Crop Profile for Squash in Georgia

Prepared: November, 2003

General Production Information

Squash (Cucurbita spp.) is a member of the cucurbit family, which consists of a number of warm-season vegetables including watermelon, cantaloupe, cucumber, and pumpkins. Squash are classified into several types based on fruit shape and color. All commercial production in Georgia is summer squash, chiefly yellow squash and zucchini. The information in this publication refers only to summer squash production in Georgia.

Production Facts

- Georgia ranked 1st in both acreage planted and acreage harvested in 2000.
- Georgia accounted for approximately 27% of U.S. squash production in 2000.
- Georgia planted 10,700 acres of squash in 2000, harvested 10,700 acres.
- About 2/3 of Georgia squash is a spring crop.
- Approximately 2/3 of Georgia squash production is bareground; 1/3 is plasticulture.
- Cash value- 4 27 million (based on avg $5 /box with 400 plastic/800 bare)
- Production costs
  - Plasticulture: $2900, assuming double cropped. Nearly all plasticulture squash is grown on plastic that has already been used for another crop (e.g., tomato).
  - Bareground culture: $2000/acre. For additional information about the economics of squash production, contact Dr. Greg Fonsah, gfonsah@uga.edu
- Crop Destination (%)
  - Fresh market > 98.5 (%)
  - Processing <1.5(%) 
  - Other (feed, etc) 0(%) 

Production Regions

Squash will grow on a wide variety of soil types with proper management. In all cases, however, the soil should be well drained. Avoid land that has been in cucurbits the previous year. Also check for previous use of long-residual herbicides as well as heavy nematode infestation. Squash is grown throughout Georgia, but most commercial production is in the southern part of the state. Primary production regions for squash grown on plastic are in the southwestern and south central part of the state including Mitchell, Colquitt, Echols and Brooks Counties among others. Bareground production occurs throughout the southern half of the state, primarily in Grady, Brooks, Berrien, Atkinson, Colquitt, Montgomery,
Toombs, Ware, Worth, Jeff Davis, Pierce, Tattnall and Thomas Counties.

Cultural Practices

*Summer Squash.* By far, the most common forms of summer squash produced in Georgia are yellow and zucchini squash. Summer squash grown on both bareground and plasticulture are produced primarily on loamy sand to sandy loam soil types in the Coastal Plain area. All spring production is bareground. When squash is grown on plastic in Georgia, it is almost always produced on plastic that was placed for another crop (e.g., tomato) that was grown earlier in the same year. About 2/3 of Georgia squash is produced bareground, and the remaining 1/3 is grown on plastic. For a complete description of plasticulture production, visit this web site. [http://www.ces.uga.edu/pubcd/b1108-w.html](http://www.ces.uga.edu/pubcd/b1108-w.html)

Planting dates for spring production range from early March for squash grown on plastic to late March for bareground culture. Most fall production plantings occur beginning in early August to early September. In Georgia, 2/3 of the squash is produced in the spring.

Planting sites are deep turned and bedded. Preplant fertilizers, comprising 25-33% of total nitrogen/potassium and 100% of phosphorous/minor nutrients, are incorporated into. For squash grown with plastic mulch, the remaining nutrients are applied through drip irrigation. In bareground culture, remaining nutrients are applied with sidedress applications. A total of 80-120 pounds of nitrogen per acre are used per crop. A total of 80 to 90 pounds of potassium and phosphorous are applied per acre depending on soil test results.

Squash is direct-seeded with a mechanical planter. A starter fertilizer application that is high in phosphorous is common at planting. Plant spacings average three feet between rows with 12-24 inches between plants within the row. Irrigation is supplied as needed with the highest demand during fruit set and enlargement. Foliar applications of calcium, boron and magnesium are commonly applied to enhance plant growth and reduce the chance of deficiency. Squash is harvested while still immature after attaining a size suitable for fancy-grade squash. Yields vary from 400 boxes per acre on bareground to around 800 boxes per acre on plastic mulch.

Summer squash production in Georgia begins as soon as soil temperatures are warm enough for seed to germinate (minimum 68°F, optimum 70°F; to 80°F). Summer squash will begin producing in 45 to 55 days from seeding. Summer squash are usually planted every 10 to 14 days to maintain production during the growing season. Although, theoretically, summer squash can be planted throughout the spring and summer up to 60 days before last frost, disease and insect problems generally curtail production during late summer and fall.

