

## Crop Profile for Sweet Corn in Florida<sup>1</sup>

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### Production Facts

- Florida ranks #1 nationally in the production and value of fresh market sweet corn, typically accounting for approximately 20 percent of both national sweet corn production and of U.S. cash receipts for fresh sales (1).
- Sweet corn has typically ranked as one of Floridas four most valuable vegetable crops. During the 2004-05 production season, sweet corn was the states third ranking vegetable crop in terms of acreage and ranked fourth in total value. Harvested acreage for sweet corn represented 15 percent of the state's total vegetable acreage during that season, while production value represented about six percent of the total production value of all Florida vegetables (2).
- A total of 487 million pounds of fresh sweet corn, valued at \$117 million, was produced on 26,300 acres in Florida during the 2006 season. Florida's fresh sweet corn producing acreage has ranged from a high of nearly 51,300 acres

harvested in 1992 to less than 27,000 acres harvested in 2006 (1).

- Costs to deliver a sweet corn crop to market vary somewhat, depending upon the production region and other factors. Typically, total costs for a crop are approximately \$3,800 per acre (3).
- Nearly 20 percent of sweet corn producers overall total direct expenses are invested in pesticides and pesticide application costs (3).

### Production Regions

The principal fresh sweet corn production region in Florida is the Everglades area (Palm Beach County) with over half of the production. The southeastern/southwestern area (Miami-Dade, Collier, and Hendry Counties) were responsible for about a quarter of the states production. The west/north area (Suwannee and Jackson Counties) account for a minor amount of sweet corn production in the late spring months. Sweet corn is still grown in the central area around Lake Apopka, but this region

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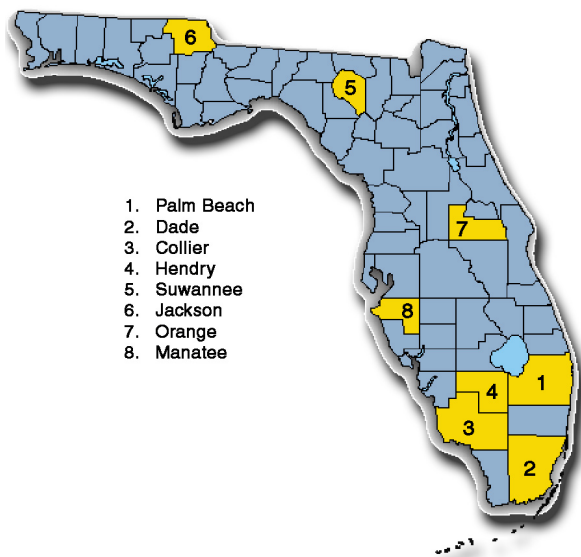
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only produces a small amount of the crop since the muck soils in this area have been taken out of production.



**Major Sweet Corn Production Regions in Florida.**

## Production Practices

As stated in the production region section, most of Florida's sweet corn producers grow the crop on organic muck soils, with lesser amounts on sandy soils and rockland (limestone) soils. Sweet corn seeds can be planted any time from August through April, depending on the specific production region. However, growers usually plant in north Florida from February to April, in central Florida from January to April, and in south Florida from October to March. Standard spacing allows for approximately 30 inches between rows, with seeds typically planted about one inch deep, 6-8 inches apart. Maximum plant population is approximately 24,000-32,000 plants per acre. A total of 64-90 days elapses from seeding to harvest. Sweet corn is wind pollinated, so isolation of varieties must occur to produce desired characteristics. Typically, a distance of at least 300 feet is needed to avoid cross-pollination. Adequate water is especially important in sweet corn production during periods of silking and tasseling and of ear development. Most of Florida's sweet corn is grown under irrigation (4).

The principal packing container used in Florida is a wire-bound crate that holds 4.5-5 dozen ears of sweet corn, weighing approximately 42 pounds.

Sweet corn is sometimes packed in a waxed fiberboard carton with the same volume as the wire crate. While wire crates are most adapted to hydro-cooling, fiberboard cartons are best adapted to cooling with liquid ice (5).

Maintenance of appropriate temperature during the post-harvest period is essential for sweet corn, because quality is determined by sugar content and volatile flavor compounds, which decrease rapidly at room temperature. Particularly important is the pre-cooling process of removing field heat from the sweet corn. Maximum quality is retained when the corn is pre-cooled to near 32F (0C) within an hour of harvest and held at that temperature during marketing. However, several factors such as of the volume of sweet corn harvested in Florida, availability of equipment, and economic and marketing considerations all contribute to these ideal conditions not usually being achieved. At 32F, sweet corn remains marketable for 5 to 8 days (and up to three weeks with the supersweet varieties), but no more than 2 days when held at 50F (10C) (5-7).

