Crop Profile for Summer and Winter Squash in New Jersey



Production Facts

- National Ranking: 4th
- % National Production: 9%
- Yearly Production: 6,200 acres
- % Crop for Fresh Market: 95%
- % Crop for Processing: 5%
- Production Costs: Vary greatly depending on summer versus winter squash and production practices.

Production Regions

Southern Counties Representing 70% of State's Production

#1	Gloucester County	26%	1545 acres
#2	Cumberland County	19%	1233 acres
#3	Salem County	16%	972 acres
#4	Atlantic County	9%	590 acres

Other Important Production Counties totaling 1860 acres

Burlington County
Monmouth County
Hunterdon County
Morris County
Sussex County
Warren County

General Production Information

Squash is one of the most important vegetable crops in New Jersey. This commodity is produced predominately for the fresh market with a small percentage produced for freezer processing and baby food. Summer squash types include mainly yellow squash and zucchini. Some golden zucchini also is produced for freezer processing. Other specialty summer squashes like patty pan and Mid Eastern types are grown for ethnic retail markets, but in such small amounts that they are not important statistically. The bulk of winter squash production consists of butternut squash. Acorn squash and spaghetti squash are the other two types that are grown in large acreage. Some specialty winter squashes that are grown in small amounts include Calabaza (Spanish pumpkin), Delicata types, hubbard types, and cheese pumpkins.

Temperature conditions in New Jersey are favorable for this crop. Excess rainfall and periods of high humidity in the summer season can increase disease pressure. However, even in years with minimal or normal rainfall, the region can have periods of high humidity, which attribute to increased disease pressure in squash. Phytophthora blight, powdery mildew, downy mildew, bacterial wilt, and viruses are the major disease problems for cucurbit crops in New Jersey. Another disease of importance is black rot, especially on butternut squash. Additionally, nematodes have been found to reduce yields in winter squash plantings. Registered fungicides have helped to control of some of these diseases.

The main insect pests affecting this crop include seed corn maggot, cucumber beetle, squash vine borer, aphids, squash bug, mites, and whiteflies. Some insecticides are effective in controlling most of these pests. Admire (imidacloprid), has been shown to control beetles, aphids, and whiteflies during early stages of crop growth. Aphids are a major problem in later plantings since they transmit viruses to the plant. Controlling aphids only lessens the severity of viral infection. Once the aphid has fed on the plant, even for a short period, the plant becomes infected with the virus. Cucumber beetle is also problematic in vectoring bacterial wilt. This disease rapidly infects the plant at any growth stage. The plant becomes infected, vascular tissue clogs with bacteria, the plant wilts, withers, and dies.

Weed control may be the most limiting factor in squash production. Chemical weed control options are limited and often ineffective. One new herbicide (labeled for most cucurbits in 2003) that has helped squash growers to control some broadleaf weeds, post-emergence is Sandea. Sandea has especially helped control weed in no-till fields. Another tool newly available is the herbicide Strategy. It has been an effective choice for controlling annual grasses and many annual broadleaf weeds when environmental conditions are suitable. Strategy is now labeled for use in all the Mid-Atlantic States. It is a jug-mix of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Cultivation is also used for weed control when possible. The following profile gives more details.

Cultural Practices

Summer Squash

Summer squash varieties are mainly seeded and sometimes transplanted from April 15 through August 15 in warmer, Southern counties and from May 10 to August 1 in cooler Northern Counties. Rows are spaced 5 to 6 feet apart with plants 2 to 3 feet apart in the row. Seeding rates range from 4 to 6 pounds of seed per acre depending on cultivar. Seed corn maggot has become a major problem in early seeded squash and growers are now coating seed with insecticide before planting. Occasionally soil fumigation is used to control weeds and soil borne diseases under plastic mulch. However, this is the exception. Generally, herbicides and soil fungicides are used for control. Soil fumigation is too expensive, delays planting, and is sometimes unpredictable in levels of control.

Summer squash types are generally grown on raised beds with drip irrigation and plastic mulch. This is the preferred method in the Southern counties that account for the highest production area. Windbreaks of planted rye strips between blocks of rows are also used in spring to protect young seedlings from sand blasting and cold winds. Raised beds in combination with clear or black plastic mulch are used for soil warming in spring. Additionally, raised beds help to control water movement in the field. Raised beds allow water to drain away from the root zone. Manipulating soil water is used to control soil borne diseases like Phytophthora root rot and Pythium. Reflective plastic mulches are used for aphid control in late plantings. The reflection disorients the insect and deters it from landing on the plant. Plastic mulch is also beneficial for weed control. However, some weeds, especially perennial weeds, like purple nutsedge grow through the plastic mulch. Weed control is one of the greatest limiting factors in squash production. The alternative to plastic mulch and raised beds is to plant in bare ground. Generally, overhead irrigation is used for bare ground plantings. However, some growers do use drip irrigation, buried alongside the row in bare ground fields.

Honeybee hives are rented and placed on squash field edges to promote adequate pollination. Recommendations advise growers to utilize one to two hives per acre to pollinate squash crops. Without good pollination yields are drastically decreased. The decline in the native bee population has forced growers to rent hives in order to produce squash and other cucurbit crops in New Jersey.

Summer squash are carefully hand harvested in the field and brought into packing barns where they are washed in chlorinated water to remove surface debris and pathogens. Handling summer squash types must be done with care since they easily scratch and bruise. Squash are sorted by size and packed in ½ bushel cartons. Size grades include US No. 1, medium, and large. After packing, summer squash are stored under refrigeration at 40-50 degrees Fahrenheit.

Winter Squash

Winter squash is seeded later than summer squash in New Jersey. This is mainly to schedule the plantings for fall harvest. Some growers may opt to plant earlier for late summer versus fall harvest. However, the majority of growers harvest in September and early October, before the first frost dates. Fields are planted between June 15 and July 15 in Southern counties and from June 15 to July 5 in cooler Northern counties. Since the planting is later than summer

squash, there is usually no problem due to seed corn maggot, because soils are warmer and generally drier. Spacing varies depending on vine habit and average fruit size. Larger squash types are spaced in rows 6 to 7.5 feet apart with 3 to 4 feet between plants. Smaller types are seeded in rows 5 to 6 feet apart with 2 feet between plants in a row. Winter squash is most commonly planted in bare ground fields without raised beds. Some growers are investigating the use of no-till systems for production of winter squashes and other cucurbit crops. If any water is supplied to the crop it is usually in the form of overhead irrigation. In many cases winter squash is a non-irrigated crop in New Jersey. Beehives are also used for improving pollination in the field, just like in summer squash production.