Approximately 80% of Georgia squash is irrigated. Bareground squash is typically irrigated with an overhead system. Plasticulture squash is watered with a trickle system. Neither system requires workers to enter the field to move or operate irrigation equipment.
Pollination. Squash have both male and female flowers on the same plant; therefore, pollen must be transferred from the male flowers to the female flowers. With the decline of wild honeybees, growers often supplement wild bee populations with commercial hives. Additionally, growers have greater concern for protecting pollinators from pesticides.

Harvesting and Marketing. Summer squash for fresh market are harvested every other day or three times a week during peak harvest. The fruit should be 1.5 to 2.5 inches in diameter with a glossy appearance. Squash are harvested with 1 to 1.5 inches of the stem attached. Zucchini squash should be about 8 inches long. Fruit should be harvested before it gets too large and seed becomes hard. Summer squash are not normally stored. They should be marketed as quickly as possible after harvest. If necessary, however, they can be stored for three to four days at 45° to 50°F and 85 percent to 90 percent humidity.

Potential Worker Exposure

At-planting. Growers typically apply an herbicide at planting (specific chemicals below). A typical application would be made by the grower or a farm employee. It would take ½ day or less to complete the application. The applicator would typically mix and load the chemicals as well. The chemicals are applied by ground. Some growers have open cabs; some have closed cabs. Larger operations are more likely to have closed cabs.

During the season, a work crew may be needed to pull or hoe weeds that escaped herbicidal control. This activity is not necessary in every field and is largely unpredictable. The work crew would typically perform this activity for ½ day or less.

Most Georgia squash is irrigated, but workers do not typically enter the field during the season to move or operate irrigation equipment.

During the season, the grower or a farm employee applies all pesticides with ground equipment. A typical application would take ½ day or less to complete. The applicator would typically mix and load the chemicals as well. Some growers have open cabs; some have closed cabs. Larger operations are more likely to have closed cabs.

All Georgia squash is harvested by hand every 2-3 days over a 3-4 week period by crews of 8-10 people harvesting for about five hours per day. There are two general categories of work crews. Some work crews are migratory. The grower negotiates with a work contractor for a certain amount of labor. The crews work for various farms and other operations; they provide a labor for a variety of farm and nonfarm tasks. Conversely, some farms have a more permanent crew of workers. These crews provide labor for a variety of tasks for the same farm. In some cases, several farms may cooperate to maintain a shared work force. In summary, a crew or individual may harvest squash every day for several weeks, or the crew or individual may harvest squash irregularly and perform other tasks some days.
Weeds

Weed control is important to insure maximum yields. Both herbicides and cultivation practices are used to control weeds. Once established, squash plants have extensive root systems that can compete well for water and nutrients in the soil with weeds. However, heavy weed growth causes competition for sun, harvest problems, and may harbor pathogens and insects. Cultivation after root establishment should be shallow and away from the squash plant due to the concentration of shallow roots near the surface. Herbicide application to reduce weed competition is a common cultural practice before vine spreading.

Weed control involves the management of several grasses and broadleaf species. Particularly troublesome weeds include yellow nutsedge and larger-seeded broad leaves.

Herbicides

- Dacthal or ethalfluralin. For bareground culture, nearly all growers apply one of these herbicides at planting. No other herbicides are applied during the season.
- Paraquat or glyphosate. For plasticulture production, nearly all growers burn down the previous crop with a single application of one of these herbicides.

Nonchemical alternatives and IPM. Growers incorporate other techniques in an IPM program for weeds, but nonchemical methods cannot replace the critical role of herbicides in squash production. Cultivation between the rows is common until the squash plants become too large. Additionally, hand weeding is common to clean up sporadic weeds during the season. Hand weeding is typically confined to small areas where herbicides failed to control weeds.

Crop rotation is an important aspect of controlling some persistent weed species and problem weeds such as sicklepod, nutsedge and cocklebur.

