Crop Profile for Summer Squash in Virginia

Prepared: February 2005

General Production Facts* and Regions[1]

- In 2002, 160 farms planted an estimated 1,000 acres of squash and 872 acres were harvested in Virginia.
- The squash production in Virginia is relatively widespread with small acreage and can be found in the Northern Neck counties, Northampton County, Roanoke County and the Richmond area.

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

Cultural Practices [2], [3], [4]

In Virginia, there are many varieties* of summer squash available to growers. Variety selection depends on several factors such as market acceptability, yield, and horticultural characteristics. Crookneck (yellow) varieties recommended in Virginia include: *Prelude II* and *Sundance*. Straightneck (yellow) varieties include: *Seneca Prolific, Lemondrop L, Multipik, Fortune, Superpik, Monet, Goldbar,* and *General Patton*. Scallop varieties available include: *Peter Pan* (green), *White Ruffles,* and *Sunburst* (golden). Finally, zucchini types include: *Zucchini Elite, Revenue, Independence II, Cashflow, Dividend, Milano, Select, Tigress, Seneca Zucchini, and Gold Rush.* Because of virus pressure in the fall, only those varieties with virus resistance should be planted for the fall crop. These include *Prelude II, Revenue, Independence II, Dividend,* and *Tigress*.

** All summer squash varieties are hybrids. Varieties are listed by maturity within each type, earliest first.*

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Planting dates for transplants vary from April 15 in southern regions to June 1 in northern areas. Container-grown plants should be transplanted through plastic mulch when daily temperatures have reached 60°F. Early plantings should be protected from winds with hot caps, tents, row covers or windbreaks. Direct seeding occurs April 15 through August 15 in Virginia and usually 4-6 lb. of seed are needed per acre.

Mulching with plastic conserves moisture, increases soil temperature, and increases early total yield. Fumigated soil also aids in control of weeds and soilborne disease. Plastic and fumigant, metam-sodium (*Vapam* HL), should be applied on well-prepared planting beds 30 days before field planting. Fertilizer must be applied during bed preparation and the soil should be moist when laying the plastic. Clear plastic mulch is mainly only used on small acreage because weed control may be unsatisfactory even with the use of herbicides and fumigation. However, black plastic or paper can be used without a herbicide under the mulch. But weed control between the beds is essential. Foil mulches can be used to repel aphids that transmit cucumber mosaic virus in fall-planted (after July 1) squash. Direct seeding through the mulch is recommended for maximum virus protection. Transplants should not be used with foil or other repellent mulches. Fumigation will be necessary when there is a history of soilborne diseases in the field.

The recommended spacing for squash is 5-6 ft. apart with plants 2-3 ft. apart in the row.

Honeybees are important for proper fruit set and pollination. Populations of pollinating insects may be harmed by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours, or wait until bloom is completed before application.

Summer squash usually takes 50 to 65 days to mature. Usually harvested by hand, squash should be harvested two to six days after blossom falls off, when the fruit are 6-8 inches long or 4-7 inches for crookneck varieties. At this point in its development, the squash is more tender as well as sweeter than at later stages. Squash should be harvested every other day to prevent fruit from getting too large on the vine and promote continuing flowering and fruit set. If the rind is too hard to be marked by the thumbnail, the fruit is too old. Remove the old fruit to allow new fruit to develop. When the squash is cut from the plant, 1-2 inches of the peduncle should be left on the fruit.[5] Harvest dates typically range from the middle of June through October.

Worker Activities

During the growing season, worker activities in the field include direct seeding (April-August), transplanting (April-June), cultivating, irrigating, scouting, spraying, occasional hand weeding, and harvesting (June-October). 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 can 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, cucumber beetles, pickleworms, squash bugs, and squash vine borers are the most economically important insect pests of squash 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, cabbage loopers, and cutworms.

Aphids
Green Peach Aphid, *Myzus persicae*
Melon Aphid, *Aphis gossypii*

Both the green peach aphid and the melon aphid are pests on squash. However, the latter is the primary species infesting squash plants in Virginia. 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 squash 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 more 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. Treat seedlings every five to seven days or as needed. See the *Chemical Insect Control* section for more information.

