Crop Profile for Summer and Winter Squash in New Jersey



Production Facts

- National Ranking: 4th
- % National Production: 9%
- Yearly Production: 6,800 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%	1768 acres
#2	Cumberland County	19%	1292 acres
#3	Salem County	16%	1088 acres
#4	Atlantic County	9%	612 acres

Other Important Production Counties totaling 2040 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, bacterial wilt, and viruses are the major disease problems for cucurbit crops in New Jersey. Other diseases of importance include downy mildew and black rot (especially on butternut squash). Newly 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. A newly registered systemic soil insecticide, Admire (imidacloprid), has shown promise in controlling 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. 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. Cultivation is used 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 almost always planted in bare ground fields without raised beds. 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. 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.

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: 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
  - PHI: 21 days
  - Efficacy rating: Good

Note: Imidacloprid registered for use in cucurbits in 1999. Limited registration time has kept percent of treated acres low for now until growers become more familiar with the product on this crop.

- **carbaryl (Sevin, Adios)**
  - Percent acres treated: 30-50%
  - Average Rate and frequency of application:
    - Adios 8-12 oz/A, once when vines run
    - Sevin 1.25 lb 80S/A, once
  - Method of application: foliar spray
  - 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 at planting
  - 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
  - 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
  - PHI: 0

- Efficacy rating: Good

- **endosulfan (Thiodan)**
  - Percent acres treated: 80-90%
  - Average rate and frequency of application: 1.33-2.67 pt 3EC/A, twice
  - Method of application: foliar spray
  - 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
  - PHI: 3 days
  - Efficacy rating: too new to determine, registered 5/2000

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.

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

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

<u>Chemical Controls:</u>

- **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
  - PHI: 7 days
  - fficacy 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
  - 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
  - PHI: 0
  - Efficacy rating: Good

- **endosulfan (Thiodan)**
  - 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
  - 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
- PHI: 3 days

- Efficacy rating: too new to determine, registered 5/2000

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.

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

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

<u>Chemical Controls</u>:

- **imidacloprid (Admire)**
  - 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
  - PHI: 21 days
  - Efficacy rating: Good

Note: Imidacloprid registered for use in cucurbits in 1999. Limited registration time has kept percent of treated acres low for now until growers become more familiar with the product on this crop.

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  - 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
- 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.

Alternative controls to be used in combination with insecticides include:

- Practice good weed control to reduce squash bug habitat

Chemical Controls:

- **carbaryl (Sevin, Adios)**
  - Percent acres treated: 30-50%
  - Average Rate and frequency of application:
    - Adios 8-12 oz/A, once when vines run
    - Sevin 1.25 lb 80S/A, once
  - Method of application: foliar spray
  - 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
  - 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
  - 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
  - PHI: 3 days
  - Efficacy rating: too new to determine, registered 5/2000

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
  - 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
  - PHI: 3 days
  - Efficacy rating: too new to determine, registered 5/2000

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
    - PHI: 21 days
    - Efficacy rating: Good

Note: Imidacloprid registered for use in cucurbits in 1999. Limited registration time has kept percent of treated acres low for now until growers become more familiar with the product on this crop.

endosulfan (Thiodan)

- Percent acres treated: 80-90%
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- PHI: 2 days

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    - Percent acres treated: 5-15%
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    - Method of application: foliar spray
    - PHI: 3 days
    - Efficacy rating: too new to determine, registered 5/2000

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.
  - **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 4EC/A, once
- Method of application: preplant incorporated
- Efficacy rating: Good on annual grasses, fair to poor on lambsquarters, pigweed, cocklebur, and purslane. No control on other broadleaf weeds and nutsedge

clomazone (Command)

- Target weeds: Annual grasses and broadleaf weeds
- Percent acres treated: 50-60%
- Average rate and frequency of application: 0.4-0.5 pt 4EC/A, once
- Method of application: preplant incorporated or preemergence
- 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.

paraquat (Gramoxone)

- Target weeds: All weeds
- Percent acres treated: 60-70%
- Average rate and frequency of application: 1.6 pts 2.5SC/A, 1-2 applications
- Method of application: Non-selective sprays between row middles with shielded sprayers, entire field application after last harvest to clean plastic mulch beds for double crop planting or for preparing for plastic mulch removal.
- Efficacy rating: Good for annual weeds, fair to poor for perennial weeds, especially lambsquarters and marestail

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: post emergence
- 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.

glyphosate (Roundup)

- Target weeds: All weeds
- Percent acres treated: 20-30%
- Average rate and frequency of application: 1-2 qts Roundup Ultra, once
- Method of application: post harvest
- Efficacy rating: Good, best results when plants are actively growing.

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, Terranil)**
    - 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
- PHI: 0 days
- Efficacy rating: Good

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:

- **mefenoxam (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
  - 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:

- **mefenoxam (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
    - PHI: 0 days
    - Efficacy rating: Fair to good

- **mefenoxam + chlorothalonil (Ridomil Gold/Bravo, Flourinil)**
    - Percent acres treated: 90-100%
    - Average rate and frequency of application:
        - 1.5-2 lb 81WP/A, once or twice
    - Method of application: Foliar spray
    - PHI: 0 days
    - Efficacy rating: Good

- **chlorothalonil (Bravo, Terranil)**
    - 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
    - PHI: 0 days
    - Efficacy rating: Good

- **mefenoxam + copper (Ridomil Gold/Copper)**
    - Percent acres treated: 90-100%
    - Average rate and frequency of application: 1.5-2 lb 70WP/
        - Summer squash: once
        - Winter Squash: once or twice
    - Method of application: Foliar spray
    - PHI: 5 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
    - PHI: 1 day
    - Efficacy rating: Good

- **trifloxystrobin (Flint)**
    - Percent acres treated: 10-20% (newly labeled product)
    - Average rate of application and frequency of application:
        - 4 oz/A, once or twice
    - Method of application: Foliar spray
    - PHI: 0 days
    - Efficacy rating: Good

- **maneb**
    - Percent acres treated: 20-30%
    - Average rate of application and frequency of application: 1.5-2 lb 80WP/A, once
    - Method of application: Foliar spray
    - 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:

- **mefenoxam (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
    - PHI: 0 days
    - Efficacy rating: Fair to good

- **mefenoxam + mancozeb (Ridomil Gold MZ)**
    - Percent acres treated: 40-50%

- Average rate and frequency of application: 2.5 lb 68WP/A, once or twice
- Method of application: Foliar spray
- PHI: 5 days
- Efficacy rating: fair to good

- **mefenoxam + chlorothalonil (Ridomil Gold/Bravo, Flourinil)**
  - Percent acres treated: 90-100%
  - Average rate and frequency of application:
    - 3 lb 81WP/A, twice
  - Method of application: Foliar spray
  - PHI: 0 days
  - Efficacy rating: Good

mefenoxam + copper (Ridomil Gold/Copper)
- Percent acres treated: 90-100%
- Average rate and frequency of application: 1.5-2 lb 70WP/
  - Summer squash: once
  - Winter Squash: once or twice
- Method of application: Foliar spray
- 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, Terranil)**
  - 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
  - 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
- 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
  - PHI: 0 days
  - Efficacy rating: Good

- **benomyl (Benlate)**
  - Target diseases: Powdery mildew
  - Percent acres treated: 20-30%
  - Average rate of application and frequency of application: 4-8 oz 50SP/A, once
  - Method of application: Foliar spray
  - PHI: 1 day
  - 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

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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