

Crop Profile for Eggplant in New Jersey

Production Facts

- New Jersey ranks either third (2001) or fourth (2000) in United States eggplant production (24).
- New Jersey supplies 12 to 14% of the total US eggplant production.
- Production has changed little since 1995 with acreage varying between 800 and 1000 acres, while crop value has increased from \$2.22 million (1995) to \$4.68 million (2002) (24).
- Yields average 20,000 to 25,000 pounds per acre with a total production of between 16,000,000 and 20,000,000 pounds. Prices received by growers rank sixth and seventh in the United States with growers receiving between \$0.11 and \$0.23 per pound (23).
- During the 1998-99 production season in southern New Jersey the operating costs per acre were estimated at \$3,934 and total cost including harvesting was \$3.19 to \$4.06 per box depending on yield (14).
- All eggplant production is for the fresh market.
- New Jersey's production season runs from July to early October with largest supply available in August and September.

Production Regions

The majority of eggplant production is located in southern New Jersey in the counties of Gloucester, Cumberland, Salem and Atlantic. There are smaller production areas in Monmouth and Burlington counties. Production is mainly for the wholesale fresh market trade for shipment to the eastern United States and Canada depending on the time of year. A small volume of eggplant is produced in the northern part of the state for roadside and green markets.

Cultural Practices

Types Grown

Eggplant is a member of the nightshade family and related to tomato, pepper and white potato. Among this group, eggplant is more sensitive to cold. The majority of the varieties and the production in New Jersey is the large "American or Harris" type, with dark purple skin and a light to dark green calyx, and a teardrop to oblong shape. There is some production of white teardrop-shaped eggplant; Italian slender types with purple skin and a dark green calyx; Japanese types with slender shape and tender dark purple to black skin; and Chinese types with a long cylindrical shape, purple to green color and a green calyx. Research is underway to evaluate varieties from Africa, the Caribbean, Southeast Asia and Europe for commercial production. There is a growing demand for non-traditional types due to increasing ethnic populations and interest in ethnic food.

Transplant Production

Eggplants are a warm season crop that does not tolerate frost. All eggplants are transplanted from plants grown locally. Plants are started in greenhouses from January

through March for transplanting in May through early July depending on the variety. Growers start seeds in 72 cell trays and move them to 18, 24 or 36 cell trays as they grow. Plants are grown using a standard soil less mix (i.e. Promix) and the fertility level is supplemented with two to three applications of a complete liquid fertilizer. Plants are hardened off by withholding water before setting in the field. Growers produce some transplants by seeding directly into greenhouse beds and setting bare rooted plants in the field. Height control is a problem with many growers because plants are started early. Since there are no chemicals for controlling plant height, transplants may be two feet tall when set in the field.

Land Preparation

Eggplants grow best on well-drained sandy-loam and loamy sand soils with a pH of 6.0-6.5. Some fields are fumigated in the fall before the cover crop is planted. The main fumigant used in New Jersey is metam-sodium at the rate of 45 to 70 gal/A. The fumigant is applied using a shank applicator and the soil is sealed behind. If the fumigant is not applied in the fall, it is injected just before plastic is laid in the spring or through the drip system after plastic is laid. A wheat or rye fall cover crop is planted the year before. Growers prefer wheat since it does not seem to hold as much moisture, plus grain rye may grow too tall to incorporate. In the spring, the cover crop is plowed down using either a moldboard or chisel plow. With secondary tillage, fertilizer is broadcast and incorporated and the soil prepared for bed making. Drip tape and plastic mulch are applied as the raised beds are being made.

Some growers apply herbicides as a broadcast application before making beds and laying plastic. Others will lay the plastic without any herbicide, then band apply between the rows before transplanting. In bare ground culture, herbicides are applied pre-transplant and additional weed control is maintained through cultivation.

Field Planting

Most eggplants are set into black plastic with drip irrigation for early production. Late plantings are transplanted into white plastic to moderate soil temperature. Eggplants are planted one row per bed at either 5 or 6 ft interrow spacing with most plantings at 6 ft. Within row spacing varies between 30 and 36 inches. Some growers plant on flat ground or low ridges without plastic especially for late plantings. These plants are irrigated with solid set overhead irrigation, cannon type equipment or drip irrigated.

Transplants are set with a water wheel, mechanical transplanter, or by hand depending on the size of the plants and type of culture. When transplanting, growers take care to set the plants straight in the transplant plant hole to avoid stem burn when the black plastic becomes too hot. In addition, some growers fill the hole around the plastic with soil to reduce the chance of water collecting around the plant, which can lead to disease. Early varieties are ready to harvest in 45 to 50 days and harvest continues until frost (early October). Late varieties are ready to harvest in 70 to 80 days.

Some eggplants grown on plastic are staked using a modified Florida weave system to increase yields and fruit quality. Stakes are placed at every plant or every other plant

and strings are woven around them. Three to five strings support the fruit load throughout the season.

In plastic mulch culture, additional liquid fertilizer is applied through the drip system at intervals throughout the growing season. In bare ground culture, plants are either side-dressed or fertigated through the drip system. Most fungicides and insecticides are applied with boom or airblast type sprayers that usually do not have enclosed cabs. Those with enclosed cabs are not typically equipped with pesticide filters.

Harvesting

Eggplants are hand harvested one to two times a week depending on temperature. Fruit are clipped from the plant above the calyx as they approach a marketable size but before the seeds start to turn color. Fruit that are allowed to stay on the plant too long will reduce total yield. Fruit are picked in plastic bushel containers, transported to packing sheds where they are washed, sorted into No. 1, No. 2 and field run grades, and packed in 1 1/9 bushel (33 lbs.) waxed cardboard cartons.

Worker Activities

Worker activities in the greenhouse include seeding, spotting transplants and watering. Fungicide treated seed is handled by workers who use the required personal protection equipment. Most growers make few if any greenhouse pesticide applications for eggplant transplant production and the existing reentry intervals (REI's) for greenhouse materials do not currently interfere with worker activity.

Field activities include transplanting, staking and tying plants, occasional hoeing for bare ground culture and harvesting one to two times a week. At the end of the season workers remove plastic mulch and stakes. Most of these activities can be easily conducted within the REI restrictions that currently exist for the materials growers are using for pest control. However, once multiple weekly harvesting begins, growers choose the most effective insecticides and fungicides with the minimum pre-harvest intervals (PHI); preferably a PHI less than 3 days, to accommodate harvest schedules. For most of the eggplant insect and fungal pests, there are sufficient choices in effective materials with low (less than 3 days) PHI's and REI's. A potential problem that may occur is with two-spotted spider mites, since the hot dry periods of infestation coincide with the peak harvesting period. Growers are limited to fenbutin-oxide (PHI of 3 days) and oxamyl (PHI of 1 day) for mite control during this period. Additionally, the third treatment of mefenoxam for phytophthora blight control occurs during the peak harvest period. The PHI of 7 days for this material may interfere with optimum harvest schedules.

Scouting activities typically occur once a week throughout the season. However, farms that employ a scouting service are usually visited twice a week for all crops. Since scouts will be returning to the farm between 48-72 hours, REI's of 48 hours or less are sufficiently short that major pest outbreaks will not occur within a field during the period of no reentry. In general, extending REI's and PHI's has the potential to be detrimental to eggplant production if effective alternative materials with low PHI's are not available.

Insect and Mite Control

The major eggplant insect and mite pests include aphids, Colorado potato beetles, flea beetles and two-spotted spider mites (7). Eggplant lacebugs, leafminers, European corn borers and corn earworms are occasional pests.

Colorado Potato Beetle, *Leptinotarsa decemlineata*

Description and Damage:

The Colorado potato beetle (CPB) has historically been the main insect pest of eggplant and other solanaceous crops (4). Adults and larvae attack foliage, flowers, and young fruit and have the potential to defoliate these crops each year. CPB occur every year in areas where solanaceous plants are grown and may infest 100% of the eggplant acreage in New Jersey. Adult beetles overwinter in the soil in and near infested fields from the previous season. In May and early June, overwintering adults emerge and walk to host plants to feed, mate and lay eggs. The adults defoliate newly transplanted fields, especially those located close to last year's fields, causing complete yield loss. However, after the bloom stage, plants can withstand up to 30% defoliation without yield loss (9). Two generations occur annually and occasionally a partial third generation may develop.

CPB adult beetles are oval-shaped, approximately 3/8 by 1/4 inch in size and have an orange or light brown head and thorax with wing covers that are yellow with black stripes. Females lay an average of 25 yellow, elliptical eggs in a cluster or mass on the undersides of eggplant leaves. Oviposition occurs for about 3 weeks, with an individual female laying approximately 500 eggs. Larvae hatch in 4 to 8 days, are convex in shape and look like grubs. They have two rows of black spots down each side, a black head and black legs. The early instars are typically darker orange or red and turn a lighter orange color as they develop through four instars. Mature larvae drop to the ground and burrow into the soil to pupate into adults in 5 to 10 days (20).

Larvae hatch from the egg mass and feed in groups, spreading out on an individual plant as they develop and feed. Infestations are typically clumped in a field, especially in the first generation as the adults move into a field from previously infested fields. Early infestations may be controlled with spot or edge treatments. Both larvae and adults feed on all parts of the plant. Severe defoliation can occur if larvae and adults are not controlled (22). In the early 1990's, 9 to 13 foliar insecticide applications were made to control CPB on eggplant (11). With the introduction of imidacloprid and related neonicotinoid insecticides, foliar applications have declined.

Monitoring:

Check newly transplanted fields weekly for overwintered adult populations. Inspect field edges closest to where a host crop was grown the previous year. The insect will move over or through another crop to infest eggplant. Treat hot spots when 15 CPB are found on 10 plants (16).

Chemical Controls:

- acetmiprid (Assail)
 - Percent acres treated: Newer material, data not available.
 - Typical rates and frequency of application: 0.6-1.1 oz 70 WP/A
 - Method of application: foliar application with ground equipment
 - REI: 12 hours PHI: 7 days
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels of CPB. Use in rotation with classes of insecticides other than the neonicotinoids. Lower rates preserve beneficial insect and spider populations and allow for faster rebound of the beneficial populations.

- *Bacillus thuringiensis tenebrionis* (Novodor)
 - Percent acres treated: 0% (25)
 - Typical rates and frequency of application: 1-4 qts FC/A
 - Method of application: foliar application with ground equipment
 - REI: 4 hours PHI: 0 days
 - Efficacy: Good on small or newly hatched larvae
 - Use in IPM and resistance management: Begin treatments when eggs begin to hatch and repeat applications 5-7 day intervals if small larvae are present. Bt is not effective on medium larvae and adults. If rainfall occurs within 24 hours of the application, reapplication may be needed (7).

- cryolite (Kryocide, Prokil)
 - Percent acres treated: 0% (25)
 - Typical rates and frequency of application: 10-12 lb 96WP/A, 1 application.
Method of application: foliar application with ground equipment
 - REI: 12 hours PHI: 0 days
 - Efficacy: Good
 - Use in IPM and resistance management: Growers do not use this material. This material could be used in rotation with other classes of insecticides when threshold levels of CPB are present. A disadvantage is a white residue left on fruit after the application.

- endosulfan (Thionex)
 - Percent acres treated: 12.7% (25)
 - Typical rates and frequency of application: 1.33 – 2.67 pt 3EC/A, 1-2 applications
 - Method of application: foliar application with ground equipment
 - REI: 48 hours PHI: 1 day
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels of CPB and use in rotation with other classes of insecticides. The broad-spectrum activity of this material results in its use when multiple pests are present.

- esfenvalerate (Asana)
 - Percent acres treated: 0% (25)
 - Typical rates and frequency of application: 5.8 – 9.6 oz EC/A
 - Method of application: foliar application with ground equipment.
 - REI: 12 hours PHI: 7 days
 - Efficacy: Not listed in the 2003 New Jersey Commercial Vegetable Recommendations book for eggplant (7).
 - Use in IPM and resistance management: Overuse of pyrethroids may impact predators and parasites and may cause a secondary outbreak of aphids. Not recommended for use in New Jersey (7).

- imidacloprid (Admire, Provado)
 - Percent acres treated: 20% (25)
 - Typical rates and frequency of application:
 - Admire: 16-24 fl oz 2F/A, 1 application (lower rates provide a shorter residual control)
 - Provado: 3.75 fl oz 1.6F/A, 1-2 applications
 Do not exceed 0.5 pounds active ingredient per acre per season regardless of application method or formulation. A 12-month plant back interval must be observed for crops not on the label.
 - Method of application:
 - Admire: soil application can be applied in-furrow, as a transplant drench, side-dressed, or drip-irrigated.
 - Provado: 1-2 foliar field applications by ground equipment.
 - REI: 12 hours PHI: 21 days (Admire)
 - REI: 12 hours PHI: 0 days (Provado)
 - Efficacy: Good
 - Use in IPM and resistance management: Growers apply imidacloprid primarily as a drench application to transplants 3-4 days before transplanting as a preventative treatment for early season control of CPB. Foliar applications of imidacloprid are recommended for threshold levels of adults and larvae when the preventative drench treatment has not been applied. For resistance management, imidacloprid is recommended for first generation CPB only (8). Second generation adults and larvae should be treated with insecticides in classes other than the neonicotinoids.

