Crop Profile for Pumpkins in Virginia

Prepared: February 2005

General Production Facts* and Regions[1,2]

- In 2002, 271 farms planted an estimated 2,500 acres of pumpkins and 2,271 acres were harvested in Virginia.
- Pumpkin acreage is distributed across the state. The top five pumpkin producing counties in Virginia are Carroll (275 acres), Nelson (252), Augusta (210), Hanover (121), and Halifax (95). Other counties include Scott, Montgomery, Roanoke, Grayson, Patrick, Bedford, and Tazewell.

Image Credit: MultiMedia and Photography Unit of the Department of Communication Services, North Carolina State University, Raleigh, NC.

**The Virginia Agricultural Statistics Service and the National Agriculture Statistics Service no longer reports on the general production or value of pumpkin in Virginia.*

Cultural Practices[3, 4, 5]

There are many pumpkin varieties available to growers that are recommended for conditions in Virginia. Varieties less than 5 lbs. include *Munchkin*, *Wee-B-Little**, *Baby Pam*, *Ironsides**, *Baby Boo*, *Baby Bear**, *Touch of Autumn**, and *Pik A Pie**. Pumpkins 5 to 10 lbs. include *Small Sugar*, *Casper*, and *Mystic Plus**. Pumpkins 10 to 20 lbs. include in size *Wizard**, *Merlin**, *Magic Lantern**, *Gold Strike**, *Pro Gold 510*, and *Sorcerer**. Finally, varieties more than 25 lbs. include, *Gold Rush*, *Autumn King**, *Howden Biggie*, *Atlantic Giant*, and *Prize Winner*. Variety selection depends on several factors, such as market acceptability, yield, and horticultural characteristics.

** Indicates hybrid varieties*

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When seeding or planting no-till pumpkins, plant into a small grain cover crop or hairy vetch. Many pumpkins are planted no-till into a wheat cover crop that has been killed upon reaching the head stage or are planted no-till following wheat harvest. A cover crop on the soil surface will reduce dirty pumpkins at harvest, provide some weed suppression, and minimize fruit rot by creating a barrier between pumpkins and the soil. Avoid fields with heavy yellow nutsedge populations or any broadleaf weed that cannot be controlled with available preemergence herbicides. Since cultivation is usually not an option in no-till planting systems and postemergence herbicides are not available to control escaped weeds, choose fields carefully for no-till pumpkin production.

Seed pumpkins in the field June 15-July 5 in cooler areas, and June 15-July 15 in warmer, southern areas. The recommended spacing for pumpkins is based on vine habit and average fruit size of the variety. For large vines with fruit over 30 lbs., space the rows 10-12 ft. apart with 5-6 ft. between plants in a row. For large vines with fruit 12-25 lbs., space rows 7.5-9 ft. apart with 4 ft. between plants in the row. For large/medium vines with fruit 8-15 lbs., space rows 6-7.5 ft. apart with 3-4 ft. between plants in the row. Finally, for small vines/bushes with fruit less than 8 lbs., space rows 5-6 ft. apart with 2 ft. between plants in a row.

If mulching, lay black plastic mulch before field plantings. This conserves moisture, increases soil temperature, and increases early and total yield. If there is a history of soilborne diseases in the field, fumigation will be necessary. Fumigated soil helps control weeds and soilborne diseases, but alone may not provide satisfactory weed control under clear plastic. Black plastic or paper can be used without an herbicide.

When applying fertilizer, at least 50% of the nitrogen should be in nitrate form. Fertilizer must be applied during bed preparation.

Harvest dates typically range from September through November. Pumpkins are harvested at full maturity. This requires a growing season of 90 to 120 days. Pumpkins are fully mature when they resist penetration with your thumbnail or when they will not scratch easily when you drag your fingernail across the outer surface. Senescing vines are also a sign of ripeness. When harvesting the fruit, use a sharp knife or snips, and leave a few inches of dry stem attached to each fruit. Never pick up freshly harvested fruit by the stem since it may separate from the fruit. Pumpkins can withstand a light frost but should be harvested before a hard freeze. Also, use care in handling fruit to prevent wounds. Wounding can negate benefits from a season-long fungicide program. After harvest, cure pumpkins at temperatures between 80°F to 85°F with a relative humidity of 75%-80% for 10 days. After curing, store pumpkins at 50°F to 55°F with 55% relative humidity. Pumpkins stored in this manner may keep for two to three months.

Worker Activities

During the growing season, worker activities in the field include seeding (June-July), cultivating, scouting, irrigating, spraying, occasional hand weeding, and harvesting (September-November). Strictly following re-entry intervals (REIs) should minimize any risk of exposure to pesticides during these activities. If workers are required to go back in the field before the proper time limit has expired then personal protective equipment (PPE) is worn. Activities that bring workers in direct contact with the plants during the growing season are generally limited to harvest time because the fruit is hand picked by the workers.

Special Use Labels

Section 18 Emergency Use Exemption and Special Local Need 24(c) labels are used to supplement the chemical tools available to producers for pest control. Once the problem or gap in pest control has been identified, specialists submit the proper documentation for the Emergency Use/Special Local Need label. Thus far, Extension specialists have been successful in obtaining these labels. Special Local Need (SLN) labels in Virginia are granted by the Virginia Department of Agriculture and Consumer Services (VDACS) and are usually only valid for limited time intervals. Section 18 Emergency Use labels are evaluated and granted by the Environmental Protection Agency (EPA) and can be renewed annually. Without these temporary use labels, pest control in vegetable crops might be extremely difficult for producers.

Insect Pests

Control recommendations found below were modified from information presented in the 2004 Commercial Vegetable Production Recommendations-Virginia[6], unless otherwise noted.

INSECTS[7]

In general, squash bug, squash vine borer, and cucumber beetles are the most economically important insect pests of pumpkin in Virginia. Other important pests include: spider mites, which can be particularly devastating in hot, dry years, and aphids, especially after cool springs. Other minor pests include: seedcorn maggots, serpentine leafminers, pickleworms, cabbage loopers, and cutworms.

Aphids

In general, aphids feed on plant sap, which may reduce plant vigor, size, and yield. Also, as they feed on the underside of the leaves, aphids excrete honeydew. This, in turn, leads to the growth of black, sooty mold, which may block out sunlight and thus reduce plant yield. In addition, aphids can vector certain plant viruses. In particular, the melon aphid is instrumental in transmitting the cucumber mosaic virus, which can be devastating to pumpkin production.

Monitoring: If a systemic insecticide such as imidacloprid or thiamethoxam is not applied at planting, then aphid scouting is recommended. Scouting for melon aphids should begin as soon as plants form runners. Examine two runners at five sites in the field. Record the number of runners with live aphids present. Treatment is recommended if greater than 20% of runners have aphids.

Chemical Control: Systemic insecticides applied at planting are the best method of control. If foliar sprays are used, then thorough spray coverage beneath leaves is important. See the *Chemical Insect Control* section for recommendations.

Biological Control: A number of natural enemies such as ladybird beetles (adults and larvae), lacewing larvae, syrphid larvae, parasitic wasps, and fungal pathogens will reduce aphid populations. Natural enemies will often keep aphid populations below damaging numbers and, therefore, should be considered before

making an insecticide application. However, if the spread of virus is of concern, chemical treatment will be necessary.

Cultural Control: Plant disease-free certified seed. Avoid planting fields immediately downwind of a barrier such as hedgerows or woodlots, which reduce wind velocity and increase the number of dispersing aphids falling into fields. These barriers can also cause overfertilization with nitrogen, which results in lush growth attractive to aphids. Use resistant varieties whenever possible.

Cabbage Looper, *Trichoplusia ni*

Cabbage loopers may be identified by their pale green color, thin white stripes down the back and sides, and their doubling-up or looping movement. These insects feed on the underside of leaves, producing ragged holes of various sizes. Feeding begins in late July or early August and usually continues through harvest. Healthy plants can usually sustain feeding injury unless populations become exceedingly large. Several generations can occur during a year. Loopers are not usually serious pests of pumpkins in Virginia.

Monitoring: Check leaf-feeding levels in the field at least weekly. Healthy and older plants can usually withstand moderate defoliation before economic yield loss to the fruit occurs. Moth activity can be monitored at blacklight traps.

Chemical Control: See the *Chemical Insect Control* section for recommendations.

Biological Control: There are several parasitic wasps and predators that attack the cabbage looper. Also, a nuclear polyhedrosis virus (NPV) can substantially reduce population levels of larvae, especially after a period of precipitation.

Cultural Control: No current recommendations for commercial production.

