

Crop Profile for Corn (Sweet) in Delaware

Prepared: August, 2000

Chemicals Revised August, 2006^[1]

General Production Information

- In 1998, 3,700 acres of sweet corn were planted in Delaware, an increase of 300 acres from that planted in 1996.
- In 1998, 3,600 acres of sweet corn were harvested in Delaware, an increase of 300 acres from that harvested in 1996.
- Production from 1996 to 1998 rose from 330,000 Cwt to 385,000 Cwt.
- The value of production, however, fell from \$5,940,000 in 1996 to \$5,506,000 in 1998.
- In 1998, 10,800 acres of sweet corn were planted in Delaware, an increase of 3,300 acres from that planted in 1996, but a decrease of 4,500 acres from that planted in 1997.
- In 1998, 10,700 acres of sweet corn were harvested in Delaware, an increase of 3,300 acres from that harvested in 1996, but a decrease of 4,600 acres from that harvested in 1997.
- Production in tons during 1996, 1997 and 1998 was 57,7000, 93,330, and 62,810 respectively.
- The value of production during 1996, 1997 and 1998 was \$3,838,000, \$6,505,000 and \$6,614 respectively.

Production Regions

Sweet corn is grown throughout Delaware

Cultural Practices

Sweet corn is a warm-weather crop. It can be planted as early as April, with successive plantings in spring and summer. However, in Delaware, corn planted later suffers much higher earworm damage. Corn germinates best in soil temperatures above 55 degrees F. The four major variety groups are white, yellow, bicolor, and supersweet varieties. Hybrids or varieties resistant to Stewart's wilt should be used. Seed should be treated with a fungicide. Some varieties that grow well in Delaware include:

Yellow: Northern Belle and Gold Cup

White: Quick Silver and Silver Queen

Bicolor: Sweet Sue

Sweet corn varies in days to maturity and is divided into early-, mid- and late-season maturing varieties.

Good soil fertility is important in growing high-quality sweet corn. The soil pH should be within a range of 6.0 to 6.8. Add lime to soil to maintain this pH range--generally 50 pounds of ground limestone per 1,000 square feet every 3 to 4 years.

Fertilizer rates

Broadcast 2 to 3 pounds of 5-10-10 or 10-10-10 per 100 square feet. Work this into a depth of 2 to 3 inches before planting, leaving a smooth seed bed. A sidedressing of 10-10-10 or ammonium nitrate when the corn is 10 inches high can help to increase the yield and quality. Avoid direct fertilizer contact with plants.

Planting

Plant sweet corn at a depth of 1 to 2 inches in rows 30 to 36 inches apart, with 10 to 12 inches between seeds. Too many seedlings in a row act like weeds, choking out the crop. Since pollen is carried across the rows by wind, never plant sweet corn adjacent to field corn. They will cross-pollinate, resulting in sweet corn with poor flavor and quality.

Moisture Requirements

Sweet corn requires a continuous supply of water for a high-yielding, quality product. If rainless periods last more than 2 weeks in the early growth stages, irrigate. As corn begins to tassel, continuous water supply becomes critical. Water is needed--about 1 inch per week from tasseling through harvest.

Harvesting

Harvest corn when the silks from the ear are brown and dry beyond the end of the husks. The ear should fill the husk so that the husk feels tight around the ear. Mature, kernels are soft, tender, and filled with a milky juice. Kernels that begin to dent are too mature. After harvest, sweet corn begins to lose quality very quickly.

Insect Pests

The most important pests in sweet corn are those which invade and damage corn ears, primarily European corn borer, corn earworm, and fall armyworm (13, 15). Another important early season pest is the black cutworm, though cutworm infestations tend to be more sporadic than the ear-invading pests. The corn flea beetle can be a problem on some varieties, as a vector of Stewart's bacterial wilt disease

early in the season (5).

Ear-Damaging Pests: European corn borer, corn earworm, and fall armyworm

Pests that invade the ear are the most important consideration in sweet corn pest management, since very little damage can be tolerated (15). Most processors can accept no more than 5% of ears with severe damage at the tip and no more than 1% of ears with side-kernel damage before the grading of corn is affected. Severe tip damage is defined as having about an inch of the tip affected. Up to 20% of ears with very minor tip injury (0.25 inch or less) are acceptable to most processors. In all cases the amount of damage accepted depends on the sweet corn variety and the needs of the customer (7). Damage tolerance is generally much lower for fresh market sweet corn (16). Growers need to obtain 95% to 98% clean ears. European corn borer, corn earworm and fall armyworm are the major ear-invading pests in Delaware (17) and are the focus of IPM programs (15). Treatment recommendations are based on larvae present during whorl and tasselling stages, before larvae invade the ears, and on blacklight trap and pheromone trap catches of adults (17).

European corn borer (*Ostinia nubilalis*)

Damage and Life Cycle

The European corn borer is a serious pest of sweet corn. Female moths lay their eggs on the underside of corn leaves from mid-May to early June. Eggs hatch in 3 to 7 days, depending upon temperature. The emerging larvae feed on leaves within the inner whorl of the plant. Larvae damage the whorls, which may affect yields for certain varieties, depending on the timing of the damage (17). During tassel development, larvae tunnel into the stalk, where extensive tunneling sometimes causes breakage. Eventually, larvae outgrow the stalk and move to the developing ear, where they may feed on the silks. Larvae enter the ear via the silks, or from the shanks or side by burrowing through plant tissues. They feed on kernels throughout the cob, causing extensive damage to the ear and reducing marketable yields (15). European corn borer generally has 2 to 3 generations in Delaware (18). It overwinters as a larva in its burrow in the sweet corn stalk or in the stem of a different host plant. Larvae pupate in late April or May, and adults emerge after 2 weeks to continue the next cycle (10).

Frequency of Occurrence

European corn borer is present and affects sweet corn yields every year; however, the percent of ears damaged and the timing of the damage can fluctuate from year to year. Annual fluctuations in moth populations affect insecticide applications for European corn borer (4).

Corn earworm (*Helicoverpa zea*)

Damage and Life Cycle

Corn earworm is the most destructive pest of sweet corn (16). In the mid-Atlantic, pupae overwinter in

the soil, but only survive in areas where the frost line is less than an inch below the soil surface. Surviving moths emerge and mate, and females deposit eggs on sweet corn foliage. The early-season larvae that hatch from these eggs may feed on the whorls or undeveloped tassels, but this feeding rarely affects corn production or quality. Adult corn earworms are highly mobile, and moth populations invade the Mid-Atlantic region from the south by mid-summer. Migrant females lay eggs singly on fresh corn silks during July and August (10). These larvae hatch in 3 to 5 days and begin feeding on the silks, working their way into the ear, where they continue feeding on kernels. Corn earworm damage is usually limited to the tip of the ear. Larvae feed and develop for 10 to 21 days, then cut through the husk as they exit the ear. They drop to the soil, where they pupate for about 14 days, after which adults emerge to begin the next generation (16).

Frequency of Occurrence

The severity of winter temperatures and the amount of snowfall greatly influence the overwintering range of corn earworm from year to year (10). Adults produced from this first generation plus those migrating from southern states produce the larval generations which invade the ear. The timing and magnitude of these summer broods vary considerably from year to year and from region to region, and are influenced by winter and spring weather conditions (16). The number of moths present each year affects management decisions, which are based on thresholds (17).