- oxamyl (Vydate L)
 - Percent acres treated: 23% (25)
 - Typical rates and frequency of application: 1-2 qt 2L/A, 1-2 applications (do not apply more than 24 pt per acre per season).
 - Method of application: foliar application with ground equipment
 - REI: 48 hrs PHI: 1 day
 - Efficacy: Good

- Use in IPM and resistance management: Treat at threshold levels of CPB and use in rotation with other classes of insecticides. The broad-spectrum systemic activity of this material results in its use when multiple pests are present.
- permethrin (Ambush, Pounce)
 - Percent acres treated: 3.0% (25)
 - Typical rates and frequency of application:
 - Ambush: 12.8 fl oz EC/A or other labeled formulation
 - Pounce: 8.0 fl oz 3.2EC/A or other labeled formulation
 - Method of application: foliar application with ground equipment.
 - REI: 24 hours PHI: 3 days
 - Efficacy: Not listed in the NJ Commercial Vegetable Production Recommendations book for eggplant (7). If permethrin is used, the synergist piperonyl butoxide (PBO) may enhance efficacy (30).
 - Use in IPM and resistance management: Overuse of permethrin will impact predators and parasites and may cause a secondary outbreak of aphids. Not recommended for use in New Jersey.
- spinosad (SpinTor 2SC)
 - Percent acres treated: 2.9% (25)
 - Typical rates and frequency of application: 3-6 fl oz 2SC/A, 1-2 applications (do not exceed 29 total fluid ounces per acre per season)
 - Method of application: foliar application with ground equipment
 - REI: 4 hours PHI: 1 day
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels of CPB and use in rotation with other classes of insecticides. Since spinosad does not impact certain predators and parasites, secondary pest outbreaks are minimized.
- thiomethoxam (Platinum, Actara)
 - Percent acres treated: Newer material, data not available.
 - Typical rates and frequency of application:
 - Platinum: 5-8 oz 2SC/A (lower rates provide a shorter residual control), 1 application
 - Actara: 2-3 oz 25WDG/A. 1-2 applications
 - Method of application:
 - Platinum: soil application can be applied in-furrow, as a transplant drench, side-dressed, or drip-irrigated.
 - Actara: 1-2 foliar field applications by ground equipment.
 - REI: 12 hours PHI: 30 days (Platinum)
REI: 12 hours PHI: 0 days (Actara)
 - Efficacy: Good
 - Use in IPM and resistance management: Thiomethoxam, like imidacloprid, is in the neonicotinoid insecticide class. For resistance management, if the soil

treatment is applied, subsequent foliar applications should be made with materials in different insecticide classes.

Alternatives:

There are effective materials that are alternatives to the EPA targeted materials including imidacloprid, thiamethoxam, acetmiprid, and spinosad. However, the first three active ingredients are in the same chemical class and should be rotated with materials in other classes for resistance management. In addition, pyrethroids such as permethrin and esfenvalerate may be effective as alternatives especially when applied with synergists such as piperonyl butoxide.

Rutgers University has developed a transgenic eggplant variety that contains a synthetic Bt gene that provides effective CPB control (9), but the varieties are currently not commercially available.

Cultural Control Practices:

The key cultural control for CPB is rotation from previous host crops, especially for control of the overwintered population. However, in the major eggplant production areas rotations are limited due to the lack of available land. Plastic-lined trenches to trap the overwintering population have been shown to reduce early adult populations (21), however growers have not adopted this method.

Biological Controls:

An introduced egg parasitoid, *Edovum puttleri*, effectively controls CPB at the commercial grower level (11). The New Jersey Department of Agriculture (NJDA) operated a successful biocontrol program from 1988 to 1996, rearing the parasitoid in the lab and releasing it into participating grower's eggplant fields. The NJDA discontinued the program after 1996 when growers began using new and more cost effective chemical pesticides, imidacloprid in particular (11).

Numerous natural enemies including ladybug larvae, lacewing larvae, predatory stinkbugs and others feed on all stages of the CPB. In one study, intercropping eggplant with certain flower species favored by CPB natural enemies significantly reduced CPB survivorship (26). Although not tested at the commercial grower level, strip-insectary intercropping may be an effective management strategy for CPB.

Other Issues:

During the periods of multiple weekly harvesting, acetmiprid and esfenvalerate would not be used due to the 7-day PHI.

**Potato Flea Beetle, *Epitrix cucumeris* (harris)
Eggplant Flea Beetle, *Epitrix fuscula* (crotch)**

Description and Damage:

Potato and eggplant flea beetles are occasional serious pests of eggplant. The potato flea beetle adult is shiny, black, approximately 1/8 inch long, with yellowish brown legs.

The eggplant flea beetle has a hairier body and is a duller black, with darker markings on the legs compared to the potato flea beetle (20). Flea beetles have large hind legs that allow them to jump from plant to plant.

The adults overwinter and emerge in the spring and begin feeding on young plants. The females lay whitish, elongate eggs at the base of the plants, and the larvae (white, thin, about 1/5 inch long) hatch and feed on the roots but do little noticeable damage (10). Larvae mature and pupate in the soil, and new adults emerge about 3 to 4 weeks from egg hatch. Flea beetles generally appear in mid-May through early June, with the first generation occurring in late June to early July. A partial second generation occurs in late summer; with some females laying eggs that will hatch into adults in August and September.

The adults chew small holes in the leaf tissue, causing a characteristic shot-hole or pin-hole damage to the leaves. Small plants are especially vulnerable to flea beetle damage, as the loss of leaf tissue will stunt plant growth. They are not a problem every year or with every planting.

Monitoring:

Flea beetles are first found on field edges or weedy areas. They are hard to monitor since they are shy and jump when approached. Fields should be monitored weekly at least through flowering for adult beetles or signs of damage. Foliar treatments are recommended at the following thresholds levels (16):

<u>Plant height:</u>	<u>Threshold:</u>
< 3 inches	2 FB/plant;
3 - 6 inches	4 FB/plant;
> 6 inches	8 FB/plant.

Chemical Controls:

- azinphos-methyl (Guthion)
 - Percent acres treated: 0.9% (25)
 - Typical rates and frequency of application: 2 pt 2L/A or other labeled formulation, 1 application prior to fruit set
 - Method of application: foliar application with ground equipment
 - REI: 5 days PHI: not applied after fruit set
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels of FB and use in rotation with other classes of insecticides. The broad-spectrum activity of this material results in its use when multiple pests are present.
- carbaryl (Sevin)
 - Percent acres treated: 3.1% (25)
 - Typical rates and frequency of application: 0.67–1.25 lb 80S/A, or 1 qt XLR Plus/A.
 - Method of application: foliar application with ground equipment.
 - REI: 12 hours PHI: 3 days

- Efficacy: Not listed in the 2003 New Jersey Commercial Vegetable Recommendations book for eggplant (7).
 - Use in IPM and resistance management: Not recommended for commercial vegetable growers in New Jersey.
- cryolite (Kryocide, Prokil)
 - Percent acres treated: 0% (25)
 - Typical rates and frequency of application: 10-12 lb 96WP/A, 1-2 applications.
 - Method of application: foliar application with ground equipment
 - REI: 12 hours PHI: 0 days
 - Efficacy: Good
 - Use in IPM and resistance management: Growers do not use this material. This material could be used in rotation with other classes of insecticides when threshold levels of FB are present.
- endosulfan (Thionex)
 - Percent acres treated: 12.7% (25)
 - Typical rates and frequency of application: 1.33 – 2.67 pt 3EC/A, 1-2 applications
 - Method of application: foliar application with ground equipment
 - REI: 48 hours PHI: 1 day
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels of FB and use in rotation with other classes of insecticides. The broad-spectrum activity of this material results in its use when multiple pests are present.
- imidacloprid (Admire, Provado)
 - Percent acres treated: 20% (25)
 - Typical rates and frequency of application:
 - Admire: 16-24 fl oz 2F/A, 1 application (lower rates provide a shorter residual control)
 - Provado: 3.75 fl oz 1.6F/A, 1-2 applications
 Do not exceed 0.5 pounds active ingredient per acre per season regardless of application method or formulation. A 12-month plant back interval must be observed for crops not on the label.
 - Method of application:
 - Admire: soil application can be applied in-furrow, as a transplant drench, side-dressed, or drip-irrigated.
 - Provado: 1-2 foliar field applications by ground equipment.
 - REI: 12 hours PHI: 21 days (Admire)
 - REI: 12 hours PHI: 0 days (Provado)
 - Efficacy: Good
 - Use in IPM and resistance management: Although the Admire treatment is primarily used for early season control of CPB, it will also control early flea beetles. The foliar application will also provide control of both CPB and FB, but

for CPB resistance management, this material is recommended for use only during the period of first generation CPB activity.

- oxamyl (Vydate L)
 - Percent acres treated: 23% (25)
 - Typical rates and frequency of application: 1-2 qt 2L/A, 1-2 applications (do not apply more than 24 pt per acre per season).
 - Method of application: foliar application with ground equipment
 - REI: 48 hrs PHI: 1 day
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels of FB and use in rotation with other classes of insecticides. The broad-spectrum systemic activity of this material results in its use when multiple pests are present.

- permethrin (Ambush, Pounce)
 - Percent acres treated: 3.0% (25)
 - Typical rates and frequency of application:
 - Ambush: 6.8-12.8 fl oz EC/A or other labeled formulation
 - Pounce: 4.0-8.0 fl oz 3.2EC/A or other labeled formulation
 - Method of application: foliar application with ground equipment.
 - REI: 24 hours PHI: 3 days
 - Efficacy: Not listed in the 2003 New Jersey Commercial Vegetable Recommendations book for eggplant (7).
 - Use in IPM and resistance management: Overuse of permethrin will impact predators and parasites and may cause a secondary outbreak of aphids. Not recommended for use in New Jersey.

- thiomethoxam (Platinum, Actara)
 - Percent acres treated: Newer material, data not available.
 - Typical rates and frequency of application:
 - Platinum: 5-8 oz 2SC/A (lower rates provide a shorter residual control), 1 application
 - Actara: 2-3 oz 25WDG/A. 1-2 applications
 - Method of application:
 - Platinum: soil application can be applied in-furrow, as a transplant drench, side-dressed, or drip-irrigated.
 - Actara: 1-2 foliar field applications by ground equipment.
 - REI: 12 hours PHI: 30 days (Platinum)
REI: 12 hours PHI: 0 days (Actara)
 - Efficacy: Good
 - Use in IPM and resistance management: Thiomethoxam is in the same insecticide class as imidacloprid. For CPB resistance management, if the soil treatment is applied, subsequent foliar applications should be made with materials in different insecticide classes.

- zeta-cypermethrin (Fury, Mustang)
 - Percent acres treated: Newer material, data not available.
 - Typical rates and frequency of application:
 - Fury: 2.4–4.3 fl oz/A (do not apply more than 25.8 oz per acre per season), 1-2 applications at least 7 days apart
 - Mustang: 2.24–4.0 fl oz/A (do not apply more than 24 oz per acre per season), 1-2 applications at least 7 days apart
 - Method of application: foliar application with ground equipment.
 - REI: 12 hours PHI: 1 days
 - Efficacy: Good
 - Use in IPM and resistance management: Apply at threshold levels of FB and rotate with materials with alternate modes of action.

Alternatives:

There are effective materials that are alternatives to the EPA targeted materials, including imidacloprid, thiomethoxam and zeta-permethrin. However, the first two active ingredients are in the same chemical class and should be rotated with materials in other classes for resistance management.

Cultural Control Practices:

Resistant varieties are not available. Reduce weeds in the fields and improve field sanitation to help prevent infestations. Deep plowing after harvest may reduce overwintering populations (28).

Biological Controls:

The effectiveness of natural enemies is not known for FB (28).

Other Issues:

During the periods of multiple weekly harvesting, azinphos-methyl, acetmiprid and esfenvalerate would not be used due to the 7-day PHI.

Two Spotted Spider Mite, *Tetranychus urticae*

Description and Damage:

Adult two spotted mites (TSSM) overwinter in the soil, on tree bark and in sheltered areas. They become active in early spring, but usually reach peak abundance in mid to late July and are active through frost depending on the environmental conditions. Adult mites have eight legs, are oval shaped and range in color from clear to yellow to brownish green with two dark spots of each side of the body. Mites are very small (1/60 inch in length) and difficult to see with the naked eye; a 10x hand lens is needed to identify mite presence. Individual spherical eggs are deposited on the undersides of the leaves. Newly hatched larvae are very small and have 6 legs and develop into the nymph stages with 8 legs.

Adults and nymphs feed on the undersides of the leaves, extracting plant sap and causing whitish spots or stippling damage that appears as leaf yellowing on the upper

leaf surface. As populations increase, the leaves turn brown, and leaves and fruit become covered in fine webbing. Heavy damage may result in leaf drop and render fruit unmarketable.

Hot dry weather promotes mite activity. The entire life cycle from egg hatch to adult can occur in 5 days at 75°F. Infestations generally begin around field margins and grassy areas especially if the field edges are mowed during dry periods. Mites disperse through a field by wind, worker and equipment movement. Rain and overhead irrigation help to hinder outbreaks. Mites are found most years in eggplant fields, but they do not typically reach economically damaging levels except during long periods of hot dry weather. The uses of pesticides that impact the natural enemy complex (pyrethroid sprays in particular) are known to cause spider mite outbreaks (13).

Monitoring:

Observe plants near field edges, especially next to dusty roads. A 10X hand lens or shaking leaves over white paper helps in identification. Fields should be monitored weekly especially during dry periods. Early season thresholds are 10-15% crown leaves infested; the late season threshold is 50% terminal leaves infested (16).