Cucumber Beetles and Rindworms
Spotted Cucumber Beetle, *Diabrotica undecimpunctata howardi*
Striped Cucumber Beetle, *Acalymma vittata*

Both the spotted and striped cucumber beetles (adults and larvae) may severely reduce pumpkin productivity. These pests are the number one concern of growers in Virginia. Adults overwinter in wooded areas and fields, then migrate in the spring to cucurbit crops. Adults mass on plants and feed voraciously on the foliage and stems, often causing girdling. Girdling will greatly reduce plant stands, particularly if plants are infested at an early growth stage. Adults will also feed on the blossoms of developing plants, causing later scarring of the fruit[8]. Cucumber beetles cause direct damage to the pumpkin rinds. Treatment to reduce feeding damage to rinds will prevent or reduce the incidence of black rot. Cucumber beetles may also transmit bacterial wilt. However, most varieties of pumpkins are not susceptible to this disease.

In addition to the damage adult cucumber beetles bring about, the larval stage, otherwise known as a rindworm, feeds directly on the roots and on the pumpkins as well. This feeding typically occurs at the bottom of the fruit where the pumpkins contact the soil, rendering them commercially unmarketable. Management of

adults (beetles) is necessary to reduce the number of rindworms present. Direct control of rindworms can be difficult.

Monitoring: Begin scouting for beetles following transplant or as soon as the plants emerge. Scout twice a week, especially when plants have less than five leaves. At each of the five sites, scout five plants for beetles. Treat when an average of two beetles/plant are found.

Chemical Control: Use foliar insecticides to control adult beetles before they feed extensively on the cotyledons and first true leaves. Begin spraying shortly after plant emergence, and repeat applications at weekly intervals if new beetles continue to invade fields. Treatments may be required until vines begin to run. To provide additional pest control, a **Special Local Need 24(c) label** has been approved in Virginia for the use of carbofuran (*Furadan* 4F) at planting. See the *Chemical Insect Control* section for more information.

Biological Control: No current recommendations for commercial production.

Cultural Control: Always cultivate the soil thoroughly before planting. The use of plastic or straw as bedding for the developing pumpkins may deter rindworm feeding. In the fall, eliminating surrounding weeds will reduce the overwintering sites for the beetles.

Cutworms
Black Cutworm, *Agrotis ipsilon*
Variegated Cutworm, *Peridroma saucia*
Granulate Cutworm, *Feltia subterranea*

Cutworms are sporadic pests of many crops. Several species of cutworm may be found in Virginia. Most are night feeders that hide under plant and soil debris common in weedy or minimum-tillage fields. Another distinguishing quality is their habit of rolling into a tight C-shape if disturbed. Newly hatched cutworm larvae feed on young plants at the soil line, often severing the stems. Later generations of cutworms feed on developing pumpkins and in severe cases may tunnel completely through the fruit, greatly diminishing marketability.

Monitoring: Even if a preplant broadcast insecticide treatment is used, fields should be scouted for cutworm damage within a week of planting or plant emergence. Cutworms are not typically seen in the open during the day; however, digging the soil around injured plants may reveal their presence. If cutworms are actively cutting plants, a postplanting contact treatment may be used.

Chemical Control: See the *Chemical Insect Control* section for recommendations.

Biological Control: Cutworms are attacked by numerous ground-dwelling insect predators, especially carabid beetles. Also, pathogens such as *Beauveria bassiana* and entomopathogenic nematodes often will infect larvae.

Cultural Control: Proper tillage will help eliminate some species of cutworms that may move off of cover crops.

Leafminers
Serpentine Leafminer, *Liriomyza* spp.

Leafminers cause injury primarily by their mining of leaves. This results in the destruction of leaf mesophyll tissue. As the larvae hatch from eggs deposited within the leaf tissue, they create slender, winding, white tunnels in their search for food. Mature larvae emerge from inside the leaf and drop to the soil, where they pupate in soil crevices or, in rare cases, the leaf. Leaf mining depresses the level of photosynthesis and may result in leaf droppage. Fewer leaves in the canopy can result in sunscalding of fruit. Many generations occur annually in Virginia, but the first is usually the most damaging.

Monitoring: The economic consequences of leaf mining are not well understood; thus, adequate scouting procedures have not been developed.

Chemical Control: See the *Chemical Insect Control* section for recommendations.

Biological Control: Parasitoids often provide excellent suppression of leafminers if broad-spectrum insecticides are not applied to the crop.

Cultural Control: No current recommendations for commercial production.

Pickleworm, *Diaphania nitidalis*
Melonworm, *Diaphania hyalinata*

The melonworm is generally a foliage feeder (unlike the pickleworm, which attacks the developing leaf and flower buds) but also causes damage to the vines and fruit. The adults overwinter in the warmer southern regions and begin to migrate north when temperatures warm. Females deposit eggs on the leaf surface. The larvae emerge several days later, feeding on the flowers, vines, and fruit for up to two weeks. Although several generations can occur during a year, pickleworm and melonworm are rarely serious pests of pumpkins in Virginia.

Monitoring: As soon as pickleworms or their damage appears, begin insecticide treatments.

Chemical Control: Make one treatment before fruit set, and then treat weekly. See the *Chemical Insect Control* section for recommendations.

Biological Control: No current recommendations for commercial production.

Cultural Control: After harvest, remove all debris from the field, destroy vines and unused fruit, and control adjoining weeds. Also, plowing early in the fall will bury the pupae. In the spring, planting early will help the crop establish itself, thus preventing major damage.

Seedcorn Maggot, *Hylemya platura*

The seedcorn maggot is most noted for its damage to seeds or seedlings in bedding trays and early-planted

fields, especially during cool, wet growing seasons. Adults emerge in early spring to lay their eggs, preferably in moist, organically rich soils, such as freshly plowed fields or greenhouse flats. Larvae or maggots hatch from the eggs and bore into seeds, cotyledons, or rotting crop debris. The maggots feed for one to three weeks before tunneling into the soil, where they pupate for a period of about one to four weeks or for the duration of the winter. Multiple generations occur annually in Virginia.

Monitoring: Once seedcorn maggot damage has been observed, treatments are ineffective. Therefore, management options must be applied to high-risk fields before planting. High-risk fields can be defined as those having previous seedcorn maggot infestations or soils high in organic matter.

Chemical Control: Control is best achieved by using insecticide seed treatments such as chlorpyrifos (*Lorsban* SL) or diazinon (*Agrox D-L Plus*, *Diazinon* 50W, *Germate Plus*, *Kernel Guard*, or *KickStart*). The use of imidacloprid (*Admire* 2F) at planting will also reduce seedcorn maggot populations. See the *Chemical Insect Control* section for recommendations. Seed treatments containing malathion or lindane or seed commercially treated at low rates for seed storage will **NOT** control seedcorn maggots. *Do **NOT** use treated seed for food or feed.*

Biological Control: No current recommendations for commercial production.

Cultural Control: Several management practices can be used to reduce the potential for damage resulting from seedcorn maggot infestations. These include plowing weeds or cover crops at least two weeks before planting or transplanting, avoiding overfertilization with manure, and completely plowing under crop debris immediately after harvest to destroy plant remnants.

Squash Bug, *Anasa tristis*

Squash bugs destroy plant tissue by secreting a toxic saliva into the plant and sucking out the sap from the leaves and stems, which depletes nutrients from the plant. This feeding causes leaves to wilt and dry out. They eventually turn black and fall off the vine. Adults can be seen feeding on the main stems, but they also feed on leaves and fruit. Nymphs are more likely found feeding on the underside of the leaves. The adults are brown or black, flat-backed, and 1/2 to 3/4 inch long. Nymphs have gray-green bodies with red or black legs. Adults overwinter in garden debris and emerge the following spring to lay eggs. When the plants develop runners, elliptical, brown eggs are laid in groups on the underside of the leaves.

Monitoring: All stages of plants may be attacked by squash bugs. If you observe wilting in a field, check the underside of leaves for egg masses, nymphs, or adults. Adults are often cryptic and hide in plant debris on the ground. A treatment is recommended if more than 1 egg mass or aggregation of nymphs is found per plant.

Chemical Control: See the *Chemical Insect Control* section for recommendations.

Biological Control: No current recommendations for commercial production.

Cultural Control: After harvest is complete, deep tillage or removal of crop residue will help to delay and/or reduce infestation the next spring. Since squash bugs like to hide in it, mulching may increase squash bug

pressure.

Squash Vine Borer, ***Melittia cucurbitae***

The squash vine borer injures plants by tunneling through their stems. This interferes with nutrient transfer in the plant, eventually causing the plant to wilt. Borer feeding weakens plants, providing the opportunity for secondary infections. The larvae have a brown head and white body, and they are rarely found outside of the vine. The adult moths may be mistaken for a wasp. The body is orange and black, often in a ringed pattern surrounding the abdomen. The squash vine borer overwinters as a pupa, and adults emerge in the spring to lay eggs.

