General Production Information

During 2001, Tennessee planted approximately 1,000 acres of summer squash. This acreage includes production for both fresh market and processing. Harvested acreage was approximately 900 acres with an average yield of 5,700 lbs per acre with a total production for both fresh market and processing at 51,300,000 lbs valued at $1,058,000 for the 2001 production season.

During 2002, the Tennessee Department of Agriculture reported that 1,000 acres were planted and 900 acres were harvested for fresh market and processing with an average production of 9,400 lbs per acre valued at $2,136,000 for 2002. State Extension Specialists indicated that approximately 550 acres were planted for processing with 500 acres harvested during 2002 and 900 acres were harvested for fresh market. Yield average was approximately 2.5 tons of processing fruit harvested per acre. Processed fruit were valued at $625,000 during 2002. It was suggested by Extension State Vegetable Production Specialists that summer squash production in Tennessee was valued at approximately 2.8 million dollars for both processing and fresh market fruit in 2002. In 2000, Tennessee ranked 11\textsuperscript{th} in summer squash production (\url{http://www.nass.usda.gov/nj/rnk00sqh.PDF}) During 2000, Tennessee produced just over 2.2 \% of the U.S. produced squash.

Cultural Practices

Worker Safety and Re-Entry Intervals

Most large scale squash producers hire migrant workers or individuals located near their community. Tennessee producers are required by federal and state laws to follow safety standards known as the Worker Protection Standards (WPS). The Worker Protection Standards are regulations which cover pesticide usage in agricultural, forest, nursery and greenhouse production. Any Tennessee producer employing individuals to work in agricultural production must inform and/or train workers concerning the Worker Protection Standards. Worker Protection Standards are standards which are to be followed by employers to help eliminate possible pesticide contamination of pesticide applicators, handlers or workers. Information pertaining to pesticide application must be posted in a central location. Information concerning products used, location of application and re-entry interval is posted at the central location.
Also, other items pertaining to safety are provided to workers, applicators and/or handlers. Table 1, includes re-entry intervals of products commonly used in Tennessee squash production. If workers, handlers and/or applicators must enter the field earlier than indicated by the pesticide label, individuals maybe required to wear certain personal protective equipment. In most cases this includes boots, gloves, hat, long sleeve shirts, and long legged trousers. The Signal Word indicated by Caution, Warning or Danger are indicators of the level of human hazard which may vary between formulations containing the same active ingredient. The Signal Word lets the applicator, handler or worker know the relative toxicity of a product. Early re-entry is generally not necessary in Tennessee squash production. Treated areas are also posted to inform workers that treatments have been made and re-entry is restricted. If employers and employees follow WPS regulations, harvest interval and re-entry intervals, agricultural workers are less likely to be at risk to pesticide exposure in Tennessee agricultural production.

Table 1. Re-entry Interval of Products Commonly Used in Summer Squash Production

<table>
<thead>
<tr>
<th>Pesticide Type</th>
<th>Active Ingredient</th>
<th>Re-entry Interval</th>
<th>Signal Word</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chlorothalonil</td>
<td>48 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td></td>
<td>Copper, fixed</td>
<td>24 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td></td>
<td>Trifloxystrobin</td>
<td>12 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td></td>
<td>Maneb</td>
<td>24 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td></td>
<td>Mancozeb</td>
<td>24 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td></td>
<td>Mefenoxam</td>
<td>48 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td></td>
<td>Metalaxyl</td>
<td>48 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td></td>
<td>Myclobutanol</td>
<td>24 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td></td>
<td>Azoxystrobin</td>
<td>4 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td></td>
<td>Sulfur</td>
<td>24 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td>Herbicides</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>-----------</td>
<td>-----</td>
<td>--------------</td>
</tr>
<tr>
<td>Herbicides</td>
<td>Bensulide</td>
<td>12 hrs</td>
<td>Caution</td>
</tr>
<tr>
<td>Ethalfluralin</td>
<td>24 hrs</td>
<td>Danger</td>
<td></td>
</tr>
<tr>
<td>Glyphosate</td>
<td>12 hrs</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>Paraquat *</td>
<td>24 hrs</td>
<td>Danger</td>
<td></td>
</tr>
<tr>
<td>Sethoxydim</td>
<td>12 hrs</td>
<td>Warning</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Insecticides</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticides</td>
<td>Dimethoate</td>
<td>48 hrs</td>
<td>Warning</td>
</tr>
<tr>
<td>Endosulfan</td>
<td>24 hrs</td>
<td>Danger</td>
<td></td>
</tr>
<tr>
<td>Bifenthrin*</td>
<td>24 hrs</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>Acephate</td>
<td>24 hrs</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>Carbaryl</td>
<td>12 hrs</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>Esfenvalerate</td>
<td>12 hrs</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>Diazinon</td>
<td>24 hrs</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>Methomyl</td>
<td>48 hrs</td>
<td>Danger</td>
<td></td>
</tr>
<tr>
<td>Disulfoton*</td>
<td>72 hrs</td>
<td>Danger</td>
<td></td>
</tr>
<tr>
<td>Phorate*</td>
<td>48 hrs</td>
<td>Danger</td>
<td></td>
</tr>
<tr>
<td>Naled</td>
<td>48 hrs</td>
<td>Danger</td>
<td></td>
</tr>
<tr>
<td>Spinosad</td>
<td>4 hrs</td>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>Abamectin*</td>
<td>12 hrs</td>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>Dicofol</td>
<td>12 hrs</td>
<td>Danger</td>
<td></td>
</tr>
<tr>
<td>Imadaclorpid</td>
<td>12 hrs</td>
<td>Caution</td>
<td></td>
</tr>
</tbody>
</table>
Worker Activities

Land Preparation: Soils are generally freshened prior to the transplanting or seeding process. This activity involves one person driving an open or enclosed-cab tractor. Summer squash production is done on bare ground and in raised rows covered with plastic and workers are required for bed preparation and formation.

Planting Method: Seeding is conducted by both hand and machine. When machine planted, seed and fertilizer are placed mechanically. This process requires one operator in an open or enclosed-cab tractor. If planting on a raised bed covered with plastic, seed or transplants are manually placed into the ground by workers. Seedling germination is generally 85-95 percent, however occasionally germination may be lowered when weather conditions and seedling diseases are favored. No thinning operations are necessary.

Irrigation: Irrigation occurs in approximately 25% of summer squash production. This generally increases the cost of production. Irrigation tape or overhead irrigation is used. If trickle irrigation is utilized, the tape is applied during planting preparation. Overhead irrigation may require the construction and disassembly of a solid irrigation system.

Cultivation: Fields are cultivated mechanically once before the squash runners expand across the field. This process also requires only one operator in an open or enclosed-cab tractor.

Scouting: Progressive growers scout at least weekly. Farm managers, farm advisors and their assistants review their findings and often consult with county agents or area specialist concerning crop protection methods. Disease and insect control is most critical during bloom, and subsequent fruit development. Pest levels should be monitored closely during these times.

Harvest: The only time agricultural workers come in contact with the squash is during harvest. All squash is harvested by hand. The workers generally dress in long-sleeve shirts and pants, due to the abrasiveness of foliage. Workers generally wear cloth or leather gloves when handling the fruit.