Pest problems for winter squash are generally the same as for summer squash. However, fruit damage from wildlife occurs more often on winter squash fruit. Deer and rodents are the heaviest feeders. Some damage from turkeys has been reported. The fruit of winter squash are also more prone to rot since they lay on the soil for extended periods of time during growth. As soon as fruit are fully mature growers will begin harvesting, curing, and storing the squash. Temperatures below 50 degrees Fahrenheit can cause chilling injury to the fruit and make them unmarketable. If no storage is available squash are not cured and are quickly marketed. Growers with storage facilities cure the squash at temperatures between 80 to 85 degrees Fahrenheit with a relative humidity of 75 to 80 percent for 10 days. The curing process heals over any cuts or bruises on the fruit surface. After curing squash are stored at a temperature around 55 degrees Fahrenheit and 55 percent relative humidity for up to 5 months. If market prices are high in the fall, most of the crop will be sold. However, growers with storage facilities will hold squash to sell during the winter months that may yield a better price. Problems that occur in storage include fruit rots, rodent feeding, and fruit fly infestations. Winter squash are packed in either 1 1/9 bushel cartons/crates or 35 pound carton/crates.

Worker Activities

Summer and winter squash are mostly seeded in the field. A small percentage of farmers (less than 1% of the total acres) may use transplants planting squash. Seed is generally planted using a mechanical seeder. In some cases seed is hand set by workers. Fungicide and insecticide treated seed is handled using latex or neoprene gloves to avoid contact with the skin. After planting worker activity in the field is limited until harvest time, other than the possibility of hand hoeing once for weed control. During the growing period farmers may scout fields once weekly to assess pest populations and crop progress. Pesticide treatments may begin just after seed emergence if pest levels warrant treatment. Seed corn maggot and cucumber beetle are the major insect pests that threaten seedling survival. Additionally, damping off is the major disease to threaten seedlings in the field.

When squash mature they are hand-harvested for about a 4 to 5 week period. Summer squash has multiple harvests that may occur on a daily basis when environmental conditions are favorable for fruit growth, or fruit are harvested every-other day. If summer squash are left on the plant grow too large, they become unmarketable. Winter squash are generally harvested once and the entire crop is removed from the field and then stored. Once harvesting of summer squash begins pesticides used to control insects and diseases have the lowest REI's and PHI's possible. Insecticides with REI's and PHI's less than 24 hours include: permethrin, esfenvalerate, thiamethoxam, and azadirachtin. Pesticides used in disease control with REI's and PHI's less than 24 hours include: chlorothalonil, azoxystrobin, metalaxyl-M, fixed copper, dimethomorph, and trifloxystrobin. The maximum REI that can be tolerated without impact to

summer squash harvests would be 48 hour in order to adequately access and control common squash pest problems. Lengthening the REI's or PHI's for this crop would be a major problem and would be detrimental to summer squash production. REI's are not a major issue in winter squash fields since worker activity is generally limited to 3 times during the season (at planting, once for hand weeding, and at harvest). Also, timing of harvest for winter squash is not a major issue since growth halts when squash mature. Although, winter squash should be harvested when fruit have hardened and before a frost to avoid disease infection (like black rot and phytophthora) and cold injury to the fruit.

Major Insect and Mite Pests

Cucumber Beetle (*Acalymma vittata*, striped cucumber beetle, *Diabrotica undecimpunetata howardi,* spotted cucumber beetle)

The striped cucumber beetle and the spotted cucumber beetle (southern corn rootworm) are major pests of squash and require the same control methods. The beetles are a greenish yellow color with black spotted or striped elytia. They measure about 1/5 inch (5mm) long and 1/10 inch (2.5mm) wide. Cucumber Beetle 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, foliar insecticides should be applied before beetles feed excessively on the cotyledons and first true leaves. Sprays should begin shortly after plant emergence, and repeat applications after scouting fields for new adult emergence. An alternative option is to use Furdan 4F or Admire 2F in furrow or as a post planting drench. Beetles are a problem every year. All squash acres are at risk from this pest. Yield reduction can be dramatic. Generally 5-15% losses can occur in treated fields. In untreated fields 100% loss can occur from beetle damage combined with bacterial wilt.

Alternative controls to be used in combination with insecticides include:

- Choose varieties tolerant to bacterial wilt
- Destroy squash crop residue
- Crop rotation

Chemical Controls:

- **imidacloprid (Admire)**
  - Percent acres treated: 20-30%
  - Average rate and frequency of application:
    - 16-24 oz 2F/A
    - once at planting
  - Method of application: in furrow, transplant drench, through drip irrigation
  - REI: 12 hours
  - PHI: 21 days
  - Efficacy rating: Good

Note: Imidacloprid registered for use in cucurbits in 1999. Most application occurs as a transplant drench, however there are not significant acres planted with transplants.

- **carbaryl (Sevin)**

- Percent acres treated: 30-50%
- Average Rate and frequency of application: 1.25 lb 80S/A, once
- Method of application: foliar spray
- REI: 12 hours
- PHI: 3 days
- Efficacy rating: Good on cucumber beetle, poor on squash bugs

Note: Sevin is not the preferred product for control of cucumber beetles in flowering cucurbits since there is a risk of bee kill with this product.

- **carbofuran (Furadan)**
  - Special Local-Needs Label 24(c)
  - Percent acres treated: 40-60%
  - Average rate and frequency of application: 3.8 oz 4F/1,000 ft of row, once
  - REI: 48 hours
  - PHI: At planting only
  - Method of application: in furrow or 7 inch band on top of row
  - Efficacy rating: Good

Note: Use of Furadan at planting frequently leads to spider mite outbreaks later in the season.

- **permethrin (Ambush, Pounce)**
  - Percentage acres treated: 20-30%
  - Average rate and frequency of application:
    - Ambush: 6.4-12.8 fl oz 2EC/A, once
    - Pounce: 4-8 fl oz 3.2EC/A, once
  - Method of application: foliar spray
  - REI: 24 hours
  - PHI: 0
  - Efficacy rating: Good

Note: Continual use of permethrin may result in spider mite outbreaks. Permethrin may be ineffective when temperatures are above 85 degrees Fahrenheit.