Monitoring: There are no practical methods for direct sampling of adults or eggs in the field. By checking plants for general vigor and other factors, borer damage may be detected. However, no regular monitoring is done specifically for this pest.

Chemical Control: See the *Chemical Insect Control* section for recommendations.

Biological Control: No current recommendations for commercial production.

Cultural Control: Proper cultural control may kill many overwintering pupae, reducing the following year's population. Soil should be disked after harvest, then plowed the following spring. Destroying vines after harvest prevents borers still in the larval stage from completing their development.

Thrips, ***Thrips tabaci***

Thrips are small, slender insects that are pale yellow to dark brown. The adult may be winged or wingless. When present, wings are narrow and fringed with long hairs. The larvae are wingless and may be green or yellow with red eyes. Both larvae and adults feed in the plants, causing silvering and sometimes deformation of the leaves; edges of the leaves tend to curl upward.

Monitoring: You can use yellow sticky cards to monitor the incidence or timing of thrips entering fields. However there are no current recommendations for commercial production.

Chemical Control: See the *Chemical Insect Control* section for recommendations.

Biological Control: No current recommendations for commercial production.

Cultural Control: Weed control and destruction of crop residues after harvest eliminates reservoir host plants and overwintering sites.

Two-Spotted Spider Mites, ***Tetranychus urticae***

Spider mites can be a very serious pest of pumpkins. Typically, they feed on the undersides of leaves, often causing them to turn brown and fall off. Severe infestations, especially of smaller, stressed plants, may result

in death. Mite problems are often associated with hot, dry weather and, as such, have become a regular problem in Virginia over the past several years.

Monitoring: Scout fields, especially areas that border roadsides or weedy edges or areas of the field that are sandy. Examine both the upper and lower sides of five crown leaves from 5 to10 locations and look for white stippling. Also note the condition of terminal leaves. Treatment should be made when 10%-15% of the crown leaves are infested early in the season, or when 50% of the terminal leaves are infested later in the season.

Chemical Control: Spot treatment of "hot spots" and areas along the edges of fields is recommended to control mite populations when problems are first noticed. Use of dimethoate for leafminer control will reduce mite populations. The products *Agri-Mek*, *Capture, Danitol*, and *Kelthane* are excellent miticides. Continuous use of carbofuran (*Furadan*) and carbaryl (*Sevin*), or pyrethroids without miticidal activity for other pests, may result in mite outbreaks. See the *Chemical Insect Control* section for more information.

Biological Control: Natural predators and diseases of mites are present in fields, but rarely at levels high enough for adequate control during outbreaks.

Cultural Control: If possible, avoid mowing field margins and grassy areas until after midsummer since this forces mites into the crop.

Whiteflies, *Bemisia argentifolii*

Whiteflies usually occur in groups on the underside of leaves. They derive their name from the mealy, white wax covering the adults' wings and body. Adults are tiny insects with yellowish bodies and whitish wings. The nymphal stages are wingless and sessile. Whiteflies suck phloem sap. Large populations can cause leaves to turn yellow, appear dry, or fall off plants. Like aphids, whiteflies excrete honeydew, so leaves may be sticky or covered with black, sooty mold. Feeding can cause plant distortion, discoloration, or silvering of leaves. Generally, plant losses do not occur unless there is a significant population of whitefly nymphs.

Monitoring: Sticky traps can be used to monitor populations.

Chemical Control: See the *Chemical Insect Control* section for recommendations.

Biological Control: Many predators, parasitoids, and fungal pathogens attack whiteflies and can usually keep populations below damaging levels. Use of broad-spectrum insecticides often eliminates natural enemy populations, however.

Cultural Control: Proper cultural controls are vitally important in managing whiteflies. Since they move from crop to crop, prompt tillage of land and destruction of crop residues can help reduce whitefly densities. Proper weed management is also recommended since many weed species can harbor whitefly populations.

Chemical Insect Control

The list below contains all of the products available to producers for insect control in pumpkins along with the

recommended application rates. Always consult the label before making an application. **PHI** = Pre-Harvest Interval. **REI** = Re-Entry Interval.

- **abamectin -** (*Agri-Mek* 0.15EC) - PHI - 7 days. Avermectin. For control of leafminers and mites, apply at a rate of 0.009-0.019 lb. a.i./A. Do **NOT** exceed 0.056 lb. a.i./A per season, and do not make more than two sequential applications. REI - 12 hours.
- **azadirachtin** (*Azatin* XL) - PHI - 0 days. Insect growth regulator (botanical). To control squash bug, apply at a rate of 0.02-0.04 lb. a.i./A. REI - 4 hours.
  (*Ecozin* 3% EC) - PHI - 0 days. Insect growth regulator. To control squash bug, apply at a rate of 0.02-0.04 lb. a.i./A. REI - 12 hours.
  (*Neemix* 4.5EC) - PHI - 0 days. Insect growth regulator. To control squash bug, apply at a rate of 0.03-0.06 lb. a.i./A. REI - 12 hours.
- ***Bacillus thuringiensi****s* (various formulations) - PHI - 0 days. Microbial. For the control of cabbage looper, consult various labels for rates and restrictions. REI - 4 hours.
- **bifenthrin** (*Capture* 2EC) - PHI - 3 days. Pyrethroid. For control of cabbage looper, cucumber beetles, cutworms, melonworms, pickleworms, rindworms, squash bug, and squash vine borer, apply at a rate of 0.04-0.10 lb. a.i./A. For control of mites and whiteflies, apply at a rate of 0.08-0.10 lb. a.i./A. Do **NOT** apply more than 0.30 lb. a.i./A per season. REI - 24 hours.
- **carbaryl** (*Sevin* 80S) - PHI - 3 days. Carbamate. For control of cucumber beetles, pickleworms, melonworms, and squash bug, apply at a rate of 1.0 lb. a.i./A. Do **NOT** apply more than 6.0 lb. a.i./A per crop. REI - 12 hours. *Carbaryl is not used as extensively now because of its high toxicity to bees.*
- **carbofuran** (*Furadan* 4F) - PHI - at plant. Carbamate. Apply 0.12 lb. a.i./1,000 linear ft. of row in-furrow at planting for control of striped cucumber beetle. *Furadan* may be mixed with water or liquid fertilizer. Do **NOT** use this product through any type of irritation system. Use of *Furadan* at planting frequently leads to spider mite outbreaks later in the season. Consult your local county Extension office for current restrictions - **Special Local Need 24(c) label**. REI - 48 hours.
- **cyromazine** (*Trigard* 75WSP) - PHI - 0 days. Triazine. For leafminer control, apply at a rate of 0.12 lb. a.i./A (one packet). Do **NOT** make more than six applications per season. REI - 12 hours.
- **dicofol** (*Kelthane* 50WP) - PHI - 2 days. Chlorinated hydrocarbon. For mite control, apply at a rate of 0.63 lb. a.i./A. Do **NOT** feed treated crops or crop residues to animals, and do **NOT** make more than two applications per season. REI - 48 hours.
- **endosulfan** (*Thionex* 3EC) - PHI - 1 day. Chlorinated hydrocarbon. For control of cucumber beetles, pickleworms, melonworms, rindworms, squash vine borer, and thrips, apply at a rate of 0.5-1.0 lb. a.i./A. For control of whiteflies, apply at a rate of 1.0 lb. a.i./A. Do **NOT** apply more than six times per season. Do **NOT** exceed more than 3.0 lb. a.i./A/season. REI - 48 hours.
- **esfenvalerate** (*Asana* XL) - PHI - 3 days. Pyrethroid. For control of cabbage looper, cucumber beetles, cutworms, pickleworms, rindworms, squash bug, and squash vine borer, apply at a rate of 0.03-0.05 lb. a.i./A. Do **NOT** exceed 0.25 lb. a.i./A per season. REI - 12 hours.
- **fenpropathrin** (*Danitol* 2.4EC) - PHI - 7 days. Pyrethroid. For mite and whitefly control, apply at a rate of 0.2-0.3 lb. a.i./A. Do **NOT** exceed 0.8 lb. a.i./A per season. REI - 24 hours.
- **imidacloprid** (*Admire* 2F) - PHI - 21 days. Nicotinoid. For control of aphids, cucumber beetles, seedcorn maggot, and whiteflies, apply at a rate of 0.25-0.38 lb. a.i./A. Do **NOT** apply more than 0.5 lb. a.i./A per year. REI - 12 hours.
- **methoxychlor** (*Methoxychlor* 50WP) - PHI - 1 day. Chlorinated hyrdrocarbon. For control of cucumber beetles and squash vine borer, apply at a rate of 1.0-1.5 lb. a.i./A. REI - 12 hours.
- **oxamyl** (*Vydate* L 2L) - PHI - 1 day. Carbamate. For the control of leafminers and thrips, apply at a

rate of 0.50-1.00 lb. a.i./A. Do **NOT** apply more than 6.0 lb. a.i./A per season. REI - 48 hours.

