Crop Profile for Squash in New York

Prepared: May, 1999

General Production Information

Summer and winter types of squash are important fresh market vegetable crops for NY producers, and are produced for local direct-to-consumer sales as well as for large wholesale markets in the eastern US. Some processing production also occurs. Because of the lack of registered herbicides, weeds are probably the most important pest of squash production; the industry has a critical need for more registrations of weed control products. Like other cucurbits, squash are susceptible to a very wide range of diseases, and along with plant host resistance and cultural practices, fungicides are important disease management tools. Several new fungicides have recently been registered for use. Cucumber beetles and aphids can cause economically significant damage by direct feeding and by vectoring diseases.

Registration of new materials by the EPA, even those designated as "low risk", does not guarantee that NY growers will have immediate access to them. The New York State Department of Environmental Conservation conducts its own in-depth reviews before registering new pesticides for use in NY, and may or may not register new materials for portions of or for the entire state.

Basic Commodity Information

State Rank: Not available.

% U.S. Production: Not available.

Acres Planted: 2899 (1997 Ag. Census figures)

Cash Value: Not available.

Yearly Production Costs: Not available.

Commodity Destination(s):

- **Fresh Market:** 95%
- **Processed:** 5% (frozen)

Production Regions: Production is scattered throughout all major growing areas of the state. Major counties include Genesee (114), Monroe (714), Niagara (101), Onondaga (215), Ontario (148), and Orleans (404).

Cultural Practices

Both summer (zucchini and yellow) and winter (butternut, acorn, buttercup and others) squashes are produced in New York, primarily for fresh market retail and wholesale sales. For summer squash, earliness is desirable, so that seedlings are started in the greenhouse for early transplanting, frequently into plastic-mulched beds. Early plantings must be protected from cold and winds with row covers, hot caps, and/or windbreaks. Later plantings can be direct seeded, when soil temperatures warm sufficiently. Growers typically make successive plantings through the season to ensure a steady supply of good quality squash. Summer squash varieties are mostly bush types, and are planted on 4-6’ rows with an in-row spacing of 18-24". Summer squash is frequently irrigated during dry seasons. A field can generally be picked from six to as many as twelve times, but this varies considerably depending on the grower and the market. All harvesting is done by hand. Because summer squash is very prone to damage from handling, it is usually packed in the field.

Only occasionally is there a market premium for early winter squash, so these are primarily direct seeded after all chance of a frost have passed. They are rarely grown on plastic mulches, except when the mulch is used for weed control, not to warm to the soil. Winter squashes include both bush and vining types. Bush types are planted in the same spacing as summer squash (above), at a seeding rate of 4-6 lbs/acre. Vining types are planted in 6-8' rows with 24-36" between plants, at a seeding rate of 2-4 lbs/acre. Winter squash is rarely irrigated except for during the driest growing seasons. Squashes are harvested by hand before frost, but after vines have died back. Once harvested, winter squashes may be marketed immediately, or cured (held at moderate temperatures and high humidity to cure rinds and suberize any wounds) and stored for four to 15 weeks before being marketed.

Note on Pesticide Use Information: Pesticide use practices vary considerably among squash producers due to differences in scale, varieties, local and yearly pest pressures, and target market. A "typical" use pattern for a particular pest or set of pests does not exist. To reflect this variability, numbers in tables in the following sections are given as estimated ranges based on grower surveys as well as expert opinion.

Insect Pests

Seedcorn maggot (*Delia platura*)

Frequency of Occurrence: Sporadic, but damage can be extensive.

Damage Caused: The larvae or maggots of this fly burrow into squash seed, often destroying the germ, which causes seed death or poor germination. Injury is more prevalent during cool, wet weather.

% Acres Affected: 100% at risk; typically 1-5% affected in a given year.

Pest Life Cycles: The seedcorn maggot is common throughout the northeastern US, where it overwinters primarily as a puparium in the soil. During spring planting time, the first generation of flies begins to emerge. They lay eggs one to two weeks later just below the surface of recently plowed ground. High crop residue and fresh manure also attract flies which feed on the organic matter. The maggots hatch in four to seven days and feed primarily on decaying organic matter. After feeding for seven to 21 days, the larvae pupate in the soil, usually near the place of larval feeding. The entire life cycle is completed in three to four weeks. There may be three or five generations of seed corn maggots per season; however, the first and second are the most destructive.