The plant residue is eventually incorporated by tillage equipment into the soil several weeks after harvest. Growers planting large acreage may plant at staggered dates so that harvest may be spread over several
weeks in order to have product for a prolonged period. This gives growers the ability to spread risk that
might occur due to poor weather or poor market conditions. After harvesting squash, they are immediately
shipped by truck to market.

Varieties

Cultivar or variety selection may be one of the more important components to successful squash
production. Listed below are several summer squash varieties recommend during 2001 and 2002.

Summer squash can be grown to maturity within 35 to 45 days of planting, and can extend for 3 to 4
weeks after the initial harvest. Prices can fluctuate greatly during one growing season, but staggered
planting dates can provide a crop from mid-June through mid-October if markets are established and
prices are satisfactory. Virus infection may reduce marketability, but some tolerant cultivars are available
and new virus tolerant cultivars are being introduced by seed companies each year. Several types of
summer squash are grown in Tennessee. Yellow crookneck types commonly grown include: Destiny III,
Dixie, Gentry, Pik-N-Pik, Prelude II, Sunglo, and Supersett. Yellow straightneck types commonly grown
include: Cougar, Fortune, General Patton, Gold Slice, Liberator III, Patriot II and Sunbar. Zucchini types
commonly grown include: Ambassador, Declaration II, Dividend, Gold Rush, Independence II, Jaguar,
Revenue, Senator, Spineless Beauty, Tigress and Zucchini Elite.

Variety Characteristics

**Destiny III** is a hybrid cultivar that produces very uniform lemon-yellow fruit. Transgenic resistance to
Cucumber Mosaic Virus, Watermelon Mosaic Virus and Zucchini Yellow Mosaic Virus. First harvest
may be expected in about 41 days after planting.

**Dixie** is a hybrid cultivar that produces very uniform, lemon-yellow fruit. First harvest can be expected
about 41 days after planting.

**Gentry** is a hybrid cultivar that produces moderate yields of butter yellow fruit which is very attractive.
The first harvest occurs within 43 days after planting.

**Pik-N-Pik** is a hybrid cultivar that produces moderate yields of yellow fruit. Contains precocious yellow
gene (yellow stem) that masks greening caused by Cucumber Mosaic Virus and Watermelon Mosaic
Virus. First harvest may be expected 50 days after planting.

**Prelude II** is a hybrid cultivar that produced good yields of fancy, yellow fruit. It has transgenic tolerance
to Watermelon Mosaic Virus and Zucchini Yellow Mosaic Virus; as well as tolerance to Powdery
Mildew. First harvest normally occurs about 40 days after planting.
**Sunglo** is a hybrid cultivar that produces moderate yields of yellow fruit. Tolerant to Powdery Mildew. First harvest is expected about 40 days after planting.

**Supersett** is a hybrid cultivar that produces moderate yields of yellow fruit. It contains precocious yellow gene (yellow stem) that masks greening caused by Cucumber Mosaic Virus and Watermelon Mosaic Virus. First harvest can be expected about 45 days after planting.

**Cougar** is a hybrid cultivar that produces high yields of yellow fruit. It contains precocious yellow gene (yellow stem) that masks greening caused by Cucumber Mosaic Virus and Watermelon Mosaic Virus. It has tolerance to Papaya Ringspot Virus and Zucchini Yellow Mosaic Virus. First harvest may be expected about 45 days after planting.

**Fortune** is a hybrid cultivar that produces high yields of bright-yellow fruit. It contains precocious yellow gene (yellow stem) that masks greening caused by Cucumber Mosaic Virus and Watermelon Mosaic Virus. First harvest occurs within 39 days after planting.

**General Patton** is a hybrid cultivar that produces high yields of lemon-yellow fruit. It contains precocious yellow gene (yellow stem) that masks greening caused by Cucumber Mosaic Virus and Watermelon Mosaic Virus. It has tolerance to Powdery Mildew. First harvest may be expected about 41 days after planting.

**Gold Slice** is a hybrid cultivar that produces high yields of bright-yellow fruit. Has good acceptance for the processing market. It produces over a long period of time. The first harvest may be expected about 48 days after planting.

**Liberator III** is a hybrid cultivar that produces very uniform, lemon-yellow fruit. It has transgenic resistance to Cucumber Mosaic Virus, Watermelon Mosaic Virus and Zucchini Yellow Mosaic Virus. The first harvest may be expected about 41 days after planting.

**Patriot II** is a hybrid cultivar that produces very uniform, lemon-yellow fruit. It has transgenic resistance to Watermelon Mosaic Virus and Zucchini Yellow Mosaic Virus. First harvest may be expected about 41 days after planting.

**Sunbar** is a hybrid cultivar that produces high yields of glossy yellow fruit. Contains precocious yellow gene (yellow stem) that masks greening caused by Cucumber Mosaic Virus and Watermelon Mosaic Virus. First harvest may be expected about 43 days after planting.

**Ambassador** is a high-yielding, hybrid cultivar that produces medium green, cylindrical fruit. It has compact plants which have open growth habit. The first harvest may be expected about 49 days after planting.

**Declaration II** is a hybrid cultivar that produces very uniform, medium-green, cylindrical fruit. It has
transgenic resistance to Watermelon Mosaic Virus and Zucchini Yellow Mosaic Virus. The first harvest may be expected about 40 days after planting.

**Dividend** is a hybrid cultivar that produces slightly tapered, medium-green fruit. It has tolerance to Cucumber Mosaic Virus, Watermelon Mosaic Virus and Zucchini Yellow Mosaic Virus. The first harvest may be expected about 46 days after planting.

**Gold Rush** is a medium-yielding hybrid cultivar that produces deep golden, cylindrical fruit. The first harvest may be expected about 52 days after planting.

**Independence II** is a hybrid cultivar that produces very uniform, medium-green, cylindrical fruit. It has transgenic resistance to Watermelon Mosaic Virus and Zucchini Yellow Mosaic Virus. The first harvest may be expected about 41 days after planting.

**Jaguar** is a hybrid cultivar that produces a very dark-green, slightly tapered fruit. It has tolerance to Watermelon Mosaic Virus and Zucchini Yellow Mosaic Virus. The first harvest may be expected about 52 days after planting.

**Revenue** is a hybrid cultivar that produces slightly tapered, medium-green fruit. It has tolerance to Cucumber Mosaic Virus, Watermelon Mosaic Virus and Zucchini Yellow Mosaic Virus. The first harvest may be expected about 44 days after planting.

**Senator** is a hybrid variety that produces high yields of medium-green, cylindrical fruit. It produces consistently high yields. The first harvest may be expected about 41 days after planting.

**Spineless Beauty** is a hybrid cultivar that produces a medium-green, slightly tapered fruit. It makes a very attractive pack. The first harvest may be expected about 50 days after planting.

**Tigress** is a hybrid cultivar that produces a very dark-green, slightly tapered fruit. It has tolerance to Watermelon Mosaic Virus and Zucchini Yellow Mosaic Virus. The first harvest may be expected about 49 days after planting.

**Zucchini Elite** is a hybrid variety that produces high yields of medium green, cylindrical fruit. It produces a very attractive pack. The first harvest may be expected about 48 days after planting.

**Sunburst** is a very high-yielding cultivar that produces bright yellow, scalloped fruit. The first harvest may be expected about 50 days after planting.