- **oxydemeton-methyl** (*Metasystox*-R 2SC) - PHI - 7 days. Organophosphate. For control of thrips, apply at a rate of 0.38-0.50 lb. a.i./A. Do **NOT** apply more than twice per season. REI - 24 hours.
- **permethrin** (*Ambush* 2EC) - PHI - 1 day. Pyrethroid. Apply at a rate of 0.10-0.20 lb. a.i./A to control cucumber beetles. To control melonworms and squash bug, apply at a rate of 0.20 lb. a.i./A. Do **NOT** apply more than 1.60 lb. a.i./A per season. REI - 24 hours.
  (*Pounce* 3.2EC) - PHI - 1 day. Pyrethroid. For control of leafminers and squash bug, apply at a rate of 0.20 lb. a.i./A. To control cucumber beetles, cutworms, melonworms, and pickleworms, apply at a rate of 0.10-0.20 lb. a.i./A. Do **NOT** apply more than 1.60 lb. a.i./A per season. REI - 24 hours.
- **pymetrozine** (*Fulfill* 50WP) - PHI - 14 days. Pyridine azomethine. To control aphids, apply at a rate of 0.09 lb. a.i./A. Do **NOT** exceed 0.20 lb. a.i./A per season. REI - 12 hours.
- **spinosad** (*SpinTor* 2SC) - PHI - 3 days. Spinosyn. For control of leafminers and thrips, apply at a rate of 0.09-0.13 lb. a.i./A. For control of cabbage looper, melonworms, and pickleworms, apply at a rate of 0.06-0.13 lb. a.i./A. Do **NOT** exceed 0.45 lb. a.i./A per season. REI - 4 hours.
- **thiamethoxam** (*Actara* 25 WDG) - PHI - 0 days. Nicotinoid. For control of aphids, apply at a rate of 0.03-0.05 lb. a.i./A. Do **NOT** exceed 0.125 lb. a.i./A per season. REI - 12 hours.
  (*Platinum* 2SG) - PHI - 30 days. Nicotinoid. For control of thrips, apply at a rate of 0.078-0.125 lb. a.i./A. Do **NOT** exceed 0.125 lb. a.i./A per season or use less than 0.078 lb. a.i./A per season. REI - 12 hours.

Pesticide Use Date - % Acres Treated

Insecticide	1993	1997	2004	Growers' Needs
azinphos-methyl	3.0	3.0	N/A	
Bt	3.0	3.0	N/A	
bifenthrin	N/A	N/A	70.0	*critical*
carbaryl	13.0	13.0	13.0	
carbofuran*	N/A	N/A	10.0	*critical*
endosulfan	26.0	26.0	25.0	
esfenvalerate	23.0	22.0	20.0	
imidacloprid	N/A	N/A	20.0	*critical*
kelthane**	N/A	N/A	20.0	*critical*
methomyl	3.0	3.0	3.0	
oxamyl	N/A	N/A	10.0	
permethrin	16.0	16.0	16.0	
thiamethoxam	N/A	N/A	25.0	*critical*

*24(c) label for *Furadan* 4F labeled at planting on bare ground in VA, some growers still use it.
** May be used when mites are a problem in hot dry years only.

Disease Pests

Control recommendations found below were modified from information presented in the 2004 Commercial Vegetable Production Recommendations-Virginia.[9]

DISEASES

Disease in pumpkins can slow down development and injure the leaves and fruit, greatly reducing the yield and making the crop less profitable. Each of the diseases listed below occurs within Virginia and depends primarily on weather conditions but also on several other factors. These factors include site location, seed quality, and effective management procedures. Good sanitation and management practices are key to a successful disease-control program. Powdery mildew and *Phytophthora* fruit rot are the most important pumpkin diseases in Virginia.

Angular Leaf Spot/Bacterial Leaf Spot, *Pseudomonas syringae* pv. *lachrymans*

Angular leaf spot first appears as small, angular, water-soaked lesions on the leaves. When moisture is present, bacteria ooze from the spot in tear-like droplets that dry and form a white residue on the leaf surface. Water-soaked areas turn gray or tan, die, and may tear away, leaving irregular holes. Water-soaked spots may also appear on the fruit and are frequently followed by soft rot bacteria. The bacteria survive in infected plant debris and on seed. The bacteria are spread by rain, overhead irrigation, tools, or workers picking fruit. Warm, wet weather favors disease development.

Monitoring: Early detection is important since control in the foliar phase can reduce infection of developing fruit.

Chemical Control: Apply fixed copper when angular leaf spot is first detected on the foliage and repeat every seven to ten days. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Angular leaf spot can be controlled by planting disease-free seed, rotating with unrelated crops, and keeping workers out of fields when foliage is wet.

Bacterial Wilt, *Erwinia tracheiphila*

Initially, the foliage becomes dull green, and individual leaves droop with early stages of infection. Eventually, leaves and entire branches lose turgor, wilt, and die. Bacterial wilt is carried by the striped and spotted cucumber beetles. The bacteria live in the digestive tract of the beetle and invade the plant through the wounds caused by the beetles. The bacteria multiply within the xylem tissue of the plant until water movement is obstructed. Entire plants may collapse and die within a few days.

Monitoring: A good diagnostic field test is to cut the plant near the crown and squeeze sap from the newly cut stem. Heavily infected plants will ooze a milky sap from the cut stem. Regardless of whether you see the milky sap, touch a clean knife to the cut surface and draw the surfaces apart. If you see threads stringing from the stem and knife blade, then the plant has bacterial wilt.

Chemical Control: Bacterial wilt control is directly related to control of cucumber beetles. Soil-applied

insecticides and repeated applications of foliar contact insecticides are necessary for adequate disease control. See the *Chemical Insect Control* section for more information regarding which insecticides are recommended.

Biological Control: No commercially effective controls are available.

Cultural Control: Control is aimed at preventing infection by the beetles. Since cucumber beetles overwinter as adults, early control measures are necessary. Young plants can be protected by row covers, cones, or other types of mechanical barriers. Infected plants should be pulled up and destroyed. There are no bacterial wilt-resistant varieties available to growers.

Black Rot, *Didymella bryoniae*

This is the same disease that causes gummy stem blight in cucurbits. However, when the fungus appears on fruit, it is called black rot. Black rot spots begin as brownish water-soaked areas, which may be large. Later, the rind becomes black and deeply wrinkled. In the center of the spots, pale and dark dots may develop. Infected pumpkins may rot in the field, especially if moderate temperatures and high moisture levels occur. On pumpkins held for fall sales, a water-soaked lesion appears (usually associated with an injury to the rind), and black rot develops. Large Halloween pumpkins are more susceptible to black rot than smaller types.

Monitoring: Black rot symptoms may be present on the fruit in the field, but they often develop in storage. Checking the fruit just before or at harvest for damage or disease symptoms may allow you to detect the disease before storage.

Chemical Control: The fungus that causes black rot has developed resistance to several classes of fungicides. The fungicides at risk for resistance development are in the class of strobilurans. They should be tank-mixed with a different class of fungicide to delay onset of resistance. Maintain this fungicide schedule until harvest. Fungicide application for black rot control will help keep "handles" on the fruit. Harvest carefully because wounding can negate benefits from a season-long fungicide program. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Pumpkin variety *Small Sugar* appears to be least affected by black rot. Rotate to provide at least two years between cucurbit plantings. Plow crop debris deeply to reduce survival of the fungus as soon as the pumpkins are harvested.

Damping-Off, *Fusarium oxysporumi* and *Pythium* spp.

These soilborne diseases cause young seedlings to wilt and die, or to not emerge at all. Generally, these diseases occur during wet soil conditions. *Pythium* more commonly causes damping-off in cucurbits, but *Fusarium* is occasionally found.

Monitoring: Monitoring your crop just after transplant will enable you to replant the current crop and will show fields that need treatment in future crops.

Chemical Control: To protect against all damping-off pathogens, seeds are usually treated with broad-spectrum contact fungicides. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Practices that promote water drainage such as planting on raised beds can help to reduce *Pythium* damping-off.