- **esfenvalerate (Asana XL)**
  - Percent acres treated: 20-30%
  - Average rate and frequency of application: 5.8-9.6 fl ox 0.66EC/A, once
  - Method of application: foliar spray
  - REI: 12 hours
  - PHI: 0
  - Efficacy rating: Good

- **endosulfan (Thionex)**
  - Percent acres treated: 80-90%

- Average rate and frequency of application: 1.33-2.67 pt 3EC/A, twice
- Method of application: foliar spray
- REI: 48 hours
- PHI: 2 days
- Efficacy rating: Good

- **bifenthrin (Capture)**
  - Percent acres treated: 5-15%
  - Average rate and frequency of application: 5.12-6.4 fl oz 2EC/A, once
  - Method of application: foliar spray
  - REI: 24 hours
  - PHI: 3 days
  - Efficacy rating: good

Seed Corn Maggot (*Delia platura*)

Seed corn maggots are more severe when spring conditions are cool and wet. Adult flies are attracted to fields that have manure applied to them or fields with high organic matter levels. They look like a smaller version of a housefly, but are narrower in appearance. They can be easily confused with other fly pests. Adult females lay egg masses in the planting hole or at the base of a new seedling. Eggs hatch quickly and the maggot larvae bore into seed or stems of transplants. They feed on endosperm of seed or stems of transplants. Generally, the seed fails to sprout or, if it does, it is weak or sickly. Seed treatment with an insecticide before planting is the best control method. Plant stand losses can reach 40-60% if seed is left untreated. In fields planted with treated seed losses can still occur in the range of 5-15% stand reduction.

Alternative controls to be used in combination with insecticides include:

- Avoid the use of manure prior to planting
- Choose fields that are well drained

Chemical Controls:

- **diazinon**
  - Percent acres treated: 20-30% foliar, 40-50% seed treatment
  - Average rate and frequency of application:
    - Foliar: 1 pt 4E/A, once
    - Seed treatment: once before planting
  - Method of application: foliar spray or seed treatment coating
  - REI: 24 hours
  - PHI: 7 days
  - efficacy rating: Good

- **chlorpyriphos (Lorsban 50SL)**
  - Percent acres treated: 50-60% seed treatment
  - Average rate and frequency of application:

    - Seed treatment: once before planting
- Method of application: seed treatment coating
- REI: seed coating treatment only
- PHI: seed coating treatment only
- efficacy rating: Good

Squash Vine Borer (*Elasmopalpus lignosellus*)

The adult of the squash vine borer is a wasp-like moth having a 1 to 1.5 inch wingspan, with metallic green forewings. The mature larva or caterpillar is a thick, white wrinkled worm with a brown head and is about 1 inch in length. The eggs are found glued to stems of squash vines. The larvae bore into stems and can completely girdle the inside of the stem. The presence of frass oozing from holes in the stems is an indication of borers in the stems. Some varieties, such as 'Waltham' butternut, are known to be resistant to the squash vine borer. Plants are most vulnerable when vines begin to run and thereafter. Foliar sprays directed at the base of the plants are recommended for control. After the crop is finished, destroy plants and plant residue to kill larvae and pupae. This can reduce populations in subsequent plantings.

Alternative controls to be used in combination with insecticides include:

- Destroying previous squash crop residues

Chemical Controls:

- **permethrin (Ambush, Pounce)**
    - Percentage acres treated: 20-30%
    - Average rate and frequency of application:
        - Ambush: 6.4-12.8 fl oz 2EC/A, once
        - Pounce: 4-8 fl oz 3.2EC/A, once
    - Method of application: foliar spray
    - REI: 24 hours
    - PHI: 0
    - Efficacy rating: Good

Note: Continual use of permethrin may result in spider mite outbreaks. Permethrin may be ineffective when temperatures are above 85 degrees Fahrenheit.

- **esfenvalerate (Asana)**
    - Percent acres treated: 20-30%
    - Average rate and frequency of application: 5.8-9.6 fl ox 0.66EC/A, once
    - Method of application: foliar spray
    - REI: 12 hours
    - PHI: 0
    - Efficacy rating: Good

- **endosulfan (Thionex)**

- Target pests: cucumber beetle, squash vine borer, pickleworm, melonworm, aphids, whiteflies
- Percent acres treated: 80-90%
- Average rate and frequency of application: 1.33-2.67 pt 3EC/A, twice
- Method of application: foliar spray
- REI: 48 hours
- PHI: 2 days
- Efficacy rating: Good

- **bifenthrin (Capture)**
  - Percent acres treated: 10-20%
  - Average rate and frequency of application: 5.12-6.4 fl oz 2EC/A, once
  - Method of application: foliar spray
  - REI: 24 hours
  - PHI: 3 days
  - Efficacy rating: good

Aphids (mainly *Myzus persicae*, green peach aphid)

Green peach aphids and other aphids transmit mosaic viruses. All life stages feed by injecting their sucking mouth-parts into the plant, thereby transmitting the virus. Later plantings and long season squashes are generally most affected by aphid transmission of mosaic viruses. Leaves of infested plants become distorted, yellowed, and curl. Some varieties are virus tolerant and can mask physical symptoms of this disease. If aphid infestations are high enough they can cause the development of sooty mold resulting from honeydew excretions. Soil insecticides and foliar spray applications are recommended for control. Aphids alone generally do not cause major economic losses. However, the mosaic viruses transmitted by aphids can cause total devastation of the squash crop. This is especially true for summer squash types in later plantings. All squash fields are at risk of viral epidemics. Yield losses from aphid transmitted viruses can reach 100% in untreated fields. Typically, late season summer squash plantings will have 20-35% yield losses from virus infection.

Alternative controls to be used in combination with insecticides include:

- Use reflective plastic mulch
- Plant border plants that encourage beneficial Ladybugs

Chemical Controls:

- **imidacloprid (Admire)**
  - Percent acres treated: 20-30%
  - Average rate and frequency of application:
    - 16-24 oz 2F/A
    - once at planting
  - Method of application: in furrow, transplant drench, through drip irrigation
  - REI: 12 hours
  - PHI: 21 days
  - Efficacy rating: Good

Note: Imidacloprid registered for use in cucurbits in 1999. Most application occurs as a transplant drench, however there are not significant acres planted with transplants.

- **thiamethoxam (Actara)**
    - Percent acres treated: 20-30%
    - Average rate and frequency of application: 2-3 oz 25WDG/A, twice
    - Method of application: foliar spray
    - REI: 12 hours
    - PHI: 0 days
    - Efficacy rating: Good

Note: Thiamethoxam is toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Do not exceed a total of 8.0oz of Actara per acre during each growing season.

- **endosulfan (Thionex)**
    - Percent acres treated: 80-90%
    - Average rate and frequency of application: 1.33-2.67 pt 3EC/A, twice
    - Method of application: foliar spray
    - REI: 48 hours
    - PHI: 2 days
    - Efficacy rating: Good

- **diazinon**
    - Percent acres treated: 20-30% foliar, 40-50% seed treatment
    - Average rate and frequency of application:
        - Foliar: 1 pt 4E/A, once
        - Seed treatment: once before planting
    - Method of application: foliar spray or seed treatment coating
    - REI: 24 hours
    - PHI: 7 days
    - Efficacy rating: Good

Squash Bug (*Anasa tristis*)

Adult squash bugs are flat-topped, gray to black and about ½ to 1 inch long. They suck plant juices and inject toxins into plant tissue, causing the leaves and shoot tips to die back. They can also prevent fruit formation if present in high enough populations. The squash bug is an annual pest that can cause high yield losses. In treated fields losses can reach 5-10% annually.