**Scallopini** is a very high-yielding cultivar that produces dark-green, fluted fruit. The first harvest may be expected about 50 days after planting.

**Peter Pan** is a very high-yielding cultivar that produces light-green, scalloped fruit. The first harvest may
be expected about 52 days after planting.

Table 2. Varieties Grown During 2002.

<table>
<thead>
<tr>
<th>Variety</th>
<th>% acreage planted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cougar</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Destiny II</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Dixie</td>
<td>10</td>
</tr>
<tr>
<td>Independence II</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Lynx</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Multi-Pik</td>
<td>20</td>
</tr>
<tr>
<td>Pik-N-Pik</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Prelude II</td>
<td>20</td>
</tr>
<tr>
<td>Senator</td>
<td>10</td>
</tr>
<tr>
<td>Spineless Beauty</td>
<td>10</td>
</tr>
<tr>
<td>Super-Pik</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Supersett</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Zucchini Elite</td>
<td>10</td>
</tr>
<tr>
<td>Others</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

Nematodes
Nematodes are rarely a problem in squash production due to the frequent rotation practiced by squash growers. In the event they do become a problem, growers select to rotate. Fumigation is available, however costs deters this control.

**Table 3. 2002 Disease Loss Estimated for Squash**

<table>
<thead>
<tr>
<th>Pest</th>
<th>% Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powdery mildew</td>
<td>20</td>
</tr>
<tr>
<td>Downy mildew</td>
<td>10</td>
</tr>
<tr>
<td>Microdochium blight</td>
<td>8</td>
</tr>
<tr>
<td>Scab</td>
<td>5</td>
</tr>
<tr>
<td>Viruses</td>
<td>8</td>
</tr>
<tr>
<td>Blossom blight</td>
<td>4</td>
</tr>
<tr>
<td>Nematodes</td>
<td>0.1</td>
</tr>
<tr>
<td>Others</td>
<td>trace</td>
</tr>
</tbody>
</table>

**Diseases**

Cucurbit crops are subject to biotic diseases caused by pathogens that include fungi, bacteria, viruses, and nematodes. Diseases can be important factors limiting production of squash. Effective disease management is essential in the production of high quality fruit. Some diseases directly attack the fruit, rendering it unmarketable. Diseases also reduce yields by killing plants prior to harvest or causing defoliation which reduces fruit size and quality, as well as exposing fruit to sun scald.

Correct disease identification is the first step in effective management. Incorrect identification
can lead to the use of the wrong management practice, wasted expense, and crop failure. Diseases caused by bacteria or viruses are not controlled with most fungicides. Likewise, a particular fungicide may only control one fungal pathogen, but not another. Squash growers should learn to recognize the more common diseases by their symptoms and have sufficient knowledge of disease development to select appropriate management practices for the particular disease situation. Growers are encouraged to visit their local county extension office in situations arising where they may need help with proper pest identification.

Fungi, bacteria, and nematodes which cause soilborne and some foliar diseases survive in the soil or on crop debris in soil between cucurbit crops. These pathogens build up to damaging levels with repeated cucurbit cropping. A 4-year rotation with non-cucurbit crops where possible is recommended to Tennessee growers.

Maintaining records of the disease history of fields is beneficial for avoiding future disease problems or implementing preventive control measures in future plantings. Late plantings should not be situated near early plantings where a disease already exists. Table 3, lists several diseases of squash and loss estimates for 2002.

**Downy mildew**  
*(Pseudoperonospora cubensis)*

Downy mildew is one of the most important foliar diseases of squash. In areas of high rainfall or with sufficient leaf wetness (usually caused by dew), this disease can be devastating. Without adequate control measures, infection can result in major losses to squash, or other cucurbits in open fields as well as in greenhouses.

Symptoms: Downy mildew symptoms in cucurbit crops are almost exclusively confined to the leaves, although there are rare reports of sporulation on fruits and floral parts. The appearance of leaf lesions varies considerably, both between and within species of cucurbit crops.

The first evidence is small, slightly chlorotic to bright yellow areas on the upper leaf surface; the color is less vivid on the lower leaf surface. Lesions generally appear on the older crown leaves and progress to the younger, more distal leaves as these leaves expand. As the lesions expand, they may remain chlorotic or yellow or become necrotic and brown. Infected areas or lesion margins are usually irregular. When conditions favor (wet), the lower leaf surface gives rise to a downy appearance, which may vary from colorless to light gray or deep purple. As lesions expand, they often coalesce, resulting in the necrosis of the infected leaves, so that in a few days the entire leaf is dead. Dead leaves expose the fruit to sunscald, which results in reductions in both quality and quantity of marketable yield.

Disease Cycle: The fungus is an obligate parasite. Its season-to-season survival is dependent on the
presence of cucurbit hosts either in areas with climates which permit their growth throughout the year or on cucurbit crops in greenhouses. The primary inoculum is considered to be windblown sporangia from infected cucurbits in areas where these plants survive the cold season. Spread of secondary inoculum within a field is usually by air currents, but it may also be dispersed by rain splash or by contact with workers or tools.

Control: The principal control measures include fungicide applications during wet periods, the use of resistant cultivars, and cultural practices. Maximum control is usually obtained only with a combination of these measures. Both protectant and systemic fungicides are effective in controlling downy mildew. However, the efficacy of protectant fungicides is reduced when hosts are highly susceptible, inoculum levels are high, and wet conditions are very favorable for disease development.

**Microdochium Blight**  
(*Microdochium tabacinum*)

Microdochium blight has become more common in cucurbit production in Tennessee. Most strains are only facultatively parasitic, if at all. Microdochium blight has occurred on pumpkin and squash since 1988 in Tennessee, where it was first mistaken for gummy stem blight. The most susceptible cucurbits are yellow squash, zucchini squash, and pumpkin.

Symptoms: The disease is characterized by the production of light tan to "bleached," sunken, spindle-shaped lesions, primarily on the main stems, petioles, main leaf veins, and peduncles and sometimes on leaf blades. On fruit, the fungus causes white, tan, or silver russetting on the upper surface. Lesions often coalesce to form a continuous dry, scabby surface. Infected stems are dry and brittle. Stem lesions cause death of leaves, and complete defoliation can occur in severe infections reducing plant photosynthesis therefore reducing yield.

Control: The disease is readily controlled with protectant fungicides; however, Flint is recommended when conditions warrant the use of fungicides.

**Scab**  
(*Cladosporium cucumerinum*)

Scab, or gummosis, can be a serious problem for summer and winter squash, pumpkin, melon, and watermelon. The disease is favored by cool temperatures.

Symptoms: The fungus can attack any aboveground portion of the plant, including leaves, petioles, stems, and fruits. On leaves and runners, pale green, water-soaked areas are the initial symptoms observed on plants. These spots gradually turn gray to white and may become "tattered" in appearance. A yellow halo generally appears around lesions. If weather conditions are favorable for disease development, scab can
deform young leaves. Scab produces it greatest damage when infections occur on fruit. Infected areas of the fruit appear as small spots or sunken areas similar to insect stings. A sticky substance may ooze from the infected area, especially on fleshy fruit. Soft-rotting bacteria may be observed invading these lesions resulting in a foul-smelling decay.