Downy Mildew, *Pseudoperonospora cubensis*

Downy mildew is most prevalent during extended periods of cool, moist weather. Symptoms appear as irregular yellowish to brown spots on the upper leaf surface, eventually becoming more distinct on both sides of the leaves. On wet mornings, the underside of the leaves may exhibit a brown to gray fungal growth. These spots grow rapidly and turn black, eventually causing the leaf to wilt and die. This can lead to a major foliage loss in the crop and sunscald to fruit.

Monitoring: Scout fields for disease incidence beginning in mid-July, even though generally this disease does not occur until mid-August. Downy mildew comes to Virginia from the South. Check the website www.ces.ncsu.edu/depts/pp/cucurbit/ to see if the disease has been detected in your region.

Chemical Control: Begin sprays when vines run or if disease occurrence is predicted for the region. Use chlorothalonil or maneb every seven days. Other effective fungicides, such as mefenoxam *plus* chlorothalonil (*Flouronil* or *Ridomil Gold Bravo*), mefenoxam *plus* copper hydroxide (*Ridomil Gold Copper*), pyraclostrobin *plus* boscalid (*Pristine*), and cymoxanil *and* famoxadone (*Tanos*), should be applied every 14 days. Apply the first two mentioned on alternate weeks when using these fungicides. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Crop rotation has little effect on prevention of downy mildew. It is important to promote healthy, vigorous growth and a good nutritional program in the crop, as plants under nutritional stress are more susceptible to developing the disease. Also, avoid overhead irrigation.

Phytophthora Blight, *Phytophthora capsici*

This highly destructive disease can cause many different problems for a crop, including: seedling damping-off, leaf spots and fruit rot, and possibly total crop loss. Stem and leaf petiole lesions appear as light to dark brown, water-soaked, and irregular in shape, eventually becoming dry, brittle, and papery. Older plants with root infections may suddenly wilt even though they show no signs of stem or vine lesions. In fruit, the symptoms begin as small, water-soaked lesions in the rind. The rind enlarges quickly and becomes a soft, sunken area covered with white fungal growth. This eventually will lead to fruit collapse in the field or storage. During periods of heavy rainfall, this disease can spread rapidly, quickly becoming a very serious problem.

Monitoring: Monitoring your crop for disease on a regular basis for disease will help you apply pesticides when needed.

Chemical Control: For protection against the stem and fruit rot phase of the disease, add fixed copper to each fungicide application used for downy mildew or gummy stem blight. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: To reduce the risk of infection, implement a complete control program should be implemented with emphasis on water management. Fields should be adequately drained to ensure that soil water does not accumulate around the base of the plants. In addition, when the vines begin to run, trench between rows to allow for faster drainage following rainfall. Avoid overhead irrigation, and rotate with crops other than peppers, eggplants, tomatoes, and other cucurbits.

Plectosporium Blight, ***Plectosporium tabacinum***

Plectosporium blight, formerly called Microdochium blight, has occurred in Virginia every year since 1994. This disease infects stems, leaf veins, and fruit. The symptoms are very distinctive and easily distinguished from other cucurbit diseases. Initially, lesions on stems and leaf veins are small, white, and diamond-shaped. Lesions quickly coalesce, causing the entire surface of the vine or leaf vein to turn white. Because leaf lesions are restricted to the veins and do not spread to the interveinal tissue, they may be overlooked in the early stages of disease development. Leaves on severely affected vines may die, and complete defoliation may occur. On the fruit, the white lesions are more circular and less diamond-shaped. Spots on the flesh remain small and scattered. Spores are most likely spread by wind and rain.

Monitoring: Check for lesions on stems and leaves throughout the season.

Chemical Control: It is important to achieve maximum foliage coverage with the fungicide application. Once symptoms appear on petioles or after fruit forms, apply the recommended fungicides and repeat every seven to ten days. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Research studies have shown that no-till pumpkin production results in less disease. Rotate with noncucurbit crops at least three years. Plant in sites with good air circulation, and plow under crop debris after harvest.

Powdery Mildew, ***Sphaerotheca fuliginea***

Initial inoculum may come from old cucurbit debris left in the field, or it may be blown in on air currents from infested areas south of Virginia. The plants reveal the characteristic white mold when infected. The mold occurs on both sides of the leaves and often results in an upward cupping effect of leaves with a severe mildew infection. The resulting decrease in photosynthesis may cause significant reductions in the quality and yield of

fruit. In contrast to downy mildew, which is more severe during wet weather, powdery mildew is actually inhibited by free moisture on leaf surfaces. Dense plant growth, low light intensity, and high fertility favor disease. Powdery mildew usually occurs from mid-July until the end of the growing season.

Monitoring: Check the upper and undersides of leaves by turning over at least 100 leaves in a field. If you find one infection site per 45 leaves, apply fungicides.

Chemical Control: Make the first application when powdery mildew is observed in the area or is detected by scouting. The fungus that causes powdery mildew has developed resistance to several classes of fungicides. The fungicides at risk for resistance development are in the class of strobilurans. They should be tank-mixed with a different class of fungicide to delay onset of resistance. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Crop rotation and tillage options will have only a minor effect on powdery mildew control. However, removing plant debris at the end of the season may reduce overwintering of the fungus. Use resistant varieties when possible. *Magic Lantern*, *Mystic Plus*, and *Merlin* have moderate resistance to powdery mildew. This resistance causes a delay in the development of powdery mildew.

Scab, *Cladosponum cucumerinum*

This fungal disease can attack all parts of the plant, but the unsightly scab lesions that develop on fruit are most damaging. These lesions usually make the fruit unmarketable. The first sign of disease is usually pale green, water-soaked areas on the leaves and runners. These spots gradually turn gray to white and become angular in shape. The only disease that scab may be confused with is angular leaf spot. Many of the symptoms are the same. However, angular leaf spot is more likely to infect only the foliage, whereas scab infection occurs on both foliage and fruit. Scab usually occurs during cool periods of weather.

Monitoring: Check for leaf lesions and lesions on runners during periods of cool, wet weather.

Chemical Control: Begin sprays as true leaves form. Repeat every five to seven days. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Choose sites that have well-drained soils and are conducive to good air drainage to allow for rapid drying of foliage. Crop rotation with noncucurbits for two or more years is also very important. Use resistant varieties when possible.

Viruses (CMV, WMV-2, PRSV-W, and ZYMV)

Viruses can be spread in the field by insect feeding, cuttings, and infected seeds. In cucumber mosaic virus (CMV), the leaves show a distinctive yellow and green mosaic pattern on the youngest leaves near the

growing tip. Over time, the leaves become malformed and curled, stunting of the vines occurs, and little fruit is produced. Watermelon mosaic virus - II (WMV-2) causes the leaves to become distorted and blistered and displays the same yellow and green mosaic pattern on the newest leaves. If plants are infected young, they can become stunted. The fruit can become misshapen, dwarfed, mottled, or spotted. Papaya ringspot virus (PRSV-W), formerly known as watermelon mosaic virus - I, causes severe plant stunting. A green mosaic pattern is visible on the leaves and is usually accompanied by malformations, leaf distortions, and narrowing leaf blades. The fruit may be malformed and present a break in the color pattern. Zucchini yellow mosaic virus (ZYMV) also causes plant stunting and exhibits a yellow mosaic pattern, leaf malformations, and dead patches on the leaves. In the fruit, deep cracks can occur, allowing secondary bacteria to invade its flesh.

Monitoring: Monitoring your crop for disease on a regular basis will help you apply pesticides when needed.

Chemical Control: Soaps and oils can be used to control virus-transmitting aphids. Once the virus is established in the crop, however, there are no effective chemical controls available. Reducing insect vectors with insecticides is an option. Remember, however, that insecticides are not always effective in reducing virus spread because the virus may have been transmitted before the insecticide killed the insect.

Biological Control: No commercially effective controls are available.

Cultural Control: Always use virus-resistant cultivars whenever possible, and keep weeds mowed around fields that may harbor viruses over the winter. Plant crops early to escape peak aphid season, and plant as far away from existing cucurbit plantings as possible. This will prevent aphid transmissions of viruses from existing fields to new fields.

Chemical Disease Control

The list below contains all of the products available to producers for disease control in pumpkins along with the recommended application rates of these chemicals. Always consult the label before making an application. **PHI** = Pre-Harvest Interval. **REI** = Re-Entry Interval.