Chemical Controls:

- bifenthrin (Capture)
 - Percent acres treated: 11.3% (25)
 - Typical rates and frequency of application: 5.12-6.4 fl oz 2EC/A, 1-2 applications. Use higher rates for mite control and do not reapply within 7 days. Do not apply more than 12.8 ounces per acre per season.
 - Method of application: foliar application with ground equipment
 - REI: 12 hrs PHI: 7 days 2EC formulation
 - REI: 9 days PHI: 9 days 1.5G formulation
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels of mites and use in rotation with other miticides.

- fenbutatin-oxide (Vendex)
 - Percent acres treated: 3.9% (25)
 - Typical rates and frequency of application: 2-4 pt 4L/A or 2-4 lb 50 WP/A, 1-2 applications but not to exceed three applications or a total of 9 pounds per acre per season
 - Method of application: foliar application with ground equipment
 - REI: 48 hours PHI: 3 days
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels of mites and use in rotation with miticides with alternate modes of action for resistance management.

- oxamyl (Vydate L)

- Percent acres treated: 23% (25)
 - Typical rates and frequency of application: 1-2 qt 2L/A, 1-2 applications
 - Method of application: foliar application with ground equipment
 - REI: 48 hrs PHI: 1 day
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels of mites and use in rotation with other miticides. Oxamyl is not typically chosen specifically to control mites, but the broad-spectrum systemic activity of this material results in its use when multiple pests are present.
- oxydemeton-methyl (Metasystox R):
 - Percent acres treated: 1.3% (25)
 - Typical rates and frequency of application: 2 pt 2SC/A, 1- 2 applications, not to exceed 3 applications per season
 - Method of application: foliar application with ground equipment
 - REI: 24 hours PHI: 7 days
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels of mites and use in rotation with other miticides.

Alternatives:

Fenbutatin-oxide and bifenthrin are effective alternatives to oxamyl and oxydemeton-methyl. However, during the period when mite outbreaks usually occur, multiple weekly harvests are also occurring. As a result, bifenthrin would not be practical to use due to the 7-9 day PHI.

Cultural Control Practices:

Destroy weeds around the field in the fall or early spring to reduce overwintering populations. Populations generally decline after periods of heavy rainfall, and overhead irrigation may have the same effect (28). Avoid planting near alfalfa and hay crops. Maintain mowed areas next to fields, or avoid mowing overgrown weedy areas especially during dry periods.

Biological Controls:

Mite natural enemies like minute pirate bugs, predatory thrips and predatory mites usually keep populations under control. Outbreaks have been associated with the use of insecticides that kill natural enemies (13).

Green Peach Aphid, *Myzus persicae*

Description and Damage:

Aphids are occasional pests of eggplant. There are multiple species with wide host ranges, but the species commonly found on eggplant is the green peach aphid (GPA). GPA are small, soft bodied, pear shaped, about 1/10-1/5 inch long, and typically light green to pink or red with or without wings, or dark brown with wings. A generation of male and female aphids mate and deposit eggs in the fall usually on fruit trees like

peach and cherry. The eggs hatch in the spring and the first two to three generations consist of females that give birth to live young without being fertilized by males. They have a great capacity for multiplying quickly. As crowding and overpopulation occurs, winged forms migrate to new host plants where they feed and produce more generations of wingless females from early summer through the fall.

Aphids feed on plants by injecting piercing sucking mouthparts into the plant tissue and removing plant juices. Aphids are usually found on the undersides of the leaves, and as they feed, they excrete excess plant sap that accumulates on the plant surfaces below the infested leaves. A black to grayish sooty mold fungus grows on the sap, discoloring the leaves and more importantly the fruit. The sooty mold is difficult to wash off and may result in unmarketable fruit. Heavy infestations on the leaves cause leaf curling and yellowing, reducing plant vigor and causing stunting.

Aphids are controlled effectively most years by naturally occurring predators and parasites. Broad-spectrum insecticide treatments, which kill natural enemies, result in occasional outbreaks.

Monitoring:

Check transplants prior to planting for infestations. Monitor for aphids when scouting other insect pests. Check on the undersides of the leaves for aphids, and look on leaf surfaces for the presence of sooty mold. Treat when infestations are increasing or when sooty mold appears.

Chemical Controls:

- acetmiprid (Assail)
 - Percent acres treated: Newer material, data not available.
 - Typical rates and frequency of application: 0.8-1.2 oz 70 WP/A
 - Method of application: foliar application with ground equipment
 - REI: 12 hours PHI: 7 days
 - Efficacy: Good
 - Use in IPM and resistance management: Use in rotation with classes of insecticides other than the neonicotinoids. Lower rates preserve beneficial insect and spider populations and allow for faster rebound of the beneficial populations.

- endosulfan (Thionex)
 - Percent acres treated: 12.7% (25)
 - Typical rates and frequency of application: 1.33 – 2.67 pt 3EC/A, 1-2 applications
 - Method of application: foliar application with ground equipment
 - REI: 48 hours PHI: 1 day
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels and use in rotation with other classes of insecticides. The broad-spectrum activity of this material results in its use when multiple pests are present.

- imidacloprid (Admire, Provado)
 - Percent acres treated: 20% (25)
 - Typical rates and frequency of application:
 - Admire: 16-24 fl oz 2F/A, 1 application (lower rates provide a shorter residual control)
 - Provado: 3.75 fl oz 1.6F/A, 1-2 applications

Do not exceed 0.5 pounds active ingredient per acre per season regardless of application method or formulation. A 12-month plant back interval must be observed for crops not on the label.
 - Method of application:
 - Admire: soil application can be applied in-furrow, as a transplant drench, side-dressed, or drip-irrigated.
 - Provado: foliar application by ground equipment.
 - REI: 12 hours PHI: 21 days (Admire)
 - REI: 12 hours PHI: 0 days (Provado)
 - Efficacy: Good
 - Use in IPM and resistance management: The Admire treatment is primarily used for early season control of CPB, but this application will also control early aphid populations. Provado will provide control of aphids, but for CPB resistance management this material is recommended for use during the period of first generation CPB.

- methomyl (Lannate)
 - Percent acres treated: 2.0% (25)
 - Typical rates and frequency of application: 1.5-3 pt LV/A
 - Method of application: foliar application with ground equipment
 - REI: 48 hours PHI: 5 days
 - Efficacy: Variable
 - Use in IPM and resistance management: Treat at threshold levels and use in rotation with other classes of insecticides. The broad-spectrum activity of this material results in its use when multiple pests are present.

- oxamyl (Vydate L)
 - Percent acres treated: 23% (25)
 - Typical rates and frequency of application: 1-2 qt 2L/A, 1-2 applications (do not apply more than 24 pt per acre per season).
 - Method of application: foliar application with ground equipment
 - REI: 48 hrs PHI: 1 day
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels and use in rotation with other classes of insecticides. The broad-spectrum systemic activity of this material results in its use when multiple pests are present.

- oxydemeton-methyl (Metasystox R):
 - Percent acres treated: 1.3% (25)

- Typical rates and frequency of application: 2 pt 2SC/A, 1- 2 applications, not to exceed 3 applications per season
 - Method of application: foliar application with ground equipment
 - REI: 24 hours PHI: 7 days
 - Efficacy: Good
 - Use in IPM and resistance management: Treat at threshold levels and use in rotation with other classes of insecticides. The broad-spectrum systemic activity of this material results in its use when multiple pests are present.
- pymetrozine (Fulfill)
 - Percent acres treated: Newer material, data not available.
 - Typical rates and frequency of application: 2.75 oz 50WDG/A, 1-2 applications Do not apply more than 2.75 oz/A per application and do not exceed 5/5 oz/A per crop per season. Allow at least 7 days between applications.
 - Method of application: foliar application with ground equipment
 - REI: 12 hours PHI: 0 days
 - Efficacy: Good
 - Use in IPM and resistance management: This material will only control aphids. Apply when aphids first appear, before populations build to damaging levels. Fulfill has low toxicity to beneficial insects.
- thiomethoxam (Platinum, Actara)
 - Percent acres treated: Newer material, data not available.
 - Typical rates and frequency of application:
 - Platinum: 5-8 oz 2SC/A (lower rates provide a shorter residual control), 1 application
 - Actara: 2-3 oz 25WDG/A. 1-2 applications
 - Method of application:
 - Platinum: soil application can be applied in-furrow, as a transplant drench, side-dressed, or drip-irrigated.
 - Actara: foliar applications by ground equipment.
 - REI: 12 hours PHI: 30 days (Platinum)
REI: 12 hours PHI: 0 days (Actara)
 - Efficacy: Good
 - Use in IPM and resistance management: Thiomethoxam is in the same insecticide class as imidacloprid. For CPB resistance management, if the soil treatment is applied, subsequent foliar applications for CPB and other pests should be made with materials in different insecticide classes.

Alternatives:

Many materials are available for aphid control, several of which are low on toxicity to the predators and parasites that control aphids naturally.

Cultural Control Practices:

Destroy weed populations around the field. Incorporate crop residue as soon as possible after the last harvest.

Biological Controls:

Numerous natural enemies help keep aphid populations under control, including lacewing larvae, syrphid fly larvae, lady beetle adults and larvae, true bugs and other predators. Parasites and a fungal disease are also important biological control agents. Overuse of certain insecticides has been shown to cause aphid outbreaks due to their detrimental impact on predators and parasites. Conservation of natural enemies in eggplant fields usually results in good aphid control.

Other Issues:

During the periods of multiple weekly harvesting oxydemeton-methyl could not be used due to the PHI.

**European Corn Borer, *Ostrinia nubilalis*
Corn Earworm, *Helioverpa zea***

Description and Damage:

European corn borer (ECB) and corn earworm (CEW) are occasional pests of eggplant, primarily infesting the fruit in August and early September when adult populations are high. ECB is a local pest whereas CEW adult populations migrate from the south especially during the fall hurricane season. The adult moths are active at dusk through early morning, laying eggs on susceptible host plants like sweet corn, peppers, tomatoes, lettuce (CEW), and other crops. Larvae hatch in 3-5 days (CEW) or 7-10 days (ECB). ECB larvae typically bore in under the calyx, whereas CEW larvae will feed anywhere on the fruit. Eggplant is not a favored host of either of these pests, but in the absence of other host plants and in combination with high populations, eggplant may sustain fruit loss during certain periods. Less than 1% of the acreage is affected most years.

Monitoring:

Growers follow the Rutgers Cooperative Extension Plant & Pest Advisory newsletter to track adult blacklight trap population levels of ECB and CEW. Fruit are also monitored weekly for larval damage.

Chemical Controls:

- *Bacillus thuringiensis aizawai* (Xentari)
 - Percent acres treated: 0.5% (25)
 - Typical rates and frequency of application: 0.5-1.5 lbs/A, 1-2 applications (CEW only). Use higher rates under heavy insect pressure and shorten the interval between applications.
 - Method of application: foliar application with ground equipment.
 - REI: 4 hours PHI: 0 days
 - Efficacy: Most effective on small or newly hatched larvae.

- Use in IPM and resistance management: Begin treatments within a week of peak adult populations to target early egg hatch. Bt is less effective on medium to large larvae. If rainfall occurs within 24 hours of the application, reapplication may be needed (7).
- methomyl (Lannate)
 - Percent acres treated: 2.0% (25)
 - Typical rates and frequency of application: 1.5-3 pt LV/A, 1-2 applications
 - Method of application: foliar application with ground equipment
 - REI: 48 hours PHI: 5 days
 - Efficacy: Inconsistent
 - Use in IPM and resistance management: The broad-spectrum systemic activity of this material results in its use when multiple pests are present.
- spinosad (SpinTor 2SC)
 - Percent acres treated: 2.9% (25)
 - Typical rates and frequency of application: 3-6 fl oz 2SC/A, 1-2 applications (do not exceed 29 total fluid ounces per acre per season)
 - Method of application: foliar application with ground equipment
 - REI: 4 hours PHI: 1 day
 - Efficacy: Good
 - Use in IPM and resistance management: Spinosad does not impact certain parasites and predators so that secondary pest outbreaks are minimized.

Alternatives:

Spinosad and *Bacillus thuringiensis aizawai* are alternatives to methomyl.

Cultural Control Practices:

Effective weed control may help reduce ECB and CEW damage by improving spray coverage within the field. Survival of overwintered ECB larvae can be disrupted through the incorporation of infested crop residue (especially for host crops like corn) as soon as possible at the end of the season.

Biological Controls:

There are many general predators like lady beetles, syrphid fly larvae, lacewings, spiders, and minute pirate bug, which feed on the eggs and small larvae of ECB and CEW. However, when populations of ECB and CEW are high, natural control is less reliable.

**Eggplant Lacebug, *Gargaphia solani*
Leafminers, *Liriomyza sp.***

Description and Damage:

Eggplant lacebugs and leafminers are occasional minor insect pests of eggplant. Lacebugs are brown with transparent, lacelike veinage on the wings, about ¼ inch in length. Adults overwinter in plant debris. Eggs are black and glued in groups on the

undersides of the leaves. Nymphs hatch and feed on the undersides of the leaves, causing them to curl and turn pale. They are not present every year and damage is usually minimal as they are easily controlled with the materials being used for other insect pests.

Leafminers are also a minor pest, not appearing most years. The adult fly is black with yellow strips and very small, about 1/10 inch long. Single eggs are laid just under the leaf surface and the larva hatch and mine between the leaf surfaces, causing serpentine white tunnels. The tunnels coalesce to appear as blotches. The larvae mature feeding within the leaf and pupate usually in the soil. The entire life cycle can be completed in 23 days and several generations can occur within a season. Usually leafminers are not a problem, but outbreaks have occurred when natural control is disturbed by broad-spectrum pesticide use.