<u>Alternative controls to be used in combination with insecticides include:</u>

- Practice good weed control to reduce squash bug habitat

<u>Chemical Controls:</u>

- **carbaryl (Sevin)**

- Percent acres treated: 30-50%
- Average Rate and frequency of application: 1.25 lb 80S/A, once
- Method of application: foliar spray
- REI: 12 hours
- PHI: 3 days
- Efficacy rating: Good on cucumber beetle, poor on squash bugs

Note: Sevin is not the preferred product for control of cucumber beetles in flowering cucurbits since there is a risk of bee kill with this product.

- **permethrin (Ambush, Pounce)**
  - Percentage acres treated: 20-30%
  - Average rate and frequency of application:
    - Ambush: 6.4-12.8 fl oz 2EC/A, once
    - Pounce: 4-8 fl oz 3.2EC/A, once
  - Method of application: foliar spray
  - REI: 24 hours
  - PHI: 0
  - Efficacy rating: Good

Note: Continual use of permethrin may result in spider mite outbreaks. Permethrin may be ineffective when temperatures are above 85 degrees Fahrenheit.

- **esfenvalerate (Asana)**
  - Target pests: cucumber beetle, squash vine borer, pickleworm, melonworm, squash bug, cabbage looper
  - Percent acres treated: 20-30%
  - Average rate and frequency of application: 5.8-9.6 fl ox 0.66EC/A, once
  - Method of application: foliar spray
  - REI: 12 hours
  - PHI: 0
  - Efficacy rating: Good

- **bifenthrin (Capture)**
  - Percent acres treated: 5-15%
  - Average rate and frequency of application: 5.12-6.4 fl oz 2EC/A, once
  - Method of application: foliar spray
  - REI: 24 hours
  - PHI: 3 days
  - Efficacy rating: good

- **azadirachtin (Azatin, Ecozin, Neemix)**
  - Percent acres treated: 1-2%
  - Average rate and frequency of application: 11-21 fl oz EC/A, once

- Method of application: foliar spray
- REI: 12 hours
- PHI: 0 days
- Efficacy rating: good if used when pests first appear and are in the early larval stages

Whiteflies (*Trialeurodes vaporariorum*, greenhouse whitefly; *Bemisia argentifolii*, silverleaf whitefly; *Bemisia tabaci*, sweet potato white fly)

Whiteflies are very tiny white flies that feed on the undersides of leaves. When the plant is disturbed they will flutter out and disperse. Feeding weakens and stunts the plant. Flies also excrete honeydew, which encourages sooty mold that results in a black fungus on leaf surfaces. Whiteflies have also been known to transmit viral diseases.

Chemical Controls:

- **imidacloprid (Admire)**
  - Target pests: cucumber beetles, aphids, whiteflies
  - Percent acres treated: 35-40%
  - Average rate and frequency of application: 16-24 oz 2F/A, once at planting
  - Method of application: in furrow, transplant drench, through drip irrigation
  - REI: 12 hours
  - PHI: 21 days
  - Efficacy rating: Good

Note: Imidacloprid registered for use in cucurbits in 1999. Most application occurs as a transplant drench, however there are not significant acres planted with transplants.

- **endosulfan (Thionex)**
  - Percent acres treated: 80-90%
  - Average rate and frequency of application: 1.33-2.67 pt 3EC/A, twice
  - Method of application: foliar spray
  - REI: 24 hours
  - PHI: 2 days
  - Efficacy rating: Good

- **bifenthrin (Capture)**
  - Percent acres treated: 5-15%
  - Average rate and frequency of application: 5.12-6.4 fl oz 2EC/A, once
  - Method of application: foliar spray
  - REI: 24 hours
  - PHI: 3 days
  - Efficacy rating: good

Mites (*Tetranychus* species)

Two spotted spider mites are most commonly found infesting squash fields. They are minute in size and may be seen better using a hand lens. Another indication is the webbing they leave on

undersides of leaves. They suck plant juices and feed on the undersides of leaves. The feeding causes yellow speckles or stippling on tops of leaves. Heavy infestations and feeding may cause leaves to cup. Mite infestations generally begin around field edges and grassy areas. Damage from this pest reduces photosynthesis in the plant and ultimately yields. Percentages of yield loss are not documented. Continuous use of Furadan, Sevin, or pyrethroids may result in mite outbreaks. The addition of crop oils or organosilicon spray additives will increase mite control.

Alternative controls to be used in combination with insecticides include:

- Do not overuse Ambush, Pounce, Furadan, or Sevin
- Rotate chemical classes

Chemical Controls:

- **abamectin (Agri-Mek)**
  - Percent acres treated: 10-20%
  - Average rate and frequency of application: 8-16 fl oz 0.15EC/A, once
  - Method of application: foliar spray
  - REI: 12 hours
  - PHI: 7 days
  - Efficacy rating: Good

- **bifenthrin (Capture)**
  - Target pests: cucumber beetle, squash vine borer, cutworms, pickleworm, melonworm, squash bug, cabbage looper, mites, whiteflies
  - Percent acres treated: 5-15%
  - Average rate and frequency of application: 5.12-6.4 fl oz 2EC/A, once
  - Method of application: foliar spray
  - REI: 24 hours
  - PHI: 3 days
  - Efficacy rating: good

- **fenpropathrin (Danitol)**
  - Percent acres treated: 5-15%
  - Average rate and frequency of application: 10.66 fl oz EC/A, once
  - Method of application: foliar spray
  - REI: 24 hours
  - PHI: 7 days
  - Efficacy rating: good

- **dicofol (Kelthane)**
  - Percent acres treated: 5-15%
  - Average rate and frequency of application: 1.25 lb 50WP/A, once
  - Method of application: foliar spray
  - REI: 12 hours
  - PHI: 2 days

- Efficacy rating: good

WEED CONTROL

Major Weed Pests (Broadleaf and Grass)

- Major Annual Grass Weeds: crabgrass, foxtail
  - **Crabgrass** (*Digitaria* species) - a summer annual grass that can grow prostrate and spreading or ascending to 1 meter in height. Seedlings have leaves that are linear with tapered leaf tips, about 10 times longer than wide. More mature plants begin tillering after the 4-5 true leaf stage with roots at the nodes of elongated stems.
  - **Foxtail** (*Poaceae* species)– a summer annual grass containing tillers that elongate in a redial fashion from the crown. Seedlings have tillers that initially ascend but become more prostrate with age. Lower nodes of tillers can develop adventitious roots.