Fall armyworm (*Spodoptera frugiperda*)

Damage and Life Cycle

The fall armyworm overwinters in Florida and the Gulf Coast. Each year, adult moths migrate into the Mid-Atlantic region, usually in late June. Each female moth can produce about 1,000 eggs. Eggs are deposited in groups of 50 to 200 on the underside of corn leaves. Larvae feed gregariously in the whorl when young, then disperse as they grow (16). Plants can generally compensate for feeding damage in the whorl stage, although extensive feeding during the early whorl stage may stunt the corn and reduce yields (10). Larvae also feed on undeveloped tassels. Larvae feed and develop for 2 to 3 weeks, then pupate in the soil. A new brood of moths emerges within 2 weeks to continue the life cycle (16). There are 2 or 3 generations per season in Delaware. Late in the season, when whorls are not available, larvae may enter ears through the silk tube and feed on kernels, causing severe damage to the ear (10). Fall armyworm becomes such a problem late in the season that it is a limiting factor in the production of late season sweet corn maturing after August 21 (13).

Frequency of Occurrence

Fall armyworm is considered a sporadic but important pest throughout the Northeast. It moves into the Mid-Atlantic region from the south, and the timing of its arrival is dependent on weather patterns. Also, moths are generally more numerous along coastal regions. A cold, wet spring in the south can promote fall armyworm survival (10).

Normally, fall armyworm starts to cause economic damage in late July and then infestations steadily

increase through the remainder of the growing season, however, moths can arrive as early as late June, at which time they lay eggs on whorl stage corn (4). The timing of moth arrival as well as the population level will influence the number of insecticide applications (4, 7).

IPM Program for Ear-Damaging Pests

Field scouting for larvae and monitoring of adults with blacklight traps and pheromone traps are used to maximize effectiveness of control strategies against European corn borer, corn earworm and fall armyworm (15). Trap catches of European corn borer and fall armyworm give a good indication of the level and timing of larval infestation of whorls. Whorl-infesting larvae can cause significant damage when populations are high (7). The early tassel stage is the most effective time to apply insecticide for control for European corn borer and fall armyworm, since it prevents worms from migrating to the ears (9, 10). Treatment is applied to most varieties of fresh market corn if over 30% of whorl plants harbor live European corn borer and/or fall armyworm larvae. Some early season varieties are more susceptible to damage and are treated if larval infestation exceeds 15% of whorl plants. A single treatment directed at the whorls usually provides sufficient control for corn borer. In general, 2 to 3 whorl applications are needed to control fall armyworm. During tasseling, the stage of corn earworm larvae present in fresh market sweet corn will determine whether treatment is applied. If late instar larvae are found on green tassels, they will soon leave the plant to pupate in the soil, without causing damage to the ear. However, if high numbers of young larvae are present on more than 15% of emerging tassels, an insecticide treatment is applied. Treatment is also applied to fresh market sweet corn if more than 15% of tassels are infested with European corn borer and/or fall armyworm. Treatment decisions for processed sweet corn during the whorl and tassel stages are based on number of infested plants with light, moderate, or heavy European corn borer feeding damage (17).

Management decisions during the silking stage for European corn borer and corn earworm are made primarily based on blacklight and pheromone trap counts of adults. A network of traps run by the University of Delaware Cooperative Extension's IPM Program and Consultants is used to monitor these pests statewide during the silking stage. Growers have access to this information via "hotlines" and websites and can use it to make control decisions. For fall armyworm, the level of activity during whorl and tassel stages of other plantings on the same farm give a good indication of the potential for ear infestation of nearby silking corn (17). For processed sweet corn, fields are scouted during silking to determine the levels of control achieved by chemical treatments (7). Direct sampling of ears during silking to determine the percentage of ears damaged is the most accurate way to decide if further control measures are prudent; however, a high level of adult activity, as determined by pheromone trap catches, may indicate the need for fixed treatment schedules and eliminate the need for direct sampling (7, 17).

Chemical Controls for Ear-Damaging Pests:

Treatment regimes in Delaware are directed against this important pest complex (4). Timing of

insecticide applications and delivery of the chemical to the target site are the keys to effective management of ear-invading pests (15). For most effective control, insecticides are applied during the whorl stage for first generation European corn borer and fall armyworm (10) and during tasseling, while larvae of all three species are dispersing (17). Lambda-cyhalothrin (Warrior 2.56-3.84 fl oz 1E/A) is the most frequently used chemical insecticide in sweet corn (4, 13, 20). Warrior is applied at rates as low as 2 fl oz 1E/A early in the year for European corn borer and corn earworm control when population pressure is low. When populations are high, and later in the season for fall armyworm control, the highest labeled rates are often used. Growers utilize the full range of labeled rates depending on the populations of pests present (7).

Timing and number of applications

The timing and total number of insecticide applications can vary considerably from year to year, as influenced by the timing and level of infestation.

European corn borer -- Insecticide sprays can be eliminated for the first 40% of the processing acreage during a low infestation year, whereas 2 to 3 sprays are required for the early to late acreage during high infestation years (4, 7). Processed corn is typically sprayed with insecticides 3 to 4 times during the season, not just for European corn borer, but for all insect control. Very rarely, in years when insect populations are unusually low, 1 to 2 sprays may be sufficient (7). Fresh market sweet corn generally received one tassel spray for ECB. In addition to corn earworm control, at least 2 silk sprays are needed to provide corn borer control in early planted fields.

Corn earworm -- On processing corn, usually the first 25% of the acreage does not require treatment for corn earworm, and 1 to 3 properly timed applications will prevent economic ear damage on the rest of the acreage during years when corn earworm populations are low. In high infestation years, the following treatment regimes may be necessary: one application on the first 25% of acreage, 2 to 3 applications on the next 50% of the acreage, and 4-6 applications on the last 25% of acreage (4). Fresh market sweet corn is sprayed 4 to 8 times for corn earworm control depending on the insect pressure and the time of planting.

Fall armyworm -- During years with early flight activity, more than 50% of whorl-stage corn may be treated 1 or 2 times specifically for fall armyworm and more frequent applications may be needed later in the season. In years when moth migration occurs later, damage still occurs, though fewer acres are treated (7).

Insecticide Use

Fresh Market

Lambda-cyhalothrin accounts for 80%-85% of chemical treatments directed against ear-infesting pests from whorl through silking stages for fresh market sweet corn (4, 20). Permethrin (Permethrin 3.2EC; 4-

8 fl oz A) is next in popularity (about 10% of acres) followed by esfenvalerate (Asana XL 5.8-9.6 fl oz 0.66EC/A) (about 5% of acres). Permethrin has provided better European corn borer control than esfenvalerate, based on growers' experience and on research results (20). Methomyl (Lannate 1.5 pt LV/A) is used to a lesser extent in Delaware since it offers less consistent control of European corn borer and corn earworm compared to the pyrethroids (7, 13, 20). Methomyl is used on about 10% of the acreage of late planted sweet corn when fall armyworm is present in the silk stage. It is either alternated or combined with a pyrethroid (20). Two to three foliar spray applications of lambda-cyhalothrin or thiodicarb (Larvin 20-30 fl oz 3.2F/A) with high-spray gallonage (50 to 75 gallons of water per acre) were used to get effective control of fall armyworm in the whorl stage for fresh market sweet corn (9, 13, 20). Thiodicarb was only used against corn earworm in silk stage corn if fall armyworm is also present (13, 20). Thiodicarb has a ground water advisory statement on the label which may limit its use in Delaware. Fresh market growers typically use 4 to 8 insecticide applications per crop season, depending on infestation levels as determined by scouting and monitoring practices (7).