Chemical Controls:

- azinphos-methyl (Guthion)
 - Percent acres treated: 0.9% (25)
 - Typical rates and frequency of application: 0.5-2.0 pt 2L/A (leafminers only) or other labeled formulation, 1 application prior to fruit set
 - Method of application: foliar application with ground equipment
 - REI: 5 days PHI: Do not apply after fruit set
 - Efficacy: Good
 - Use in IPM and resistance management: Labeled for leafminers only. The broad-spectrum activity of this material results in its use when multiple pests are present.

- malathion (Cythion)
 - Percent acres treated: 0% (25)
 - Typical rates and frequency of application: 1 qt 57 EC/A (lacebug only), 1 application
 - Method of application: foliar application with ground equipment
 - REI: 12 hours PHI: 3 days
 - Efficacy: Poor
 - Use in IPM and resistance management: This material is labeled on eggplant for lacebug only. The broad-spectrum systemic activity of this material results in its use when multiple pests are present.

- oxamyl (Vydate L)
 - Percent acres treated: 23% (25)
 - Typical rates and frequency of application: 1-2 qt 2L/A, 1 application
 - Method of application: foliar application with ground equipment
 - REI: 48 hrs PHI: 1 day
 - Efficacy: Good
 - Use in IPM and resistance management: The broad-spectrum systemic activity of this material results in its use when multiple pests are present.

- spinosad (SpinTor 2SC)
 - Percent acres treated: 2.9% (25)
 - Typical rates and frequency of application: 3-6 fl oz 2SC/A, 1 application (do not exceed 29 total fluid ounces per acre per season)
 - Method of application: foliar application with ground equipment
 - REI: 4 hours PHI: 1 day
 - Efficacy: Good
 - Use in IPM and resistance management: Spinosad does not impact certain parasites and predators so that secondary pest outbreaks are minimized.

Alternatives:

Spinosad is an effective alternative to oxamyl, azinphos-methyl and malathion.

Cultural Control Practices:

Destroy alternate hosts, particularly broad-leaf weeds.

Biological Controls:

A complex of natural enemies controls leafminer and eggplant lacebugs.

Weed Control

The major weeds that infest eggplant are summer annual broadleaves including common cocklebur, common lambsquarters, common purslane, common ragweed, hairy galinsoga, ivyleaf morningglory, jimsonweed, smooth pigweed and velvetleaf. Summer annual grasses include barnyardgrass, giant foxtail, green foxtail, yellow foxtail, fall panicum, large crabgrass and goosegrass. The main perennial weed affecting eggplant is yellow nutsedge.

General Monitoring Scheme:

All weeds listed below are monitored and treated at the same threshold levels. Most growers will use this type of scheme for the perennial weeds.

Using a county soil map, identify the different soils in the field. Take a sample from each area where soil types differ and obtain an analysis of texture and organic matter. This information is used to develop a cultural and/or chemical control program for each soil type.

Scout fields in a zigzag pattern sampling 10 random locations. Sample either 1 square yard or 10 ft of row at each location depending on which scheme works best with the field. Note the weed species and whether they are scattered throughout the field or predominate in one area. This is done in late summer prior to planting eggplant the following year to develop a control strategy for the following season. Thresholds:

<u>Number of Weeds:</u>	<u>Threshold:</u>
< 1	Very light
1-4	Light
4-10	Medium
10-100	Heavy
> 100	Very heavy

After transplanting the following year, repeat the same pattern except sample 5 locations with the 1 square yard method and 5 locations with the 10 ft of row method. Note which weeds could be controlled by cultivation between the rows and which would not. This monitoring takes place once 15 – 20 days after transplanting. Threshold:

<u>Average Number of Weeds:</u>	<u>Threshold:</u>
<0.25	No control required
0.25 – 1	Some control may be required
>1	Control required

Annual Broadleaf Weeds

Common Cocklebur, *Xanthium strumarium*

Description and Damage:

This summer annual reproduces by seed from early spring through summer. Seed can germinate from as deep as 6 inches in the soil. The cotyledons and first leaves are opposite. Later leaves are alternate with a triangular shape, green in color with purple to brown spots and at maturity may be 6 inches long. The stem is hairy with dark spots. The flowers are found in the upper part of the plant and the male and female flowers are separate. The male flower falls off leaving the female flower enclosed within a bur. The burs are elliptical to egg-shaped, woody, covered with hooked trichomes and contain many seeds (32, 33, and 34).

On eggplant grown without plastic mulch, cocklebur can compete shortly after planting if not controlled. At harvest, the weeds can interfere with the laborers as the burs stick to clothing and slow down harvesting.

Chemical Controls:

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 12–36 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Controls most weeds and can be used as a preplant postemergent control measure.

- halosulfuron-methyl (Sanda)
 - Percent acres treated: Newer material, data not available
 - Typical rates and frequency of application: 0.5-1.0 oz/A, 1-4 applications depending on rate. Do not exceed 2 oz/A per 12-month period. Up to a 36 month, plant-back interval applies depending on the rotational crop.
 - Method of application: Directed spray between rows as a preemergent application or when weeds are 1 – 3 inches tall.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: More than one application may be necessary to control multiple flushes of weeds. This material is used when cocklebur is present but less than 3 inches tall. Since it is applied only when the weed is present, resistance development is reduced. However, weeds can become resistant to this herbicide if used with herbicides with the same mode of action (ALS/AHAS materials). Use mechanical control and chemical weed control from other herbicide classes.

- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:

- Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
- Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications

Do not apply more than 3 applications per season.

- Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
- REI: 12 hours PHI: 30 days
- Efficacy: Good
- Use in IPM and resistance management: This material is used when cocklebur is present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.

Alternatives:

There are only three chemicals available for common cocklebur control. The possibility of chemical resistance to halosulfuron-methyl restricts flexibility to control this weed. Monitoring weeds the summer before planting eggplant will help identify cocklebur and allow spot treatment to reduce the weed population. However, with only three options for control the chance of building up resistance is increased.

Cultural Control Practices:

Monitoring the weeds in the previous crop followed by cultivation will help reduce cocklebur, but seeds can survive for one to several years in the soil (32). Cultivation is only practical for approximately one month after transplanting since the plants are too large to allow equipment to pass between the rows.

Biological Controls:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting. If practical, leave weeds to regrow, then map the field and develop weed management strategies for the following year.

Common Lambsquarters, *Chenopodium album*

Description and Damage:

This erect summer annual reproduces by seed and emerges from spring to early summer from near the soil surface (down to approximately 1 inch). The first set of leaves is opposite then alternate for all others. Young leaves have either smooth or toothed margins being light green on top and maroon on the underside. As the plant grows, the leaves become more toothed in appearance. Young leaves and older leaves on mature plants have a gray to white mealy coating that feels oily to the touch. Stems are gray in color and are fragile when the plants are young, but are erect, vertically ridged and have maroon stripes at maturity. Flowers develop from June to September

in spiked groupings. The seeds are small and persist in the soil for many years (5, 32, 33, and 34).

Lambsquarters emerge in groups of plants shortly after the soil is tilled and continue to emerge each time the soil is disturbed. If not controlled, this weed competes directly with eggplant early in the season for light, nutrients and moisture.

Chemical Controls:

- bensulide (Prefar 4E)
 - Percent acres treated: 0.1% (25)
 - Typical rates and frequency of application: 5 – 6 quarts/A, 1 application
 - Method of application: Broadcast preplant (incorporate 1 – 2 inches) or preemergence (irrigate within 36 hours with ½ inch water).
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- DCPA (Dacthal W-75)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 8–14 lbs/A, 4-6 weeks after transplanting; 1 application
 - Method of application: Broadcast over plants when eggplant is grown without plastic mulch, or directed spray between rows with plastic mulch as a preemergent weed treatment.
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 6–20 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Controls most weeds and can be used as a preplant postemergent control measure.

- halosulfuron-methyl (Sandea)
 - Percent acres treated: Newer chemical, data not available
 - Typical rates and frequency of application: 0.5-1.0 oz/A, 1-4 applications depending on rate. Do not exceed 2 oz/A per 12-month period. Up to a 36

- month, plant-back interval applies depending on the rotational crop. Will not control lambsquarters post emergence.
- Method of application: Directed spray between rows as a preemergent treatment.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: More than one application may be necessary to control multiple flushes of weeds. Weeds can become resistant to this herbicide if it is used with herbicides with the same mode of action (ALS/AHAS materials). Use mechanical control and chemical weed control from other herbicides classes.
- napropamide (Devrinol 50-DF)
 - Percent acres treated: 23.1% (25)
 - Typical rates and frequency of application: 2-4 lbs/A, 1 application
 - Method of application: Broadcast and incorporated prior to transplanting.
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good
 - Use in IPM and resistance management: Best chemical to use during periods of wet weather. Good for rotation with the other herbicides to reduce chance of resistance.
 - paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications
 Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Fair to good
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.
 - trifluralin (Treflan HFP)
 - Percent acres treated: 1.1% (25)
 - Typical rates and frequency of application: 1.0-1.5 pts/A, 1 application
 - Method of application: Broadcast and incorporate within 24 hours prior to transplanting. Do not used under plastic mulch.
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good

- Use in IPM and resistance management: Avoid planting during periods of cold wet weather to reduce the risk of temporary stunting. Good for rotation with the other herbicides to reduce chance of resistance.

Alternatives:

There are several chemical options to control lambsquarters.

Cultural Control Practices:

Cultivation for up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Common Purslane, *Portulaca oleracea*

Description and Damage:

This summer annual reproduces by seed and stem segments that root at individual nodes. Seeds germinate from May through August. The plant has a prostrate mat-forming habit with thick succulent leaves and stems. Leaves are green on the upper side with a maroon color on the underside. Stems are green when young, turning maroon as the plant matures. Flowers appear from July through September, have yellow petals and are only open when it is sunny. The leaves decay after a frost, but the maroon stems remain (5, 32, 33, and 34).

Purslane is common in all of New Jersey and can spread easily from field to field on equipment. Each time a field is cultivated plants are broken up and each stem piece has the potential to produce a new plant at the node. This weed is more of a potential problem early in the season since it prefers high light intensity. As eggplants grow, the purslane is shaded.

Chemical Controls:

- bensulide (Prefar 4E)
 - Percent acres treated: 0.1% (25)
 - Typical rates and frequency of application: 5 – 6 quarts/A, 1 application
 - Method of application: Broadcast preplant (incorporate 1 – 2 inches) or preemergence (irrigate within 36 hours with ½ inch water).
 - REI: 12 hours PHI: Not available
 - Efficacy: Poor to fair
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- DCPA (Dacthal W-75)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 8–14 lbs/A, 4-6 weeks after transplanting, 1 application
 - Method of application: Broadcast over plants when eggplant is grown without plastic mulch, or directed spray between rows with plastic mulch as a preemergent weed treatment.
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application. Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 3–6 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Fair
 - Use in IPM and resistance management: This chemical would not be effective for early-planted eggplant since the weed would not have germinated before transplanting.

- halosulfuron-methyl (Sanda)
 - Percent acres treated: Newer chemical, data not available
 - Typical rates and frequency of application: 0.5 –1.0 oz/A, 1-4 applications depending on rate. Do not exceed 2 oz/A per 12-month period. Up to a 36 month plant-back interval applies depending on the rotational crop.
 - Method of application: Directed spray between rows as a preemergent treatment.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Suppresses weeds
 - Use in IPM and resistance management: More than one application may be necessary to control multiple flushes of weeds. Weeds can become resistant to this herbicide if it is used with herbicides with the same mode of action (ALS/AHAS materials). Use mechanical control and chemical weed control from other herbicide classes.

- napropamide (Devrinol 50-DF)
 - Percent acres treated: 23.1% (25)
 - Typical rates and frequency of application: 2.0-4.0 lbs/A, 1 application
 - Method of application: Broadcast and incorporated prior to transplanting.
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair

- Use in IPM and resistance management: Best chemical to use during periods of wet weather. Good for rotation with the other herbicides to reduce chance of resistance.
- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications
 Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Fair
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.
- trifluralin (Treflan HFP)
 - Percent acres treated: 1.1% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 1 application
 - Method of application: Broadcast and incorporate within 24 hours prior to transplanting. Do not use under plastic mulch.
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair
 - Use in IPM and resistance management: Avoid planting during periods of cold wet weather to reduce the risk of temporary stunting. Good for rotation with the other herbicides to reduce chance of resistance.

Alternatives:

There are several effective options to control purslane.

Cultural Control Practices:

Cultivation up to approximately one month after transplanting will help reduce weed populations. Cultivation should be done during sunny dry periods to reduce the chance of the plant re-rooting.

Biological Control:

Purslane sawfly, *Sofus pilicornis*, controls purslane, but the insect is very susceptible to other pesticides.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Common Ragweed, *Ambrosia artemisiifolia*

Description and Damage:

Ragweed is a summer annual with an erect plant habit from 1 to 7 feet tall. This weed reproduces from seed that germinates from May to late June. Germination is inhibited with high temperatures (86°F or above). The leaves have rounded margins and are hairy and deeply cut when small. As the plant matures, the tips become less rounded. Leaves are opposite up to the fourth node then alternate. Stems are branched with long rough hairs. Stems with some desiccated leaves will persist through the winter. Flowers are present from August to October with the male flowers in the top of the plant and female flowers on the lower portions. The seed can survive up to 80 years (32, 32, and 34).

This weed can compete with eggplant through the production season if not controlled. Ragweed will germinate and overtake the eggplant during the season. It also affects the labor force since it produces large amount of pollen, of which many people are allergic.