Disease Cycle: This fungus survives in soil on squash, melon, and pumpkin vines and reportedly may grow extensively as a saprophyte. The fungus may also be seedborne. It is disseminated on clothing, equipment and by insects. Spores can survive long-distance spread in moist air. The most favorable weather conditions for disease development are during cool wet weather (valley fogs, heavy dews, and light rains). After infection a leaf spot may appear within 3 days, and a new crop of spores may be produced by the fourth day.

Control: The use of scab-resistant cultivars may be an effective means of control. Scab resistance or tolerance has been reported in Cucurbita pepo, C. maxima, and C. moschata, however no resistant cultivars are commercially available. Because the scab fungus appears to overseason well, rotation of cucurbit crops with nonhost crops is necessary, with two or more years between cucurbit crops. The use of disease free seed is important. Select sites which have good air movement and allow for rapid drying of the foliage. Protectant fungicides may aid in the control of this disease, however during prolonged periods of cool wet weather may not be as effective.

**Powdery Mildew**

*Sphaerotheca fuliginea* and *Erysiphe cichoracearum*

This disease can be a serious production problem. All cucurbits are susceptible; however, symptoms are less common on commercial cucumbers, because many cultivars are resistant. Powdery mildew reduces yields by decreasing the size or number of fruit or the length of time crops can be harvested. Fruit quality can be reduced by sunscald and premature or incomplete ripening with resultant poor storability (winter squash), and reduced size and weight of fruit.

Symptoms: Whitish, talcum-like, powdery fungal growth develops on both upper and lower leaf surfaces and on petioles and stems. Symptoms usually develop first on older leaves, on shaded lower leaves, and on upper leaf surfaces. Infected leaves usually wither and die, and plants senesce prematurely reducing photosynthesis, therefore reducing yield.

Disease Cycle: Powdery mildew of squash are obligate parasites. Primary sources of inoculum dispersed over long distances, from greenhouse-grown cucurbits and from alternate hosts. Spores may remain viable for 7-8 days. Powdery mildew develops quickly under favorable conditions (high humidity, low light intensity and a dense canopy). The time between infection and symptom appearance may only take 3 to 7 days, and a large number of spores may be produced.

Control: Resistant cultivars and fungicides are used to manage powdery mildew. Resistance is used
extensively in cucumber and melon and is being incorporated into other cucurbit crops.

Adequate management with fungicides requires that the product have full coverage and reach the lower canopy. The use of systemic fungicides can aid in coverage. No more than 4 applications of strobilurin fungicides (Flint, Quadris) may be made to a crop. Consecutive applications of these products should be avoided, and should be alternated with chlorothalonil and sulfur. Sulfur added to chlorothalonil gives extra powdery mildew control.

Fungicides

The use of fungicides is very important in squash production in Tennessee. Wet humid conditions are conducive for fungal and bacterial growth. Fungicide applications are normally made prior to disease onset. Fungicide applications are generally repeated on a 7 - 10 day schedule when wet and/or humid conditions prevail. Each fungicide varies in its degree of control. Table 4 indicates relative effectiveness observed in University fungicide trials.

Chlorothalonil (Bravo, Equus, etc) has a 0-day PHI. This product is applied at the rate of 1.125 - 2.25 lbs active ingredient per acre. Cost ranges on the low side of $8.58 to a high of $18.31.

The formulation 6L rate ranges from 1.5 - 3 pints and a range in cost of $8.58-17.18. The formulation of 82.5WDG rate ranges from 1.4 - 2.7 lbs with a cost range from $9.49-18.31 per application per acre. This product is used to control downy mildew, microdochium blight, and scab. High rates are recommended for scab control.

Mancozeb (Mancozeb 80WP) has a 5-day PHI. This product is applied at rates ranging from 1.6 - 2.4 lbs active ingredient per acre with a cost ranging from $5.50 - 8.25 per acre per application. Mancozeb is used for downy mildew and microdochium blight control.

Maneb (Maneb80WP) has a 0-day PHI. This product is applied at rates ranging from 1.2 - 1.6 lbs active ingredient per acre. Formulation rates range from 1.5 - 2 lbs per acre per application. No more than12.8 lbs active ingredient per acre may be applied. Maneb is used to control downy mildew and microdochium blight.

Trifloxystrobin (Flint 50WDG) has a 0-day PHI. Rate ranging from 0.047 - 0.0625 lbs active ingredient per acre and a formulation rate ranging from 1.5 - 2 oz. per application per acre. Cost ranging from $19.13-25.50 per application per acre. Trioxy is used for microdochium blight and powdery mildew.

Azoxystrobin (Quadris 2L) has a 1-day PHI. This product is applied at rate ranges from 0.17 - 0.24 lbs
active ingredient per acre. Formulation is applied at rates ranging from 11-15.6 fl. oz. and costs ranging from $24.23 - 34.37 per acre per application. This product is most effective against powdery mildew but does have some control of microdochium blight and downy mildew.

**Mefenoxam** and **chlorothalonil** (Ridomil Gold Bravo 81SP) is a combination of two active ingredients 4.4% mefenoxam and 72% chlorothalonil. It has a 0-day PHI. The formulation is applied at 2 lbs per acre per application with a cost of $34.40. Rate of active ingredient per acre is 0.088 lbs mefenoxam and 1.44 lbs chlorothalonil. This product is limited to 4 applications per crop. This product is packaged in a water soluble bag making it safer to use for the end user.

**Mefenoxam** and **mancozeb** (Ridomil Gold MZ) has a 5-day PHI. Ridomil Gold is a combination of two active ingredient 3.9% mefenoxam and 64% EBDC the ingredient of mancozeb. Active ingredient applied per acre per application is 0.0975 lbs of mefenoxam and 1.6 lbs of EBDC. Formulation is applied at 2.5 lbs per acre per application. The mixture of these products give fair control of downy mildew and the mancozeb portion gives fair control of microdochium blight.

**Myclobutanil** (Nova 40W) has a 0-day PHI is applied at rates ranging from 0.0625 - 0.125 lbs active ingredient per acre. Cost ranging from $15.44 - 19.30 with a formulation rate range of 2.5 - 5 oz. Nova is used to control powdery mildew.

**Sulfur** (wettable sulfur) has a 0-day PHI. This product is applied at the formulation rate ranging from 3 - 4 lbs per acre. Is used to control powdery mildew.

### Table 4. Relative effectiveness of disease-control products in cucurbit crops (0 to 5 scale).

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Disease</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Downy Mildew</td>
<td>Microdochium Blight</td>
<td>Powdery Mildew</td>
<td></td>
</tr>
<tr>
<td>Chlorothalonil</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Copper, fixed</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Trifloxystrobin</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Maneb, Mancozeb</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Fungicide</td>
<td>% acreage used</td>
<td>Average # of Apps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>----------------</td>
<td>-------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorothalonil</td>
<td>75</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper, fixed</td>
<td>40</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trifloxystrobin</td>
<td>20</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maneb, Mancozeb</td>
<td>30</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mefenoxam</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myclobutanil</td>
<td>30</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azoxystrobin</td>
<td>40</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfur</td>
<td>40</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captan*</td>
<td>90</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
* Captan is applied as a seed treatment

**Alternatives:**

There are several items that are labeled to control diseases in squash production, however efficacy is the key that determines if a product is recommended for use in Tennessee. The products listed below have not shown effective control in on-farm demonstrations.