- **azoxystrobin** (*Amistar* 80WDG, *Quadris* 2.1F) - PHI - 1 day. Strobilurin. Apply at a rate of 0.18-0.25 lb. a.i./A for control of powdery mildew. For resistance management, do **NOT** make more than one application of *Amistar* or *Quadris* before alternating with a fungicide that has a different mode of action. Do **NOT** make more than four applications per acre per crop per season or apply more than 1.0 lb. a.i./A per crop per season. REI - 4 hours.
- **chlorothalonil** (*Bravo* 6F) - PHI - 0 days. Substituted aromatic. For control of downy mildew and plectosporium blight, apply at a rate of 1.125-1.50 lb. a.i./A. To control black rot, powdery mildew, and scab, apply at a rate of 1.50-2.25 lb. a.i./A. REI - 48 hours.
  (*Echo* 6F, *Equus* 6F) - PHI - 0 days. Substituted aromatic. For control of downy mildew and plectosporium blight, apply at a rate of 1.125-1.50 lb. a.i./A. To control black rot, powdery mildew, and scab, apply at a rate of 1.50-2.25 lb. a.i./A. Do **NOT** exceed 15.75 lb. a.i./A/season. REI - 12 hours.
- **copper, fixed** (*various formulations*) - PHI - 0 days. Inorganic. To control angular leaf spot or bacterial leaf spot, apply at a rate of 0.60-1.20 lb. a.i./A (2.4F) or 0.575-1.150 lb. a.i./A (4.6F). Apply fixed copper at a rate of 0.81 lb. a.i./A (53.8DF), beginning sprays when vines run and repeating every 7 days for control of downy mildew. REI - 24 hours.

- **cymoxanil *and* famoxadone** (*Tanos* 50WDG) - PHI - 3 days. Strobilurins. For control of downy mildew, apply at a rate of 0.25 lb. a.i./A. For resistance management, do **NOT** make more than one application of *Tanos* before alternating with a fungicide that has a different mode of action. Do **NOT** make more than four applications per season. *Tanos* must be tank-mixed with a contact fungicide that has a different mode of action. Do **NOT** use for control of powdery mildew. REI - 12 hours.
- **dimethomorph** (*Acrobat* 50WP) - PHI - 0 days. Morpholines. To control downy mildew and *Phytophthora* blight, apply 0.2 lb. a.i./A. *Acrobat* must be tank-mixed with another fungicide active against downy mildew and *Phytophthora* blight. Do **NOT** make more than two sequential applications of *Acrobat* before alternating with another fungicide with a different mode of action. Do **NOT** make more than five applications per season. Do **NOT** exceed 1.0 lb. a.i./A/season. REI - 12 hours.
- **maneb** (*Manex* 80WP) (*Maneb* 80WP) - PHI - 5 days. Dithiocarbamates. To control downy mildew, apply 1.20-1.60 lb. a.i./A. Begin when disease threatens. Spray on a 7- to 10-day interval. REI - 24 hours.
- **mefenoxam** (*Ridomil Gold* 4E) (*Ultra Flourish* 2E) - PHI - 0 days. Phenylamides. For control of damping-off, apply 0.5-1.0 lb. a.i./A in a 7-inch band at planting. REI - 48 hours.
- **mefenoxam *plus* chlorothalonil** (*Ridomil Gold/Bravo* 76WP)* - PHI - 0 days. Phenylamides. For control of downy mildew, apply at a rate of 1.52 lb. a.i./A. Begin applications before infection but when conditions are favorable. Continue at 14-day intervals until the threat of disease is over. Avoid late-season applications when plants reach full maturity and begin senescence. REI - 48 hours. (*Flouronil* 76WP)* - PHI - 14 days. Phenylamides. For control of downy mildew, apply at a rate of 1.52 lb. a.i./A. Begin applications before infection but when conditions are favorable. Continue at 14-day intervals until the threat of disease is over. Avoid late-season applications when plants reach full maturity and begin senescence. REI - 48 hours.
  ***** *Up to four applications can be made per crop.*
- **mefanoxam *plus* copper hydroxide** (*Ridomil Gold Copper* 65WP) - PHI - 5 days. Phenylamides. For control of downy mildew, apply at a rate of 1.3 lb. a.i./A. Begin applications when conditions are favorable for disease but before infection. Avoid late-season application when plants reach full maturity or begin senescence. REI - 48 hours.
- **myclobutanil** (*Nova* 40W) - PHI - 0 days. Triazoles. For powdery mildew control, apply at a rate of 0.06-0.13 lb. a.i./A mixed with chlorothalonil. Do **NOT** apply more than 0.6 lb. a.i./A per crop. REI - 24 hours.
- **pyraclostrobin** (*Cabrio* 20EG) - PHI - 0 days. Strobilurins. For control of black rot and powdery mildew, apply at a rate of 0.15-0.20 lb a.i./A. Do **NOT** make more than one sequential application. Do **NOT** apply more than 0.8 lb. a.i./A/ season or make more than four applications in a season. REI - 12 hours.
- **pyraclostrobin *and* boscalid** (*Pristine* 38W) - PHI - 0 days. Strobilurins. For control of downy mildew and powdery mildew, apply at a rate of 0.30-0.44 lb. a.i./A. To control black rot, apply 0.30-0.44 lb. a.i./A and alternate with chlorothalonil. The use of additives or adjuvants may improve the performance of *Pristine*. Consult the label for more information. For resistance management, do **NOT** make more than four applications per season (1.76 lb. a.i./A/season). Do **NOT** make more than one application before alternating with a nonstrobilurin fungicide. REI - 12 hours.
- **sulfur** (*Micronized Wettable Sulfur* 80W) - PHI - N/A. To control powdery mildew, apply 3.2 lb. a.i./A. Sulfur may injure plants, especially at high temperatures. Certain varieties may be more sensitive. Consult label for precautions. REI - 24 hours.
- **trifloxystrobin** (*Flint* 50WDG) - PHI - 0 days. Strobilurins. Apply 0.05-0.06 lb. a.i./A to control powdery mildew. Do **NOT** apply more than 0.25 lb. a.i./A/season. Do **NOT** exceed more than four

total applications of *Flint* or other strobilurin fungicides per acre per season. To limit the potential for resistance to develop, do **NOT** make more than one application before alternating with a nonstrobilurin fungicide. REI - 12 hours.

- **triflumizole** (*Procure* 50WS) - PHI - 0 days. Triazoles. To control powdery mildew, apply 0.13-0.25 lb. a.i./A. mixed with chlorothalonil. Applications should begin when vines start to run or at the first sign of disease. Do **NOT** apply more than 1.25 lb. a.i./A/season. REI - 12 hours.

Pesticide Use Date - % Acres Treated

Fungicide	1993	1997	2004	Growers' Needs
azoxystrobin	N/A	N/A	60.0	*critical*
benomyl	19.0	19.0	N/A	
boscalid	N/A	N/A	30.0	
chlorothalonil	55.0	55.0	60.0	*critical*
copper	3.0	6.0	10.0	
dimethomorph	N/A	N/A	10.0	
maneb	3.0	3.0	30.0	
mefenoxam	N/A	N/A	50.0	*critical*
metalaxyl	48.0	48.0	N/A	
myclobutanil	N/A	N/A	50.0	*critical*
pyraclostrobin	N/A	N/A	30.0	*critical*
thiophanate-methyl	3.0	3.0	10.0	
triadimefon	32.0	32.0	N/A	
trifloxystrobin	N/A	N/A	10.0	*critical*

Nematode Pests

Control recommendations were taken from 2004 Commercial Vegetable Production Recommendations-Virginia.

NEMATODES

Root-knot nematodes (*Meloidogyne* spp.) are the most important species of nematode affecting pumpkins in Virginia.[10] These nematodes restrict water and nutrient uptake, giving the plant a stunted, wilted appearance. The diagnostic feature of root-knot nematode infection is the presence of galls on roots of affected plants. Severely affected plants may have galls as large as 1 inch in diameter. Nematode problems can be magnified by hot, dry summers. Symptoms and damage can mimic other diseases and pests, making identification nearly impossible to determine on site. Soil and root samples should be collected and analyzed by an expert.

Monitoring: Both diagnostic and predictive nematode assay programs in Virginia provide data to producers on the numbers and kinds of nematodes in soil along with recommendations for control. Soil samples for

diagnostic assays are processed without charge to determine the cause of production problems during the growing season. Predictive nematode assays are done on samples collected after harvest.

Chemical Control: When using soil fumigation, it is important to sufficiently prepare the fields for planting. All crop debris and clods should be removed, and soil moisture should be adequate. Otherwise, soil fumigation will not be effective because the gaseous fumigant has not penetrated all soil particles. It is also necessary to allow an aeration period between fumigant applications and planting. Otherwise, crop injury will occur. For recommendations, see the *Chemical Nematode Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Sanitation and good cultural practices are the best preventive measures against nematodes. Examples include obtaining nematode-free roots and washing soil from machinery and tools before using them at different locations. Crop rotation with nonhost crops to reduce nematode populations is highly recommended in the event of nematode activity.