Processing

Processing sweet corn is treated less frequently than fresh market sweet corn, since processing corn can tolerate higher levels of feeding damage (13). Growers of processing sweet corn typically use an average of 3 to 4 insecticide applications seasonally, with 4 to 6 applications typical for late-planted sweet corn (7). Lambda-cyhalothrin is the primary insecticide used by processors for control of ear-infesting lepidopteran pests. It is used on about 95% of the acreage. Lambda-cyhalothrin may be combined with methomyl instead of thiodicarb for late season fall armyworm control in processing sweet corn (7, 20) since restrictions on thiodicarb prohibit its use in processing sweet corn (9). Growers have used permethrin on the remaining acres treated, accounting for about 5% in the past few years (20).

Additional chemical controls which are used rarely in Delaware against these ear invading pests are (7, 9):

For European corn borer and fall armyworm only:

1. diazinon (7-14 lb 14G/A) [Whorl application only (20).]
2. *Bacillus thuringiensis* var. *kurstaki* (DiPel 1.5-2 pt ES/A applied over whorls using conventional ground or center pivot irrigation systems or DiPel 5-10 lb 10G/A by ground or by aircraft (9).) [Few growers use this product, since efficacy of granular whorl application is greatly reduced with rainfall (7).]

For European corn borer only:

1. methyl parathion (PennCap-M 2-4 pt 2FM/A) [Growers do not use PennCap-M during tasseling and pollen shed as it will seriously reduce bee populations (13). Used only when European corn borer pressure is very high, or where another chemical control has failed (7).]
2. chlorpyrifos (Lorsban 6-8 oz 15G/1,000 ft of row applied at planting) [Less than 10% of fresh

market acreage is treated (4).]

Alternative Controls for Ear-Damaging Pests

No cultural or biological control strategies are used against ear-damaging pests in Delaware (13).

Natural Controls

There are several natural predators and parasites of the European corn borer in Maryland, though these generally do not keep populations below economic injury levels (10).

Transgenic Bt Sweet Corn

In 1998, Maryland and Delaware growers harvested about 3,500 acres of processed sweet corn genetically engineered with the *Bacillus thuringiensis* (Bt) gene (13). A limited amount of fresh market Bt sweet corn was planted on a trial basis (4). These new genetically engineered varieties offer effective control of ear-invading lepidopteran pests, and should reduce the need for insecticide treatments. However, under lower insecticide use regimes, some minor pests typically controlled by materials applied for ear pests may require treatment in Bt corn to prevent economic infestations. For example, dusky sap beetle requires chemical control as it is not affected by the Bt gene (4, 21).

Bt varieties give nearly 100% control of European corn borer, and at low to moderate population pressure also suppress corn earworm and fall armyworm. Early in the season, the level of control achieved is typically sufficient to prevent economic damage to the ear in processing and most fresh market fields. However, under high pressure late in the growing season, some corn earworm and many fall armyworm larvae survive Bt expression and invade the ear tip (4). These larvae pose an ear quality problem for most fresh market farmers and many processors. Thus, 1 to 4 foliar insecticide treatments are typically necessary to control these survivors and also control non-target pests such as dusky sap beetles (4, 7). The product typically used on Bt sweet corn is lambda-cyhalothrin (Warrior 2.56-3.84 fl oz 1E/A). Late plantings of Bt corn should be avoided, since population pressure of fall armyworm late in the season results in insufficient pest suppression and can dramatically affect sweet corn yield and quality (7).

Pest mortality tends to be very high in Bt sweet corn, and the selective pressure placed on pest populations may speed the rate of pest adaptation to these crops. Researchers have been working closely with EPA and seed producers to develop resistance management strategies for genetically altered crops. Research models indicate that by maintaining patches of susceptible, non-engineered crops within or near a transgenic crop, growers can greatly slow the development of resistance in the pest population by providing Bt-susceptible mates (22, 23). However, no refuge of non-Bt sweet corn is required with the use of Bt sweet corn. Instead, the nearby non-Bt field corn acreage and other host plants are expected to provide enough susceptible insects to dilute resistance. In addition, growers are required to destroy the remaining stalks of Bt sweet corn within 30 days after harvest to prevent any surviving larvae from

reaching pupation. This practice, plus the fact that a portion of the Bt sweet corn acreage will receive supplemental insecticides, will ensure the high dose strategy and reduce the risks of resistance development (4). Also, seed companies require growers using Bt sweet corn varieties to scout fields for the development of resistant European corn borer and corn earworm individuals and to use IPM strategies for the management of non-target pests (21), although at this time there are no specific guidelines as to what constitutes sufficient scouting or IPM strategies (7).

The Bt hybrids are an excellent new pest management option for fresh market growers and processors, but will require careful and intensive management to assure adequate economical pest control and to avoid the development of resistant insect pest populations (7).

Other Major Insect Pests in Delaware

Cutworms

Damage and Life Cycle

Cutworms are a sporadic but potentially serious early-season pest of sweet corn in the Northeast (10). Black cutworm (*Agrotis ipsilon*), the most damaging cutworm species in sweet corn, also feeds on a broad range of other vegetable crops. The life cycle is not completely known for this pest in the Mid-Atlantic states. It may overwinter as a mature larva or a pupa, or perhaps adults are carried on the wind from the South. Females deposit eggs on debris or dense weeds in moist soil during April and early May. Eggs hatch in 7 to 14 days, and young larvae feed on the leaves of young corn plants. Larger larvae bore into plant stems or cut stems at or below ground level. Larvae develop through 7 instars, feeding for 4 or 5 weeks before pupating in the soil. Two more generations appear in the summer, but are not damaging to corn (18).

Frequency of Occurrence

Cutworms are a sporadic but serious pest of sweet corn (20). In many cases, infestations are lower on sweet corn than field corn, because most fields are conventionally-tilled and rotated with other crops, and thus do not possess the field characteristics that favor cutworms (4). However, sweet corn growers who use no till or minimum tillage practices, or those who rotate with small grain rather than vegetable crops, typically have more cutworm problems (11). There is considerable variation in this pest regionally (13). Moth populations can fluctuate considerably from year to year as well (19).

IPM Program

Sweet corn fields are scouted for cutworm damage from April through early June, and blacklight and pheromone traps are used to monitor adult populations (18). Treatment is recommended at the 1 to 2 leaf

stage if more than 10% of plants show larval feeding damage or 3% cut plants. Corn in the 3 to 4 leaf stage is treated if 5% of plants have been cut and 4 or more cutworms are found per 100 plants. However, stand count has an influence on management decisions, since it will affect the amount of damage that can be tolerated (10). Generally, growers only treat areas that have a history of cutworm infestation, or when a problem occurs (7, 13).

Chemical Controls

Preventive treatments applied before or during planting are generally not used, since cutworm problems are difficult to predict and effective rescue treatments are available (15). Rescue treatments are typically applied to less than 5% of acreage annually, usually to minimum tillage fields or those following small grain cover crops (20). Chemical applications for cutworms are applied in the evening to achieve maximum control (11). The primary insecticides used in Delaware are lambda-cyhalothrin (Warrior 2.0-2.75 fl oz 1E/A) and permethrin (4-8 fl oz Permethrin 3.2EC/A). (Note that both of these are used at low or below label rates.) Both chemicals are effective and market price generally determines which one is used (7). There are no differences in insecticide usage between fresh market and processed sweet corn for control of cutworms (7, 13).