Timing of Control: Preplant.

Yield Losses: Stand losses can reach as high as 30%.

Cultural Control Practices: The following cultural practices help minimize losses from this insect: incorporating crop residues well before planting; avoiding manure applications before planting; avoiding low, wet areas; and shallow planting to speed emergence. No resistant varieties are available.

Regional Differences: None.

Biological Control Practices: Naturally occuring predators, parasitoids, and pathogens, including nematodes, may help suppress infestations.

Post-Harvest Control Practices: None.

Chemical Controls:

Pesticide	% Trt.	Type of Appl.	Typical Rates lbs ai/acre	Timing	# of Appl.	PHI[1] days	REI hours
chlorpyrifos *(Lorsban)*	<1	grower-applied seed treatment	0.004	at planting	1	95	--
lindane + captan *(Isotox)*	<1	grower-applied seed treatment	0.015 lbs product/ acre	at planting	1	95	--

1. PHIs in this and all tables in this document indicate the shortest actual number of days between application and harvest, and not label PHIs.

Use in IPM Programs: The use of commercial or grower applied seed treatments is consistent with Cornell IPM recommendations.

Use in Resistance Management: None reported.

Alternatives: Thiamethoxam (trade name Adage), a new insecticide from Novartis, may be an effective alternative, but trials have yet to be conducted.

Cucumber Beetles (various spps.)

Frequency of Occurrence: Annually.

Damage Caused: Early in the growing season when squash plants are small, heaving feeding by the striped or spotted cucumber beetle can kill a plant in a few days. The beetles like to feed on the thick and fleshy cotyledon leaves. Later in the season the striped cucumber beetle will feed on stems, foliage and fruit, while the spotted cucumber beetle feeds primarily on the leaves. The striped cucumber beetle larvae can feed on the pumpkin roots causing stunted plants and delayed fruit development. Cucumber beetles also carry the bacterium that causes bacterial wilt and squash mosaic virus.

% Acres Affected: 100%

Pest Life Cycles: Striped cucumber beetle (*Acalymma vittatum*), spotted cucumber beetle (*Diabrotica undecimpunctata howardi*), and western corn rootworm (*Diabrotica virgifera virgifera*) all attack vine crops in NY. Striped cucumber beetles overwinter as adults and rapidly convene on newly emerged plants. The other two species occur later in the season and damage more mature plants. Eggs of striped cucumber beetles are laid in soil near the base of the plant, and larvae feed on the root and stem of cucurbit plants.

Timing of Control: crop emergence

Yield Losses: up to 100% in heavily infested, untreated areas of fields.

Cultural Control Practices: use of trap crops or yellow mulches to aggregate overwintering adults. Row covers will provide protection early in the season, but they must be removed when blossoms appear. Some tolerance has been seen in certain varieties. The use of preferred varieties as trap crops for more efficient control shows potential.

Regional Differences: None

Biological Control Practices: None

Post-Harvest Control Practices: Deep plowing and clean cultivation after harvest may reduce overwintering populations.

Other Issues: Research has recently been conducted on methods to trap beetles and/or use bait stations.

Foliar Insecticides for Control of Cucumber Beetles, Aphids, and Squash Bugs:

Pesticide	Target Pest[1]	% Trt.	Type of Appl.	Typical Rates lbs ai/acre	Timing	# of Appl.	PHI days	REI hours
carbaryl *(Sevin)*	CB SB	65-70	foliar	0.8	seedling through fruit set	2	3 S[2]; 14 W	12
endosulfan *(Thiodan)*	CB, A SB	60-65	foliar	0.75	seedling through fruit set	2	2 S; 14 W	24
esfenvalerate *(Asana)*	CB SB	85-90	foliar	0.04	seedling through fruit set	2	3 S; 14 W	12
permethrin *(Ambush)*	CB, A SB	1-5	foliar	0.125	seedling through fruit set	1	1 S; 14 W	12
oxydemeton-methyl *(Metasystox-R)*	A	<1	foliar	0.5	seedling through fruit set	1	3 S; 21 W	48

1. Key to Target Pests: CB=cucumber beetles, SB=squash bug, A=aphids

2. S=summer squash; W=winter squash

Use in IPM Programs: Use of all 4 materials consistent with Cornell IPM recommendations. Scouting thresholds have been established.

Use in Resistance Management: None reported.