Chemical Controls:

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 6–18 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Fair
 - Use in IPM and resistance management: Controls most weeds and can be used as a preplant postemergent control measure.

- halosulfuron-methyl (Sanda)
 - Percent acres treated: Newer chemical, data not available
 - Typical rates and frequency of application: 0.5-1.0 oz/A, 1-4 applications depending on rate. Do not exceed 2 oz/A per 12-month period. Up to a 36 month plant-back interval applies depending on the rotational crop.
 - Method of application: Directed spray between rows as a preemergent application or when weeds are 1–3 inches tall.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: More than one application may be necessary to control multiple flushes of weeds. Weeds can become resistant to this herbicide if it is used with herbicides with the same mode of action (ALS/AHAS materials). Use mechanical control and chemical weed control.

- napropamide (Devrinol 50-DF)

- Percent acres treated: 23.1% (25)
 - Typical rates and frequency of application: 2-4 lbs/A, 1 application
 - Method of application: Broadcast and incorporated prior to transplanting.
 - REI: 12 hours PHI: Not available
 - Efficacy: Poor to Fair
 - Use in IPM and resistance management: Best chemical to use during periods of wet weather. Suppresses weeds only, which may lead to resistance.
- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray), 1-3 applications
 Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.

Alternatives:

There are few chemical alternatives for common ragweed. If any of the above materials are lost or no new herbicides developed, ragweed control will be difficult.

Cultural Control Practices:

Cultivation up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Hairy Galinsoga, *Galinsoga ciliata*

Description and Damage:

Hairy galinsoga is an erect plant with a branching stem approximately 4 to 30 inches tall. The leaves are opposite, triangular with a pointed tip and slightly toothed on the margins. The seed is produced from early spring through September and has no dormancy thus there can be several generations in a season. The leaves and stem are

green and covered with hair. Flowers are present from June to October. They have 4 to 5 white three-toothed petals around several yellow center flowers. One plant can produce thousands of seed, but they survive only for a few years (32 33).

Galinsoga is more of a problem for bare ground culture eggplant than for eggplant grown with plastic mulch.

Chemical Controls:

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 6–12 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Controls most weeds and can be used as a preplant postemergent control measure. This will not eliminate all weeds since weed seeds germinate all summer and each plant produces many seeds.

- halosulfuron-methyl (Sanda)
 - Percent acres treated: Newer chemical, data not available
 - Typical rates and frequency of application: 0.5–1.0 oz/A, 1-4 applications depending on rate. Do not exceed 2 oz/A per 12-month period. Up to a 36 month plant-back interval applies depending on the rotational crop.
 - Method of application: Directed spray between rows as a preemergent application or when weeds are 1–3 inches tall.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: More than one application may be necessary to control multiple flushes of weeds. Weeds can become resistant to this herbicide if it is used with herbicides with the same mode of action (ALS/AHAS materials). Use mechanical control and chemical weed control from other herbicide classes.

- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applicationsDo not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days

- Efficacy: Good
- Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.

Alternatives:

There are few chemical controls for galinsoga. This is one weed that needs additional control options.

Cultural Control Practices:

Cultivation between the rows up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Ivyleaf Morningglory, *Ipomoea hederacea*

Description and Damage:

The plant is a long vining summer annual with deeply three-lobed leaves and erect hairs on the stems, petioles and leaves. The cotyledons are “butterfly shaped” and similar to other morningglories before taking on the typical ivy-shape. The vining stems twine around other plants or grow along the ground. Flower petals are white or pale blue to purple and form a trumpet or funnel shape. Plants die with the first frost, but the dry vines can be found in undisturbed fields through the winter (32, 33, and 34).

Morningglory can grow over the top of eggplants any time during the season. If not controlled, this weed can take over a whole field, reducing yields or making the field unharvestable. Field margins are more prone to initial infestations.

Chemical Controls:

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 3–6 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Fair
 - Use in IPM and resistance management: Can be used around field edges to reduce the chance of the morningglory infesting the field.

- halosulfuron-methyl (Sandea)
 - Percent acres treated: Newer chemical, data not available
 - Typical rates and frequency of application: 1.0 oz/A, 1-2 applications. Do not exceed 2 oz/A per 12-month period. Up to a 36 month plant-back interval applies depending on the rotational crop.
 - Method of application: Directed spray between rows before weeds emerge.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Suppression only with applications at the higher rate
 - Use in IPM and resistance management: More than one application may be necessary to control multiple flushes of weeds. Weeds can become resistant to this herbicide if it is used with herbicides with the same mode of action (ALS/AHAS materials). Use mechanical control and chemical weed control from other herbicide classes.

- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications
 Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Fair to good
 - Use in IPM and resistance management: This material is used when morningglory is present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.

- Trifluralin (Treflan HFP)
 - Percent acres treated: 1.1% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 1 application
 - Method of application: Broadcast and incorporate within 24 hours prior to transplanting. Do not use under plastic mulch.
 - REI: 12 hours PHI: Not available
 - Efficacy: Poor to fair
 - Use in IPM and resistance management: Avoid planting during periods of cold wet weather to reduce the risk of temporary stunting. Good for rotation with the other herbicides to reduce chance of resistance.

Alternatives:

There are few alternative chemical controls for morningglory. Other chemical options should be explored.

Cultural Control Practices:

Cultivation around field edges will help reduce movement of morningglory into the field.

Biological Control:

None available.

Post Harvest Control Practices:

Spot treating at the end of the season will reduce the weed population.

Jimsonweed, *Datura stramonium*

Description and Damage:

This large summer annual is erect with a branching stem. The plant grows 12 to 60 inches tall with egg-shaped fruit covered with green spines that turn light brown at maturity. Plants emerge from May until late summer. The cotyledons are opposite, narrow and pointed with the first true leaves being complete with no toothed margins. Later leaves are large toothed and pointed at the tip, resembling oak leaves. The plant has a thick large taproot, which makes it difficult to pull. Flowers are produced from June until frost and open in the late afternoon and evening. The flowers are white to purple and funnel shaped. The seeds are enclosed in a capsule that is divided into four segments with many seeds in each (5, 32, 33, and 34).

Jimsonweed competes with eggplant for nutrients, water, and light and can interfere with harvesting since the seed capsules have sharp spines. This weed is found in groups and can reduce yields, but generally is not found over a whole field.

Chemical Controls:

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 12–18 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Controls most weeds and can be used as a preplant postemergent control measure.

- halosulfuron-methyl (Sanda)
 - Percent acres treated: Newer chemical, data not available
 - Typical rates and frequency of application: 0.5-1.0 oz/A, 1-4 applications depending on rate. Do not exceed 2 oz/A per 12-month period. Up to a 36 month plant-back interval applies depending on the rotational crop.
 - Method of application: Directed spray between rows as a preemergent application.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good

- Use in IPM and resistance management: More than one application may be necessary to control multiple flushes of weeds. Weeds can become resistant to this herbicide if it is used with herbicides with the same mode of action (ALS/AHAS materials). Use mechanical control and chemical weed control from other herbicide classes.
- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications
 - Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.

Alternatives:

There are few chemical alternatives for jimsonweed control. Other chemical control options should be explored.

Cultural Control Practices:

Cultivation between the rows up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Since this weed is found in groups, spot treating at the end of the season helps reduce the population. Incorporate plant residue after spot treating to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Smooth Pigweed, *Amaranthus hybridus*

Description and Damage:

The plant is erect and 1 to 7 feet tall with many branches. The stems are slender with dense short hairs on the upper part. The leaves are simple, alternate, oval and egg-shaped with a green color above and light green to magenta on the underside. The cotyledons are narrow and pointed dark green on the top surface and bright red below. Seedling stems are green, very hairy and may be red at the base. The plants have a

shallow taproot and may be pink or red in color. Flowers and seed heads are mainly located at the top of the plant. The plants persist in the field after frost (5, 32, and 33).

Several other species that are found in New Jersey have similar descriptive characteristics. Among these are redroot pigweed (*Amaranthus retroflexus*) and Powell amaranth (*Amaranthus powellii*). All three species may be found in the same field (5).

Pigweed can compete with eggplant throughout the growing season especially for bare ground plantings. Harvesting can be slowed if weeds are not controlled between the rows. Pigweed has the potential to infest a complete field.

Chemical Controls:

- bensulide (Prefar 4E)
 - Percent acres treated: 0.1% (25)
 - Typical rates and frequency of application: 5–6 quarts/A, 1 application
 - Method of application: Broadcast preplant (incorporate 1–2 inches) or preemergence (irrigate within 36 hours with ½ inch water).
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- DCPA (Dacthal W-75)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 8–14 lbs/A, 4-6 weeks after transplanting, 1 application
 - Method of application: Broadcast over plants when eggplant is grown without plastic mulch, or directed spray between rows with plastic mulch as a preemergent weed treatment.
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good depending on the species
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 12-24 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Good for control of smooth pigweed, but only if applied as a pre-transplant treatment.

- halosulfuron-methyl (Sandea)

- Percent acres treated: Newer chemical, data not available
 - Typical rates and frequency of application: 0.5-1.0 oz/A, 1-4 applications depending on rate. Do not exceed 2 oz/A per 12-month period. Up to a 36 month plant-back interval applies depending on the rotational crop.
 - Method of application: Directed spray between rows either as a preemergent application or when weeds are 1–3 inches tall.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: More than one application may be necessary to control multiple flushes of weeds. Weeds can become resistant to this herbicide if it is used with herbicides with the same mode of action (ALS/AHAS materials). Use mechanical control and chemical weed control from other herbicide classes.
- napropamide (Devrinol 50-DF)
 - Percent acres treated: 23.1% (25)
 - Typical rates and frequency of application: 2-4 lbs/A, 1 application
 - Method of application: Broadcast and incorporated prior to transplanting
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good
 - Use in IPM and resistance management: Best chemical to use during periods of wet weather. Good for rotation with the other herbicides to reduce chance of resistance.
- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications
 Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.
- trifluralin (Treflan HFP)
 - Percent acres treated: 1.1% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 1 application
 - Method of application: Broadcast and incorporate within 24 hours prior to transplanting. Do not use under plastic mulch.
 - REI: 12 hours PHI: Not available

- Efficacy: Fair
- Use in IPM and resistance management: Avoid planting during periods of cold wet weather to reduce the risk of temporary stunting. Good for rotation with the other herbicides to reduce chance of resistance.

Alternatives:

There are several options for the control of pigweed.

Cultural Control Practices:

Cultivation between the rows up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Velvetleaf, *Abutilon theophrasti*

Description and Damage:

This summer annual is erect (3 to 5 feet) with an unbranched hairy stem. The large leaves are heart shaped, covered with soft hairs which gives it a velvety texture. Seeds emerge from mid to late May. The cotyledons are heart shaped, alternate and hairy as are the young leaves, which point downward. The plant flowers from July into the fall. Flowers are produced on small stalks in the upper leaf axils and have five yellow petals. The fruits have a distinct appearance of a circular cup-shaped disk that is ribbed and pointed at the end of each rib. Seeds remain viable for many years in the soil (5, 32, 33, and 34).

Velvetleaf can compete with eggplant throughout the production season. The plants can grow above the eggplant and shade a field if the population is high. Velvetleaf is more of a problem in fields that have been in a short rotation with corn or where improperly composted manure is applied.

Chemical Controls:

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 6–12 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good

- Use in IPM and resistance management: Glyphosate provides good weed control before transplanting. Since velvetleaf plants are found in groups in many fields, spot treatment is possible.
- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications
 Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.
- halosulfuron-methyl (Sanda)
 - Percent acres treated: Newer chemical, data not available
 - Typical rates and frequency of application: 0.5-1.0 oz/A, 1-4 applications depending on rate. Do not exceed 2 oz/A per 12-month period. Up to a 36 month plant-back interval applies depending on the rotational crop.
 - Method of application: Directed spray between rows as a preemergent application or when weeds are 1–3 inches tall.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: More than one application may be necessary to control multiple flushes of weeds. Weeds can become resistant to this herbicide if it is used with herbicides with the same mode of action (ALS/AHAS materials). Use mechanical control and chemical weed control from other herbicide classes.

Alternatives:

There are few alternative chemicals for velvetleaf control. This is an area where additional herbicides are needed.

Cultural Control Practices:

Cultivation between the rows up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Other Issues:

If manure is applied it should be well composted. Velvetleaf seeds pass through animal digestive systems and the seeds are spread in the manure.

Annual Grass Weeds

Barnyardgrass, *Echinochloa crus-galli*

Description and Damage:

This summer annual is erect (up 5 feet) and grows in clumps. The seed germinates from early spring to midsummer. When the weed emerges, the leaf opens parallel to the ground. The sheaths are tinted maroon near the base. The leaves have no auricles or ligules and have a smooth green collar. After the first leaves, the remainder are upright. Mature plants are similar to the seedlings with blades that are 4 to 8 inches in length. The sheaths are open and smooth with a collar that is whitish and smooth. Flowers occur from July through September. The seed heads come out of the top sheath and are branched with green to purple panicles. Barnyardgrass is killed by the first frost, but the thick stem remains standing through the winter (5, 32, 33, and 34).

Barnyardgrass can compete with eggplant early in the season especially if not grown on plastic mulch. Within row, competition is more of a concern if soil is not thrown around the plants during cultivation.