Biological Control: A number of natural enemies such as lady 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: Virus-resistant cultivars including transgenic varieties are commercially available and should be considered in the pest management decision-making process for aphids. 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.

Cabbage Looper, *Trichoplusia ni*

Cabbage loopers may be identified by their pale green color, thin white stripes down the back and sides, and by their doubling-up or looping as they move. 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 squash 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 more information.

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 (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 squash 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, which will greatly reduce plant stands. Adults will also feed on the blossoms of developing plants, causing later scarring of the fruit[8]. Cucumber beetles also have the potential to transmit bacterial wilt.

In addition to the damage adult cucumber beetles cause, the larval stage, otherwise known as a rindworm, feeds directly on the roots and on the fruit as well. This feeding typically occurs at the bottom of the fruit where it comes in contact with the soil, rendering the squash unmarketable. Direct control of rindworms is difficult; however, management of adults (beetles) will reduce rindworm populations.

Monitoring: 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: Cucumber beetles can transmit bacterial wilt and cause stand losses by direct feeding injury. If adult beetles are abundant and there is a history of disease problems, insecticides should be applied before beetles feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence. Repeat applications at weekly intervals if new beetles continue to invade fields. 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: Plant varieties resistant to bacterial wilt. Always cultivate the soil thoroughly before planting. The use of plastic or straw as bedding for the developing fruit 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 fruit and in severe cases may tunnel completely through the fruit. This greatly diminishes 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 in the soil around injured plants may reveal them. If cutworms are actively cutting plants, a postplant contact treatment may be used.

Chemical Control: See the *Chemical Insect Control* section for more information.

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 brassicae*

Leafminers injure leaves primarily by mining the leaves, which 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 sun scalding 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 more information.

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 damages 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, and the larvae emerge several days later, feeding on the flowers, vines, and fruit for up to two weeks. Several generations can occur during a year, allowing pickleworm and melonworm to be considered serious pests of squash 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 more information.

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. Resistant varieties are also available.

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 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 seed 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 eliminate plant remnants.

Squash Bug, *Anasa tristis*

Squash bugs destroy plant tissue by secreting a toxic saliva into the plant, 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 wilting is observed 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 >1 egg mass or aggregation of nymphs is found per plant.

Chemical Control: Begin treatments if more than 1 egg mass per plant is present. Sprays should target nymphal stages. ***Note:*** *Use of Metasystox-R for aphid control will reduce squash bug populations.* See the *Chemical Insect Control* section for more information.

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 residue, mulching may increase squash bug pressure.

Squash Vine Borer, *Melittia cucurbitae*

The squash vine borer injures plants by tunneling through the 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, white body, and 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. Plants are checked for general vigor and other factors, and borer damage may be detected, but no regular monitoring is done specifically for this pest.

Chemical Control: When vines begin to run, apply to bases of plants four times at seven day intervals. ***Note:*** *Use of SpinTor for looper control will reduce squash vine borer populations*. See the *Chemical Insect Control* section for more information.

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, 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: Yellow sticky cards can be used 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 more information.

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 cucurbits. 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 cause death. Mite infestations are often associated with hot, dry weather and as such have become a regular problem

in Virginia during years with low rainfall.

Monitoring: Scout fields, especially areas that border roadsides or weedy edges or sandy areas of the field. Examine both the upper and lower sides of five crown leaves from five to ten 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*, *Kelthane MF*, and *Capture* are excellent miticides. Continuous use of carbofuran (*Furadan*), carbaryl (*Sevin*), or the pyrethroids for other pests may cause mite outbreaks.

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.