Alternatives: Research indicates that imidacloprid is effective against cucumber beetles. IR-4 petitioned EPA for a Section 3 label in 1996, but no decision has been made. Adios, a commercial attractant/feeding stimulant/insecticide is available but has not been adopted by producers.

Aphids (primarily *Aphis gossypi*)

Frequency of Occurrence: Sporadic

Damage Caused: Direct feeding of aphids on squash is not usually a problem. However, aphids can transmit watermelon mosiac virus (WMV) and other viruses. These diseases, which have no treatment after infection, can reduce yields significantly. Also, sooty mold can develop on fruits on the honeydew secreted by aphids, resulting in cosmetic damage that renders squash unmarketable.

% Acres Affected: up to 25%

Pest Life Cycles: Aphids live in colonies on the undersides of leaves. They feed on sap from the leaves which can weaken a plant and reduce fruit production.

Timing of Control: When runners are present.

Yield Losses: Usually small.

Cultural Control Practices: Planting resistant varieties is the primary means of controlling the virus. Plant late season fields far away from existing cucurbits.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: See "Cucumber Beetle" section above for use pesticide use patterns.

Use in IPM Programs: As-needed use of insecticides is consistent with Cornell IPM recommendations. A scouting protocol and economic thresholds have been established.

Use in Resistance Management: None reported.

Alternatives: Pymetrozine (Fulfill; Novartis) is a new aphicide that may be an effective alternative.

Squash bug (*Anasa tristis*)

Frequency of Occurrence: Frequently found, but not always at economically significant levels.

Damage Caused: Leaves fed upon by squash bugs first develop small specks, which turn yellow and later brown, vines will wilt from the point of the attack to the end of the vine, and affected parts become black and crisp. Small plants can be killed by squash bug feeding. Adult squash bugs live on the underside of leaves and are difficult to kill. These bugs also feed directly on developing fruit.

% Acres Affected: 100%

Pest Life Cycles: Adults are flat, grayish or yellowish brown, about 5/8 inch in length. Eggs are reddish orange and laid in clusters on the upper leaf surface. Nymphs are pale green, and darken as they mature. Young nymphs feed in clusters. Adults and nymphs feed on leaves and stems, and directly on developing fruit. Adults overwinter in crop debris and other sheltered places.

Timing of Control: Beginning when plants develop runners, through harvest.

Yield Losses: Up to 50% in severely affected fields.

Cultural Control Practices: None.

Regional Differences: None.

Biological Control Practices: Naturally-occurring predators, parasitoids, and pathogens help suppress infestations. A tachinid fly parasitoid is very common.

Post-Harvest Control Practices: Removal or thorough destruction of crop debris and other field trash will remove overwintering shelter. Deep tillage will bury and kill overwintering adults.

Other Issues: None.

Chemical Controls: See "Cucumber Beetle" section above.

Use in IPM Programs: As-needed use of insecticides is consistent with Cornell IPM recommendations. Scouting thresholds have been established.

Use in Resistance Management: None reported.

Diseases

Powdery mildew (*Sphaerotheca fuliginea*)

Frequency of Occurrence: Occurs annually throughout the state.

Damage Caused: The fungus on the foliage and young stems first appears as white talcum-like spots of fungal growth on plant surfaces. Later the spots turn brown and dry, and plants may appear stunted. Left untreated, plants infected early tend to produce smaller fruit. Fruit may be poorly colored and/or sunburned because of the loss of foliage.

% Acres Affected: 100%

Pest Life Cycles: The causal fungus can be introduced by wind from areas with relatively warm winters where the fungus overwinters. A white talcum-like growth appears on the foliage after infection. Periods of high temperatures favor disease development. The disease can usually be found on yellow summer squash before any other cucurbit

Timing of Control: from fruit initiation to end of season

Yield Losses: up to 75% in severely affected fields.

Cultural Control Practices: None.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Other Issues: Research on chemical and non-chemical strategies for managing powdery mildew is ongoing (Zitter; McGrath) and includes screening of new fungicides for efficacy and crop tolerance.