Chemical Controls:

- bensulide (Prefar 4E)
 - Percent acres treated: 0.1% (25)
 - Typical rates and frequency of application: 5–6 quarts/A, 1 application
 - Method of application: Broadcast preplant (incorporate 1–2 inches) or preemergence (irrigate within 36 hours with ½ inch water).
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- clethodim (Select 2EC)
 - Percent acres treated: Newer material, data not available
 - Typical rates and frequency of application: 6–8 oz/A when the weed is at most 2–8 inches tall; 1–2 applications
 - Method of application: Broadcast, post emergence to the weeds and eggplant
 - REI: 24 hours PHI: 20 days
 - Efficacy: Good

- Use in IPM and resistance management: Must use an oil concentrate or nonionic surfactant for good control. Control may be reduced if hot dry weather conditions occur. For best control the weed should be actively growing and before tillers are present.
- DCPA (Dacthal W-75)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 8–14 lbs/A, 4 to 6 weeks after transplanting; 1 application
 - Method of application: Broadcast over plants when eggplant are grown without plastic mulch, or directed spray between rows with plastic mulch as a preemergent weed treatment.
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.
- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 3–9 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Controls most weeds and can be used as a preplant postemergent control measure.
- napropamide (Devrinol 50-DF)
 - Percent acres treated: 23.1% (25)
 - Typical rates and frequency of application: 2-4 lbs/A, 1 application
 - Method of application: Broadcast and incorporated prior to transplanting
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Best chemical to use during periods of wet weather. Good for rotation with the other herbicides to reduce chance of resistance.
- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3 – 2.7 pts/A (preplant), 1.3 pts/A (directed spray), 1-3 applications
 Do not apply more than three applications per season.

- Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Fair to good
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.
- sethoxydim (Poast 1.5EC)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 3–4 applications
Do not apply more than 4.5 pts/A per season
 - Method of application: Broadcast for weeds up to 8 inches tall.
 - REI: 12 hours PHI: 20 days
 - Efficacy: Good
 - Use in IPM and resistance management: Must use an oil concentrate or nonionic surfactant for good control. Control may be reduced if hot dry weather conditions occur. For best control the weed should be actively growing and before tillers are present.
- trifluralin (Treflan HFP)
 - Percent acres treated: 1.1% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 1 application
 - Method of application: Broadcast and incorporate within 24 hours prior to transplanting. Do not use under plastic mulch.
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Avoid planting during periods of cold wet weather to reduce the risk of temporary stunting. Good for rotation with the other herbicides to reduce chance of resistance.

Alternatives:

There are many chemical controls for barnyardgrass.

Cultural Control Practices:

Cultivation between the rows up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Giant Foxtail, *Setaria faveri*

Green Foxtail, *Setaria viridis*
Yellow Foxtail, *Setaria glauca*

Description and Damage:

These three species are similar in general characteristics. They have a clump forming erect habit. These summer annuals reproduce by seed that germinates from late spring through summer. The first leaf opens parallel to the ground and is much longer than its width. The leaves emerge rolled, auricles are absent and the ligule is fringed with hairs. The leaves are smooth on the lower surface. Giant foxtail has short numerous hairs on the upper surface of the blade and the margin of the sheath, whereas green foxtail has rough blades and no hairs and the sheaths have hairy margins. Yellow foxtail is covered with long hairs at the base of the upper surface. The collar is green and smooth on all species. At maturity the plants appear very similar as the seedlings except the sheathes are often reddish at the base and have a prominent midvein. Roots are fibrous and tillers will root at the base of the plant. Foxtails flower from mid to late summer with seed heads present from late summer through fall. The seed heads are coarse bristly in appearance and approximately 0.8 to 6 inches in length. The giant foxtail seed head is the largest of the three with a green to purple color. Green foxtail has a seed head larger and greener than yellow foxtail. The yellow foxtail seed head has a yellowish color. The seed head remains yellow through early winter, which helps distinguish it from the other foxtails that turn brown (32, 33, 34).

All three foxtails can compete with eggplant early in the season if not controlled, especially within the row when plastic mulch is not used.

Chemical Controls:

- bensulide (Prefar 4E)
 - Percent acres treated: 0.1% (25)
 - Typical rates and frequency of application: 5–6 quarts/A, 1 application
 - Method of application: Broadcast preplant (incorporate 1–2 inches) or preemergence (irrigate within 36 hours with ½ inch water).
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- clethodim (Select 2EC)
 - Percent acres treated: Newer material, data not available
 - Typical rates and frequency of application: 6–8 oz/A when the weed is 2–8 inches tall (green and yellow foxtail) or 2–12 inches tall (giant foxtail); 1–2 applications
 - Method of application: Broadcast, post emergence to the weeds and eggplant
 - REI: 24 hours PHI: 20 days
 - Efficacy: Good
 - Use in IPM and resistance management: Must use an oil concentrate or nonionic surfactant for good control. Control may be reduced if hot dry weather

conditions occur. For best control the weed should be actively growing and before tillers are present.

- DCPA (Dacthal W-75)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 8–14 lbs/A, 4-6 weeks after transplanting; 1 application
 - Method of application: Broadcast over plants when eggplant are grown without plastic mulch, or directed spray between rows with plastic mulch as a preemergent weed treatment.
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are at most 6-20 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Controls most weeds and can be used as a preplant postemergent control measure.

- napropamide (Devrinol 50-DF)
 - Percent acres treated: 23.1% (25)
 - Typical rates and frequency of application: 2-4 lbs/A, 1 application
 - Method of application: Broadcast and incorporated prior to transplanting
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Best chemical to use during periods of wet weather. Good for rotation with the other herbicides to reduce chance of resistance.

- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applicationsDo not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.

- REI: 12 hours PHI: 30 days
 - Efficacy: Good
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.
- sethoxydim (Poast 1.5EC)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 3–4 applications
Do not apply more than 4.5 pts/A per season
 - Method of application: Broadcast for weeds up to 8 inches tall.
 - REI: 12 hours PHI: 20 days
 - Efficacy: Good
 - Use in IPM and resistance management: Must use an oil concentrate or nonionic surfactant for good control. Control may be reduced if hot dry weather conditions occur. For best control the weed should be actively growing and before tillers are present.
- trifluralin (Treflan HFP)
 - Percent acres treated: 1.1% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 1 application
 - Method of application: Broadcast and incorporate within 24 hours prior to transplanting. Do not use under plastic mulch.
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Avoid planting during periods of cold wet weather to reduce the risk of temporary stunting. Good for rotation with the other herbicides to reduce chance of resistance.

Alternatives:

There are several chemicals labeled with good efficacy for foxtail control.

Cultural Control Practices:

Cultivation between the rows up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Fall Panicum, *Panicum dichotomiflorum*

Description and Damage:

The plant growth habit varies from erect to sprawling. Seeds germinate from late spring to midsummer. The first leaves are parallel to the ground, rolled in a bud and lack auricles. The ligule has a fringe of hair and the first few leaves and sheaths are hairy on the underside, but become hairless with age. The collar is very hairy. The mature plants appear waxy with enlarged nodes and red to purplish sheaths. Plants grow 20 to 40 inches tall. The roots are fibrous and can root from the lower nodes. Fall panicum flowers from July to October. The seed heads are red to purple, large with an open branching appearance (32, 33, and 34).

As with the foxtails, fall panicum can compete with eggplant early in the season especially for small transplants and fields without plastic mulch.

Chemical Controls:

- bensulide (Prefar 4E)
 - Percent acres treated: 0.1% (25)
 - Typical rates and frequency of application: 5–6 quarts/A, 1 application
 - Method of application: Broadcast preplant (incorporate 1–2 inches) or preemergence (irrigate within 36 hours with ½ inch water).
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- clethodim (Select 2EC)
 - Percent acres treated: Newer material, data not available
 - Typical rates and frequency of application: 6–8 oz/A when the weed is 2–8 inches tall, 1–2 applications
 - Method of application: Broadcast, post emergence to the weeds and eggplant
 - REI: 24 hours PHI: 20 days
 - Efficacy: Good
 - Use in IPM and resistance management: Must use an oil concentrate or nonionic surfactant for good control. Control may be reduced if hot dry weather conditions occur. For best control the weed should be actively growing and before tillers are present.

- DCPA (Dacthal W-75)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 8–14 lbs/A, 4-6 weeks after transplanting; 1 application
 - Method of application: Broadcast over plants when eggplant are grown without plastic mulch, or directed spray between rows with plastic mulch as a preemergent weed treatment.
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are 4–12 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Controls most weeds and can be used as a preplant postemergent control measure.

- napropamide (Devrinol 50-DF)
 - Percent acres treated: 23.1% (25)
 - Typical rates and frequency of application: 2-4 lbs/A, 1 application
 - Method of application: Broadcast and incorporated prior to transplanting
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good
 - Use in IPM and resistance management: Best chemical to use during periods of wet weather. Good for rotation with the other herbicides to reduce chance of resistance.

- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications
 Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Fair to good
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.

- sethoxydim (Poast 1.5EC)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 3–4 applications
Do not apply more than 4.5 pts/A per season.
 - Method of application: Broadcast for weeds up to 8 inches tall.
 - REI: 12 hours PHI: 20 days
 - Efficacy: Good

- Use in IPM and resistance management: Must use an oil concentrate or nonionic surfactant for good control. Control may be reduced if hot dry weather conditions occur. For best control the weed should be actively growing and before tillers are present.
- trifluralin (Treflan HFP)
 - Percent acres treated: 1.1% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 1 application
 - Method of application: Broadcast and incorporate within 24 hours prior to transplanting. Do not use under plastic mulch.
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Avoid planting during periods of cold wet weather to reduce the risk of temporary stunting. Good for rotation with the other herbicides to reduce chance of resistance.

Alternatives:

There are several good chemical alternatives for fall panicum control.

Cultural Control Practices:

Cultivation between the rows up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Large Crabgrass, *Digitaria sanguinalis*

Description and Damage:

This summer annual grows mainly prostrate, but as the plant matures the stem may turn upward to 40 inches. Seeds germinate from mid spring through late summer. Seedlings are upright and the leaves taper to the tip. The leaves are rolled in the bud, lack auricles, but have a jagged membranous ligule. Stiff hairs are found on the blade and sheath at a 90° angle to the plant surface. The collar has long hairs at the margin. On mature plants, hairs are found on both blade surfaces and on the sheath. Plants tiller at the four or five leaf stage and elongate later in the summer. Older sheaths and leaves may turn dark red to maroon. The plant has fibrous roots and may root from nodes after tiller elongation. The seed heads are at the top of the plant and consist of 3-5 spikes. The individual spikes have two rows of seedpods.

Large crabgrass is killed by the first frost, although brown patches of plants can remain in uncultivated areas (5, 32, 32, and 34). Large crabgrass is only a problem early in the season when eggplants are planted on bare ground.

Chemical Controls:

- bensulide (Prefar 4E)
 - Percent acres treated: 0.1% (25)
 - Typical rates and frequency of application: 5–6 quarts/A, 1 application
 - Method of application: Broadcast preplant (incorporate 1–2 inches) or preemergence (irrigate within 36 hours with ½ inch water).
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- clethodim (Select 2EC)
 - Percent acres treated: Newer material, data not available
 - Typical rates and frequency of application: 6–8 oz/A, 1–2 applications
 - Method of application: Broadcast, post emergence to the weeds and eggplant when the weed is 2-6 inches tall.
 - REI: 24 hours PHI: 20 days
 - Efficacy: Good
 - Use in IPM and resistance management: Must use an oil concentrate or nonionic surfactant for good control. Control may be reduced if hot dry weather conditions occur. For best control the weed should be actively growing and before tillers are present.

- DCPA (Dacthal W-75)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 8–14 lbs/A, 4-6 weeks after transplanting; 1 application
 - Method of application: Broadcast over plants when eggplant are grown without plastic mulch, or directed spray between rows with plastic mulch as a preemergent weed treatment.
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are 3–12 inches tall.
 - REI: 4 hours PHI: Not available

- Efficacy: Good
 - Use in IPM and resistance management: Controls most weeds and can be used as a preplant postemergent control measure.
- napropamide (Devrinol 50-DF)
 - Percent acres treated: 23.1% (25)
 - Typical rates and frequency of application: 2-4 lbs/A, 1 application
 - Method of application: Broadcast and incorporated prior to transplanting
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good
 - Use in IPM and resistance management: Best chemical for use during periods of wet weather. Good for rotation with the other herbicides to reduce chance of resistance.
 - paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications

Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Fair to good
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.
 - sethoxydim (Poast 1.5EC)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 3–4 applications
Do not apply more than 4.5 pts/A per season.
 - Method of application: Broadcast up to maximum weed height of 6 inches.
 - REI: 12 hours PHI: 20 days
 - Efficacy: Good
 - Use in IPM and resistance management: Must use an oil concentrate or nonionic surfactant for good control. Control may be reduced if hot dry weather conditions occur. For best control the weed should be actively growing and before tillers are present.
 - trifluralin (Treflan HFP)
 - Percent acres treated: 1.1% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 1 application

- Method of application: Broadcast and incorporate within 24 hours prior to transplanting. Do not use under plastic mulch.
- REI: 12 hours PHI: Not available
- Efficacy: Good
- Use in IPM and resistance management: Avoid planting during periods of cold wet weather to reduce the risk of temporary stunting. Good for rotation with the other herbicides to reduce chance of resistance.

Alternatives:

There are good pre and post emergent weed control options for large crabgrass.