Chemical Insect Control

The list below contains all of the products available to producers for insect control in squash 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.
- ***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 loopers, cucumber beetles, cutworms, pickleworms/melonworms, rindworms, squash bug, and squash vine borer, apply at a rate of 0.04-0.10 lb. a.i./A. For control of two-spotted spider mite, 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 pickleworm and melonworm, apply at a rate of 0.5-1.0 lb. a.i./A. For control of cucumber beetle 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 - 3 days. Apply 0.12 lb. a.i./1000 linear feet 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. Growers should consult with their local county Extension office for current restrictions - **Special Local Need 24(c) label**. REI - 48 hours.
- **diazinon** (*Diazinon* 4EC) - PHI - 7 days. For control of green peach aphid and leafminers, apply at a rate of 0.5 lb. a.i./A. REI - 24 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 - 12 hours.

- **endosulfan** (*Thionex* 3EC) - PHI - 2 days. Chlorinated hydrocarbon. For control of cucumber beetles, pickleworm, melonworm, green peach aphid, melon aphid, rindworms, and squash vine borer, apply at a rate of 0.5-1.0 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 - 24 hours.
- **esfenvalerate** (*Asana* XL) - PHI - 3 days. Pyrethroid. For control of cabbage looper, cucumber beetles, cutworms, pickleworms, melonworms, 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 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 - 48 hours.
- **imidacloprid** (*Admire* 2F) - PHI - 21 days. Nicotinoid. For control of cucumber beetles, green peach aphid, melon aphid, and seedcorn maggot, 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 acre per year. REI - 12 hours.
- **methomyl** (*Lannate* LV) - PHI - 3 days. Organophosphate. For control of cucumber beetles, pickleworms, melonworms, melon aphids, and cabbage loopers, apply at a rate of 0.45-0.90 lb. a.i./A. Do **NOT** apply more than 5.4 lbs. a.i./A per crop, and do **NOT** make more than 12 applications per season. REI - 48 hours.
- **methoxychlor** (*Methoxychlor* 50WP) - PHI - 1 day. Chlorinated hydrocarbon. For control of cucumber beetle 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 lb. a.i./A per season. REI - 48 hours.
- **oxydemeton-methyl** (*Metasystox*-R 2SC) - PHI - 14 days. Organophosphate. For control of green peach aphids, 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, *Pounce* 3.2EC) - PHI - 0 days. Pyrethroid. For control of leafminers and squash bugs, apply at a rate of 0.20 lb. a.i./A. To control cabbage loopers, cucumber beetles, cutworm, melonworm, pickleworm, rindworm, and squash vine borer, 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. For control of green peach aphids and melon 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 loopers, 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, *Platinum* 2SG) - 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*) - PHI - 30 days. Nicotinoid. For control of aphids, 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
Bt	5.0	5.0	N/A	
bifenthrin	N/A	N/A	70.0	*critical*
carbaryl	19.0	19.0	10.0	
carbofuran*	N/A	N/A	20.0	*critical*
diazinon	5.0	5.0	N/A	
dicofol	N/A	N/A	15.0	*critical*
endosulfan	21.0	21.0	20.0	
esfenvalerate**	26.0	26.0	16.0	
imidacloprid	N/A	N/A	20.0	*critical*
malathion	5.0	5.0	5.0	
methomyl	11.0	10.0	10.0	
thiamethoxam	N/A	N/A	20.0	*critical*

*24(c) label for *Furadan* 4F labeled at planting on bare ground in VA, some growers still use it.

**Most growers are gradually switching to the newer pyrethroids like bifenthrin.

Disease Pests

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

DISEASES

Disease in squash 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. These diseases depend primarily on weather conditions but also on a number of other factors such as site location, seed quality, and effective management procedures. Good sanitation and management practices are key to a successful disease control program. Powdery and downy mildew, blossom blight, and Phytophthora blight are the most common diseases affecting squash in Virginia.

Bacterial Wilt, *Erwinia tracheiphila*

Initially, the foliage becomes dull green in color, and individual leaves droop in the 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: Weekly scouting for cucumber beetles should begin following transplant of plants or as soon as the plants emerge. When an average of two beetles per plant is found a treatment plan should be started. 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. 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.

Biological Control: No commercially effective controls are available.

Cultural Control: Control is aimed at prevention of the 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.