Alternative Controls

None available

Corn flea beetle (*Chaetocnema publicaria*)

Damage and Life Cycle

Corn flea beetles overwinter as adults in litter and debris around fields and feed on weeds until early corn seedlings become available in late April or May. Eggs are scattered in the soil at the base of young corn plants. Larvae hatch in 10 to 14 days and feed on the roots for 3 to 4 weeks before tunneling into the soil to pupate. Three or more generations are completed annually (10). Direct damage due to adult feeding on leaves is insignificant except in the most severe infestations of slow-growing sweet corn varieties; however, feeding can transmit Stewart's bacterial wilt (also known as bacterial wilt disease) to susceptible varieties (18). Some of the processing varieties and many of the fresh market varieties are susceptible to Stewart's wilt (7). The disease appears in late May and becomes progressively worse throughout the season (18). Incidence of bacterial wilt on sweet corn has been shown to be directly related to the size of corn flea beetle populations. Control of the flea beetle is the primary means of preventing the disease (10).

Frequency of Occurrence

In recent years corn flea beetle has become an increasingly important pest where annual populations justify preventive control of the beetle to discourage the spread of Stewart's bacterial wilt (7). The most severe infestations occur when a mild winter is followed by a cool spring (18).

IPM Program

Flea beetles are an important component of IPM programs in Delaware (7). Scouting for beetles throughout the fields during the spike stage on calm sunny days can give an indication of the level of beetle activity (18). Treatment is recommended if 5% of plants or more are infested with beetles (10). Fields are scouted following preventive insecticide application, since sometimes systemics provide insufficient control when beetle pressure is high (7).

Chemical Controls

Preventive systemic soil insecticides are applied at seeding to control corn flea beetle on about 95% of fresh market and about 90% of processing acreage (7, 24). Carbofuran (Furadan 2.5 fl oz 4F/1,000 ft of row in the seed furrow at planting) and terbufos (Counter 8 oz 15G/1,000 ft of row in the seed furrow or 8-16 oz 15G/1,000 ft of row if banded) are the most commonly used products. Fields are routinely scouted to determine the efficacy of preventive insecticides. Some years, an additional foliar insecticide applications (1-3) are needed on some fresh market fields when beetle populations are high. The most commonly used foliar insecticides are lambda-cyhalothrin (Warrior 2.56-3.84 fl oz 1E/A) and permethrin (4-8 fl oz Permethrin 3.2EC/A). Both products are effective, so product selection is driven by price. Processing sweet corn rarely requires foliar insecticides for control of flea beetle (7).

Pesticide Use Issues

On the Eastern Shore, the loss of systemic soil insecticides for control of flea beetle would result in a significant increase in the number of foliar applications. Also, these products give a broad spectrum of control with a single economical application, suppressing populations of soil pests such as wireworms and grubs in addition to controlling flea beetles. Flea beetle control is critical to prevent outbreaks of bacterial wilt, which in extreme cases have resulted in up to 80% yield loss in some fields (7). Typical annual yield loss from bacterial wilt in fresh market sweet corn in Delaware is about 2-3% yield loss.

Alternative Controls

Most processing varieties show some level of resistance to bacterial wilt (5). Where possible, growers use cultivars resistant to bacterial wilt disease (9), especially for early plantings during cool springs following mild winters (13). However, market demands often require that growers choose susceptible varieties with other characteristics over varieties with bacterial wilt resistance (7).

No biological control strategies are available to control this pest (13).

Dusky sap beetle (*Carpophilus lugubris*)

Damage and Life Cycle

Adult and pupal stages of the dusky sap beetle overwinter in corn refuse in the soil or in protected places above ground. Adults are first noticed at about the time tassels appear on the earliest sweet corn. They invade corn borer tunnels and feed on frass. They also feed on the pollen as it ripens on the tassels and later as it lodges in the leaf axils. Mating and egg laying begin when the females are 5 to 6 days old. Eggs are deposited on worm frass and wet accumulations of pollen, which are suitable for larval development if these sites remain moist for 10 to 14 days. Sap beetle activity increases as the corn matures, and adults usually invade the ear when the silks begin to turn brown. The majority of eggs are laid on worm frass at the ear tip or scattered through the silk strands. As the larvae hatch, they move deeper into the ear where they penetrate and hollow out the developing kernels. Full-grown larvae leave the ear and burrow into the soil to pupate. At least 2 or 3 overlapping generations occur each year in the mid-Atlantic region (16).

Frequency of Occurrence

Dusky sap beetle is a sporadic but important pest of sweet corn (7, 15). Previously, this pest was controlled by chemical applications made for key pests. It is an emerging problem in Bt sweet corn where these chemical applications have been reduced (4, 7). Winter survival is an important factor in determining the spring population. Many overwintering adults are killed by freezing temperatures during December and January. Sap beetle problems are most severe during late June, July, and into August (7, 25), particularly if corn is damaged by other pests, such as European corn borer or corn earworm. Sap beetle problems are most likely to occur on farms producing a variety of fruit and vegetable crops (10), which includes most of Maryland sweet corn producers (7). The number of beetles present each year affects management decisions, which are based on thresholds (13).

IPM Program

Corn is sampled when fresh green silking is complete and wilted silks are present. The silk area at the tip of 20 primary ears at each of 5 sites per field are inspected to determine the percent of ears infested with adult beetles, eggs, or larvae. Insecticide treatments are applied as needed if more than 10% of the ears are infested with beetle adults, eggs, and/or larvae (5, 7, 10).

Chemical Controls

Sap beetle populations are usually controlled by insecticides applied to treat the major ear-invading insects; however, there are times when densities of these major pests are low, but sap beetle populations are high enough to warrant insecticide treatment. Lambda-cyhalothrin (Warrior 2.56-3.84 fl oz 1E/A) is

the first choice of growers, followed by diazinon (2.5 pt 4EC/A or other labeled formulations). Esfenvalerate (Asana XL 5.8-9.6 fl oz 0.66EC/A) and methyl parathion (PennCap-M 2-4 pt2FM/A) may be used in rare instances (7). Insecticides are applied more frequently to fresh market sweet corn, since less injury can be tolerated than in processing corn (13).

Alternative Controls

Most Maryland growers minimize sap beetle problems by using tight husk varieties with good husk extension (7). Deep tillage in the fall to destroy overwintering stages and use of crop sanitation practices during the growing season minimize alternative food sources and help to reduce the build-up of sap beetle populations on a farm (4).

No biological control strategies are used to control this pest.(13).

Minor Insect Pests in Delaware

Minor Soil Insect Pests: Seedcorn Maggot, wireworm and white grubs

Seedcorn maggot, wireworms, and white grubs are minor pests of sweet corn, and rarely cause major economic damage. These pests are generally controlled by chemical applications directed at important pests such as flea beetles (7).

Seedcorn maggot *(Delia platura)*

Damage and Life Cycle

Seedcorn maggot is a common insect throughout the Northeast (10). Adult flies emerge from overwintering puparia during spring planting time and females lay eggs just below the surface of the soil. Eggs hatch in 4 to 7 days, and emerging larvae feed on decaying organic matter. Maggots may burrow into the corn seed and consume the germ, preventing germination. Larvae feed for 21 days, then pupate in the soil. There are 4 to 5 generations per season, but only the first and second generations are a problem, since they coincide with planting times. When damage occurs, it is often extensive, covering much of the field (11).