Chemical Nematode Control[11]

Several chemicals are currently available for nematode control, although this may change in the next few years. Currently, the multipurpose soil fumigants chloropicrin, chloropicrin *plus* dichloropropene (*Telone C-17, Telone C-35)*, metam-potassium (*K-PAM* HL), metam-sodium (*Vapam* HL), and methyl bromide (*Terr-O-Gas 67, MC-33*) are recommended for use in Virginia. In addition, dichloropropene (*Telone II*) is a soil fumigant used only for nematodes. The nonfumigant nematicide, oxamyl (*Vydate* L), is also recommended for use in pumpkins. Typically, chemical controls are used only when cultural practices cannot provide adequate control. However, these chemicals are still important tools when other control methods have failed.

Weed Pests

Control recommendations were taken from 2004 Commercial Vegetable Production Recommendations-Virginia.[12]

WEEDS

The herbicides currently labeled for weed control in pumpkins help control annual grasses, certain perennial grasses, and certain broadleaf weeds. However, producers in Virginia are faced with many additional broadleaf weed problems, including common lambsquarters, jimsonweed, morningglory species, and yellow nutsedge. Successful weed management is vital to the production of quality pumpkins. Weeds compete with the crop for light, space, nutrients, and particularly water. Weed growth promotes disease problems and can harbor deleterious insects and diseases. Weeds also impair the ability to harvest effectively, reducing the quantity of marketable fruit and increasing labor costs. Pumpkins, like most crops, require early-season weed control to ensure a quality crop. In addition, the spreading nature of this crop makes weed control difficult once the vines begin to form. If not controlled, weeds can greatly reduce fruit quality and may interfere with the harvest.

Monitoring: Proper weed identification is an important part of effective weed control. Weeds observed in previous crops within a given field should be noted to aid in future herbicide decisions. It is also important to monitor the effectiveness of preplant incorporated and preemergent herbicides once the crop emerges.

Chemical Control: To provide additional pest control, a **Special Local Need 24(c) label** has been approved in Virginia for the preemergence use of ethalfluralin (*Curbit* 3E) and the postemergence and postharvest use of paraquat (*Gramoxone Max* 3SC). Recommended rates can be found in the *Chemical Weed Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Cultivation is a very important part of weed control. Weeds will compete with a crop for nutrients, water, and sunlight, reducing yield and making the crop less profitable. Mechanical cultivation provides effective weed control but is limited to small weeds that can be easily uprooted or covered. More importantly, do not perform mechanical cultivation once the plants have begun to vine ("run"). These vines are very tender and are easily damaged by tractor wheels or cultivators. Supplement mechanical control with chemicals or hand weeding to remove weeds in the rows or after the plants produce vines. Hand weeding provides effective weed control and is safe to the crop. Weed when the crop and weeds are small to reduce crop damage. Removing large weeds with extensive root systems may damage crop roots or vines. Hand weeding, however, is labor-intensive. Using cultivation techniques with herbicides is the most cost-effective way to combat weeds and to produce a high yield. Crop rotation is also important to prevent domination of any one weed species year after year. Also, avoid fields with a history of severe weed infestations.

Chemical Weed Control

The list below contains all of the fully labeled products available to producers for weed control in pumpkins. However, these are subject to change. Always consult the label before making an application. **PHI** = Pre-Harvest Interval. **REI** = Re-Entry Interval.

*Use the following herbicides for **weed control <u>under</u> plastic mulch** or crop injury and/or poor weed control may result.*

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedlings. Apply herbicides under plastic mulch to control weeds around the planting hole and when clear or black plastic is used. Trickle irrigation tubes left on the soil surface may cause weed problems by leaching away herbicide at emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tube several inches deep in the bed to reduce this problem. Delay punching the planting holes until seeding or transplanting.

- **bensulide** (*Prefar* 4E) - PHI - N/A. Amide. Apply at a rate of 5.0-6.0 lb. a.i./A preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds, including common lambsquarters, smooth pigweed, and common purslane. REI - 12 hours.

*Use the following herbicides to treat **soil strips <u>between</u> rows of plastic mulch** or crop injury and/or poor weed control may result.*

Note: All herbicide rate recommendations are made for spraying a broadcast acre.

<u>Preemergence</u>:

- **bensulide** (*Prefar* 4EC) - PHI - N/A. Amide. Apply at a rate of 5.0-6.0 lb. a.i./A before planting, and incorporate 1-2 inches deep with power-driven rotary cultivators. Or, apply preemergence and activate with 1/2 inch of sprinkler irrigation for 36 hours, primarily for annual grass control. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds, including common lambsquarters, smooth pigweed, and common purslane. REI - 12 hours.
- **ethalfluralin** (*Curbit* 3E) - PHI - N/A. Nitroanilines. To control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed species, apply at a rate of 0.38-0.75 lb. a.i./A. Control of many broadleaf weeds, including common lambsquarters, jimsonweed, morningglory species, ragweed species, and mustard species, may **NOT** be acceptable. Dry weather following application may reduce weed control. Cultivate to control tolerant weeds or if rainfall or irrigation does not occur before weed emergence. Do **NOT** preplant incorporate, apply under plastic mulch or tunnels, use on transplanted summer squash, or use when soils are cold or wet. This could cause crop injury. REI - 24 hours.
- **ethalfluralin *plus* clomazone** (*Strategy* 2.1SC) - PHI - N/A. Pyridazinones/Nitroanilines. Apply 0.394-1.575 lb. a.i./A *Strategy* preemergence (based on soil texture) to control annual grasses and many annual broadleaf weeds. *Strategy* is a jug-mix of ethalfluralin and clomazone. However, it is often recommended that growers mix *Curbit* and *Command* in order to choose appropriate rates and minimize injury. Read and follow all the recommendation and warnings for ethalfluralin and clomazone. REI - 24 hours.

<u>Postemergence</u>:

- **clethodim** (*Select* 2EC) - PHI - 14 days. Cyclohexanediones. Apply at a rate of 0.094-0.125 lb. a.i./A with oil concentrate to be 1% of the spray solution postemergence to control many annual and certain perennial grasses, including annual bluegrass. However, it will **NOT** consistently control goosegrass. *The use of oil concentrate may increase the risk of crop injury during hot or humid conditions.* To reduce the risk of crop injury, switch to a nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or during hot, dry weather or drought conditions. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will **NOT** be controlled. Do **NOT** tank-mix with or apply within 2-3 days of any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. REI - 24 hours.
- **halosulfuron** (*Sandea* 75WG) - PHI - 2-5 true leaves. Sulfonylurea. Apply 0.023-0.031 lb. a.i./A as a banded, directed spray between rows of plastic mulch to suppress or control yellow nutsedge and broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Make the application when the crop has two to five true leaves but has not yet begun to

bloom or run. *Sandea* applied postemergence will **NOT** control common lambsquarters or eastern black nightshade. Occasionally, you may observe slight yellowing of the crop within a week of *Sandea* application. Recovery is rapid with no effect on yield or maturity. Do **NOT** apply *Sandea* to crops treated with a soil-applied organophosphate insecticide or use a foliar-applied organophosphate insecticide within 21 days before or 7 days after a *Sandea* application. Do **NOT** exceed a total of 0.094 lb. a.i./A/season. REI - 12 hours.

- **paraquat** (*Gramaxone Max* 3SC) - PHI - N/A. Bipyridyliums. Apply at a rate of 0.6 lb. a.i./A as a directed spray to control emerged weeds between the rows after the crop has been established. Add a nonionic surfactant according to the label instructions. Do **NOT** allow spray or spray drift to contact the crop or injury may result. See label for additional information and warnings**. Special Local Need 24 (c) label**. REI - 12 hours.
- **sethoxydim** (*Poast* 1.5EC) - PHI - 14 days. Cyclohexanediones. Apply at a rate of 0.2-0.3 lb. a.i./A with oil concentrate to be 1% of the spray solution postemergence to control annual grasses and certain perennial grasses. *The use of oil concentrate may increase the risk of crop injury during hot or humid conditions.* To reduce the risk of crop injury, switch to a nonionic surfactant when grasses are small and soil moisture is adequate. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will **NOT** be controlled. Do **NOT** tank-mix with or apply within 2-3 days of any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. Do **NOT** apply more than 0.6 lb. a.i./A in one season. REI - 12 hours.

*Use the following herbicides when **seeding into soil <u>without</u> plastic mulch** or crop injury and/or poor weed control may result.*

Note: All herbicide rate recommendations are made for spraying a broadcast acre.