Cultural Control Practices:

Cultivation between the rows up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Goosegrass, *Eleusine indica*

Description and Damage:

The plant grows prostrate forming a rosette, but as it matures the stems may turn upward to approximately 24 inches. The leaf sheaths are flattened and have a whitish to silver color in the center. Seeds germinate from early to midsummer when soil temperatures are above 65⁰F. Leaves grow parallel to the ground, lack auricles and have a short, membranous unevenly toothed ligule that is gapped in the center. The blades are smooth and distinctly formed at the midrib. The collar is broad and hairless. Mature plants are similar to the seedlings except there may be some hairs on the blades, toward the ligule on the sheath and on the collar edge. The roots are fibrous and do not root at the nodes. Goosegrass flowers in June through September and seed heads mature from late summer through early autumn. The seed heads are at the top of the plant and consist of 2 to 6 spikes. The individual spikes have two rows of seedpods. The plants die with the first hard freeze (5, 32, 33, and 34).

Goosegrass can compete with eggplant early in the season, especially in fields without plastic mulch. Within row, competition is more of a concern if soil is not thrown around the plants during cultivation.

Chemical Controls:

- bensulide (Prefar 4E)
 - Percent acres treated: 0.1% (25)
 - Typical rates and frequency of application: 5-6 quarts/A, 1 application

- Method of application: Broadcast preplant (incorporate 1–2 inches) or preemergence (irrigate within 36 hours with ½ inch water).
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.
- clethodim (Select 2EC)
 - Percent acres treated: Newer material, data not available
 - Typical rates and frequency of application: 6–8 oz/A, 1–2 applications
 - Method of application: Broadcast, post emergence to the weeds and eggplant when the weed is 2-6 inches tall.
 - REI: 24 hours PHI: 20 days
 - Efficacy: Poor
 - Use in IPM and resistance management: Must use an oil concentrate or nonionic surfactant for good control. Control may be reduced if hot dry weather conditions occur. For best control the weed should be actively growing and before tillers are present.
- DCPA (Dacthal W-75)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 8–14 lbs/A, 4-6 weeks after transplanting; 1 application
 - Method of application: Broadcast over plants when eggplant are grown without plastic mulch, or directed spray between rows with plastic mulch as a preemergent weed treatment.
 - REI: 12 hours PHI: Not available
 - Efficacy: Fair to good
 - Use in IPM and resistance management: Good for rotation with the other herbicides to reduce chance of resistance.
- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.63–1.0 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are 3–12 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Controls most weeds and can be used as a preplant postemergent control measure.
- napropamide (Devrinol 50-DF)
 - Percent acres treated: 23.1% (25)
 - Typical rates and frequency of application: 2-4 lbs/A, 1 application
 - Method of application: Broadcast and incorporated prior to transplanting

- REI: 12 hours PHI: Not available
 - Efficacy: Fair to good
 - Use in IPM and resistance management: Best chemical to use during periods of wet weather. Good for rotation with the other herbicides to reduce chance of resistance.
- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications
 - Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Fair to good
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. Since it is applied only when the weed is present, the development of resistance is reduced.
 - sethoxydim (Poast 1.5EC)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 3–4 applications
Do not apply more than 4.5 pts/A per season.
 - Method of application: Broadcast up to maximum weed height of 6 inches.
 - REI: 12 hours PHI: 20 days
 - Efficacy: Poor
 - Use in IPM and resistance management: Must use an oil concentrate or nonionic surfactant for good control. Control may be reduced if hot dry weather conditions occur. For best control the weed should be actively growing and before tillers are present.
 - trifluralin (Treflan HFP)
 - Percent acres treated: 1.1% (25)
 - Typical rates and frequency of application: 1.0–1.5 pts/A, 1 application
 - Method of application: Broadcast and incorporate within 24 hours prior to transplanting. Do not use under plastic mulch.
 - REI: 12 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Avoid planting during periods of cold wet weather to reduce the risk of temporary stunting. Good for rotation with the other herbicides to reduce chance of resistance.

Alternatives:

There are good pre and post emergent weed control options for goosegrass.

Cultural Control Practices:

Cultivation between the rows up to approximately one month after transplanting will help reduce weed populations.

Biological Control:

None available.

Post Harvest Control Practices:

Incorporate plant residue immediately after harvesting to reduce weed seed production. Planting a cover crop will help keep weeds under control.

Perennial Weeds

Yellow Nutsedge, *Cyperus esculentus*

Description and Damage:

Yellow nutsedge has triangular stems, yellowish green foliage and has a grass appearance before maturity. Tubers, the main form of reproduction, sprout from May until mid-July. Rhizomes spread from the plants that emerge producing new plants until the day length reaches a critical length (late June). The plants produce 0.4 to 0.8 inch tubers and most are located in the top 6 inches of soil. They require a cold period to break dormancy, but remain viable for at least 10 years. Nutsedge leaves are shiny, flat or ridged and formed in groups of three, which give it the triangular shape. Flowers are inconspicuous and are organized on yellow to brown spikelets. These are located on stems and visible from July to September. After the first killing frost foliage and rhizomes die, but the tubers survive in the soil (5, 32, 33, 34).

Yellow nutsedge has the potential to reduce yields in eggplant under any management system. The stems will even push through plastic mulch as the plants emerge from the soil. Nutsedge does not tolerate shading once the plant is established. It is mainly a problem shortly after transplanting through mid season.

Chemical Controls:

- glyphosate (Roundup Ultra Max)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application: 0.5–2.5 qt/A, 1 application
Do not apply more than 6.5 qts/A per year.
 - Method of application: Broadcast at least 3 days prior to transplanting when weeds are 6 inches tall.
 - REI: 4 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Use of glyphosate prior to planting generally is not practical since the soil is tilled and the nutsedge does not emerge until after bedding.

- halosulfuron-methyl (Sandea)
 - Percent acres treated: Newer chemical, data not available
 - Typical rates and frequency of application: 0.5-1.0 oz/A, 1-4 applications depending on rate. Do not exceed 2 oz/A per 12-month period. Up to a 36 month plant-back interval applies depending on the rotational crop.
 - Method of application: Directed spray between rows when weeds are at the 3–5 leaf stage.
 - REI: 4 hours PHI: 30 days
 - Efficacy: Suppresses nutsedge as a preemergent treatment; good as a post emergent application.
 - Use in IPM and resistance management: More than one application may be necessary to control multiple flushes of weeds. Weeds can become resistant to this herbicide if it is used with herbicides with the same mode of action (ALS/AHAS materials). Use mechanical control and chemical weed control from other herbicide classes.

- paraquat (Gramoxone Extra, Gramoxone Max, Gramoxone Super Tres)
 - Percent acres treated: 0.0% (25)
 - Typical rates and frequency of application:
 - Gramoxone Extra: 1.5–3.0 pts/A (preplant), 1.5 pts/A (directed spray); 1-3 applications
 - Gramoxone Max and Super Tres: 1.3–2.7 pts/A (preplant), 1.3 pts/A (directed spray); 1-3 applications
 Do not apply more than three applications per season.
 - Method of application: Broadcast prior to planting or directed spray between rows when weeds are succulent and less than 6 inches high.
 - REI: 12 hours PHI: 30 days
 - Efficacy: Fair
 - Use in IPM and resistance management: This material is used when weeds are present but less than 6 inches tall. The foliage is burnt back, but there is no control of the tubers. Tubers will sprout later.

Alternatives:

There are few alternatives for controlling nutsedge. This is an area where additional options are needed.

Cultural Control Practices:

The use of green plastic mulch will help control the emerging plants. The mulch allows some light through which permits the plants to emerge, but not develop completely.

Biological Control:

None available.

Post Harvest Control Practices:

Post harvest applications of glyphosate in August will reduce tuber survival.

Disease Control

Damping Off, *Pythium sp.*, *Rhizoctonia sp.*

Description and Damage:

Some damping off occurs every year in greenhouse transplant production. Seeds or seedlings may rot before emergence, resulting in reduced plant stands. Post emergence damping off is characterized by lesions that girdle the stem at the base of the plant causing the seedling plant to wilt and die. Fungi survive for long periods in soil and may persist in plant debris or on roots of weeds. Conditions of high soil moisture, overcrowding, compaction, poor ventilation and cool, damp, cloudy weather promotes damping off. Spread occurs from infected to healthy plants through splashing water.

Monitoring:

Growers monitor the transplants as they water the greenhouses.

Chemical Controls:

- thiram (Thiram)
 - Percent acres treated: Unknown
 - Typical rates and frequency of application: 4 oz 75 WP per 100 lbs of seed (2/3 tsp per pound of seed)
 - Method of application: soak seed in hot water at 122°F for 25 minutes. Dry seed then slurry or dust with thiram.
 - REI: 24 hours PHI: Not available
 - Efficacy: Good
 - Use in IPM and resistance management: Seed treatments are recommended for disease prevention.

Alternatives:

SoilGard (see below) is an effective alternative for plants grown in soilless mix.

Cultural Control Practices:

Good sanitation (sterilized planting trays, proper soil pasteurization and weed control in and around the greenhouse) will help reduce damping-off incidence. Fumigation and solarization of greenhouse soil is recommended when producing bare-root transplants or placing trays directly on the soil.

Biological Controls:

Soilless mixes containing microorganisms that suppress damping-off fungi may help with control. SoilGard is a naturally occurring soil fungus that is an antagonist to the plant pathogenic fungi that cause damping off. SoilGard 12G (1-1.5 lb/cu yd of soilless mix) is added during the blending of soilless mixes. One day of incubation is needed prior to seeding or transplanting.

Post Harvest Control Practices:

Not applicable for this pathogen.

Phytophthora Blight, *Phytophthora capsici*

Description and Damage:

Phytophthora is a soil borne pathogen that attacks eggplant throughout the production season, causing collar rot, stem cankers and fruit rot. This disease is present every year in New Jersey where pepper, eggplant, tomatoes and/or cucurbits are grown. *Phytophthora capsici* produces a thick-walled spore that allows it to survive on plant debris in the soil. Losses can be devastating if inoculum levels are high in combination with favorable environmental conditions (prolonged periods of saturated soils). In most years, this disease affects less than 10% of the eggplant crop.

Infections usually begin in low spots or areas of poor drainage. Initial infections appear as a brown or black lesion at the soil level on the stem, which becomes soft and water soaked. Infected stems collapse and the plant dies, usually as a group in the areas of poor drainage. The disease spreads within a field primarily through water movement including splashing irrigation and rainstorms and can spread from field to field on contaminated tools and equipment (29). The aerial phase results from spores splashing from infected plants and soil onto the stems and fruit, causing both stem and fruit rots. The fruit infections are typically round, dark brown areas on the fruit, with an expanding light tan border. A white to gray fungal growth may be present on the lesion, especially during periods of high humidity and moisture.

Monitoring:

Look for wilted plants in the field, especially in low spots and at ends of rows where water can collect after rain or irrigation. The treatment threshold is disease presence.

Chemical Controls:

- fixed copper (Basicop, Champ, Champion, Copper-Count-N, Cuprofix Disperss, Kocide, Super CU, Tenn-Cop, Top Cop with sulfur, Top Cop Tri-Basic, Tri-Basic Copper Sulfate)
 - Percent acres treated: 47% (25)
 - Typical rates and frequency of application: 2 lb 77WP/A or other labeled formulation, 7-10 day schedule for stem and fruit rot (approx. 8-10 applications)
 - Method of application: Foliar application with ground equipment
 - REI: 24 hours PHI: 0 days
 - Efficacy: Good
 - Use in IPM and resistance management: Use with a spreader sticker to prevent the stem and fruit rot phase.

- mefenoxam (Ridomil Gold, Ultra Flourish)
 - Percent acres treated: 45.8% (25, 1997 data), 5.4% (25)
 - Typical rates and frequency of application:
 - Ridomil Gold: 1 pt 4E/A, 3 applications OR
 - Ultra Flourish: 1 qt 2E/A, 3 applications

- Method of application: First application applied broadcast prior to planting or in a 12-16 inch band over the row before or after transplanting. Two supplemental post-directed applications to 6 – 10 inches of soil on either side of the plants at 30-day intervals (7).
- REI: 12 hours PHI: 7 days
- Efficacy: Fair to good depending on local resistance levels
- Use in IPM and resistance management: These chemicals are used for the prevention of collar rot and must be applied to the soil before the plants are infected to obtain satisfactory control. Chemical control must be used in combination with cultural controls for water management for best results.

Alternatives:

Soil fumigation, which is being used for verticillium wilt (see below), is also part of the management strategy for phytophthora. Chemical controls including fumigation must be combined with cultural control practices for effective management of this disease.

Cultural Control Practices:

A key management strategy to reduce the threat of phytophthora is rotation from susceptible crops (cucurbits, peppers, eggplants, and tomatoes) for as long as possible or at least 3 years (1). For many New Jersey growers, good rotations are not feasible due to the lack of land available from other host crops. Other important cultural controls to reduce the development and incidence of phytophthora involve water management in the field, with the goal of keeping water moving away from the base of the plants. Practices include subsoiling, planting on ridges or high (minimum 9”) raised dome-shaped beds, constructing drainage ditches and waterways to remove excess water (including the ends of the rows), avoiding planting low spots where water collects and filling in the transplant holes with clean soil. When collar rot occurs in plastic mulch culture fields, infected plants are rogued and plastic mulch and healthy plants are removed around the infected area.

Biological Controls:

None available.

Post Harvest Control Practices:

Chlorine wash during packing may reduce post harvest losses.