Frequency of Occurrence

Seedcorn maggot is a rare pest of sweet corn, since insecticide seed treatments are used by nearly all growers (7, 13, 15). Injury is most severe in cool wet springs when germination is delayed. Fields high

in crop residue and other organic matter are more susceptible to high levels of infestation (10).

Wireworms

Damage and Life Cycle

Wireworms are the larvae of click beetles (Elateridae). Several species attack corn and a variety of other grasses. Eggs are deposited on host plants in late spring. Larvae infest the soil, hollowing out seeds and pruning roots, making them susceptible to rot. They may also tunnel into or feed on the underground portion of seedling stems, causing wilting, distorted growth, and often plant death. Larvae feed and develop for 3 to 5 years before pupation (10).

Frequency of Occurrence

Wireworms are rarely a problem in sweet corn (15). They are most commonly found in corn fields where the preceding crop was pasture, hay, or sod. They do the most damage during cool, wet springs (10).

White grubs (Scarabidae)

Damage and Life Cycle

The adult scarab beetles which produce white grubs prefer to lay their eggs in fields which have extensive weed growth during mid-summer. Larvae hatch during late-summer and move through the soil where they feed on the roots of sweet corn, causing wilting, stunting and eventually death of young plants if infestations are heavy. Damage is usually localized. White grubs feed and develop as larvae for 1 to 4 years, depending upon the species (10).

Frequency of Occurrence

White grubs are rarely a problem in sweet corn (15). Like wireworms, white grubs are most commonly found in corn fields where the preceding crop was sod or other grasses (10). They thrive best in cool, wet soils (15).

IPM Program for minor soil pests

Seedcorn maggot, wireworms, and white grubs are not a major focus of IPM programs in sweet corn (11, 13). Feeding by all of these pests can result in wilted or stunted plants that often die. In addition, reduced germination is characteristic of seedcorn maggot and wireworms. Damage from grubs and

wireworms tends to be localized within a field, while seedcorn maggot damage can cover most of a field (10). These symptoms can be recognized by an IPM scout. In areas where plants have failed to emerge, sampling may be done to determine the pest species present (17). Since damage occurs in the early growth stages, rescue treatments are ineffective for these pests (13). If damage is extensive enough to warrant replanting, seed treatment or soil insecticide is applied to prevent reinfestation (17).

Wireworm infestation levels of a field can be determined prior to planting (9), but few growers sample fields routinely. Growers may sample fields where preventive insecticide treatments are not used if wireworms have been a problem in the past, to determine if preventive treatment is warranted (11).

Grubs uncovered in the soil during spring tillage and planting operations are the best indication of a potential infestation. It is important to determine the species of grub, since not all white grubs cause significant damage to sweet corn. Annual white grubs and Japanese beetle grubs rarely cause economic damage unless the corn is planted extremely early (10). Most of the processing acres on the Eastern shore include grubs in scouting programs (7)

Chemical controls for minor soil pests

Because damage is inflicted early in growth stages, seed treatments and soil systemic insecticides are the only chemical treatments applied for this pest complex. Foliar rescue treatments are not used for these pests (10).

Seed treatments

Insecticide seed treatments are effective and inexpensive (7, 10, 15) and are used by nearly all growers (7, 11, 13). These products are very effective against seedcorn maggot and deter feeding by wireworms and white grubs (7).

Preventive soil insecticides

Soil insecticides are applied either in the spring or fall when the soil temperature at the 6-inch depth is at least 50° F (10° C) and soil moisture is equivalent to that desired for planting. Frequently, the insecticide is applied immediately before planting. When early spring planting is contemplated, the fall treatment is preferred (9).

Preventive systemic soil insecticides are applied at seeding to control corn flea beetle on about 95% of fresh market and about 90% of processing acreage (7, 24). These products will control, or at least suppress, populations of minor soil pests. Soil treatments directed specifically at seedcorn maggot, wireworms, or white grubs are very rare. Carbofuran (Furadan 2.5 fl oz 4F/1,000 ft of row in the seed furrow at planting) and terbufos (Counter 8 oz 15G/1,000 ft of row in the seed furrow or 8-16 oz 15G/1,000 ft of row if banded) are the most commonly used soil inscticides.

Alternative controls for minor soil pests

A variety of cultural control measures are effective against these pests. Late plantings during cool springs and shallow placement of seeds may speed germination times and reduce injury levels (10). Delayed planting also may starve soil pests and increase natural control from bird predation (15). However, late plantings are not economically feasible for most growers of fresh market and processing sweet corn (7). Crop rotation with less susceptible crops and late-summer plowing may be used to help reduce white grub populations (10). Growers also may avoid planting sweet corn following alfalfa, sod, or pasture, to reduce the risk of wireworms (15). Fields with cover crops or those high in organic matter may be plowed in early spring to reduce the potential for seedcorn maggot infestation (10). Overall, these cultural control methods are used to a very limited extent by Maryland growers (12, 13).

No biological control strategies are used to control these pests in Maryland (13).

Additional Minor Insect Pests

True armyworm (*Pseudaletia unipuncta*)

Damage and Life Cycle

True armyworms overwinter in soil or debris as partially developed larvae (27), completing their development in early spring and then pupating. Moths emerge from late April to early May and deposit eggs on corn and other grasses. Larvae feed on seedling and early whorl stage corn during late May and June. Feeding results in characteristically ragged leaves. Later plantings of sweet corn may also be damaged by a second generation of larvae (18). This pest typically produces 3 generations a year (27).

Frequency of Occurrence

True armyworm is a sporadic and minor pest of sweet corn (15). It is unusual for armyworms to occur at levels high enough to justify treatment. Infestations only occur in fields bordering small grains, which often harbor this pest (7, 13).

IPM Program

Field edges bordering small grains are routinely scouted for armyworm infestations. Occasionally, edges of sweet corn fields and small grain fields are treated to prevent migration of armyworms into sweet corn (7). The need for treatment is based on the percent and severity of damaged plants and the average larval size (18).

Chemical Controls

Chemical controls are rarely needed for true armyworm, and generally can be limited to edges of a field bordering small grains, to prevent infestation of sweet corn. A very low percentage of acreage is treated (7, 12). Lambda-cyhalothrin (Warrior 2.56-3.84 fl oz 1E/A) and permethrin (4-8 fl oz Permethrin 3.2EC/A) are the primary insecticides used.

Alternative Controls

Controlling grassy weeds can reduce the risk of armyworm damage. No biological control strategies are available to control this pest.(13).

Corn leaf aphid (*Rhopalosiphum maidis*)

Damage and Life Cycle

Corn leaf aphids overwinter on small grains as either eggs or females that give birth during early spring. Wingless females produce offspring without mating for numerous generations. During late May and June, winged aphids migrate to corn and wild grasses where they spend the summer. Aphids injure sweet corn by removing plant sap with their needle-like mouthparts (10). They also excrete a sugary liquid, called honeydew, which can coat tassels and interfere with pollen shed as well as causing cosmetic damage to the ears (7, 10). Corn leaf aphids reproduce rapidly, and populations can increase dramatically in a very short time. As aphid numbers rise, colonies usually begin to appear on the leaves, tassels, and between the husk leaves on the ear (10).