- Major Annual Broadleaf Weeds: pigweed, common lambsquarters, ragweed, purslane, galinsoga, cocklebur, velvetleaf, marestail, jimsonweed, morningglory
  - **Pigweed** (*Amaranthus* species, primarily redroot pigweed, *A. retroflexus*) – a summer annual broadleaf that is erect and freely branching. Small flowers are enclosed by spiny bracts that give the terminal and axillary spikes a bristly appearance. Seedlings have cotyledons that are narrow and pointed with true leaves that are dull green to reddish on the upper surface and bright red beneath.
  - **Common Lambsquarters** (*Chenopodium album*) – an erect summer annual with a gray-mealy coating, particularly on the surfaces of young leaves. Seedlings have hypocotyls that are green or tinged with maroon. Stems of young seedlings are covered with mealy-white granules. Mature plants have stems that are erect, branching, hairless, and vertically riged, often with maroon stripes.
  - **Ragweed** (*Ambrosia artemisiifolia*, common ragweed; *Ambrosia trifida*, giant ragweed) – an erect, branching summer annual. Seedlings of common ragweed have spotted or entirely purple hypocotyls with thick cotyledons. Young leaves are opposite and become alternate as plant matures. Mature plants have leaves and stems that are hairy and one or generally twice compound (pinnatifid). Giant ragweed seedlings have round to oblong cotyledons that are thick. Young leaves are opposite and remain opposite. Mature plants have leaves and stems that are hairy. Leaves are palmately lobed with 3-5 simple lobes.
  - **Purselane** (*Portulaca oleracea*) – a summer annual with a prostrate mat-forming habit and thick succulent stems and leaves. Young seedlings are erect but soon become prostrate. Mature plants have stems that are heavily branched, purplish red or green, smooth, completely prostrate or turned up at the ends.
  - **Galinsoga** (*Galinsoga ciliata*) – a summer annual with erect, freely branching stems 10-70 cm in height. Leaves are broadly egg-shaped to triangular, pointed at the apex and coarsely toothed on the margins. Seedling hypocotyls are short, green, turning maroon with age. Dense hairs cover the upper leaf surface, stems, and petioles. Leaf margins are coarsely

toothed with hairs pointing toward the leaf apex. Mature plants have stems that are erect or spreading, much-branched, and covered with somewhat coarse hairs.

- **Cocklebur** (*Xanthium strumarium*) – an erect, branched, summer annual with distinctive prickly burs in late summer and fall. Stems are brown- to purple-spotted and leaves are triangular with a sandpaper texture. Seedling hypocotyls are stout and purple towards the base. Cotyledons are thick, fleshy, lanceolate, tapered at both ends, and very large. Mature plants have branched stems that are rough and hairy with dark spots and longitudinal ridges. Leaves are alternate and similar to those of seedlings, but much larger.
- **Velvetleaf** (*Abutilon theophrasti*) – an erect summer annual, usually with unbranched stems. Heart-shaped leaves and stems are covered with soft hairs that are velvety to the touch. Seedling hypocotyls are stout, green or maroon at the base, and covered with short hairs. Leaves are alternate, angled downward over the seedling, with the apexes pointed at the ground. Stems are hairy. Stems and leaves emit an unpleasant odor when crushed.
- **Marestail** (*Conyza canadensis*) – a winter or summer annual. Seedlings develop into a basal rosette. Mature plants produce an erect central stem with a terminal panicle of inconspicuous flowers.
- **Jimsonweed** (*Datura stramonium*) – a large summer annual with erect branching stems and distinctive egg-shaped seed capsules covered with prickles. The foliage has a strong unpleasant odor. All parts of the plant are poisonous and should not be ingested. Seedling hypocotyls are maroon and hairy. Cotyledons are thick, smooth, lanceolate. Petioles of cotyledons are hairy on the upper surface. In mature plants, stems are smooth, green or purple, with inconspicuous hairs. Leaves are alternate, large, on stout petioles, oval to ovate, smooth, and dark green above. Leaf margins resemble those of oak leaves, coarsely and unevenly toothed.
- **Morningglory** (*Ipomea* species) **–** summer annual weeds with long climbing or trailing viny stems. Leaves may be heart-shaped or lobed. Flowers are attractive and funnel-shaped. This plant is very competitive and generally difficult to control in most crops.

- Major Perennial Weeds: yellow nutsedge, Bermudagrass
  - **Yellow nutsedge** (*Cyperus esculentus*) – a perennial with 3-angled stems, long grass-like leaves, yellowish green foliage, and 1-2 cm long tubers at the ends of rhizomes. Flowers are in spikelets at the ends of the stems.
  - **Quackgrass** (*Elytrigia repens* (L.) Nevski) –a rhizomatous perennial that generally grows erect, bending at the nodes. Leaves are rolled in the bud; auricles are narrow, slender and clasp the stem. The ligule is membranous and very short. Blades are 4-30 cm long and 3-10 mm wide, flat, hairy to smooth on the upper surface and smooth on the lower surface. Sheaths are rounded and smooth, but those near the base of the plant may have short hairs. The collar is broad. It grows in cultivated fertile soil where reduced tillage is practiced and in waste areas.
  - **Bermudagrass** (Cynodon dactylon) – a wiry perennial with spreading rhizomes and stolons. The leaves are gray-green to bluish green. Mature plants have a spreading, prostrate to ascending habit, forming dense mats when mowed, but may grow erect in unmowed areas.

Weed Pests:

Frequency of occurrence: Annually

Damage caused: Yield reduction from weed competition for water, nutrients, and sunlight. Weeds interfere with harvesting fruit and block pesticide application coverage. Some weed species harbor disease organisms and insect pests. High weed populations encourage moisture retention in the plant canopy, which increases disease pressure.

Percent acres affected: 100%

Critical timing of control measures: Preplant, preemergence, and postemergence, post harvest

Yield losses: Vary with weed pressure

Cultural controls: Cultivation, crop rotation, hand weeding and hoeing

Post harvest control practices: Use of burn-down, non-selective herbicides to destroy squash crop to clean plastic mulch beds for double cropping. Cut harrowing to destroy crop and weeds.

CHEMICAL CONTROLS – HERBICIDES

- **bensulide (Prefar)**
    - Target weeds: Annual grasses and some broadleaf weeds
    - Percent acres treated: 60-75%
    - Average rate and frequency of application: 5-6 quarts 4E/A, once
    - Method of application: preemergence or preplant incorporated
    - REI:12 hours
    - PHI: preemergence application only
    - Efficacy rating: Good on annual grasses, fair to good on lambsquarters, fair on pigweed species and common purslane. No control on other broadleaf weeds, morningglory, and nutsedge.