Verticillium Wilt, *Verticillium albo-atrum* and *V. dahliae*

Description and Damage:

Verticillium wilt is a soil borne pathogen that attacks a range of crops including tomatoes, potatoes, peppers, strawberries, okra and brambles. It occurs sporadically as long as fields are rotated from host plants, however it can be present in a field for up to eight years (12). Fields with high levels of verticillium that are not properly managed with good cultural practices like rotation, will have losses as great as 50%. Overall, less than 5% of total acres are affected each year. The fungus can be transported from field to field through infested soil on machinery. This disease attacks the vascular system,

causing interveinal yellowing, wilting and drying of leaves. Symptoms often appear on one side of the leaf or plant, with older lower leaves affected first. Leaf symptoms include a characteristic V-shaped lesion at the leaf tip. Symptoms progress slowly and in late stages, the plant will be permanently wilted and stunted. The presence of root knot or root lesion nematodes may increase the severity of the disease (17). Growers fumigate before planting to control this disease. There are no rescue treatments.

Monitoring:

Monitor fields weekly for symptoms of verticillium and remove infected plants from the field.

Chemical Controls:

- chloropicrin, dichloropropene + chloropicrin (Telone C-17, Telone C-35)
 - Percent acres treated: 0% (25)
 - Typical rates and frequency of application:
 - Chloropicrin: 50 gal/A, once
 - Telone C-17: 11-17 gal/A, once
 - Telone C-35: 13-20.5 gal/A, once
 - Method of application: At least 2-3 weeks prior to planting, inject fumigant 6 – 8 inches into the soil and work the soil immediately after application to reduce fumigant loss;
 - REI: 72 hours PHI: Not applicable
 - Efficacy: Good
 - Use in IPM and resistance management: Fumigation should be combined with good rotations and the use of resistant or tolerant varieties.

- metam-sodium (Vapam), metam-potassium (K-PAM)
 - Percent acres treated: 14.3% (25)
 - Typical rates and frequency of application:
 - Vapam: 56–75 gal HL/A, once
 - K-PAM: 30–60 gal HL/A, once
 - Method of application: At least 2-3 weeks prior to planting, inject fumigant 6 – 8 inches into the soil and work soil the immediately after application to reduce fumigant loss; OR apply via irrigation systems (solid set sprinkler or drip/trickle), injecting fumigant in one inch of water per acre.
 - REI: 48 hours PHI: Not applicable
 - Efficacy: Soil fumigation will provide some control by delaying symptom expression (7).
 - Use in IPM and resistance management: Fumigation should be combined with good rotations and the use of resistant or tolerant varieties.

- methyl bromide (Terr-O-Gas 67, MC-33)
 - Percent acres treated: 0% (25)
 - Typical rates and frequency of application: 225 – 350 lbs/A, once

- Method of application: At least 2 to 3 weeks prior to planting, inject into the soil and seal with a plastic film.
- REI: 48 hours PHI: Not applicable
- Efficacy: Good
- Use in IPM and resistance management: Growers do not use this material in New Jersey.

Alternatives:

There are no alternative chemicals available.

Cultural Control Practices:

Avoid planting in contaminated fields and observe a 4-5 year rotation with crops other than tomato, potato, pepper, strawberry or any of the brambles. Resistant or tolerant varieties like Classic, Epic, Vernal and Viserba appear to maintain yield in infested soils (7).

Biological Controls:

No biological controls are commercially available.

Post Harvest Control Practices:

Not applicable.

Bacterial Soft Rot, *Erwinia spp.*

Description and Damage:

Soft rot bacteria are present wherever eggplants are grown, as they are commonly associated with plant debris, soil, and water. Some losses may occur in the field, but soft rot is primarily a post harvest problem for eggplant. The bacteria enter fruit through cuts, breaks, insect damaged areas and abrasions, and dissolve the material (pectin) that holds plant cells together. As the tissue decays it turns brown, soft and slimy. At the favorable temperature range for infections (75 and 85 °F) the fruit will rot within 3 to 10 days (19). This disease is associated with harvesting during warm, rainy periods and inadequate chlorination when washing fruit after harvest. In New Jersey, this problem occurs primarily during August harvests due to the favorable environmental conditions. Losses can be high since loads may be rejected due to high levels of rotted fruit.

Monitoring:

Look for discolored areas on the stem or fruits or a slimy rot on stems and fruit. Avoid harvesting when plants are wet or planting after potatoes and cabbage.

Chemical Controls:

There are no chemical controls to prevent bacterial soft rot from developing.

Alternatives:

No chemical alternatives are available.

Cultural Control Practices:

To reduce losses from this disease careful handling of fruit during harvesting and packing and controlling insects, is necessary. When environmental conditions are favorable for soft rot, avoid picking fruit when fields are wet and do not pick in the heat of the day. Practice good sanitation such as removing infected fruit from the field.

Biological Controls:

No biological controls are available.

Post Harvest Control Practices:

During packing, maintain chlorine concentration at 75 – 150 ppm and avoid wash water temperature differences of more than 10 °F from fruit field temperatures. Cold water on hot fruit will increase the movement of bacteria into the fruit. Storage temperatures should be 45 – 50 °F. Disinfect picking containers.

Phomopsis Blight, *Phomopsis vexans***Description and Damage:**

Phomopsis Blight is a sporadic fungal disease that affects all plant parts of eggplant throughout crop development, including leaves, stems and fruit. The disease overwinters in plant debris, is favored by hot, wet weather, and spreads through splashing rain. Young seedlings may be infected soon after emergence. Dark lesions at the soil line become sunken and eventually cause stem girdling and seedling death. Leaves may be attacked throughout the season, resulting in premature leaf drop. Leaf spots are clearly defined, up to 1 inch in diameter, brown to gray with narrow dark brown margins and black specks (pycnidia) in lesion centers. Spots and cankers can also form on mature stems and branches. Fruit lesions occur as pale, sunken circular areas with pycnidia, tiny black spots embedded in the center of the lesion. The fruit damage is the greatest concern (27) since the fruit will be rendered unmarketable. Growers treat fields preventatively from fruit set through frost.

Monitoring:

Look for the presence of the disease while scouting for other pests. Check at least weekly throughout the growing season. The threshold is presence of the disease.

Chemical Controls:

- azoxystrobin (Quadris)
 - Percent acres treated: 1.9% (25)
 - Typical rates and frequency of application: 6.2 – 15.4 fl oz 2.1F/A, up to 4 applications
 - Method of application: Foliar application with ground equipment
 - REI: 4 hours PHI: 0 days
 - Efficacy: Good
 - Use in IPM and resistance management: The strobilurins (Flint, Quadris, and Cabrio) must be rotated with other classes of fungicides to reduce the development of resistance.

- fixed copper (Basicop, Champ, Champion, Copper-Count-N, Cuprofix Disperss, Kocide, Super CU, Tenn-Cop, Top Cop with sulfur, Top Cop Tri-Basic, Tri-Basic Copper Sulfate)
 - Percent acres treated: 47% (25)
 - Typical rates and frequency of application: 2 lb 77WP/A or other labeled formulation, 7-10 days or approximately 8-10 applications.
 - Method of application: Foliar application with ground equipment
 - REI: 24 hours PHI: 0 days
 - Efficacy: Copper + maneb sprays for phytophthora also control stem and leaf phase of phomopsis (12).
 - Use in IPM and resistance management: Treat on a 7-10 day schedule when the disease first appears.

- maneb (Maneb)
 - Percent acres treated: 27% (25)
 - Typical rates and frequency of application: 1.5 – 2.0 lb 80WP/A or other labeled formulation, 7-10 days or approximately 8-10 applications.
 - Method of application: Foliar application with ground equipment
 - REI: 12 hours PHI: 5 days
 - Efficacy: Good
 - Use in IPM and resistance management: Treat on a 7-10 day schedule when the disease first appears.

- pyraclostrobin (Cabrio)
 - Percent acres treated: New material, data not available
 - Typical rates and frequency of application: 8 – 12 oz 20EG/A, up to 4 applications
 - Method of application: Foliar application with ground equipment
 - REI: 12 hours PHI: 0 days
 - Efficacy: Good
 - Use in IPM and resistance management: The strobilurins (Flint, Quadris, and Cabrio) must be rotated with other classes of fungicides to reduce the development of resistance.

- trifloxystrobin (Flint)
 - Percent acres treated: New material, data not available
 - Typical rates and frequency of application: 1.5 – 2 oz 50WDG/A, up to 4 applications
 - Method of application: Foliar application with ground equipment
 - REI: 12 hours PHI: 0 days
 - Efficacy: Good
 - Use in IPM and resistance management: The strobilurins (Flint, Quadris, and Cabrio) must be rotated with other classes of fungicides to reduce the development of resistance.

Alternatives:

All three of the newest chemicals that are labeled for eggplant (Flint, Quadris, and Cabrio) are in the same fungicide class. Resistance has been documented with the strobilurins when resistance management practices like alternating classes of fungicides are not followed. Copper and maneb are the only fungicides labeled on eggplant that can be used in rotation with the newer materials.

Cultural Control Practices:

Cultural control practices include rotation, destruction of infected plant material, disease free seedbed soil and disease free transplants. Resistant varieties for the seedling canker phase include 'Florida Market' and 'Florida Beauty' (12, 27). However, these varieties are not commercially acceptable in New Jersey. There are no resistant varieties for the leaf, stem, and fruit phases.

Biological Controls:

No biological controls are available.

Post Harvest Control Practices:

During packing, maintain chlorine concentration at 75 – 150 ppm and avoid wash water temperature differences of more than 10 °F from fruit field temperatures. Storage temperatures should be 45 – 50 °F. Disinfect picking containers.

Nematode Control

Description and Damage:

Plant parasitic nematodes are non-segmented roundworms that live in the soil and feed on plant roots. Symptoms include a general lack of plant vigor, chlorosis of the foliage, stunting and progressive dying of the older leaves. Infestations are typically clumped in a field, resulting in patches of affected plants, although tillage will widen the areas of infestations over time. Root knot (*Meloidogyne hapla*) and lesion (*Pratylenchus penetrans*) nematodes have been associated with verticillium in eggplant production. Both are widespread in agricultural areas and have a wide host plant range that includes many vegetable crops. Root knot nematodes are about 1/20 inch in length. Root knot juveniles attack the roots, penetrating as far as the vascular system. Secretions at the feeding sites cause cells to enlarge and multiply, resulting in characteristic root galls. Lesion nematodes are smaller, at 1/50 inch in length. They enter the root and damage the surface of the root. Infected roots may not develop properly and small lesions will be present. In the major production areas, nematodes are a minor pest. However, the presence of root knot or root lesion nematodes may increase the severity of verticillium symptoms (17).

Monitoring:

Soil samples can be taken in the fall to assess nematode populations for fields to be planted the following spring. To determine if nematodes are present in a current production field, growers take soil samples within the suspected infested area.

Chemical Controls:

- chloropicrin, dichloropropene + chloropicrin (Telone C-17, Telone C-35)
 - Percent acres treated: 0% (25)
 - Typical rates and frequency of application:
 - Chloropicrin: 50 gal/A, once
 - Telone C-17: 11-17 gal/A, once
 - Telone C-35: 13-20.5 gal/A, once
 - Method of application: At least 2-3 weeks prior to planting, inject fumigant 6 – 8 inches into the soil and work the soil immediately after application to reduce fumigant loss.
 - REI: 72 hours PHI: Not applicable
 - Efficacy: Good
 - Use in IPM and resistance management: Soil samples are taken to determine if damaging levels of nematodes are present.

- fenamiphos (Nemacur)
 - Percent acres treated: 0% (25)
 - Typical rates and frequency of application: 3-5.9 fl oz 3SC/1,000 linear foot of row or other labeled formulation, once.
 - Method of application: Apply in a 12-inch band over the row at transplanting and immediately incorporate into the soil.
 - REI: 48 hours PHI: Not applicable

- Efficacy: Good
 - Use in IPM and resistance management: Will provide nematode control only. New Jersey growers typically do not use this material because of the lack of disease and weed control.
- metam-sodium (Vapam), metam-potassium (K-PAM)
 - Percent acres treated: 14.3% (25)
 - Typical rates and frequency of application:
 - Vapam: 56–75 gal HL/A, once
 - K-PAM: 30–60 gal HL/A, once
 - Method of application: At least 2-3 weeks prior to planting, inject fumigant 6 – 8 inches into the soil and work soil the immediately after application to reduce fumigant loss; OR apply via irrigation systems (solid set sprinkler or drip/trickle), injecting fumigant in one inch of water per acre.
 - REI: 48 hours PHI: Not applicable
 - Efficacy: Soil fumigation will provide some control by delaying symptom expression (7).
 - Use in IPM and resistance management: Soil samples are taken to determine if damaging levels of nematodes are present.
 - methyl bromide (Terr-O-Gas 67, MC-33)
 - Percent acres treated: 0% (25)
 - Typical rates and frequency of application: 225 – 350 lbs/A, once
 - Method of application: At least 2 to 3 weeks prior to planting, inject into the soil and seal with a plastic film.
 - REI: 48 hours PHI: Not applicable
 - Efficacy: Good
 - Use in IPM and resistance management: NJ growers do not use this material.

Alternatives:

There are no alternative materials for nematodes. Vydate L is labeled for nematode control on eggplant, but it is on the list of materials under EPA review.

Cultural Control Practices:

Some cover crop plants are suppressive to nematode populations. Some antagonistic crops like marigold and asparagus produce chemicals that are toxic to nematodes. The incorporation of large amounts of organic matter reduces population levels as well. The decomposition products of some plants kill nematodes, such as butyric acid from ryegrass and timothy and isothiocyanates from rapeseed and other plants in the genus *Brassica*. The maximum benefit of these 'natural nematicides' is obtained when plant material is incorporated into the soil as green manure (7). Tarping areas where green manure is incorporated is likely to enhance efficacy.

Biological Controls:

Biological control of nematodes is an active area of research, but at this time there are no commercially available products that are consistently effective (1).

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