- **Neem oil** (Trilogy 5.46) has a 0-day PHI. The label has 4 hour REI and caution as the signal word. It is applied at the rate range of 5.46 - 10.92 lbs neem oil per acre. Used to control multiple diseases.

- **Potassium salts** (M-pede) has a 0-day PHI. The label has a 12 hour REI and warning as the signal word. It is labeled to control powdery mildew, leaf miners, spider mites, leafhoppers, and plantbugs.

**Viruses**

Mosaic viruses are one of the most common types of viruses observed in squash production. Leaves of infected plants become mottled and vines are stunted. The most devastating symptom is greening of fruit.

Control: Mowing weedy areas in early season prior to planting and throughout the season may reduce populations of insect vectors, therefore reducing virus infections. Some varieties have resistance for certain viruses. Precocious yellow-stemmed varieties mask the fruit-greening effects of some viruses.

**Blossom Blight**

Blossom Blight is also known as wet rot. Blossoms and fruits rot with a whisker like fungal growth usually on the blossom end of the fruit. Control may be achieved by selecting sites and plant spacings that provide good air circulation for rapid drying of fruit and leaves.

**Alternaria leaf blight**

*(Alternaria cucumerina)*

This organism can survive in the soil for 1-2 years in diseased plant debris and infested debris is considered the primary source of disease inoculum. This disease may also be spread by air carrying spores or rain splashing spores onto leaves. Alternaria leaf blight is rarely a problem in squash production.
Control: Rotation with another crop grown for 2 years or more reduces levels of inoculum. The removal of old plant debris or deep plowing may aid in reducing incidence of disease. Applications of foliar fungicides delay the onset or slow disease development.

## Insect Pests

Insects can play an important role in squash production. Most often, they occur as pests, but the beneficial action of some insects such as bees is essential to the successful production of squash. Therefore, in designing and implementing control strategies for squash pests, consideration should be given to preserving or enhancing the actions of the beneficial insects.

Several insects and mite pests present serious problems for squash production on a regular basis, while others may occur at less severe levels or on a less consistent basis. The occurrence of insect pests on squash also depends greatly on location. Recognition of the pest and an understanding of its potential damage is important for selecting appropriate control methods, as each pest does not respond the same way to a given control method.

### Flea beetles - Palestriped flea beetle

*(Systena blanda)*

The palestriped flea beetle is a general feeder feeding on a multitude of plants. Larvae can be found feeding on roots and generally cause little significant injury to squash.

Life cycle: Adult flea beetles overwinter in debris in or near fields. They resume feeding on weedy hosts in early spring until succulent crops are available. Eggs are deposited near the base of plants and hatch within a week then grubs begin to feed on plant roots or lower stems for 3 to 4 weeks before pupating. After 7-10 days of pupation the adult emerges.

Damage: Adults attack the foliage of plants leaving small round holes. Most serious injury occurs early in the growing season and heavy infestation may cause leaves to die.

Control: Keep fields clear of weeds, destroy old crop residue after harvest. Plastic row coverings restrict egg laying activities. Several at planting insecticides are very effective in reducing flea beetle populations.
**Aphids:**

- bean aphid (*Aphis fabae*)
- cowpea aphid (*Aphis craccivora*)
- melon aphid (*Aphis gossypii*)

Aphids are common in many succulent vegetables. Aphids vary in size and color.

**Damage:** They extract sap from the terminal leaves and stems of plants. They may also feed on developing pods causing them to shrink, curl, partially filled or become malformed. Their feeding can result in deformation, wilting, or death of the plant depending on populations and size of the plant. Saliva injected during feeding usually causes the deformation of plant tissue. Some aphids fly while others are flightless, however during stress conditions may produce winged offspring. Aphids are also responsible for the transmission of several viruses. Insecticides have little effect on virus transmission. **Control:** Control is achieved by applying systemic insecticides.

**Cutworms, Black cutworm** (*Agrotis ipsilon*),
**Granulate cutworm** (*Feltia subterranea*),
**Spotted cutworm** (*Amathes c-nigrum*)

Cutworms may injure many types of vegetables. They cause greatest damage to seedlings and newly set plants. Larvae hide under clods or in cracks of the soil by day and feed at night cutting young plants near the ground or feeding on the foliage. The black cutworm is the most destructive cutworm. The black cutworm larvae often sever several plants in a row resulting in the need to replant. Cutworms overwinter as larvae or pupae. In early spring, larvae which have overwintered resume activity and feed until they are mature.

**Cucumber Beetles**

(spotted - *Diabrotica undecipunctata*, striped - *Acalymma vittata*)

The spotted cucumber beetle is about 1/4 inch long, yellow to greenish-yellow with 12 black spots on its back and a black head. They overwinter in the adult stage near plants and in debris. Some migrate south and have been known to travel 500 miles in 3-4 days. Their larvae are yellowish white with a brown head and a brownish patch on top of the last body segment. They reach about 1/2 inch long when fully grown. The larvae feed on plant roots. When there is ample moisture, they will feed on the flesh of fruit, especially fruits lying on the soil surface.

The striped cucumber beetle is pale white-yellow to orange with a black head. Its wings have three black stripes running their entire length. There are punctures or striping on the wings also, so that it appears as if a small punch were used to make a row of dents on the wing covers.

Its larvae are about 1/3 inch long when fully grown and also feed on plant roots. The larvae are white, with brownish ends and slender bodies.
Damage: The spotted and striped cucumber beetles are among the first insects to attack cucurbits as the plants emerge. They attack plants as they come through the ground, feeding on the cotyledons and stems. Their chewing may result in loss of cotyledons, which weakens seedlings. Often they eat the growing point from the young plant and kill it. Also, they will chew into or half way through the stem, weakening it so that it may break off during a strong wind. Other than immediate stand loss, the damage is incurred from cucumber beetles through their ability to carry bacterial wilt. The bacterium causing this disease is carried in the insect's body and is transmitted to the plant as the beetles feed.

Control: Effective control of cucumber beetles can result in effective limitation of the disease. The disease often appears as the squash is beginning to bloom and set fruit, and the plant dies rapidly, overnight. Once the plants are blooming, the disease appears to not pose a problem.

Most control measures are needed within two weeks of plant emergence from the soil. Stand loss is the primary concern with cucumber beetles. however, on squash, the potential for bacterial wilt should also be considered. In general, if 4 to 5 beetles are found in sampling 50 plants, an insecticide should be applied. Controls are generally not needed after the plants begin to flower and fruit.

Squash Bugs (*Anasa tristis*)

Squash bugs are quite mobile and can move easily among plants within a field, and later move to late planted fields. The insects spend most of their time within the plant canopy, mainly around the stems and on the underside of the leaves. Adults often seek shelter under leaves that are in contact with the ground.

Both the nymphs and adults feed by sucking sap from the plant. Overwintered adults can cause extensive damage if they appear in the fields just after the plants have emerged and feed on young seedlings. Their feeding can greatly stress and kill young seedlings. Once the plants are larger, they can withstand a moderate number of squash bugs. Both adults and nymphs prefer the leaves but will feed on all above ground plant parts.