Note: If using under plastic mulch band under the plastic immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. If no mulch is used apply as a banded directed shielded spray preemergence to the weeds and activate with one-half 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 lambsquarter, smooth pigweed, and common purslane.

- **clomazone (Command 3ME) - (winter squash only)**
    - Target weeds: Annual grasses and broadleaf weeds including common lambsquarter, velvetleaf, spurred anoda, and jimsonweed.
    - Percent acres treated: 30-40%

- Average rate and frequency of application: 4-8 oz 3ME/A, once
- Method of application: preplant incorporated or preemergence
- REI: 12 hours
- PHI: 45 days
- Efficacy rating: Good on annual grasses, good on most broadleaf weeds, fair to poor on galinsoga, morningglory, and ragweed, no control of nutsedge, carpetweed, cocklebur, and pigweed

Note: Growers have been skeptical about using Command to control weeds due to crop injury. Command does not control mustards, morningglory species, and pigweed species.

- **ethalfluralin + clomazone (jug-mix) (Strategy)**
  - Target weeds: Annual grasses and many broadleaf weeds
  - Percent acres treated: too new to determine use
  - Average rate and frequency of application: 0.394-1.575 lb/A, once
  - Method of application: preemergence, as a banded directed shielded spray
  - REI: 24 hours
  - PHI: preemergence application only
  - Efficacy rating: Good on annual grasses, good on most broadleaf weeds, fair to poor on galinsoga, morningglory, and ragweed, no control of nutsedge and cocklebur.

Note: Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium fine textured soils and sites that have been heavily manured.

- **sethoxydim (Poast)**
  - Target weeds: Grasses
  - Percent acres treated: 30-40%
  - Average rate and frequency of application: 1-1.5 pts 1.5EC/A, once
  - Method of application: postemergence
  - REI: 24 hours
  - PHI: 14 days
  - Efficacy rating: Good when grasses are small, control reduced when hot, dry conditions occur and if grasses are large and tillers are present.

Note: Do not tank-mix with or apply within 2 to 3 days of any other pesticides unless labeled.

- **halosulfuron (Sandea)**
  - Target weeds: Yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga.
  - Percent acres treated: 10-20% (summer squash), 50-60% (winter squash)
  - Average rate and frequency of application: 0.5-0.66 dry ounce 75WG/A, once
  - Method of application: postemergence
  - REI: 12 hours

- PHI: 30 days
- Efficacy rating: Good on target weeds. Will not control common lambsquarter or eastern black nightshade.

Note: Do not apply until the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). Do not use oil concentrate. Do not apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application.

- **clethodim (Select)**
  - Target weeds: Many annual and certain perennial grasses, including annual bluegrass
  - Percent acres treated: 20-30%
  - Average rate and frequency of application: 6-8 oz 2EC/A, once or twice
  - Method of application: Postemergence as a banded directed shielded spray
  - REI: 24 hours
  - PHI: 14 days
  - Efficacy rating: Good on target weeds. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled.

Note: Use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and moisture is adequate. Repeated applications may be needed to control certain perennial grasses.

- **paraquat (Gramoxone Max)**
  - Target weeds: All weeds
  - Percent acres treated: 60-70%
  - Average rate and frequency of application: 0.6 lb 3SC/A, once or twice
  - Method of application: Non-selective sprays between row middles with shielded sprayers after crop establishment, and entire field application as a preplant burndown to clean plastic mulch beds for double crop planting or for preparing for plastic mulch removal.
  - REI: 48 hours
  - PHI: 30 days
  - Efficacy rating: Good; non-selective herbicide. Poor on Pennsylvania smartweed.

Note: This is a Special Local-Needs 24(c) label postemergence as a banded spray between the rows of plastic mulch in New Jersey. Add nonionic surfactant according to the labeled instructions. Do not exceed spay pressure of 30 psi.

DISEASES

Bacterial Wilt (*Erwinia tracheiphila*)

Insect control is essential for prevention of bacterial wilt. Controlling cucumber beetles before they feed on squash plants helps prevent this disease. Symptoms include initial wilting of individual leaves followed by wilting of entire stems and branches. Diagnosing bacterial wilt is easily done by cutting a wilted stem close to the crown of the plant, rejoining the cut surfaces, and then slowly pulling them apart. If bacterial slime is present it will extend from one cut end to the other.

Cultural controls:

- Planting resistant/tolerant varieties
- Rotate corps to discourage beetles
- Removal and destruction of infected plants.

Black Rot (*Phoma cucurbitacearum*)

Winter squash are affected by a black rot that occurs on the fruit. Symptoms can appear in the field before harvest, especially in butternut squash. On butternut a unique superficial, tan to white petrified area can develop in distinct concentric rings, with pycnidia embedded in the tissue. These symptoms develop when the fruit are immature. More typically, if fruit are damaged before or during storage, a brown to pinkish water-soaked are develops, followed by blackened areas with conspicuous fruiting bodies. The vegetative tissue of winter squash types is resistant, except for the oldest leaves. This disease in not a problem in summer squash.

Cultural Controls:

- Do not place infected fruit in harvest bins
- Crop rotation
- Reduce injury on fruit during harvest and storage

Chemical Controls:

- **chlorothalonil (Bravo, Echo, Equus)**
  - Percent acres treated: 90-100%
  - Average rate and frequency of application: 2 pt 6F/A, two to three times
  - Method of application: Foliar spray
  - REI: 12 hours
  - PHI: 0 days
  - Efficacy rating: Good

- **azoxystrobin (Quadris)**
  - Percent acres treated: 60-70%
  - Average rate of application and frequency of application: 11-15.5 fl oz 2.1F/A, two to three times
  - Method of application: Foliar spray
  - REI: 12 hours
  - PHI: 1 day

- Efficacy rating: Good

Note: To control black rot chemically, chlorthalonil and azoxystrobin should be alternated throughout the fungicide spray schedule until harvest. Fungicide application for black rot control will help maintain "handles" on the fruit. Harvest carefully because wounding can negate benefits from a season-long fungicide program.

Damping-Off

This is a seedling disease caused by Fusarium, Pythium, Phytophtora, or Rhizoctonia fungi. Seedlings rot at the soil level and quickly die. This disease tends to occur under conditions of over crowding of seedlings, high soil moisture, poor aeration and overcast conditions. It can also be accentuated by deep planting. Seedlings are most susceptible to damping off during the first few weeks after emergence.