Blossom Blight, *Choanephora cucurbitarum*

Blossom blight is a fungal disease that attacks flowers and young fruit. It first attacks the blossoms and progresses into the developing fruit, causing a wet rot at the blossom end. The fungus appears as spines with dark heads on the surface of infected tissues. It develops during periods of rainy, humid weather and is a serious problem in some years. The spores can be spread by insects, wind, and splashing water.

Monitoring: Checking the current fruit set for decay on the blossom end can show whether aeration needs to be improved for the subsequent fruit.

Chemical Control: Fungal sprays are not particularly effective but in some instances may reduce fruit losses.

Biological Control: No commercially effective controls are available.

Cultural Control: Reduce the humidity around the plant by using raised beds and wider plant spacing, planting open foliage varieties, and maintaining good weed control. This allows air movement to dry the soil and the foliage. Avoid planting squash on heavy, poorly drained soils.

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. Although *Pythium* is more commonly found causing damping-off in cucurbits, *Fusarium* is occasionally found.

Monitoring: Monitoring your crop just after transplant will enable replanting for the current crop and reveal 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. *Ridomil Gold* 4E or *Ultra Flourish* 2E can be used for *Pythium* disease control.

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 conditions. 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 to sunscald in 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 mancozeb every seven days. Other effective fungicides such as mefenoxam *plus* chlorothalonil (*Flouronil* or *Ridomil Gold Bravo*), mefenoxam *plus* copper hydroxide (*Ridomil Gold Copper*), mefenoxam (*Ridomil Gold*), pyraclastobin *plus* boscalid (*Pristine*), and cymoxanil *plus* famoxadone (*Tanos*) should be applied every 14 days. Apply chlorothalonil or mancozeb on alternate weeks. 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 likely to develop the disease. Also, avoid overhead irrigation.

Plectosporium Blight, *Plectosporium tabacinum*

Plectosporium blight, formerly called Microdochium blight, has been present 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 die, and complete defoliation may occur in severe cases. 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 the field weekly for tan flecks developing on the stems early in the season and on the

petioles and fruit later in the season.

Chemical Control: It is important to achieve maximum foliage coverage with the fungicide application. Once symptoms appear on petioles or after fruit form, apply chlorothalonil (*Bravo, Echo,* or *Equus*) and repeat every 7-10 days. A spray schedule that alternates *Cabrio* or *Flint* with chlorothalonil will also provide control. See the *Chemical Disease Control* section for more information.

Biological Control: No commercially effective controls are available.

Cultural Control: Rotate with noncucurbit crops for at least three years. Plant in sites with good air circulation, and plow under crop debris after harvest.

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, which enlarges quickly and becomes a soft, sunken area covered with white fungal growth. This eventually will lead to fruit collapse in the field or in storage. During periods of heavy rainfall, this disease can spread rapidly, quickly becoming a very serious problem.

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

Chemical Control: Mefenoxam applied preplant can provide some early-season protection and late-season protection if applied for downy mildew control. For protection against the stem and fruit rot phase of the disease, dimethomorph (*Acrobat*) *plus* fixed copper or mancozeb *plus* zoxamide (*Gavel*) may be applied. 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, a complete management 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 out susceptible crops for two or more years.

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 with upper and undersides of leaves by turning over at least 100 leaves in a field. If one infection site per 45 leaves is found, fungicides need to be applied.

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 and 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.

Scab, *Cladosponum cucumerinum*

This fungal disease can attack all parts of the plant but is most damaging because of the unsightly scab lesions that develop on fruit, usually making it unmarketable. The first signs of disease are 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 chlorothalonil 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 the 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. The 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 (WMV-1), 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 can be malformed and present a break in 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 the flesh of the fruit.