Foliar Fungicides for Squash Disease Control:

Pesticide	Disease[1]	% Trt.	Typical Rates lbs ai/acre	Timing	# of Appl.	PHI days	REI hours
benomyl *(Benlate)*	An, GSB, PM	65-70	0.25	fruitset through harvest	1-2	1 S; 14 W	24

chlorothalonil *(Bravo)*	An, Al, DM, GSB, PM, S, SLS	90-95	1.5	fruitset through harvest	1-2	1 S; 14 W	48
thiophanate-methyl *(Topsin-M)*	An, GSB, PM	5-10	0.25	fruitset through harvest	1	1 S; 14 W	12
maneb *(Maneb)*	An, GSB, S, Al, DM	<1	0.75-1.5	fruitset through harvest	1	5 S; 14 W	24
mancozeb *(Dithane)*	An, GSB, DM	1-2	1-1.5	fruitset through harvest	1	5 S; 14 W	24
copper compounds	ALS, BLS	25-30	varies with formulation	fruitset through harvest	1-2	1 S; 14 W	12
azoxystrobin[2] *(Quadris)*	PM, An, DM, GSB, S, SLS	5-10	0.18-0.25	fruitset through harvest	1-2	1 S; 14 W	4
myclobutonil[2] *(Nova)*	PM	60-70	0.125	fruitset through harvest	1-2	1 S; 14 W	24
triademefon[3] *(Bayleton)*	PM	60-65	0.125	fruitset through harvest	1	1 S; 14 W	12
mefenoxam *(Ridomil Gold Bravo)*	DM	5-10	2 lbs product/ acre	fruitset through harvest	1-2	5	48

1. Key to diseases: An=Anthracnose; Al=Alternaria leaf blight; GSB=Gummy stem blight; PM=powdery mildew; S=Scab; SLS=Septoria leaf spot; DM=Downey mildew; BLS=Bacterial leaf spot; ALS=Angular leaf spot.

2. Azoxystrobin is expected to be labeled in NY by the summer of 1999, and myclobutonil by EPA by the end of 1999. They were both available to growers in 1998 through a Section 18 label (except azoxystrobin was not allowed on Long Island); a Section 18 request has been filed for myclobutonil use in 1999.

3. Use is being cancelled by manufacturer. Existing stocks may be used.

Use in IPM Programs: Cornell IPM recommendations call for the use of fungicides on a 7-14 day schedule beginning when powdery mildew is first found in the field. Because control hinges upon getting fungicide on the underside of the leaves and on the lower leaves, it is recommended to use a systemic fungicide in combination with a contact fungicide (chlorothalonil or fixed copper) and to maximize spray coverage.

Use in Resistance Management: Pathogen strains have become resistant to triademefon (no longer available) and benomyl or thiophanate-methyl. It is recommended that growers alternate between two systemic fungicides with different modes of action (e.g. azoxystrobin and myclobutonil) and also use a protectant fungicide (e.g. chlorothalonil) not at risk for resistance.

Alternatives: Recent registration of azoxystrobin nationally by the EPA and pending registration of myclobutonil provide very useful tools in controlling this disease, and in managing resistance. Trifloxystrobin (Flint; Novartis) has provided excellent powdery mildew control in Cornell trials. Sovran (from BASF) is another new unregistered fungicide similar to Flint. Oils and sulfur are registered and effective. Kaligreen and eKsPunge (potassium bicarbonate) may be registered for use in NY by 1999.

Gummy stem blight/Black rot (*Didymella bryoniae* and *Phoma cucurbitacearum*)

Frequency of Occurrence: Frequently found throughout the state.

Damage Caused: Gummy stem blight refers to the foliar and stem-infecting phase of the disease, and black rot to the fruit rot phase. Gummy stem blight causes leaf and stem necrosis and tissue death. Infected fruit rot either in the field or after harvest. The disease is more prevalent in winter squash than in summer squash.

% Acres Affected: 100% at risk; up to 50% affected per year (winter squash).

Pest Life Cycles: The gummy stem blight fungus is both seed- and soil-borne. The pathogen may be carried in or on infected seed. In the absence of host plants, the fungus can overwinter for a year and a half or more on infected crop residue. Infection occurs when temperatures are warm and moisture is available. Wounding, insect damage, and powdery mildew infection predispose plants to infection with gummy stem blight.

Timing of Control: Mid-July through season.

Yield Losses: Can be up to 75% in severely affected areas.

Cultural Control Practices: Two year crop rotation away from cucurbits. Use disease-free seed treated with fungicide. Avoid injury to the fruit at harvest.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: Curing of winter squashes to heal rind injuries and reduce risk of further injury. Destroy crop debris after harvest to remove this source of inoculum.