Cultural controls:

- Avoid long periods of high soil moisture and over irrigation
- Avoid soil compaction
- Use raised beds to obtain better soil drainage
- Plant high quality seed with good vigor

Chemical Controls:

- **metalaxyl-M (Ridomil Gold, Ultra Flourish)**
  - Percent acres treated: 60-70%
  - Average rate and frequency of application:
    - Ridomil Gold: 1-2 pts 4E/A, once or twice
    - Ultra Flourish: 2-4 pt 2E/A, once or twice
  - Method of application: Banded over top of row after seeding
  - REI: 12 hours
  - PHI: 0 days
  - Efficacy rating: Fair to good

Downy Mildew (*Pseudoperonospora cubensis*)

Downy mildew generally does not occur in New Jersey until mid-August. However, scouting fields for disease incidence beginning in mid-July will help to keep early infections under control. Symptoms are almost always found on the undersides of the leaves. The first symptoms appear on older leaves as small, slightly chlorotic to bright yellow areas on the upper leaf surface. On the upper leaf surface, lesion margins are irregular in shape. Downy lesions can be found on undersides of leaves and can be colorless to light gray to deep purple in color. As lesions expand, they often come together, creating large necrotic areas on the leaf. Eventually, the entire leaf is dead and no longer protect the fruit from sunscald. It is important to begin protective sprays when the canopy is complete in the field.

Cultural Controls:

- Planting away from inoculum sources

- Using more distant plant spacings to reduce canopy density
- Avoid overhead irrigation to reduce leaf wetness

Chemical Controls:

- **dimethomorph (Acrobat)**
  - Percent acres treated: 30-40%
  - Average rate and frequency of application: 6.4 oz 50WP/A twice
  - Method of application: Banded over top of row after seeding
  - REI: depends on tank-mix
  - PHI: depends on tank-mix
  - Efficacy rating: good (see note)

Note: Acrobat must be tank mixed with another fungicide registered on winter squash or summer squash to be effective.

- **chlorothalonil (Bravo, Echo, Equus)**
  - Percent acres treated: 90-100%
  - Average rate and frequency of application: 1.5-3 pt 5F/A
    - Summer squash: once or twice
    - Winter squash: two to three times
  - Method of application: Foliar spray
  - REI: 12 hours
  - PHI: 0 days
  - Efficacy rating: Good

- **Maneb (Manex, Maneb)**
  - Percent acres treated: 20-30%
  - Average rate of application and frequency of application:
    - 1.5-2 lb 80WP/A, once or twice
  - Method of application: Foliar spray
  - REI: 24 hours
  - PHI: 5 days
  - Efficacy rating: Good

- **fixed copper**
  - Percent acres treated: 90-100%
  - Average rate of application and frequency of application:
    - 2.25 lb 53.8DF/A, three to four times
  - Method of application: Foliar spray
  - REI: 24 hours
  - PHI: 0 days
  - Efficacy rating: Good

Note: Other fungicides listed below are effective on downy mildew and should be applied every 14 days. Apply chlorothalonil or maneb on alternate weeks when using these materials.

- **metalaxyl-M + chlorothalonil (Ridomil Gold/Bravo, Flourinil)**
  - Percent acres treated: 90-100%
  - Average rate and frequency of application: 2 lb 76WP/A, two or three times
  - Method of application: Foliar spray
  - REI: 48 hours
  - PHI: 0 days
  - Efficacy rating: Good

- **metalaxyl-M + copper (Ridomil Gold/Copper)**
  - Percent acres treated: 90-100%
  - Average rate and frequency of application: 2 lb 65WP/A
    - Summer squash: once
    - Winter Squash: once or twice
  - Method of application: Foliar spray
  - REI: 48 hours
  - PHI: 5 days
  - Efficacy rating: Good

- **metalaxyl-M + mancozeb (Ridomil Gold MZ)**
  - Percent acres treated: 60-70%
  - Average rate and frequency of application: 2.5 lb 68WP/A
    - Summer squash: once
    - Winter Squash: once or twice
  - Method of application: Foliar spray
  - REI: 12 hours
  - PHI: 5 days
  - Efficacy rating: Good

Phytophthora Blight (*Phytophthora capsici*)

Phytophthora blight is one of the most serious diseases of squash in New Jersey. Losses from this disease can be devastating. Entire fields can be lost if inoculum levels in a field are high combined with the proper environmental conditions. Prolonged periods of saturated soil conditions can quickly spread Phytophthora spores through a field. Roots and stems near the soil line turn dark brown to black and become soft and water soaked. Infected stems collapse quickly, and ultimately the plant dies. Fruit can also be attacked at any stage and the fruit surface often contains a layer of white sporulation on top of rotted lesions. Fruit infection may also occur in storage and cause major post-harvest losses.

Cultural Controls:

- Improve field drainage with ditches and raised beds
- Crop rotation with non-susceptible crops for 3 years or more

- Reduce soil compaction
- avoid over irrigation

Chemical Controls:

- **dimethomorph (Acrobat)**
  - Percent acres treated: 40-50%
  - Average rate and frequency of application:
    - 6.4 oz 50WP/A once or twice
  - Method of application: Banded over top of row after seeding
  - REI: 12 hours
  - PHI: 0 days
  - Efficacy rating: good (see note)

Note: Acrobat must be tank mixed with another fungicide registered on winter squash or summer squash to be effective.

- **zoxamide (Gavel)**
  - Percent acres treated: Label too new to determine use
  - Average rate and frequency of application: 1.5-2 lb 75DF/A, once or twice
  - Method of application: foliar application
  - REI: 48 hours
  - PHI: 5 days
  - Efficacy rating: good

Powdery Mildew (*Sphaerotheca fuliginea*)

In New Jersey, powdery mildew usually occurs from mid-July until the end of the growing season. A whitish, talcum-like, powdery fungus develops on both the tops and bottoms of leaves and stems. Symptoms will first be found on shaded, lower, older leaves. Favorable conditions for this disease occur when there are long periods of rain and high humidity associated with moderate temperatures, and low light conditions.

Chemical Controls:

- **chlorothalonil (Bravo, Echo, Equus)**
  - Percent acres treated: 90-100%
  - Average rate and frequency of application: 1.5-3 pt 5F/A
    - Summer squash: once or twice
    - Winter squash: two to three times
  - Method of application: Foliar spray
  - REI: 12 hours
  - PHI: 0 days
  - Efficacy rating: Good

- **azoxystrobin (Quadris)**
  - Percent acres treated: 60-70%

- Average rate of application and frequency of application: 11-13 fl oz 2.1F/A, two to three times
- Method of application: Foliar spray
- REI: 4 hours
- PHI: 1 day
- Efficacy rating: Good

- **trifloxystrobin (Flint)**
  - Target diseases: Powdery mildew
  - Percent acres treated: 10-20% (newly labeled product)
  - Average rate of application and frequency of application:
    - 1.5-2 oz/A, once or twice
  - Method of application: Foliar spray
  - REI: 12 hours
  - PHI: 0 days
  - Efficacy rating: Good

Viruses

There are numerous viruses that infect squash crops. In New Jersey four major viruses are present in fields: cucumber mosaic virus, watermelon mosaic virus, papaya ring spot virus, and zucchini yellow mosaic virus. Symptoms of virus infection first appear on younger leaves that are distorted in shape with a yellow discoloration. Plants may be stunted with abnormal growth. Fruit may also be discolored, distorted, bumpy, and malformed. Aphids are the major vectors of viruses in squash crops. However, chewing insects like cucumber beetles, grasshoppers and whiteflies can also aid in transmission of viruses in squash crops.