Corn leaf aphid is one of several species of aphids that transmit maize dwarf mosaic virus to sweet corn (10), however, this is only a potential problem for non-resistant varieties planted after July 1. (9). The virus can be spread to sweet corn by aphids from neighboring infected grasses, particularly johnsongrass (*Sorghum halepense*) (28). The most important management strategies for maize dwarf mosaic virus are the use of virus-tolerant varieties (14) and control of weeds that are potential host plants for the virus, especially johnsongrass (10).

Frequency of Occurrence

Aphids are rarely a problem because infestations either build up too late to cause significant damage or they are controlled by natural enemies (10).

IPM Program

Few growers include corn leaf aphid in their IPM programs (13).

Chemical Controls

Growers very seldom treat specifically for corn leaf aphids (4, 13). Management practices for controlling European corn borer and corn earworm generally prevent populations from reaching economic levels (15). Prior to the use of lambda-cyhalothrin for the control of ear-invading larvae, aphids were an important pest of fresh market corn, due to cosmetic damage to husks. Aphids are not a problem on processing sweet corn. In rare instances when lambda-cyhalothrin is not used to control larval ear pests, and treatment specifically for aphids is considered, methomyl (Lannate 1-1.5 pt LV/A) or endosulfan (Thiodan 1 pt 3EC/A) are used at low or below labeled rates (7).

Diseases

Infectious diseases of sweet corn are caused by fungi, bacteria, viruses, and nematodes, and some are vectored by insects. Successful and cost-effective disease management requires accurate identification of pathogens and timely application of control measures (10). Some diseases are controlled mainly by management of insect vectors, while for others, cultural or chemical controls may be necessary, at least in some years (9).

Bacterial Diseases

The most important bacterial disease in Delaware is Stewart's bacterial wilt, which is seen to a greater or lesser extent every year. Bacterial stalk rot also occurs, but is rare and limited to fields under irrigation or those watered from streams. Unlike Stewart's wilt, stalk rot rarely results in important economic losses.

Stewart's bacterial wilt

Life Cycle and Damage: *Erwinia stewartii*, the bacterium that causes Stewart's wilt, or bacterial wilt, overwinters in the digestive tract of flea beetles and is transmitted by beetles feeding on the leaves. Although flea beetles are not the only insects known to vector this disease to sweet corn, transmission by other insects is not of economic importance. Epidemics of bacterial wilt may follow warm winters, which favor flea beetle survival. As many as 40% of overwintering flea beetles carry the bacterium in spring, and this percentage climbs as the season progresses (11). When young plants are infected, brown discoloration, and sometimes cavities, form in the center of the stem. These plants may die. In older plants, infection results in streaked leaves and growth may be stunted (28).

Frequency of Occurrence: Bacterial wilt is an important disease throughout the Eastern United States, but its occurrence and severity depend on the winter weather conditions and the susceptibility of the sweet corn variety. The extent of bacterial wilt damage depends on the growth stage of corn infected, the bacterial strain, host susceptibility, and nutritional factors. Younger plants are most severely affected (10). In Delaware, some bacterial wilt damage is seen annually on susceptible varieties. Bacterial wilt infection rate is typically about 10% in fresh market sweet corn and 1% in processing sweet corn, however, the disease is not severe and generally causes no more than 5% yield loss when it occurs (24). In extreme cases where susceptible varieties are used and other controls have failed, up to 80% yield loss from bacterial wilt has been reported (7).

Management: Use of bacterial wilt resistant varieties is an important management strategy employed by most growers of processing and fresh market sweet corn, although the level of resistance varies among varieties (24). Also, lower quality and yield of many resistant varieties combined with competition and other market factors compels many growers to select more susceptible varieties (7). Management of bacterial wilt is achieved by control of the flea beetle vector. A winter temperature index is used to estimate flea beetle survival (10), though they typically are successful at overwintering in the Mid-Atlantic region (31). 90 to 95% of growers treat preventively at seeding to control flea beetle populations (7, 24). Fields are scouted to determine the effectiveness of treatment. When beetle populations are high, a single foliar rescue treatment is also applied to reduce transmission of bacterial wilt (24). Such foliar treatments are not typically needed every year, but may be applied to as much as 40% of early planted corn during bad years (7).

Chemical Controls: There are no chemical controls that work directly on bacterial-wilt infected plants (9). The disease is managed by chemical control of the flea beetle vector (24). Preventive systemic soil insecticides are applied at seeding to control corn flea beetle on about 95% of fresh market and about 90% of processing acreage (7, 24). Carbofuran (Furadan 2.5 fl oz 4F/1,000 ft of row in the seed furrow at planting) is the most commonly used product, followed by terbufos (Counter 8 oz 15G/1,000 ft of row in the seed furrow or 8-16 oz 15G/1,000 ft of row if banded). Esfenvalerate (Asana XL 5.8-9.6 fl oz 0.66EC/A) is used to a lesser extent (7, 13). Fields are routinely scouted to determine the efficacy of preventive insecticides. Some years, an additional single foliar insecticide application is necessary on some fresh market fields when beetle populations are high. The most commonly used foliar insecticides are lambda-cyhalothrin (Warrior 2.56-3.84 fl oz 1E/A) and permethrin (4-8 fl oz Permethrin 3.2EC/A). Both products are effective, so product selection is driven by price. Processing sweet corn rarely requires foliar insecticides for control of flea beetle (7).

Cultural Controls: Most processing varieties show some level of resistance to bacterial wilt (5). Where possible, growers use cultivars resistant to bacterial wilt disease (9), especially for early plantings during cool springs following mild winters (13). However, market demands often require that growers choose susceptible varieties with other characteristics over varieties with bacterial wilt resistance (7).

Viral Diseases

The only sweet corn disease caused by a virus that is of economic importance in Delaware is maize dwarf mosaic virus (35), and it has not been a problem for several years.

Maize dwarf mosaic virus

Life Cycle and Damage: Maize dwarf mosaic virus has a large host range, including at least 251 grass species in 79 genera (10). It can be spread by aphids from neighboring infected grasses to sweet corn. The virus overwinters in perennial grasses, and johnsongrass (*Sorghum halepense*) is an important overwintering host (28). The disease is spread by at least 12 species of aphids, and transmission occurs within the first few seconds of feeding (10).

Frequency of Occurrence: Maize dwarf mosaic virus ranges throughout the United States, and is common in the Northeast (10). The virus only occurs in Delaware on sweet corn planted after July 1, because the build up of disease titer in host weeds becomes sufficient in late summer to overwhelm the genetic resistance of many varieties. Very little sweet corn is planted in Delaware after the first of July and the virus occurs on less than 5% of these acres.

Management: The most important management strategy for maize dwarf mosaic virus is the use of virus-tolerant varieties. Tolerance is usually adequate to prevent yield loss in the sweet corn varieties developed in the last 20 years. If it weren't for the dwarf mosaic resistant varieties, growers couldn't plant sweet corn after mid-May without significant yield losses (14). Control of weeds that are potential host plants for the virus, especially johnsongrass, is an important management strategy (10). However, aphids living on johnsongrass or other hosts may shift to sweet corn when weeds are killed. Although this is typically not a concern with resistant commercial sweet corn varieties, in extremely dense johnsongrass populations the potential exists for the transmission of a large amount of the viral pathogen into sweet corn which could overwhelm the tolerance mechanisms and cause viral symptoms (14).