Other Issues: Research on gummy stem blight and other foliar diseases of cucurbits is ongoing in NY (Zitter). This includes pathogen variability, fungicide resistance and genetic resistance.

Chemical Controls: See table in "Powdery Mildew" section, above, for pesticide use patterns of labeled fungicides. In addition, seed treatment with thiram (see "Fusarium Crown and Fruit Rot" section, below) provides some protection against the seed-borne phase of this disease.

Use in IPM Management: Cornell IPM recommendations call for the use of fungicides on a 7-10 day schedule beginning when powdery mildew or gummy stem blight is first found in the field. The same fungicides generally control both diseases, and powdery mildew infection can increase the severity of gummy stem blight infections.

Use in Resistance Management: Gummy stem blight isolates from NY have been identified as being resistant to both benomyl and thiophanate-methyl, and it is recommended to use these products in combination with a protectant fungicide (chlorothalonil). Resistance is more widespread for thiophanate-methyl.

Alternatives: Recent registration of azoxystrobin by the EPA provides a very useful tool in controlling this disease. Trifloxystrobin (Flint), a new fungicide from Novartis, may also be an effective alternative.

Phytophthora blight (*Phytophthora capsici*)

Frequency of Occurrence: Can be found most years in at least some part of the state.

Damage Caused: All aboveground plant parts can be affected. Initial symptoms are in sudden, permanent wilt of infected plants (crown blight phase). Fruits that do develop are undersized and distorted. A white mold and spores develop on this affected area, which later appear as a yeast;-like growth. The disease is more prevalent in winter squash than in summer squash.

% Acres Affected: 50%

Pest Life Cycles: The fungus is primarily soil-borne, has a number of hosts, and can remain in the soil for years.

Timing of Control: Mid-July through harvest.

Yield Losses: Can be up to 100% in severely affected fields.

Cultural Control Practices: No resistant varieties are available. Use a minimum of three year rotation with crops other than peppers, eggplants, tomatoes, and cucurbits. Select well-drained fields. Movement of the fungus in water and in soil can be an important means of spread between fields.

Regional Differences: Most severe in Long Island and other eastern NY counties. Sporadic in far western counties.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: No effective fungicides are registered for use.

Downy mildew (*Pseudoperonospora cubensis*)

Frequency of Occurrence: Sporadic but can spread quickly.

Damage Caused: This fungus causes heavy blighting of the leaves. Infection that is not quickly treated results in defoliation and poor fruit development.

% Acres Affected: 100% at risk; up to 20% affected per year.

Pest Life Cycles: Like powdery mildew, the causal fungus overwinters in areas with mild winters and is carried by wind to other areas. Periods of moist weather favor disease development.

Timing of Control: Mid-July to end of season.

Yield Losses: Up to 50% in severely affected areas.

Cultural Control Practices: None.

Regional Differences: This diseases is much more prevalent in eastern growing areas of the state, and is less common in central and western counties.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Other Issues: None.

Chemical Controls/Use in IPM Programs: See "Powdery Mildew" section, above, for pesticide use information. Due to the rapid spread of this disease, systemic materials are needed for control. Mefenoxam is an important tool for controlling this disease, and the recent registration of azoxystrobin provides another effective material.

Use in Resistance Management: None reported.

Alternatives: Trifloxystrobin (Flint), a new fungicide from Novartis, may be an effective alternative. While infrequently used in NY, fosetyl-Al (Aliette) can be used for control of downy mildew.

Scab (*Cladosporium cucumerinum*)

Frequency of Occurrence: Can be found in most growing areas in most years.

Damage Caused: The fungus can attack any aboveground portion of the plant, including leaves, petioles, stems and fruits. The disease is most damaging because of the unsightly scab lesions that develop on fruit, usually making them unmarketable.

% Acres Affected: 100% at risk of infection. Typically 10-50% of acreage actually affected per year.

Pest Life Cycles: The fungus causing scab overwinters mainly in squash and pumpkin vines, but may also be seedborne. Spores are produced in the spring and are readily spread.

Timing of Control: when vines begin to run.

Yield Losses: up to 50% in cases of severe infection.

Cultural Control Practices: Minimum two year rotation away from cucurbits. Select sites with good drainage. Plant only disease-free seed, and treat with a fungicide to control seed decay and damping-off.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Chemical Controls: See "Powdery Mildew" section, above.

Septoria leaf spot (*Septoria cucurbitacearum*)

Frequency of Occurrence: Can be found in most growing areas in most years.

