fruit are ready for harvest. Because of the concern for powdery mildew resistance development and other potentials for fungicide resistance development, New Jersey cucurbit growers are taught the importance of rotating fungicide chemistries (FRAC groups).

Most fungicide application programs are scheduled for powdery and downy mildew control. For powdery mildew control, rotate chlorothalonil (FRAC group M5) plus Nova (myclobutanil, 3) or Procure (triflumizole, 3) with chlorothalonil plus Pristine (pyraclostrobin + boscalid, 11 + 7). If downy mildew is present in the region, tank-mix and rotate one of the following with a protectant such as chlorothalonil (M5): Tanos (famoxodone plus cymoxanil, 11 + 27); or Curzate (cymoxanil, 27); or Ranman (cyazofamid, 21) or pyraclostrobin (Cabrio, 11). *See Table 3 which follows for the Current (2006) Pesticide Recommendations for Disease Pests, Product Rates Per Acre and Use (4)*

### **Chemical Use in IPM Programs**

The Rutgers Vegetable IPM Program uses the threshold of 1 powdery mildew lesion per 50 leaves to initiate fungicide use. By using this threshold, fungicide applications can often be delayed from 1 to 3 weeks.

### **Chemical Use in Resistance Management**

Alternating fungicides with different modes of action is the primary means of managing fungicide resistance development in pumpkin crops. Using FRAC groups as a means for identifying fungicide materials with similar modes of action and resistance risk are a primary means for reducing the chances for fungicide resistance development in important fungal diseases in pumpkin.

### **Alternatives**

None.

### **Cultural Control Practices**

Following proper crop rotations and avoiding overhead irrigation along with the use of resistant/tolerant pumpkin cultivars and fungicide resistance management programs are recommended.

### **Biological Controls**

None.

### **Post Harvest Control Practices**

Farmers are encouraged to remove mature fruit from field as soon as possible, and till under crop residues as soon as harvest is completed to help break disease cycles.

**Table 3: Current (2007) Pesticide Recommendations for Disease Pests,  
Product Rates Per Acre and Use** <sup>(4)</sup> (Key: G=general, R=restricted)

<b>Damping off</b>	
<b>mefenoxam</b> – 1-2 pt Ridomil Gold 4E/A or 2-4 pt Ultra Flourish 2E/A	G
<b>Angular leaf spot/bacterial leaf spot</b>	
<b>fixed coppers</b> – at labeled rates	G
<b>Powdery Mildew</b>	
Tank mix <b>chlorothalonil</b> – 2-3 pt 6F with either	
<b>myclobutanil</b> (Nova – 5 oz 40WP/A), or	G
<b>triflumizole</b> (Procure – 4-8 oz 50 WP/A)	G
and alternate with	
<b>micronized wettable sulfur</b> – 4 lb 80W/A, or	G
<b>chlorothalonil</b> – 2-3 pt 6F	G
plus	
<b>pyraclostrobin + boscalid</b> (Pristine – 12.5-18.5 oz 38 W/A)	G
<b>Downy mildew</b>	
Tank mix either	
<b>chlorothalonil</b> – 1.5-2 pt 6F/A, or,	G
<b>maneb</b> – (Manex- 2-3 pt 4F/A),	G
with	
<b>cyazofamid</b> - (Ranman – 2.1-2.75 fl oz 400 SC/A), or,	G
<b>propamocard hydrochloride</b> - (Previcur Flex – 1.2 pt 6F/A), or,	G
<b>cymoxanil</b> (Curzate – 3.2 oz 60 DF/A), or,	G
<b>pyraclostrobin + boscalid</b> (Pristine – 12.5-18.5 oz 38 W/A), or,	G
<b>famoxodone + cymoxanil</b> - (Tanos – 8 oz 50 WDG/A), or,	G
<b>pyraclostrobin</b> (Cabrio – 8-12 oz 20 WG/A)	G
<b>Plectosporium blight</b>	
<b>chlorothalonil</b> – 1.5-2 pt 6F/A, or	
<b>maneb</b> – (Manex- 2-3 pt 4F/A)	
<b>Gummy stem blight (Black rot)/Anthracnose</b>	
Alternate	
<b>chlorothalonil</b> – 2-3 pt 6F	G
with a tank mix of chlorothalonil plus	
<b>pyraclostrobin + boscalid</b> (Pristine – 12.5-18.5 oz 38 W/A), or,	G
<b>azoxystrobin</b> (Quadris – 11.0-15.4 fl oz 2.08F/A, or, Amistar – 3.5-5.0 oz 80 WDG/A),	G
or,	
<b>pyraclostrobin</b> (Cabrio – 8-12 oz 20 WG/A)	G
<b>Phytophthora blight; for suppression only apply;</b>	
<b>dimethomorph</b> - (Forum – 6.0 fl oz 4.18 SC/A) plus fixed copper at labled rates, or,	G
<b>cyazofamid</b> - (Ranman – 2.75 fl oz 400 SC/A); do not tank mix with copper, or,	G
<b>famoxodone + cymoxanil</b> - (Tanos – 8-10 oz 50 WDG/A)	G