Review pesticides recommended for weed management in the Georgia Pest Control Handbook. [http://www.ent.uga.edu/pmh](http://www.ent.uga.edu/pmh)

Insect Pests

A number of insects are serious problems in Georgia squash production. Aphid and the concomitant virus transmission are, by far, the most serious insect problem for Georgia squash producers. Sweetpotato whitefly (silverleaf) is the next most serious insect pest, followed by pickleworm, and cucumber beetles.
In 2000, insects caused losses of nearly $3.9 million (damage + cost of control). Aphids, primarily because of virus transmission, were responsible for losses of $1.4 million, followed by silverleaf whitefly ($1.2 million), and pickleworm + melonworm ($670,000). http://www.ent.uga.edu/IPM/sl00/sl00.htm

Insects are not a major problem for spring squash production. Nearly all insecticides are applied to the fall crop.

**Aphids** and concomitant virus transmission are the most important pests of squash in Georgia.

Many aphid species attack squash. Aphids can overwinter on many different wild hosts. Adults of the first generation reproduce sexually; the offspring become winged adults that fly to host crops. The next several generations reproduce asexually. Asexual reproduction allows aphid populations to increase very rapidly. Aphids suck sap from leaves and stems, reducing plant vigor and yield quantity/quality. Additionally, some aphids vector mosaic viruses that can greatly reduce crop yields. In the fall, 100 percent reductions in yields have been recorded.

**Mosaic Virus Management:** Ultra fine oils have been found useful for interfering with the transmission of aphid-born mosaic viruses in summer squash. The use of oils is not a panacea, but growers can delay early primary and secondary infection within the field so that marketable squash is produced over a longer period of time.

In using oils, the method of application has been the key to on-farm success. In Georgia, growers commonly use the following procedures to apply oils for aphid/virus management.

- Pressure - 400 psi;
- Volume - 15 to 100 gpa dependent on addition of nozzles as plant size dictates;
- Nozzles - TX-5 stainless steel or ceramics giving comparable droplet sizes;
- Oil concentration - 3 quarts of JMS Stylet Oil or 1 gallon of Saf-T-Side per 100 gallons of water; and
- Delivery speed - 2.5 to 3.0 mph.

Timing of the applications is critical. The first few applications are the most important, and delays in early sprays have been the most common cause for field failures. The first application is recommended by the time 25% emergence is expected. Even though much of the first application may be to bare ground, it is not uncommon to find winged aphids on the cotyledons of squash, even during the late cracking stage.

Growers make subsequent applications twice per week on a regular schedule. An insecticide may be added the first week and as needed thereafter to prevent the development of aphid colonies that increase the potential for secondary, in-field viral transmission. Oil sprays may be discontinued within two weeks of final harvest since expression of mosaic in individual plants requires about 14 to 21 days after
Aphids and virus transmission are a much bigger problem for the fall crop. The increased aphid/virus pressure is an important reason why 2/3 of the Georgia squash crop is produced in the spring.

**Pickleworm** and melonworm are the caterpillar stage of moths. They are mostly green and up to 3/4 inch long. Eggs are deposited on hairy plant parts, such as the blossoms and young leaves. Larvae feed on young leaves at the growing tips of vines or inside blossoms. Larvae later bore into both young and older fruit, although young fruit are preferred. Fruit are riddled with small (1/8 inch) holes.

Pickleworm and melonworm are serious pests of fall squash. After the fruit is set in the fall, Georgia growers commonly apply insecticides on a weekly schedule. The insecticides are mixed and applied with oil sprays.

**Silverleaf Whitefly** is a serious pest of fall squash. Even small infestations of immature whiteflies can induce silverleaf symptoms in squash. The foliage turns silver and the fruit becomes very pale and unmarketable.

The oil sprays used to delay mosaic virus transmission by aphids also give some prevention of silverleaf. Growers also commonly mix an insecticide with oil applications to manage whitefly outbreaks. Insecticides are not needed in every oil application, rather used as needed to suppress whitefly development.

**Miscellaneous pests.** [Cucumber beetle](#), [squash bug](#), and [squash vine borer](#) are sporadic pests of commercial squash. Growers in Georgia rarely apply insecticides specifically to control these pests, but insecticide applications for other pests probably help prevent populations of these insects from reaching damaging levels.