Damage Caused: Lesions form on leaves and fruit, causing foliar blighting as well as cosmetic damage to fruit. Fruit show raised, white, rash-like spots on the surface. The disease is more prevalent on winter squash than on summer squash.

% Acres Affected: 100% at risk of infection; typically 10-50% of acres actually affected per year.

Pest Life Cycles: The fungus overwinters in NY on infected crop debris. In spring, spores are dispersed via splashing or wind-borne rain.

Timing of Control: June through harvest

Yield Losses: up to 30% in severely infected fields

Cultural Control Practices: Minimum two year rotation out of all cucurbits. No resistant varieties are available.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: Crop debris should be destroyed as soon as possible to remove this source of disease for other plantings.

Chemical Controls: See "Powdery Mildew" section, above.

<u>Anthracnose</u> (*Colletotrichum orgiculare*)

Frequency of Occurrence: Can be found most years in at least some part of the state.

Damage Caused: Symptoms on leaves begin as watersoaked spots. These become circular, tan areas which expand into characteristic brown spots with light centers. Infected petioles can become girdled. Infected fruit develop circular, sunken, watersoaked areas, which can ooze under humid conditions.

% Acres Affected: 100% at risk of infection; up to 15% affected per year.

Pest Life Cycles: The fungus survives from one season to the next on infected plant tissue and may survive up to two years in the absence of a host. Spread of the disease can occur by splashing rain, irrigation water, insects, workers, or equipment. Disease development is favored by warm, humid weather. The fungus can be seedborne as well.

Timing of Control: During warm, most seasons.

Yield Losses: Can be up to 50% in severely affected fields.

Cultural Control Practices: Resistant varieties should be used whenever possible. Use a minimum of two year rotation with unrelated crops. Use commercially-produced, disease-free seed.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: Crop debris should be destroyed as soon as possible to remove this source of disease for other plantings and to initiate decomposition.

Chemical Controls: See "Powdery Mildew" section, above.

<u>Bacterial wilt</u> (*Erwinia tracheiphila*)

SEE ALSO DISCUSSION UNDER CUCUMBER BEETLES

Frequency of Occurrence: Sporadic, but increasing in occurrence

Damage Caused: This bacterium is xylem-limited but becomes systemic in these tissues throughout the plant. Wilting of the plant is the general symptom, since bacterial multiplication causes plugging of the xylem elements. Symptoms also consist of interveinal chlorosis and marginal necrosis of the leaves, with the leaves eventually becoming totally brown (frosted) and standing upright. Internodes may be stunted and leaves take on a "tufted" appearance, because they are underdeveloped. Pumpkin plants may survive initial infection, but are stunted and produce underdeveloped and unmarketable fruit.

% Acres Affected: 100% at risk; up to 10% affected per year.

Pest Life Cycles: Survives in the body of the adult cucumber beetle (primarily the striped). Perennial weeds apparently do not serve as host reservoirs of the bacterium. Therefore beetle control is the only current method of control. The bacterium is not seedborne.

Timing of Control: Early (emergence) to midseason.

Yield Losses: Up to 100% in severely affected fields.

Cultural Control Practices: See comments under Cucumber beetles.

Regional Differences: None.

Biological Control Practices: Greenhouse studies at Cornell (Zitter) established the efficacy of Messenger (Eden Bioscience product), which has systemic acquired resistance properties, as a deterrent to beetle feeding and injury. Additional tests are under way to determine if Messenger (also called harpin, under license from Cornell) could have a direct effect on the bacterium. Registration of this product by EPA is pending.

Post-Harvest Control Practices: See "Cucumber Beetle" section above.

Chemical Controls: See "Cucumber Beetle" section above. Disease control is obtained through controlling the insect vector. No pesticides are effective in controlling the disease directly.

Bacterial leaf spot (*Xanthomonas campestris* pv. *campestris*)

Frequency of Occurrence: Sporadic

Damage Caused: : This bacteria becomes systemic, with symptoms showing on leaves and fruit. Leaf lesions start as water soaked areas and then appear as necrotic spots. The fruit usually develop necrotic lesions, which progress to cause collapse and rotting fruit.

% Acres Affected: 100% at risk; up to 5% affected per year.

Pest Life Cycles: Important as a seedborne bacterium. May also survive on crop debris.

Timing of Control: Early to midseason as immature fruit appear and develop.