Note: Cabrio, Tanos, Pristine and Amistar/Quadris all belong to FRAC group 11 and should be tank-mixed when possible. Do not apply FRAC group 11 fungicides consecutively.

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## Vertebrate Pests of Pumpkin in New Jersey

### *Primary Vertebrate Pest*

**White-tailed deer** - White tailed deer (*Odocoileus virginianus*) are destructive pests of pumpkin production in specific locations. Usually little damage is sustained by seedlings, except when deer pass through fields trampling plants. Most deer damage occurs just prior to harvest, when deer feed on mature fruit.

Deer either bite into and consume pumpkins or scar the rinds, rendering fruits vulnerable to disease or unmarketable due to rind defects. Some New Jersey farmers experience nearly 100% repeated crop losses due to deer feeding damage.

While chemical repellents are available as a non-lethal control measure, they do not successfully retard feeding. Under higher deer population densities, repellent efficacy breaks down completely. The high cost of deer repellents, combined with their low efficacy and need for repeated application makes repellents an ineffective choice for protecting commercial pumpkin crops.

The only effective non-lethal crop protection for suburban fringe pumpkin farms with high deer populations is installation of zinc-coated hi-tensile wire wildlife exclusion fence. Fencing is expensive, impractical, and unattainable for growers raising large pumpkins acreages on annually rotated or rented fields.

Without fencing, the most cost effective means of managing deer is for farmers to use existing regulated hunting seasons and to open lands under their control to hunters. When this fails, or in areas where farmers do not control deer habitat surrounding their damaged fields, they must contact local Fish & Wildlife Officers and secure Deer Depredation Permits to Shoot (PTS). In addition to excessive management time and cost of shooting deer under PTS, in suburbanized areas there are frequently municipal no-discharge ordinances, public opposition to shooting, safety concerns, and other problems. Many deer live in un hunted wooded public and private land “refuges” within one mile of fields. Thus, landowners hold the key to deer management by controlling access to hunting. Farmers need to discuss intolerable economic deer damage problems with their neighboring landowners, landlords, communities, and municipalities.

In more rural farming communities, dogs trained to harass deer can be placed to live in crop fields and be limited by “electronic fencing.” However, this is most useful on perennial crops, not pumpkins.

Observations from vegetable IPM personnel suggest that where dense foliage and vine growth occurs, deer are less likely to cause damage to the fruit.

### *Threshold*

Deer crop damage assessment, not the presence of deer or deer population density estimates, is the determining factor. Local deer population densities under 20 per square mile usually result in economically “tolerable” damage from deer. Deer densities between 25-40 per square begin to result in “intolerable economic damage” from deer. In many areas of NJ and the Mid-Atlantic states, deer densities in nearby areas to fields exceed 80-100 per square mile, resulting in losses from deer such that on thousands of acres of cropland, farmers have been forced to change selection of crops or abandon agriculture.

Even if growers adequately manage all the other pests listed in this profile, all these measures come to naught if the deer cannot be controlled or their impact minimized. Nearly all the costs of production will be realized before the most damaging aspect of deer predation occurs on the fruit, just prior to harvest.