The adults often congregate near the base of the plant and the young bugs (nymphs) concentrate on the leaf where they hatch and then migrate to other plant parts. Squash bugs can increase in numbers very rapidly and, in high numbers, can cause plant wilting. When large numbers of squash bugs are combined with hot, dry weather, the stress on plants is greatly increased. However, squash bugs generally do not kill plants rapidly.

Control: Effective management of squash bug relies on early detection, and the proper timing and application of insecticides. Good cultural practices help prevent serious squash bug damage. Healthy, vigorously growing plants, produced through good plant nutrition, proper soil drainage and timely irrigation, are better able to tolerate feeding by squash bug. Planting of cultivars which are less attractive or more tolerant to squash bug can reduce the need for insecticides.
Squash Vine Borer
(*Melitta satyriniformis*)

This lepidopterous pest occurs across the state. It is a pest of both squash and pumpkin. The moth resembles a large wasp without the stinging apparatus. Female deposits eggs near the base of the plant about the time the first planting of squash begins until bloom. A small larva emerges and enters the stem of the plant. This larva then feeds inside the stem and eventually causes it to die. As the worm feeds, it pushes its excrement out the entrance hole. This will develop the appearance of a dark mass. The worm will eventually exit the stem and enter the soil to pupate.

**Damage:** Larvae cause serious damage to plants. Their feeding inside the stem or the main stalk of the plant will eventually cause the stem or stalk to die. Feeding destroys the plant material which transmits food and water within the plant. When feeding occurs, runners or branches of a plant begin to wilt or die while the rest of the plant appears healthy. Usually a sticky excrement may be observed at the entrance hole. This is generally near the base of the plant and always near the soil surface.

**Control:** Squash vine borers are not considered a major insect pest of cucurbits. However, if they have been a problem in the past, control can be achieved by a spray schedule started when the plants begin to bloom and continued once a week until harvest is completed. Often, if a field has not had problems in the past, there is no need to control squash vine borer. Sprays for other insects also generally provide control of the squash vine borer.

**Melonworm** (*Diaphania hyalinata*) and **Pickleworm** (*Diaphania nitidalis*)

These lepidopterous larvae occur infrequently in Tennessee. They attack just about all cucurbits except watermelon. The melonworm is green with two white, well separated slender stripes running the full length of the body on the upper side. These worms are very active when disturbed and will wiggle violently. The pickleworm is green to coppery color with a brown head, measuring approximately 3/4" long. Just behind the head is small brown patch. Young larvae are strikingly marked, with nearly 100 black spots evenly scattered over the body.

**Damage:** Melonworms are rarely found; however, if found, they feed mainly on the foliage and in the plant terminals. The melonworm is mainly a leaf feeder and seldom feeds on the fruits. The pickleworm feeds on the fruits of squash. Pickleworm larvae can cause serious problems on squash by feeding on the fruit. Early in the season, pickleworms bore into the stems and terminal buds, especially blossoms of squash. Later in the season, pickleworms bore into the fruit from the side next to the ground. They push out small masses of green, sawdust-like excrement from the holes bored in the fruit. After feeding for about two weeks, the larvae moves out of the fruit to the leaves, where it will spend 7 to 10 days as a pupa inside the cocoon.
Control: Pickleworms are occasionally observed but seldom a problem. If the foliage feeding melonworm becomes a problem, it can easily be controlled by sprays used for other pests. Most insecticides will kill the foliage feeding melonworm. The pickleworm is another matter because of its feeding habits. When the pickleworm becomes a problem, a spray schedule of five to seven days should be followed. To lessen future problems with pickleworm, plant material from infested fields should be destroyed after harvest to prevent further population build-up. Destroy any transplants left in the greenhouse.

**Spider Mites** (*Tetranychus urticae*)

These minute creatures are difficult to see without the aid of a hand lens. They are not insects but have been lumped into the classification with spiders and ticks, because they have eight legs. The two-spotted spider mite is the most common. It is red and brown in color with two spots in the back part of its oval body. Mite populations explode during hot, dry weather and are found on the underside of the leaves. Mites reproduce very rapidly and can become very numerous in a short period of time. This is one reason that insecticides should be alternated if at all possible to avoid resistance. Spider mites lay shiny, spherical, straw-colored eggs on the underside of the leaves. These eggs hatch in 3 days. A female lays an average of 100 eggs, and most eggs hatch. Mites can complete a life cycle in 5 days when the temperature is 75°F or above. Mites spin a fine silk webbing on the underside of the leaves which can often be seen easier than the mites.

Damage: Mites feed by sucking the contents from individual leaf cells. The feeding of one mite is not damaging, but mites are usually present in huge numbers. When this occurs, their feeding puts tremendous stress on the plant. Damage appears as mottling of the leaf from the many tiny feeding punctures by the mites. This area dies and the leaf turns bronze-colored or dies. Infestations of mites often start near an unpaved road or in spots in the field and spread from these areas. Under hot, dry conditions, mite populations can build to damaging levels within 3 to 5 days.

Control: With the rapid life cycle of mites, control is based on stopping the build-up before large infestations become established. This requires being aware of the weather and plant conditions. It also requires field inspection for possible build-ups. If weather conditions favor mite build-up, growers may choose to spray earlier to control this pest. Mites often occur in patches within a field or at the edge of the field. Sometimes treatment of localized infestations can be effective and can save money by not treating the entire field. Effective control of mites depends greatly on achieving thorough, even distribution of the miticide. The miticide must get to the underside of the leaves where the mites are present. One application does not always completely control a mite infestation. Most miticides do not kill the eggs, since unhatched eggs will eventually hatch within three days after the spray application. One of the best mite controls is a good rain shower. Overhead irrigation will also work; however, it may favor disease development.

**Vegetable Leafminer**

(*Liriomyza spp.*)
Leaf-mining flies in the genus *Liriomyza* are among two species observed in Tennessee, *L. sativae* and *L. trifolii*.

**Life Cycle:** Adult leafminers are small flies with a extremely small wing length. Adult females puncture the upper surfaces of leaves with the ovipositor for feeding and egg laying. Adults feed on fluids that exude from the wounds. Mating occurs soon after adults emerge from the pupal stage. Generally, there is a preoviposition period of 2-5 days, depending on the ambient temperature and relative humidity. Oviposition occurs for up to 3 weeks, with the number of eggs deposited depending on the temperature. Adults may live up to 4 weeks. Eggs are cream-colored and oval, laid singly in separate leaf punctures. Eggs hatch within 2-7 days. Larvae feed on the leaf mesophyll for 6-12 days. Full-grown larvae slit the leaf epidermis, exit the leaf, fall to the ground, and pupate in the soil. The duration of the pupal stage ranges from 9 to 19 days. Many overlapping generations occur during a growing season.

**Damage:** Losses in cucurbits due to leafminers are difficult to quantify. Most researchers believe that leafminers are secondary pests. The mining activity of leafminer larvae and feeding and egg laying by adult females may cause photosynthetic reduction. High populations of larvae can cause leaf distortion and premature leaf abscission, resulting in sunscalded fruit. Infestation may also predispose the plant to other foliar diseases. Adult leafminers may be able to transmit viruses, because of their feeding habits.