Cultural Controls:

- Plant resistant/tolerant varieties
- Use reflective mulch to deter aphids
- Eliminate perennial weed hosts
- Avoid planting near old cucurbit fields

Nematodes

Some 100 species of plant-feeding nematodes can seriously damage various economic plants. Before starting any nematode management procedure, one should determine if the kinds of plant feeding nematodes and the numbers present in the soil warrant action. Nematode kinds and numbers are determined from soil and root samples collected in the field. When nematode damage is suspected, both soils and roots should be examined to find out if and to what extent nematodes may be involved. The best time to sample is while the crop is still growing so that areas that are suspected of being stunted by nematodes can be seen and sampled.

Chemical Controls:

- **oxamil (Vydate L)**
  - Percent acres treated: 5-10%

- Average rate and frequency of application: 1-2 gal 2L/A
    - once 2 weeks before planting, incorporate into top 2-4 inches of soil
    - second application 2-3 weeks later after planting
- Method of application: soil applied spray
- REI: 48 hours
- PHI: 1 days
- Efficacy rating: Good

Cultural Controls:

- **Prevention of spread**
    - Plant-feeding nematodes move only short distances, a few inches to a few feet, under their own power. Nematodes are commonly spread by the movement of infested soil and/or infected plants by man. Sanitation and good cultural practices are the best preventative measures against nematodes. Obtain nematode-free transplants from reputable sources. Wash soil from machinery and tools before using them at another location. Nematodes may also be spread by wind, water, soil erosion, and animals.

- **Crop rotation**
    - Rotation of crops is an effective and widely used cultural practice to reduce nematode populations in the soil. To be most effective, crops that are poor hosts or nonhosts of the target nematodes should be included in the rotation sequence.

- **Cover Crops**
    - Some plants commonly used as cover crops are naturally suppressive to certain nematode species, but no single crop is effective against all nematodes. The cover crop plant may be a nonhost and therefore, the nematodes starve, their population being reduced as with fallow. Nematodes invade the roots of certain other cover crop plants, but they fail to reproduce. Yet, another "antagonistic" plant species exude chemicals from their roots which are toxic to nematodes, including marigolds and asparagus.

- **Green Manures and soil ammendments**
    - In general, the incorporation of large amounts of organic matter into the soil reduces populations of plant-feeding nematodes. The decomposition of products of some plants kill nematodes. These include butyric acid released during the decomposition of ryegrass and timothy, and isothiocyanates released during the decomposition of rapeseed and other plants in the genus *Brassica*. Maximum benefit of these "natural" nematicides is obtained when the plant material is incorporated into the soil as green manure.

- **Plant nutrition and general care of the plant**
    - The harmful effects of nematodes on plants can be reduced by providing the plants with adequate nutrition, moisture, and protection from stress. These tactics may sometimes be of limited usefulness, because if susceptible crops are grown continuously, the nematode population may increase to levels that cause serious damage.

- **Fallow**
  - Fallow is the practice of keeping land free of vegetation for weeks or months by frequent tilling or applying herbicides. In the absence of a host, nematodes gradually die out; however, eggs of some nematodes may survive for years in the soil. Because fallow may be destructive to soil and the land is out of production during that time, extended periods of fallow are not recommended.

- **Integrated management practices**
  - Each of the practices mentioned above reduces the soil population of plant-feeding nematodes to varying degrees. Each practice has limitations and the degree of nematode control achieved depends on the environmental factors, as well as the particular nematode and crop being considered. Maximum benefit is realized when several of these practices are employed in an integrated crop management program. Because the host range of different nematode varies, the selection of cover crops, rotation crops, and green manures will be determined by the kinds of nematodes present. No single practice is a "cure-all" for all nematode problems.

ABIOTIC DISORDERS

Air Pollution Injury

Occasionally, when environmental conditions are right, air pollution injury may occur on squash. In New Jersey, the most common injury is from ozone. Generally, ozone is produced by the action of sunlight on the exhaust products from combustion. Most ozone is generated over large urban areas from automobile exhaust. As polluted air masses move over long distances they can disperse the ozone many miles way from where it was originally generated. Ozone is absorbed passively by plants through the stomata. Ozone injury appears on the upper surface of older leaves, which initially have a yellow netted appearance due to loss of chlorophyll between the veins. The chlorotic areas later turn brown or bronzed.

Poor Pollination

Low numbers of native bees have forced growers to rely on rented honey beehives to increase populations of pollinating insects. Even with the importation of hives into a field, poor pollination can occur due to the attractiveness of other flowering plants, cloudy overcast conditions that deter bees from flying, and hives that become weakened by mites that attack bee hives and winter injury. Even if insects are doing a good job of pollinating the flowers, excessively cold or hot temperatures can disrupt pollination in the flower. To improve pollination, growers should not plant crops that compete with the squash flowers for bee attraction, should not spray foliar pesticides when bees are active, and should choose pesticides that are less toxic to bees.

Blossom End Rot

Blossom end rot is associated with a calcium deficiency. Even when calcium is present in proper levels in the soil, calcium deficiencies can occur. Calcium is taken up by roots through a process called mass flow. Therefore, proper soil moisture must be present in order for the plant to absorb calcium. In squash blossom end rot symptoms include a leathery appearance on the blossom end of the fruit. The progression of this disorder results in a blackening and rotting at the end of the fruit. Preventing blossom end rot can be done by first making sure there is adequate calcium levels in the soil. In addition, the calcium/magnesium balance in the soil may need to be adjusted so that there is not an excessive level of magnesium. Magnesium and calcium can compete for uptake in a plant. Most importantly, after making sure adequate levels of calcium exist, proper soil moisture levels need to be assured through irrigation.

Sunscald

Sunscald occurs when there is insufficient leaf cover to protect tender fruit from the sun. Papery white areas on the side of the fruit that is exposed to direct sunlight appear. This disorder generally occurs on winter squashes. The marking on the skin makes the fruit unmarketable and can cause rot to the affected area. To prevent sunscald the plant needs to have good vine growth throughout the season. Proper fertilization, protecting leaves from fungal diseases that cause defoliation, and proper irrigation to prevent wilting are ways to promote good vine health.

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