Chemical Controls: There are no chemical controls that can kill the virus in an infected plant. Preventing the buildup of the vector aphid populations may help. Often, the control program for European corn borer and corn earworm will keep aphid populations low (15). In any case, insecticides applied after aphid populations have been discovered do not effectively control the spread of the disease, since transmission of the virus occurs during initiation of plant feeding (10). For these reasons, insecticides are rarely applied specifically for the purpose of controlling aphids or maize dwarf mosaic virus. Control of johnsongrass and other potential host weeds is an important disease management strategy (10) and is achieved in fresh market or processing sweet corn with a single application of one of the following herbicides (9):

butylate - 3-6 lbs ai A (3.75-7.33 pts/acre Sutan+ 6.7EC).

Metolachlor - 1.5-2 lbs ai/A (1.54- 2.05 pts/acre of Dual II 7.8E). [Only controls seedling johnsongrass (14)].

alachlor - 1.5-3 lbs ai/A (1.5-3 qts/acre MicroTech or 2.3-4.6 lbs/acre of Partner 65DF). [Only controls seedling johnsongrass (14)].

glyphosate - 1-2 lbs ai/A (1-2 qts/acre of Roundup Ultra 4SC) [For no-till corn, preplant or preemergence use only. Postharvest application is done every 3 to 5 years on 2 to 5% of acreage (any tillage) to suppress populations of specific major weeds, including horsenettle, johnsongrass, Canada thistle, quackgrass and field bindweed (14).]

nicosulfuron - 0.031 lb ai/A (0.66 oz/acre Accent 75SP) [Newly labeled only for specific varieties of sweet corn for processing in 1999. A single application may be used annually in sweet corn up to 10 inches high, or up to 18 inches if drop nozzles are used. This product will provide postemergent control johnsongrass, shattercane, and other annual grasses which are potential hosts for maize dwarf mosaic virus (14).]

Fungal Diseases

The only significant fungal diseases in Delaware are common smut, southern corn leaf blight, northern corn leaf blight, common rust, and southern rust. Nearly all sweet corn seed comes pre-treated with fungicides from the seed companies (11, 13).

Common smut

Life Cycle and Damage: Common smut (*Ustilago maydis*) is the most frequently occurring disease of sweet corn in Delaware. It is easily recognized by large galls that form in the ears, leaves, and tassels of the plant. Galls are silvery-white when formed, but later produce masses of powdery dark brown to black spores. The disease overwinters on top of the soil as teliospores, which develop into airborne basidiospores in the spring. In favorable climatic conditions, these basidiospores can infect susceptible plant tissues which have been damaged by mechanical injury or insect feeding (10).

Frequency of Occurrence: Common smut is a widespread and economically important disease in Delaware, for which there is no chemical control. It is most common when weather conditions are hot and dry (11). Common smut results in about 3 to 5% yield loss annually in both processing and fresh market sweet corn (24).

Management: There is a variable range of smut resistance among sweet corn varieties and the more resistant varieties are used as often as possible, particularly for processing (7). Most varieties are at least moderately resistant (24). Early cultivation can reduce infection rates by reducing mechanical damage to corn roots and stems and lowering transmission rates. This is practiced by most growers in Delaware. Crop rotation, which is practiced for a variety of reasons, also helps reduce smut transmission to sweet corn (24).

Controlling European corn borer as soon as the tassels appear is said to reduce the risk of smut transition (9), but this strategy doesn't eliminate the disease in Delaware. 50 to 75 % of Delaware fresh market sweet corn acres and all processing acres are scouted for insects, and smut damage will be noted.

Chemical Controls: There are no fungicides available for control of smut in Delaware sweet corn. Control of European corn borer during the tassel stage may be helpful in reducing the spread of the disease.

Leaf blights

Two important leaf blight diseases occur in Delaware: southern corn leaf blight (*Bipolaris maydis*) and northern corn leaf blight (*Exserohilum turicum*). Both are minimal and sporadic, and their occurrence depends upon the resistance level of the variety used and environmental conditions.

Life Cycle and Damage: Leaf blights cause spots or lesions on the leaves. When lesions are numerous, the leaf may die. Spores are the overwintering stage for both fungi. Spores of *Bipolaris* overwinter in infected leaf tissue in crop debris in the field. The spores of *Exserohilum turicum* can survive with or without plant debris. Overwintering spores may be spread by wind to susceptible plants in the spring. Southern corn leaf blight requires 4 or more hours of moist conditions for transmission and spreads quickly during extended periods of moisture when temperatures are between 75oF and 95oF. Infection of northern corn leaf blight requires leaf surfaces to be moist for 5 hours when temperatures are about 70oF. Sporulation for both species occurs under moist conditions when temperatures are favorable (10).

Frequency of Occurrence: Southern corn leaf blight occurs throughout the world (10) and northern corn leaf blight is also widespread (31). Both southern corn leaf blight and northern corn leaf blight are most likely to develop in poorly drained sites or areas adjacent to woods or other wind breaks (10). Southern corn leaf blight and northern corn leaf blight are minimal and sporadic in Delaware.

Management: Resistant varieties are available for both blight diseases (10). Fifty to 75 % of Delaware sweet corn acres are scouted for insects, and leaf blight incidence and severity is noted. Crop rotation and plowing under of corn stubble are important means of reducing inoculum sources for both species. Fungicide sprays are effective against these diseases but are rarely needed. Growers using susceptible cultivars can monitor weather conditions to determine if the spread of southern corn leaf blight is favored; however, sprays will not be necessary unless sufficient inoculum is present (10). There are no differences in management practices between fresh market and processing sweet corn.

Chemical Controls: Chemical control is generally not used for control of blight diseases in Delaware sweet corn.

Rusts

Common rust

(*Puccinia sorghi*), the only economically important rust species that occurs in Delaware.

Life Cycle and Damage: Spores of both rust fungi overwinter in the Southwest and are reintroduced to our region each year, carried on the wind. All exposed plant tissues are susceptible to infection, but leaves are most often affected. Brown spots occur on both sides of the leaves and darken as they age. In severe cases the leaf may die. The worst infestations may lead to economic losses due to smaller ear production and cosmetic injury from pustule development on the ears (10).

Frequency of Occurrence: Common rust is widespread and occurs throughout Delaware. Its severity can fluctuate considerably from year to year, but it is most severe during warm, humid weather. Common rust has been occurring more regularly over the last five years, but is only an economic problem on susceptible cultivars.

Management: Resistant cultivars are used by more than 80% of fresh market and processing sweet corn growers. They are particularly important to growers making successive plantings of fresh market corn in the same field. Fields are monitored for rust during the early growth stages. If infection occurs prior to the whorl stage, a fungicide is applied (9). One pustule per leaf on 80% of the leaves prior to tasseling is the threshold for moderately susceptible fresh market varieties. A lower threshold is used for highly susceptible cultivars (10). Thresholds are not used in processing sweet corn, where cosmetic damage to the husk is unimportant (7).

Chemical Controls: In most years, on most cultivars, disease occurrence is insufficient to warrant treatment, and no fungicide is used. Rust can cause cosmetic damage and reduce yields on certain fresh market and processing varieties some years. When necessary, 2 applications of propiconazole (4 fl oz 3.6 EC/A Tilt) may be applied to less than 10% of late season fresh market and processing sweet corn acreage (24).

Nematodes

Several genera of nematodes (*Pratylenchus*, *Longidorus*) are pathogenic to corn in the Northeast (10), and some of these are found in Delaware soil samples; however, the population levels present are usually insufficient to cause economic damage to sweet corn. Nematicides are recommended on a prescriptive basis for specific problems identified by soil sampling. Needle nematodes (*Longidorus*) has caused economic damage by reducing stands and stunting plants during sporadic occurrences.