Yield Losses: Up to 50% in severely affected fields.

Cultural Control Practices: None.

Regional Differences: None.

Biological Control Practices: A field test on pumpkins of the efficacy of Actigard (Novartis product) which has systemic acquired resistance properties, established a good level of control. Additional tests are planned with Actigard and Messenger (Eden Bioscience, under license from Cornell). Registration of these products by EPA is pending.

Post-Harvest Control Practices: Destroy all crop debris to remove this source of the disease.

Chemical Controls: Copper compounds are the only fungicides with any efficacy. See "Powdery Mildew" section, above.

Angular Leaf Spot (*Pseudomonas syringae* pv. *lachrymans*)

Frequency of Occurrence: Sporadic

Damage Caused: Leaf lesions caused by this disease turn necrotic, and the centers fall out, leaving a tattered appearance. Infections of stems, petioles and fruits develop watersoaded spots which enlarge and become covered with a white crust. Infection of young fruit may result in curved or deformed fruit later. Secondary soft rots usually develop on infected fruit. This disease is more prevalent on winter squash than summer squash.

% Acres Affected: 50% at risk of infection; typically between 1-3% of acreage affected in any given year.

Pest Life Cycles: This bacterial pathogen survives on crop debris and is also seed-borne.

Timing of Control: At planting.

Yield Losses: Up to 50% in severely affected fields. More typical losses are 1-10%.

Cultural Control Practices: Rotate away from cucurbits for at least two years. Avoid planting next to other cucurbits.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: Crop debris should be destroyed after harvest.

Chemical Controls: See "Powdery Mildew" section, above.

Alternaria Leaf Blight (*Alternaria cucumerina*)

Frequency of Occurrence: Annually.

Damage Caused: This fungus attacks leaves, beginning as small lesions and progressing into large necrotic areas. Infected plants may become defoliated, and are more susceptible to heat and wind damage. Fruit infection results in surface lesions which render fruit unmarketable. Infected fruit often rot after harvest.

% Acres Affected: 100% at risk; up to 10% affected per year.

Pest Life Cycles: The fungus survives in crop debris or on weeds and other crops. Wind carries fungal spores from one area to another. The disease is favored by warm temperatures and moisture from dews, rains or overhead irrigation.

Timing of Control: Midseason to harvest.

Yield Losses: Usually minimal, since fungicides used for powdery mildew and other diseases keep it under control.

Cultural Control Practices: Rotation away from cucurbits for a minimum of two years. Schedule overhead irrigation to allow sufficient drying of foliage prior to extended evening wet periods.

Regional Differences: None.

Biological Control Practices: No resistant varieties are available.

Post-Harvest Control Practices: Crop debris should be destroyed to remove this inoculum source.

Chemical Controls: See "Powdery Mildew" section above for pesticide use information.

Fusarium crown and fruit rot (*Fusarium* spp.)

Frequency of Occurrence: Annually

Damage Caused: Pumpkins and squash are particularly susceptible to Fusarium crown and fruit rot. Affected plants exhibit crown necrosis and often visible fungal growth. Plants are stunted and eventually wilt. Pumpkin fruit show a firm, dry rot on the rind in contact with the soil.

% Acres Affected: 100% at risk; up to 20% affected each year.

Pest Life Cycles: This disease is seed- and soil-borne and may survive on hosts other than cucurbits.

Timing of Control: Midseason to harvest.

Yield Losses: Up to 50% in severely affected areas.

Cultural Control Practices: Rotation away from cucurbits for a minimum of three years. Movement of the fungus in soil on equipment from infested fields can be an important means of spread between fields. Use commercially-produced, disease-free seed.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: None.

Fungicides for Soil-Borne Diseases:

Pesticide	**% Trt.**	**Type of Appl.**	**Typical Rates**	**Timing**	**# of Appl.**	**PHI days**	**REI hours**
thiram[1] *(Thiram)*	60-70	commercial seed treatment	label rates	before planting	1	90	--
captan[2] *(Captan)*	30-40	commercial seed treatment	label rates	before planting	1	90	--
mefenoxam[3] *(Ridomil Gold)*	<1	soil	1-2 pts product/ acre	at planting	1	90	12

1.For Fusarium and other soil-borne diseases.

2.Not effective against Fusarium.

3.For damping-off diseases.

Use in IPM Programs: Use of commercially treated seed is recommended.