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

Chemical Control: Soaps and oils can be used to control virus-transmitting aphids, but once the virus is established in the crop, there are no effective chemical controls available. Reducing insect vectors with insecticides is an option, but remember that insecticides are not always effective in reducing virus spread because the virus may have been transmitted before the insecticide kills 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 to prevent aphid transmission 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 squash 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** apply 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 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 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 powdery mildew and scab, apply at a rate of 1.50-2.25 lb. a.i./A. REI - 12 hours.
  *When apply cholorthalonil, do **NOT** apply during intense heat, sunlight, or drought conditions and/or if there is a poor vine canopy.* Do **NOT** exceed 15.75 lb. a.i./A/season.
- **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.
- **mancozeb *plus* zoxamide** (*Gavel* 75DF) - PHI - 5 days. Substituted aromatic. For control of downy mildew and phytophthora blight, apply at a rate of 1.13-1.5 lb. a.i./A. Start applications when plants are in the two-leaf stage, and repeat at 7 to 10 day intervals or when environmental conditions are favorable for disease development. Do **NOT** apply more than 10.67 lb. a.i/A/crop. REI - 48 hours.
- **mefenoxam *plus* mancozeb** (*Ridomil Gold* MZ 68WP) - PHI - 5 days. Substituted aromatic. For control of downy mildew, apply at a rate of 1.7 lb. a.i./A. Begin application when conditions are favorable for disease but before infection, and continue at 14-day intervals until threat of disease is over. Avoid late-season applications when plants reach full maturity or begin senescence. You may make up to four applications per crop. Use caution when apply other fungicides that contain similar active ingredients. Consult the label before application. 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. 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 powdery and downy 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. 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.
- **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** apply 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 indication 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	11.0	10.0	N/A	
chlorothalonil	26.0	26.0	60.0	*critical*
copper	5.0	5.0	5.0	
dimethomorph	N/A	N/A	10.0	*critical*
mancozeb	5.0	5.0	10.0	
metalaxyl	26.0	26.0	N/A	
mefenoxam	N/A	N/A	60.0	*critical*
myclobutanil	N/A	N/A	50.0	*critical*
pyraclostrobin	N/A	N/A	20.0	*critical*
thiophanate-methyl	5.0	5.0	5.0	
triadimefon	11.0	10.0	N/A	
trifloxystrobin	N/A	N/A	10.0	

Nematode Pests

Control recommendations were taken from 2004 Commercial Vegetable Production Recommendations-Virginia.[10]

NEMATODES

The root-knot nematode (*Meloidogyne* spp.*)* is the most important species of nematode affecting squash in Virginia.[11] 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 that the fields be sufficiently prepared for planting. All crop debris and clods should be removed, and soil moisture should be adequate. Otherwise, soil fumigation will not be effective due to lack of penetration of all soil particles by the gaseous fumigant. 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 lower their population size is highly recommended in the event of nematode activity.

Chemical Nematode Control

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 squash. Typically, chemical controls are used only when cultural practices cannot provide adequate control. However, these chemicals are still important tools when other methods of control 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 squash work on annual grasses, certain perennial grasses, and certain broadleaf weeds, including common lambsquarters, jimsonweed, and pigweed species. However, producers in Virginia are faced with many broadleaf weed problems, including morningglory species, mustards, and yellow nutsedge. Successful weed management is vital to the production of quality squash. Weeds compete with the crop for light, space, nutrients and, particularly, water. Weed growth promotes disease problems and can harbor harmful insects and diseases. Weeds also impair the ability to harvest effectively, reducing the quantity of marketable fruit and increasing labor costs. 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 preemergence 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 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 component 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, mechanical cultivation should not be performed on varieties of squash that vine ("run"). These vines are very tender and are easily damaged by tractor wheels or cultivators. Mechanical control must be supplemented with chemicals or hand weeding to remove weeds in the rows or after the plant produces vines. Hand weeding provides effective weed control and is safe to the crop. Weeding should be performed 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 costly in terms of labor. Using cultivation 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, avoiding fields with a history of severe weed infestations may be appropriate.

Chemical Weed Control

The list below contains all of the fully labeled products available to producers for weed control in squash; 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. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch 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 5-6 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.