*Insecticides.* Nearly all insecticides applied to Georgia squash are applied to the fall crop.

**Oils:** applied 11 or more times 1-2 times per week to control aphids and virus transmission. USDA-NASS reports that 21% of the acreage was sprayed with oils in 2002.

- Imidacloprid: applied at planting to control aphids and/or whiteflies. USDA-NASS reports that 28% of the acreage was treated in 2002.
- Esfenvalerate, permethrin: mixed with oil sprays to control pickleworm/melonworm. Growers do not add a melonworm/pickleworm insecticide with every oil spray, but it is common to treat for melonworm/pickleworm on a weekly schedule after the fall fruit set. USDA-NASS reports that about 20% of the acreage was treated with esfenvalerate or permethrin in 2002.
- Endosulfan: commonly mixed with oil sprays to control whiteflies and/or worms. Growers add endosulfan to about half of the oil sprays. USDA-NASS reports that growers treated 63% of the acreage with endosulfan in 2002.
- Methomyl and carbaryl: applied to less than 10% of the acreage. Growers mix these insecticides with oil sprays occasionally, primarily to control worms.

*Nonchemical alternatives and IPM.* Because nearly all Georgia squash is sold as fresh produce, injury thresholds are very low. For the major pests (i.e., aphids, whitefly, and melonworm/pickleworm), insecticides are a critical component of squash IPM.

However, growers employ other IPM techniques to minimize insecticide inputs. Most growers grow squash as a spring-planted crop. The early crop avoids most insect problems and the need for insecticide applications. Georgia squash is typically scouted 2 times per week. Because aphids/virus are such an important pest, oil applications must be made on a regular basis. However, oils have a relatively small impact on populations of beneficial arthropods. Other, more broad spectrum, insecticides are added to the oil sprays on the basis of monitoring data.


### Diseases

Diseases can cause serious problems in squash production. In 1997, disease caused a 15% reduction in crop value for squash; the value of the loss plus the cost of control exceeded $27 million (1998 Georgia Plant Disease Loss Estimates, June 1999).

**Downy mildew**, caused by the fungus *Pseudoperonospora cubensis*, is found annually on squash and other cucurbits. It is a serious disease of squash, causing reductions in fruit quality and yield. Harvesting is more costly and time-consuming. Plants may die if infected early in the growing season. Downy mildew can reduce yield, fruit quality, and harvesting time. Downy mildew can kill plants if plants are severely infected early.

Spore movement occurs primarily during late morning to midday. The spore germinates and penetrates the leaf tissue after landing on a wet leaf. New lesions and more spores are produced in 4-7 days. If conditions are right for infection (night temperatures between 55°-75 ° F. with >90% humidity), an epidemic can develop quickly.

Growers employ a regular spray program, although resistant cultivars may require fewer fungicide applications.

**Phytophthora** crown and fruit rot is a serious disease of cucurbits. Summer squash is highly susceptible. Leaves develop water soaked lesions that expand rapidly. Shoot dieback, wilting, and death can occur
quickly after initial infection. *Phytophthora* also causes dark water soaked lesions on the fruit; white fungal growth will quickly cover the fruit. During periods of warm, wet weather, *Phytophthora* can decimate an entire planting of squash within a few days.

Growers use cultural practices (e.g., well-drained fields and weed management) to help control *Phytophthora*, but preventive fungicide applications are usually part of the management scheme.

*Pythium cottony leak* (also called *Pythium fruit rot*) usually appears where fruits touch the ground. Spots develop and coalesce very quickly. The infected area of the fruit becomes soft and brown, covered with a fluffy white mat of fungus. In conditions of high humidity and standing water, fruits may spoil within 48 hours of infection. *Pythium* can also spread after harvest through fruit-to-fruit contact.

Growers use cultural controls (e.g., drainage and plowing) to help manage *Pythium*. Fungicide applications at planting are also common.

*Squash Mosaic Virus complex* comprises five viral pathogens that cause similar diseases in summer squash. Four of these viruses are important squash diseases in Georgia; aphids transmit all four. The viruses cause a greenish coloration in yellow squash; infected zucchini fruit are rough and mottled with darker green areas. The mosaic viruses also affect the function and appearance of the foliage. The plants produce fewer fruit, and the fruit quality if also reduced.