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## *Secondary Vertebrate Pests*

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**Woodchucks** (*Marmota monax*) and **rabbits** (*Sylvilagus floridanus*) are minor pests of pumpkins. Damage is usually localized and limited to areas near their burrow. Both plants and fruit can be fed upon. Single animals may cause little damage but large numbers of either woodchucks or rabbits would be detrimental.

### *Threshold*

Presence.

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## **Chemical Use in IPM Programs**

None.

## **Chemical Use in Resistance Management**

None.

## **Alternatives**

Hunting, presence of dogs in the fields, and repellents (including human hair and moth balls), have been used with either no or little success for managing deer. Hunting can provide temporary relief, but segmented agricultural areas and woodlots, suburban areas with tree breaks and greenways found throughout New Jersey, and a general lack of natural predators afford deer with ideal habitat and ample food resources. The ideal approach to deer depredation above the economic damage threshold includes integrated wildlife management plans on wooded properties near farm fields. Wildlife management plans usually include access for recreational hunting because it is low cost and effective when professionally managed. Good management includes 2:1, 3:1, or even 4:1 antlerless to antlered harvest ratios required by the landowner of hunters, and/or Community-based Deer Management plans with the goals of maintaining deer herds below 25-40 deer per square mile, which is a generally useful threshold density at which growers begin to experience intolerable economic crop damage from deer feeding.

## **Cultural Control Practices**

When alternative methods such as hunting are unsuccessful, deer exclusion fencing, at substantial costs to farm operators is necessary for hi-value crop protection. Hi-tensile wire deer exclusion fencing is the only reliable non-lethal control method where deer populations exceed 40 deer per square mile and unmanaged, un hunted refuges exist within one mile of fields. The population density, neighboring unmanaged deer "refuges," and capital available on the farm determine the appropriate fencing method. Land Grant university fence installation designs vary (five or seven wire single strands; electrified single

strands; woven wildlife exclusion fence 80 inches in height with two strands of hi-tensile wire above for 96 inch height). Fences, especially electric, require proper installation and maintenance for long, effective life. Deer fencing provided through the New Jersey Department of Agriculture is available and useful for small areas. Temporary, portable fencing is available for small fields at moderate cost and effectiveness. Rutgers NJAES Extension has a fact sheet on this very useful design for small market farmers. However, fixed fencing is expensive and cannot be moved once in place. Larger acreages would need larger rotational fields – likely to be outside of deer fenced areas. In order to keep rotational options open, farmers often rent land from other land-owners who may not agree to the deployment of deer fencing.

### **Biological Controls**

None significant. Natural populations of coyote and bear are increasing in the state, which ultimately may help manage the deer herd.

### **Post Harvest Control Practices**

None.

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## **Risk of Worker Exposure to Pesticides in Pumpkin Production**

For most pumpkin growers, their greatest point of risk of exposure is during the mixing of pesticides. Most growers have cabs on the tractors that prevent contamination by drift to the applicator. It is unknown how many have cabs that are equipped with their own ventilating systems.

There may be some hand-weeding by field crews, depending upon the amount and species of weeds that survive the herbicide treatments. Generally hand-weeding is done by workers using long-handled hoes for rouging out herbicide-resistant weeds or weed escapes that managed to evade the applied herbicides. Hand-weeding is usually limited in the early growth stages of the pumpkins and exposure to residues would be minimal as long as re-entry times are observed for fungicide and insecticide applications.

Pumpkins are hand harvested either by farm crews or by consumers in pick-your-own situations. As long as pre-harvest intervals and re-entry times for pesticide use are observed, there should be minimal exposure to residues.

Overall, in the production of pumpkins, there would be minimal risk of pesticide exposure to field workers as long as the re-entry intervals are observed.

### **Crop Scouting**

Field scouting of pumpkins begins within the week after plants are either transplanted or have germinated in the field. Whoever is scouting the field(s) may be exposed to pesticide residue; however, taking precautions will greatly reduce or eliminate concerns of contamination. Following the regulations for field re-entry times, not scouting the field while the foliage is still wet from rain or pesticide applications, and wearing appropriate clothing will minimize these concerns.

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