Weeds

Weed Management in Sweet Corn

Weed management is an important issue in sweet corn, since weeds account for about a third of all crop losses. Weeds result in economic losses in sweet corn in several ways, including: 1) reducing yield due to competition for water, nutrients, and light; 2) increasing production costs or reducing yields by interfering with harvest; 3) reduction of effectiveness of insect and disease control measures due to weed interference; 4) serve as refuge for insects and pathogens; and 5) reduction in yield due to crop injury resulting from weed control measures. An integrated approach, including a combination of cultural and mechanical methods, crop rotation, and herbicides, provides the most economical and effective weed management in sweet corn. This integrated approach focuses on proper herbicide selection and optimal timing of application in combination with cultural practices to increase the competitive ability of the crop relative to weeds.

Frequency of Occurrence: Annually.

% Acres Affected: 100%

Pest Life Cycles: A wide range of annual and perennial weed species is present in sweet corn fields in DE. Some of the more common annual broadleaf weeds are: smooth pigweed, common lambsquarters, common ragweed, velvetleaf, nightshade, common cocklebur; common annual grasses are: fall panicum, giant foxtail, and crabgrass; and common perennial species include: yellow nutsedge, Canada thistle, horsenettle, and johnsongrass.

Timing of Control: Preplant, pre-emerge, and postemergence.

Yield Losses: Can be as high as 75% in severely affected fields.

Regional Differences: Weed spectra can vary regionally.

Cultural Control Practices: Cultivation is useful in sweet corn weed control, and is frequently practiced. Banding of herbicides is also useful when combined with cultivation although this is not often practiced in DE.

Biological Control Practices: None available.

Post-Harvest Control Practices: Application of herbicides and/or cultivation after harvest can be useful in controlling perennial weeds, but has no impact on reducing yield loss in the current crop.

Other Issues: Considerable research is being conducted in weed control in sweet corn, including the use

of cultivation; screening new herbicides for crop tolerance and efficacy; determining efficacy of lower-than-labeled rates of herbicide; banding herbicides; and effects of crop rotation on weed populations. An important focus is developing non-atrazine based weed control programs.

Chemical Controls Herbicides are the most important component of weed management programs in sweet corn. Proper timing of herbicide application is essential for good weed control and reducing the risk of crop injury.

Chemical Controls:

Pesticide	% Acres Treated	Weeds⁶	Typical Rates lbs ai/acre	Timing⁷	# of Appl.	PHI days	REI hours
<i>glyphosate</i> (Roundup)	15 P	Brdlvs Grass	1.0	Preplant	1	80	4
	10 F	Perennial					
<i>butylate</i> (Sutan+)	0 P	Grass	3.0-6.0	PPI	1	70	12
	1 F						
<i>atrazine</i> (Aatrex & others)	50 P	Brdlvs	0.5-1.0 ¹	PPI, PRE, POST	1	45	12
	75 F	Grass					
<i>alachlor</i> (Lasso, Partner)	25 P	Brdlvs/ss	1.25-2.5	PPI, PRE	1	70	12
	20 F	Grass					

<i>dimethenamid</i> ⁴ (<i>Frontier</i>)	3 P	Brdlvs/ss		PPI, PRE			
	<1 F	Grass	1.125		1	45	12
<i>metolachlor</i> (<i>Dual</i>)	70 P	Brdlvs/ss		PPI, PRE			
	50 F	Grass	1.0-2		1	70	12
<i>pendimethalin</i> ³ (<i>Prowl</i>)	10 P	Brdlvs	0.75-1.0	PRE	1	60	4
<i>bentazon</i> (<i>Basagran</i>)	3 P	Brdlvs		POST			
	4 F	Perennial	0.75-1		1	55	12
2,4-D (<i>several</i>)	5 P	Brdlvs		POST			
	<3 F	Perennial	0.125-0.25		1	45	48
<i>nicosulfuron</i> ⁵ (<i>Accent</i>)		Grass		POST			
	<1 P	Perennial	0.03		1	45	4

1. Rates vary considerably from 0.5 to 1.5 lb ai/acre depending on situation.
2. Manufacturer will withdraw from market by 2002.
3. Not labeled on fresh market sweet corn.
4. New product; use may increase as growers become more familiar with this herbicide
5. New product; only labeled on certain processing sweet corn varieties. Future use may increase as the number of varieties increase and growers become more familiar with this herbicide, but the potential for injury to the crop is significant and timeliness of application is critical.
6. Weeds: Grass= annual grasses; Brdlvs= annual broadleaf weeds; Brdlvs/ss= small-seeded broadleaf weeds (i.e. pigweed); Perennial= perennial species (grass, broadleaf, or sedges).

7. Timing of application: Preplant= prior to planting; POST= postemergence; PPI= pre-plant incorporated; PRE= preemergence.

Integrated Approach to Weed Management

Herbicide selection is based on the species of weeds present, and the grower's knowledge of previous weed problems in a field. Most of the processed sweet corn acreage is scouted for postemergence weed problems, while only about 30% of fresh market sweet corn field are scouted after emergence; the remaining acres are cultivated.

Use in IPM Programs: Use of herbicides in conjunction with cultural practices is consistent with IPM recommendations.

Use in Resistance Management Programs: Triazine resistant lambsquarters and pigweed are a problem in some growing areas, although their occurrence has not been quantified. It is critical to have an array of herbicides with differing modes of action to prevent additional resistance problems.

Efficacy Issues: 2,4-D can cause serious injury to sweet corn, an important limiting factor in its use. Most herbicides are designed with a relatively narrow spectrum of weed control in order to minimize crop injury. Therefore, producers need a range of available herbicides for flexibility in managing weeds.

Rotational Concerns: Almost all of the acreage planted with sweet corn before June 1, is planted with a second crop (soybeans, spinach, snap beans, or cucumbers) immediately after planting. Or planted with barley in mid-September. Thus a herbicide program must not include herbicides at rates which will limit crop rotation.

Alternatives: A number of new herbicides (or herbicides whose labels are expanding to include more varieties) will become available in the future, and are currently being researched. Examples include Axiom (flufenacet + metribuzin), Accent (nicosulfuron; label expansion), and Aim (carfentrazone). Based on recent trials, these new herbicides tend to require a higher level of management for proper use, exhibit higher incidences of crop injury, are more weather dependent, and provide a narrower window for timing of application. In the future, there may be a significant shift to herbicide (glyphosate-, glufosinate-, or sulfosate-) resistant cultivars.

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[\[1\]](#) FOOTNOTES:

Ambush 2EC and Pounce 3.2 EC have been changed to Permethrin 3.2EC for use against ear damaging insect pests, Cut Worms, Corn Flea Beetle, and True Army Worms.

In 2000, when this Profile was written, the statement was made that Thiodicarb (Larvin) would not be available for use on sweet corn in the mid-Atlantic region after the 1999 growing season. Thiodicarb is currently labeled for sweet corn, however, it has a ground water advisory statement on the label that may limit its use in Delaware against ear damaging insect pests.

Diazinon seed treatments have been cancelled on sweet corn and have been deleted from this profile for use against insects.

Cyanazine (Bladex) has been cancelled on sweet corn for weed control.

Mancozeb is no longer labeled for sweet corn against Common Rust.