**Control:** Insecticides are the major control measure used in squash production. Scouting is recommended and should be initiated prior to bloom. Foliar insect treatments should be initiated when numerous leaf punctures or small mines are observed on the majority of leaves on the plant. Care should be taken to preserve bees. Destruction of all broadleaf weed hosts and burial of crop residues can aid in leafminer management.

Other occasional observed pests include: cabbage looper, corn earworm, garden fleahopper, granulate cutworm, greenhouse whitefly, harlequin bug, Japanese beetle, melon worm, onion thrips, seedcorn maggot, southern armyworm, southern corn rootworm, and saltmarsh caterpillar or yellow woollybear.

**Table 6. 2002 Insect Loss Estimated for Squash**

<table>
<thead>
<tr>
<th>Pest</th>
<th>% Loss in Processing</th>
<th>% Loss in Fresh Market Squash</th>
</tr>
</thead>
<tbody>
<tr>
<td>aphids</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>squash bug</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>squash vine borer</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>
Insecticides:

**Endosulfan** (Phaser/Thiodan 3EC, 50WP) has a 2-day PHI. This product is applied at a rate range of 0.5 - 1 lb active ingredient per acre. The 3EC formulation is applied at 21.33 fl.ozs. - 42.56 fl. ozs. per acre per application at a cost of $4.90 - $9.78. The 50WP formulation is applied at rate range of 1-2 lbs per acre at a cost ranging from $6.75 - 13.50 per application. When used to control squash vine borer, this product should be applied to stems and vines near base of plants at 5-7 day intervals beginning when moths first appear. This usually begins in early June through August. Endosulfan is used to control aphids, cucumber beetles, pickleworms, squash bugs, and the squash vine borer.

**Naled** (Dibrom 8EC) has a 0-day PHI. This product is applied at 1 pint per acre or 1 lb. active ingredient per acre. Naled is labeled for control of aphids. Cost of this material is $10.73 per application per acre.

**Imadacloprid** (Admire 2F, Provado 1.6F) Admire has a 21-day PHI and Provado has a 0-day PHI. Admire is applied as a soil application at the rate range of 16-24 fl ozs per acre or 0.25-0.375 lbs active ingredient per acre at a cost ranging from $72.38 to 108.56 per acre. Provado is applied at the rate of 3.75 fl ozs. per acre or 0.047 lbs active ingredient per acre at a cost of $13.33 per application. Five days must be allowed between soil and foliar applications. Imadacloprid is generally used for aphid and cucumber beetle control.

**Bifenthrin** (Capture 2EC) has a 3-day PHI. The formulation is applied at the rate range of 2.6-6.4 fl. ozs. per acre and 0.04 - 0.10 lbs active ingredient per acre at a cost ranging from $8.18 - 20.14. Bifenthrin is used to control flea beetles, cucumber beetles, cutworms, pickleworms, squash bug, and squash vine borer.

**Carbaryl** (Sevin 50WP, 80WP, 4XLR) has a 0-day PHI. Applied at the rate of 1 lb active ingredient per acre per application. Phytotoxicity may occur following application of carbaryl during hot humid weather.
The formulation of 50WP is applied at 2lbs per acre at a cost of $8.50 per application, 80WP applied at 1.25 lbs at a cost of $8.13 per application, and 4XLR at 1qt per acre at a cost of $7.83 per application. For pickleworm control spray on foliage when worms appear in blossoms and continue at 5-7 day intervals. Used to control cucumber beetles, cutworms, pickleworms, and squash bug.

**Esfenvalerate** (Asana XL 0.66EC) has a 3-day PHI. This product is applied at the rate range of 5.8 - 9.6 fl. ozs. per acre per application with 0.03 - 0.05 lbs active ingredient per acre. Cost ranging from $4.33 - 7.16 per acre per application. Esfenvalerate is used to control cucumber beetles, cutworms, pickleworms, squash bugs, and squash vine borers.

**Diazinon** (Diazinon AG500 4EC) has a 7-day PHI. Is applied at the formulation rate range of 0.5-1 pint per acre. Active ingredient per acre rate ranges from 0.25 - 0.5 lbs active ingredient per acre. At a cost ranging from $2.06 to 4.13 per acre per application. Diazinon is used to control leafminers. Diazinon will no longer be available for use after 2004.

**Spinosad** (Spin Tor 2SC) has a 3-day PHI. Is applied at formulation rate range of 4-8 fl.ozs. per acre or 0.062-0.125 lbs active ingredient per acre. Spinosad is used to control leafminers, and pickleworms. Cost of an application ranges from $17.75 - 35.50 per acre.

**Methomyl** (Lannate 90SP, 2.4LV) has a 1 or 3-day PHI and is dependent on rate per acre used. Applied at the rate range of 0.45 - 0.9 lbs active ingredient per acre per application. The formulation 90SP is applied at the rate range of 0.5 - 1 lb per acre at a cost ranging from $11.18 - 22.35 and 2.4LV is applied at the rate range of 1.5 - 3 pints per acre at a cost ranging from $10.31 - 20.63 per application. Methomyl is used to control pickleworms.

**Permethrin** (Pounce 3.2EC, 25WP, Ambush 2EC, 25WP) has a 0-day PHI. Applied at the rate range of 0.1 - 0.2 lbs active ingredient per acre per application. The formulation of Pounce 3.2EC is applied at rates ranging from 4 - 8 fl.ozs. at a cost ranging from $4.47 - 8.94. The formulations of both Ambush and Pounce 25WP are applied at the rates of 6.4 - 12.8 oz and pricing was not available. The Ambush formulation of 2EC is applied at rates ranging from 6.4 - 12.8 fl. ozs. per acre at a cost ranging from $5.80 - 11.60 per application per acre. This product is used to control the squash vine borer.

**Dicofol** (Kelthane 50WSP) has a 2-day PHI. Is applied at the formulation rate of 1.25 lbs per acre or 0.625 lbs active ingredient per acre per application at a cost of $16.75. No more than 2 applications per season may be made. Latron B-1956 is added per 100 gallons of spray mixture. Dicofol is used to control spider mites.

**Abamectin** (AGRI-MEK 0.15EC) has a 7-day PHI. Applied at the formulation rate range of 8-16 fl.ozs per acre or 0.009-0.019 lbs active ingredient per acre. Abamectin is used to control spider mites. Cost of application ranging from $40.80 - 81.60 per acre.
### Table 7. Estimated Insecticide Use During 2002

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>% acreage used for Processing</th>
<th>Average # of Applications for Processing</th>
<th>% acreage used for Fresh Market</th>
<th>Average # of Applications for Fresh Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abamectin</td>
<td>&lt;1</td>
<td>1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Bifenthrin</td>
<td>25</td>
<td>1</td>
<td>80</td>
<td>3</td>
</tr>
<tr>
<td>Carbaryl</td>
<td>10</td>
<td>1</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>Diazinon</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Dicofol</td>
<td>--</td>
<td>--</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Endosulfan</td>
<td>--</td>
<td>--</td>
<td>90</td>
<td>4</td>
</tr>
<tr>
<td>Esfenvalerate</td>
<td>20</td>
<td>1</td>
<td>80</td>
<td>3</td>
</tr>
<tr>
<td>Imidacloprid</td>
<td>--</td>
<td>--</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Methomyl</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Naled</td>
<td>10</td>
<td>1</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Permethrin</td>
<td>10</td>
<td>1</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Spinosad</td>
<td>--</td>
<td>--</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

**Alternatives:**

**Neem oil** (Trilogy 5.46) has a 0-day PHI. This product has caution as the signal word and a 4 hour REI. Labeled to control multiple pests. Used at the rate range of 5.46 - 10.92 lbs per acre neem oil. Labeled to
control aphids, mites and suppress whiteflies and thrips.