<u>Preplant Incorporated</u>:

- **clomazone** (*Command* 4EC) - PHI -N/A. Pyridazinones. Apply 0.25-0.5 lb. a.i./A preplant, and incorporate right after application. For best results, use equipment that will provide shallow, thorough incorporation. Poor incorporation technique may cause excessive crop injury in streaks throughout the field. Use lower rates on fields with coarse-textured soils that are low in organic matter and when planting short-season varieties. Use higher rates when planting full-season varieties in fine-textured soils that are high in organic matter. Expect some temporary injury - visible as a partial whitening of leaf and/or stem of the crop - that becomes apparent after seedling emergence. Complete recovery from early injury will occur without affecting yield or delaying maturity. *Command* is an excellent broad-spectrum herbicide that will control annual grasses and most broadleaf weeds, except pigweed species, carpetweed, morningglory species, and yellow nutsedge. Do **NOT** apply when wind or weather conditions favor herbicide drift or apply to fields next to horticultural, fruit, vegetable, or other sensitive crops. Vapor drift may injure these crops. Immediate incorporation will reduce or eliminate vapor drift. REI - 48 hours.
  Warning: Herbicide residues may limit subsequent cropping options when Command is used for weed control in pumpkins. See planting restrictions on the label, or consult your local Cooperative Extension office for more information.

Preplant Incorporated or Preemergence:

- **bensulide** (*Prefar* 4EC) - PHI - N/A. Amide. Apply at a rate of 5-6 lb. a.i./A before planting, and incorporate 1-2 inches deep with power-driven rotary cultivators. Or apply preemergence and activate with 1/2 inch of sprinkler irrigation for 36 hours, primarily for annual grass control. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds, including common lambsquarters, smooth pigweed, and common purslane. REI - 12 hours.

Preemergence:

- **ethalfluralin** (*Curbit* 3E) - PHI - N/A. Nitroanilines. Apply at a rate of 0.56-0.75 lb. a.i./A to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed species. Control of many other broadleaf weeds, including common lambsquarters, jimsonweed, morningglory species, ragweed species, and mustard species, may **NOT** be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur before weed emergence. Do **NOT** preplant incorporate, apply under plastic mulch or tunnels, use on transplanted pumpkins, or use when soils are cold or wet. This could cause crop injury. **Special Local Need 24(c) label**. REI - 24 hours.
- **ethalfluralin *plus* clomazone** (*Strategy* 2.1SC) - PHI - N/A. Pyridazinones/Nitroanilines. Apply 0.394-1.575 lb. a.i./A *Strategy* preemergence (based on soil texture) to control annual grasses and many annual broadleaf weeds. *Strategy* is a jug-mix of ethalfluralin and clomazone. However, it is often recommended that growers mix *Curbit* and *Command* in order to choose appropriate rates and minimize injury. Read and follow all the recommendation and warnings for ethalfluralin and clomazone. REI - 24 hours.

Postemergence:

- **clethodim** (*Select* 2EC) - PHI - 14 days. Cyclohexanediones. Apply at a rate of 0.094-0.125 lb. a.i./A with oil concentrate to be 1% of the spray solution postemergence. This will control many annual and certain perennial grasses, including annual bluegrass. However, it will **NOT** consistently control goosegrass. *The use of oil concentrate may increase the risk of crop injury during hot or humid conditions.* To reduce the risk of crop injury, switch to a nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or during hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will **NOT** be controlled. Do **NOT** tank-mix with or apply within 2-3 days of any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. REI - 24 hours.
- **halosulfuron** (*Sandea* 75WG) - PHI - 2-5 true leaves. Sulfonylurea. Apply 0.023-0.031 lb. a.i./A as a banded, directed spray between rows of plastic mulch to suppress or control yellow nutsedge and broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Make the application when the crop has two to five true leaves but has not yet begun to bloom or run. *Sandea* applied postemergence will **NOT** control common lambsquarters or eastern black nightshade. Occasionally, you may observe slight yellowing of the crop may be observed within a week

of *Sandea* application. Recovery is rapid with no effect on yield or maturity. Do **NOT** apply *Sandea* to crops treated with a soil-applied organophosphate insecticide, or use a foliar-applied organophosphate insecticide within 21 days before or 7 days after a *Sandea* application. Do **NOT** exceed a total of 0.094 lb. a.i./A/season. REI - 12 hours.

- **paraquat** (*Gramaxone Max* 3SC) - PHI - N/A. Bipyridyliums. Apply at a rate of 0.6 lb. a.i./A as a directed spray to control emerged weeds between the rows after the crop has been established. Add nonionic surfactant according to the labeled instructions. Do **NOT** allow spray or spray drift to contact the crop, or injury may result. See label for additional information and warnings. **Special Local Need 24(c) label**. REI - 12 hours.
- **sethoxydim** (*Poast* 1.5EC) - PHI - 14 days. Cyclohexanediones. Apply at a rate of 0.2-0.3 lb. a.i./A with oil concentrate to be 1% of the spray solution postemergence to control annual grasses and certain perennial grasses. *The use of oil concentrate may increase the risk of crop injury during hot or humid conditions.* To reduce the risk of crop injury, switch to a nonionic surfactant when grasses are small and soil moisture is adequate. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will **NOT** be controlled. Do **NOT** tank-mix with or apply within 2-3 days of any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. Do **NOT** apply more than 0.6 lb. a.i./A in one season. REI - 12 hours.

Postharvest:

- **paraquat** (*Gramaxone Max* 3SC) - PHI - N/A. Bipyridyliums. Apply at a rate of 0.6 lb. a.i./A as a broadcast spray after the last harvest. Add a nonionic surfactant according to the label instructions. Use to prepare plastic mulch for replanting or to aid in the removal of the mulch. See the label for additional information and warnings. **Special Local Need 24(c) label**. REI - 24 hours.

Pesticide Use Date - % Acres Treated

Herbicide	1993	1997	2004	Growers' Needs*
bensulide	7.0	13.0	5.0	
clomazone	26.0	49.0	70.0	*critical*
ethalfluralin	7.0	6.0	20.0	*critical*
glyphosate	19.0	4.0	50.0	*critical*
paraquat	7.0	94.0	25.0	
sethoxydim	7.0	10.0	20.0	*critical*

* Growers could use additional PRE herbicides for broadleaf and grass weeds as well as POST. 30% of growers are probably using halosulfuron PRE or POST with new registration.

Table 1: Effectiveness of herbicides recommended for weed control in summer pumpkins.[13]

Herbicide	Barnyardgrass	Crabgrass, Large	Fall Panicum	Foxtail spp.	Goosegrass	Johnsongrass (Seedlings)	Yellow Nutsedge	Carpetweed	Cocklebur, Common	Cranesbill	Galinsoga, Hairy	Jimsonweed	Lambsquarterss, Common	Morningglory spp.	Shepherdspurse	Pigweed spp.	Purslane, Common	Ragweed, Common	Smartweed, Pennsylvania	Nightshade, Eastern Black	Velvetleaf
Preplant or Preplant Incorporated																					
Prefar	G	G	G	G	G	G	G	G	P	G	N	P	F	F	-	G	G	P	P	F/G	F/G
Preemergence or Preplant Incorporated																					
Alanap	P	P/F	P	F	P/F	-	N	F	P	N	F	F	F	F	N	F/G	F/G	F	P	P	F
Preemergence																					
Strategy	G	G	G	G	G	G	N	G	N/F	-	F	G	G	P	F	-	G	F	G	P	G
Postemergence																					
Poast	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Select	G	G	G	G	P	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Herbicide performance is affected by weather, soil type, herbicide rates, weed pressure, and other factors. These ratings indicate ONLY relative effectiveness in tests conducted by the University of Delaware, University System of Maryland, The Pennsylvania State University, Rutgers (The State University of New Jersey), and Virginia Polytechnic Institute and State University. Actual performance may be better or worse than indicated in this chart.

G = good F = fair P = poor N = no control - = insufficient data

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On-Line Resources

C&P Press Online Crop Protection Reference
http://www.greenbook.net/free.asp

Crop Data Management Systems - Pesticide Labels
http://www.cdms.net/pfa/LUpdateMsg.asp

Insects and Related Pests of Vegetables
http://ipmwww.ncsu.edu/AG295/html

Pests of Vegetables and Fruit Trees

http://everest.ento.vt.edu/~idlab/vegpests/vegfact.html

Virginia Agricultural Statistics Service
http://www.nass.usda.gov/va/

Virginia Tech Pesticide Programs
http://www.vtpp.ext.vt.edu

Virginia Tech Weed Identification Guide
http://www.ppws.vt.edu/weedindex.htm

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