In addition to squash, these viruses infect many other wild and domestic plant species. Several different aphid species vector the viruses between plants and between species. The virus transfer can occur in less than one minute of feeding, which makes insecticides an unreliable option to control these types of viruses.

Growers use cultural practices such as destroying abandoned cucurbit fields, weed hosts, and volunteer cucurbits to reduce the virus inoculum available. However, a regular program of oil sprays is the primary way that growers manage the spread of viral diseases. Oil sprays are applied on a 3-4 day interval at 400 psi, beginning when foliage is first available to aphids. More detailed information about controlling mosaic viruses is included in the discussion of aphids in the "Insect Management" section.

*Powdery Mildew* is an important fungal disease that appears as a white powdery mildew on both leaf surfaces. In Georgia, powdery mildew is more commonly caused by *Sphaerotheca fuliginea*, but *Erysiphe cichoracearum* can also cause this disease. Powdery mildew is especially prevalent in hot, dry conditions. White or brown mealy growth will be found on upper and lower surfaces and stems. Severe infections will weaken and stunt the plant and may defoliate the plant.

Growers apply preventive fungicide applications when weather conditions favor the disease.

*Nematode*. Root-knot nematode attacks squash roots in Georgia. They enter young roots during feeding
and cause a swelling. These nematodes restrict water and nutrient uptake giving the plant a stunted, wilted appearance. Nematodes can be controlled with rotation of a grass crop with the squash. Growers also use a nematicide when sufficient rotation is not possible.

**Other minor diseases** include scab, bacterial wilt, angular leaf spot, and *Choanephora* wet rot, but these diseases are less important. Fungicide applications may be necessary in some situations.

**Fungicides.** Regular fungicide applications are critical for both spring and fall production. Squash is short-season crop; growers typically apply fungicides no more than 4-5 times each season. Growers use several different products based on the particular diseases and to manage disease resistance.

- **Chlorothalonil:** very important for management of diseases and for preventing/delaying disease resistance to other products. About 40% of growers use a combination product that contains chlorothalonil and metalazyl-m) one time, and about 70% of growers apply chlorothalonil again later in the season. USDA-NASS reports that 68% of the Georgia squash acreage was treated with chlorothalonil 2-3 times during 2002. Chlorothalonil is recommended as part of the control program for all major fungal diseases of squash.
- **Mancozeb:** applied at least once by about 70% of growers. About 30% apply mancozeb or similar products (e.g., maneb) 2-3 times per season. Mancozeb is part of the control program for downy mildew.
- **Pyraclostrobin or azoxystrobin:** applied 1-2 times to about 40% of the acreage. Most growers use pyraclostrobin because it is considered to be more effective. These fungicides are used to control downy mildew.
- **Myclobutanil:** applied to 60% of acreage at least once per season to control powdery mildew.
- **Triflumizole:** applied to about 40% of acreage at least once per season to control powdery mildew.
- **Metalaxyl:** applied to about 15-20% of squash produced on plastic to control crown/fruit rot. It is added to the drip irrigation.
- **Dichloropropene:** applied to about 30-40% of bareground production at planting to control nematodes.


**Nonchemical alternatives and IPM.** Disease management in squash is based on a combination of tactics. Effective fungicides are a critical component. Chlorothalonil is particularly important because of its role in resistance management. Other products, with a more targeted mode of action, are much more susceptible to resistance problems. The availability of chlorothalonil will prolong the effective life of many other fungicides.

Crop rotation, particularly with pasture grasses and small grains, can help reduce problems (particularly with nematodes). Viral diseases are often eliminated or reduced by planting early before virus-
transmitting insects become a problem. Planting resistant varieties is the best method for controlling squash mosaic viruses. Transgenic, pathogen derived resistance is available in some squash cultivars.

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References

Background information for this profile was taken from Circular 527/Revised May 1999, Commercial Squash Production. Please visit the following web site to review the entire publication. http://www.ces.uga.edu/pubcd/C527.htm

Additional details concerning squash production and pest management in Georgia are also available at this web site. http://www.uga.edu/vegetable/squash.html