**Azadirachtin** (Aza-Direct) has a 0-day PHI. Has a 4 hour REI and caution as the signal word. It has a label which states control of aphids, whiteflies, leaf hoppers, mites, armyworms, thrips, beetles and weevils.

**Thiamethoxam** (Actara) has a 0-day PHI. Is labeled to control flea beetles, aphids, whiteflies, and stink bugs. It has caution as the signal word and a 12 hour REI. It is applied at the rate of 2-4 oz/acre with no more than 0.125 lbs active ingredient per acre.

**Potassium Salts** (M-Pede) has a 0-day PHI. This product has a 12 hrs REI and caution as the signal word. Labeled to control various insects and powdery mildew.

**Cyromazine** (Trigard 75WP) has a 0-day PHI. It is applied at the rate of 2.66 oz per acre per application or 0.125 lbs active ingredient per acre. It is labeled to control leaf miners. The label has caution as a signal word with a 12 hour REI. No more than 6 applications per season.

**Thiamethoxam** (Platinum) has a 30-day PHI. It is soil incorporated at the rate of 0.078 lbs active ingredient per acre. Maximum of 0.125 lbs active ingredient per acre per season. The label has caution as the signal word and a 12 hour REI. This product is labeled to control aphids, whiteflies and flea beetles. Platinum is new on the market and fairly expensive when applied at planting treatment.

**Pymetrozine** (Fulfill 50WP) has a 14-day PHI. It is applied at the rate of 2.75 oz. (0.085 lbs ai) per application with a maximum of 5.5 oz (0.17 lbs ai)per season. This product is labeled to control aphids and suppress whiteflies.

**Bacillus thuringiensis** (Javelin) has a 0-day PHI and has caution as the signal word and a 4 hour REI. It controls several lepidopterious pests. It is applied at the rate range of 0.12 - 1.5 lbs formulation per acre per application.

---

**Weeds**

Weeds are a constant battle in most cropping systems. Weed populations vary throughout the field. Some field conditions are more conducive to weed growth. Weed control is often achieved with applications of preemergent herbicides and/or post emergent herbicides. In squash production shallow mechanical cultivation and/or hand hoeing are generally needed to aid controlling weeds prior to runners forming. Pruning runners may delay fruit development and/or reduce yield. Cultivation and herbicide applications are generally limited to during early season.
Herbicides:

Materials used for weed control are generally less expensive than multiple cultivations or hand hoeing. In most cases, no more than two cultivations per season occur after planting. This is generally the rule, since runners spread across the field. Pre-emergent herbicides are available for use prior to planting and post-emergent herbicides are available after plants have been set or seeds have emerged.

Soil Applied Herbicides:

**Bensulide** (Prefar 4E) applied at the formulation rate range of 5-6 quarts per acre or 5 - 6 lbs active ingredient per acre. Cost of an application ranges from $55.00 - 66.00 per acre.

This product is approximately 70% effective against crabgrass, foxtails, goosegrass, seedling and fescue. Is 50% effective against seedling johnsongrass, lambsquarters, and pigweed.

**Ethalfluralin** (Curbit 3EC) applied at the formulation rate of 3-4.5 pints per acre or 1.12 - 1.7 lbs active ingredient per acre. Cost per acre ranges from $14.25 - 21.38 per application. This product is 80% effective against crabgrass, 70% effective against foxtails, lambsquarters, goosegrass, pigweed, seedling fescue and seedling johnsongrass, and 60% effective against signalgrass.

Post Emergent Herbicides:

**Sethoxydim** (Poast 1.5E) has a 14-day PHI. This product is applied at the formulation rate range of 1.5 - 3 pints per acre or 0.28 - 0.56 lbs active ingredient per acre. Cost per acre per application ranges from $19.22 - 38.44. Sethoxydim is used for control of grasses.

The following products glyphosate and paraquat are both non-selective herbicides. Glyphosate is systemic in nature and controls many perennial weeds, where paraquat products are contact herbicides. Contact herbicides burn down and may only kill young perennials and most annual plants.

**Glyphosate** (Roundup 4L and others) This product is applied at the formulation rate of 12 - 32 fl. ozs. per acre or 0.375 - 1 lb active ingredient per acre. Cost per application ranges from $3.33 to 8.88 per acre per application. This material is used between the rows after planting and often sprayed across the entire field as a broadcast application prior to planting.

**Paraquat** (Gramoxone Extra 2.5EC) is a burn-down herbicide. Application rate is 1.5 pints per acre formulation or 0.47 lbs active ingredient per acre. Cost of an application of this material is $6.77 per acre. This material is applied to the field prior to planting. It is often sprayed early in the season between rows to reduce weed pressure. This product is a restricted use pesticide with a signal word of Danger.
Table 8. 2002 Herbicide Use Estimate for Summer Squash

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>% Use</th>
<th>Ave. # apps.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bensulide</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Ethalfluralin</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Sethoxydim</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Paraquat</td>
<td>25</td>
<td>1</td>
</tr>
</tbody>
</table>

Alternatives:

**DCPA** (Dacthal W 75) rate range of 6 - 7.5 lbs active ingredient per acre. This product will not control emerged weeds. Must be applied as a pre-emergent herbicide. This product is used to control annual grasses and small seeded broad leaf weeds. Not labeled for a transplanted crop.

**Trifluralin** (Treflan 4EC, Trifluralin) applied at the rate range of 0.5 - 0.75 lbs active ingredient per acre. This product has a 30-day PHI. This product can be applied as a pre-emergent or post emergent herbicide. This product is used to control annual grasses and small seeded broad leaf weeds.

**Clethodim** (Select 2EC) has a 14-day PHI. This product is applied at the rate range of 6 - 8 fl.oz formulation per acre. Used to control annual and perennial grasses. This product has a 24 hour re-entry interval with warning as the signal word.

**Clomazone** (Command 3ME) has a 65-day PHI. Is used at the rate of 0.5 lbs active ingredient per acre. Clomazone has caution as the signal word and a 12 hour REI. It is used to control annual grasses and some broadleaf weeds. It is used as a preemergent herbicide.
Contacts

Bost, Steve  
Professor, Entomology and Plant Pathology 
University of Tennessee, Agricultural Extension Service. 
scbost@utk.edu. 
615-832-6802.

Hale, Frank  
Professor, Entomology and Plant Pathology 
University of Tennessee, Agricultural Extension Service. 
fahale@utk.edu. 
615-832-6802.

Straw, Allen  
Assistant Professor, Plant Sciences and Landscape Systems 
University of Tennessee, Agricultural Extension Service. 
astraw@utk.edu. 
865-974-7422.

References


5. Recommended Commercial Vegetable Cultivars The University of Tennessee, Agricultural Extension Service, PB418.

6. 2000 Ranking of Squash Producing States (http://www.nass.usda.gov/nj/rnk00sqh.PDF)