Use in Resistance Management: None reported.

Soilborne Diseases and Seed Decay (*many types*)

Many seedborne and soilborne fungi can cause early seedling death. This can occur early in the season as damping-off or later as stem cankers. Seed treatments (see "Fusarium Crown and Fruit Rot" section) are the most cost-effective method of control. Cultural practices that also aid in disease management include selecting well-drained fields, and avoiding planting into cool wet soils.

Viruses (*five principal*)

A number of viruses infect squash, including cucumber mosaic virus, watermelon mosaic virus, papaya ringspot virus, and zucchini yellow mosaic virus, and squach mosaic virus. The first four are transmitted by aphids in a nonpersistent manner. Squash mosaic virus is beetle-transmitted, seedborne, and is principally a problem for melon and some squash varieties. These viruses cause mosaic, distorted growth, stunting, distortions in leaf coloration, and small, misshapen and poorly-colored pumpkin fruit. No pesticides are available to control viruses; controlling the aphid vectors with insecticides is usually ineffective for controlling virus spread. Growers rely on the following cultural control practices: choosing resistant varieties when possible, choosing varieties that don’t show color breaking on the fruit, isolating late plantings from early plantings, use of specialized reflective mulches, weed control, and the use of row covers. These have limited value because of the spreading nature of most squash vines.

Weeds

Broadleaf and Grass Weeds

Frequency of Occurrence: Annually.

Damage Caused: Reduced yields from weed competition, and loss of efficiency in harvesting. Weeds can interfere with pesticide applications. Growers marketing pumpkins through pick-your-own operations need relatively clean fields for customers to travel through.

% Acres Affected: 100%

Pest Life Cycles: Annual and perennial weeds such as ragweed, lambsquarters, redroot pigweed, nightshade species, Galinsoga, yellow nutsedge, annual and perennial grasses, mustards, and others, are a problem throughout the growing season.

Timing of Control: Preplant, preemergence, and postemergence.

Yield Losses: As high as 100% in severely infested fields.

Regional Differences: None.

Cultural Control Practices: Due to very few herbicides being registered on pumpkins, and their narrow weed control spectra, cultivation is necessary for squash production in NY. Some producers use the "stale seedbed" technique, where weeds are controlled by a broad-spectrum herbicide and then the field is planted with a minimum of soil disturbance. In addition, growers frequently rely on expensive handweeding (hoe crews) to clean up weed escapes.

Regional Differences: None.

Biological Control Practices: None.

Post-Harvest Control Practices: Cultivation. Post-harvest application of herbicides to control perennial weeds.

Chemical Controls:

Pesticide	% Trt.	Type of Appl.	Typical Rates lbs ai/acre	Timing	# of Appl.	PHI days	REI hours
DCPA[1] *(Dacthal)*	<1	soil surface	6.0	preemerge or postemerge	1	30 S; 100 W	12
paraquat *(Gramoxone)*	5-10	soil surface	1.0	preplant	1	30 S; 100 W	12
bensulide *(Prefar)*	<1	soil surface	--	preplant or preemerge	1	30 S; 100 W	?
ethalfluralin[2] *(Curbit)*	1-5	soil surface	1.5	preemerge or banded postemerge	1	30 S; 100 W	12
sethoxydim *(Poast)*	1-5	soil surface	0.28	postemerge	1	45	12
glyphosate *(Roundup)*	5-10	soil surface	1.0	preplant	1	30 S; 100 W	4

1. Manufacturer has discontinued production. Existing stocks may be used.

2. May be applied to seeded crops no later than 2 days after planting or banded between rows after corp emergence or transplanting. This is an SLN registration.

Efficacy Issues: Bensulide is effective on annual grasses and some broadleaves. Ethalfluralin is effective on annual grasses. Glyphosate and paraquat are broad spectrum, and are used with the stale seedbed technique. The industry has a critical need for more weed control options for squash production.

Alternatives: Research in other states indicates that halosulfuron may be a safe and effective herbicide in summer squash, but it does cause injury to winter squash types. IR-4 is conducting residue trials onmethoxyfenozide in 1999; efficacy trials need to be conducted.

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3. *Vegetable Production Handbook.* 1994. Cornell Cooperative Extension, Cornell University.

4. Information for and review of this Crop Profile were provided by producers, consultants, researchers and Extension Educators. Pesticide use information was gathered through a survey of twenty squash growers in the state.