Preemergence

- **bensulide** (*Prefar* 4E) - PHI - N/A. Amide. Apply at a rate of 5-6 lb. a.i./A as a banded, directed, shielded spray preemergence to the weeds and activate with 1/2 inch of sprinkler irrigation within 36 hours to control most annual grasses. 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.
- **clomazone** (*Command* 3ME) - PHI - N/A. Pyridazinones. To control annual grasses and many broadleaf weeds, including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed, apply at a rate of 0.094-0.188 lb. a.i./A (based on soil texture). Mustards, morningglory species, and pigweed species will **NOT** be controlled. Combine with *Curbit* 3EC to control pigweed species where *Curbit* is registered for use. Some temporary crop injury may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. REI - 12 hours. ***Warning: Herbicide residues may limit subsequent cropping options when Command is used for weed control in squash. See planting restrictions on the label, or consult your local Cooperative Extension office for more information.***
- **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 result in 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 (based on soil texture) preemergence to control annual grasses and many annual broadleaf weeds. *Strategy* is a jug-mix of ethalfluralin and clomazone. However, it is often recommended that *Curbit* and *Command* be mixed by the growers to allow selection of appropriate rates and minimize injury. Read and follow all the recommendations and warnings for ethalfluralin and clomazone. REI - 24 hours.
- **halosulfuron** (*Sandea* 75WG) - PHI - N/A. Sulfonylurea. Apply 0.023-0.047 lb. a.i./A (based on soil texture) between rows of plastic mulch to suppress or control broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following *Sandea* use early in the season. When observed, 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.

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 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 when hot or humid conditions prevail.*

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 if 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, 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, slight yellowing of the crop may be observed within a week of *Sandea* application. When observed, 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 to control emerged weeds between the rows after crop establishment. 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 when hot or humid conditions prevail.* 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 or Preemergence</u>

- **bensulide** (*Prefar* 4EC) - PHI - N/A. Amide. Apply at a rate of 5-6 lb. a.i./A before planting. Incorporate 1-2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with 1/2 inch of sprinkler irrigations with 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

- **clomazone** (*Command* 3ME) - PHI - N/A. Pyridazinones. To control annual grasses and many broadleaf weeds including, common lambsquarters, velvetleaf, spurred anoda, and jimsonweed, apply at a rate of 0.09-0.19 lb. a.i./A (based on soil texture). Mustards, morningglory species, and pigweed species will **NOT** be controlled. Combine with *Curbit* 3EC to control pigweed species where *Curbit* is registered for use. Some temporary crop injury may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. REI - 12 hours. ***Warning: Herbicide residues may limit subsequent cropping options when Command is used for weed control in squash. See planting restrictions on the label, or consult your local Cooperative Extension office for more information.***
- **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, or use when soils are cold or wet. This could result in crop injury. REI - 24 hours.
- **ethalfluralin *plus* clomazone** (*Strategy* 2.1SC) - PHI - N/A. Pyridazinones/Nitroanilines. Apply 0.39-1.58 lb. a.i./A (based on soil texture) preemergence to control annual grasses and many annual broadleaf weeds. *Strategy* is a jug-mix of ethalfluralin and clomazone. However, it is often recommended that *Curbit* and *Command* be mixed by the growers to allow selection of appropriate rates and minimize injury. Read and follow all the recommendations 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 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 when hot or humid conditions prevail.* 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 if 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.
- **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 to control annual grasses and certain perennial grasses. *The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.* 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 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	5.0	5.0	10.0	
clomazone	11.0	77.0	15.0	
DCPA	N/A	N/A	2.0	
ethalfluralin	5.0	5.0	70.0	*critical*
glyphosate	5.0	5.0	3.0	
sethoxydim	11.0	10.0	35.0	*critical*

*Herbicides with greater safety to squash with activity on both broadleaf weeds and grasses.

Table 1: Effectiveness of herbicides recommended for weed control in summer squash.[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																					
Strategy	G	G	G	G	G	G	N	G	N/F	-	F	G	G	P	F	-	G	F	G	P	G
Postemergence																					
Gramoxone Max	F/G	F/G	F/G	G	F/G	-	G	G	G	-	G	G	F/G	F/G	-	G	F/G	G	P	-	-
Poast	G	G	G	G	G	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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