The most common method of pre-cooling sweet corn in Florida is hydro-cooling by showering or immersion in water. Corn in crates may be hydro-cooled for over an hour to bring it to a temperature of 41F (5C). Hydro-cooling is more efficient when done on bulk corn rather than crated corn, because it allows greater contact between the water and the corn. An alternate pre-cooling treatment involves the use of slush icing (package icing) in fiberboard cartons. Corn intended for local markets remains marketable for up to 2 days without pre-cooling, as long as it is kept cool after harvest (5,6). Researchers in Florida are also developing procedures for preparing and handling fresh-cut sweet corn kernels, which they believe to be a potentially successful marketing alternative for sweet corn, given the increasing popularity of fresh-cut vegetables (7). The entire sweet corn crop in Florida is sold on the open market.

## Workers Activities

With respect to labor activities associated with the crop, most are non-worker related. Seeds and fertilizer are mechanically planted/applied, scouts access the fields at appropriate times, and

applications are done either aerially or by ground equipment. Workers have contact with the sweet corn crop only at harvest. Since sweet corn is planted in staggered stages for an approximate eight-month production window, these workers are largely harvesting continuously at a rate relative to market activity (8).

Sweet corn harvest can occur from mid-November through mid-July, with the most active harvest period occurring from April through May (2). Sweet corn ears are harvested only once, using either hand or mechanical methods. The majority are harvested by hand. Harvested ears may be packed on a harvest aid or taken to an assembly area in the field or packinghouse for grading and packing. Greater selection for marketable ears can occur with hand harvesting, which usually utilizes self-propelled packinghouses with conveyors. During the hand harvest process approximately two-thirds of the workers walk through the rows removing ears, which are placed on conveyors that shuttle the corn to packers, who make up the rest of the team. Ground workers wear long-sleeved shirts and pants, due to the abrasive nature of the plant foliage. Mechanical harvesters cut the part of the stalk that contains the ears, which are then removed from the stalk by "strippers." During grading, cull ears and trash are removed (8).

## Pest Management

Florida's warm, humid climate is ideal for the development of pest populations. Sweet corn grown in Florida is subject to damage from numerous insect, weed, disease, and nematode pests. Florida vegetable growers in general employ prevention, avoidance, monitoring, and of course suppression practices.

With regard to prevention, over half of Florida vegetable growers clean implements after fieldwork and nearly half manage water in an effort to suppress pests. Approximately eighty percent remove or plow down crop residue or practice some type of tillage or cultivation to manage pests (9).

About a quarter of Florida vegetable growers adjust planting/harvest dates to avoid pests or alternate planting locations. Nearly half of the vegetable growers rotate crops to control pests (9).

Only one in twenty Florida vegetable growers will use pheromones to monitor pest levels, while one in five field map weed problems. Forty percent conduct soil tests to monitor pest levels and record pest levels. Half of the growers monitor weather for conditions conducive to pest activity. Three-quarters of the growers scouted for pests on 95 percent of the acreage (9).

With regards to pest suppression, few Florida vegetable growers (less than ten percent) use pheromones or directly release beneficial pests. About a quarter of the growers adjust planting methods. About a third of the growers use biological pesticides (mostly B.t.). Over half maintain ground cover or other barriers, and nearly two-thirds alternate pesticides to avoid resistance (9).

## Insect/Mite Management

### *Insect/Mite Pests*

The most important insect pests on sweet corn in Florida are the fall armyworm, corn earworm, lesser cornstalk borer, cutworms, corn silk fly, cucumber beetles, aphids (corn leaf aphid, bird cherry-oat aphid, melon aphid, rust plum aphid, and potato aphid), and wireworms. Less common pests of sweet corn include grasshoppers, corn blotch leafminer, twospotted spider mites, sap beetles, stink bugs, maize weevils and billbugs, white grubs, and white fringed beetles. Insect pest management tactics are ever changing in order to incorporate new technologies and to adapt to new pests that are introduced into Florida (10).

**FALL ARMYWORM** (*Spodoptera frugiperda*). Several types of armyworms may feed on the foliage of Florida sweet corn. However, the fall armyworm, which is the most important insect pest on sweet corn in Florida, is the most destructive, not only because it is a more consistent problem, but also because the resulting damage is more direct. Fall armyworm larvae, in addition to feeding on the leaves, will burrow into the growing point of the whorl, producing a characteristic row of long holes on the inner leaves. They may also enter the husk and feed directly on the kernels. Increase of fall armyworm populations is greatest when cool, wet springs are followed by warm, humid weather in the southern part of the state, where the pest overwinters (11).

Adults can be seen along the north Florida coast during all months but are most abundant from April to December. The fall armyworm does not enter diapause and cannot survive extended periods of low temperatures, instead maintaining populations in warmer areas from which adults move northward in the spring. The female moth is highly mobile, migrating each spring from frost-free areas in the southern part of the state and spreading throughout the southeast region of the country. Eggs are laid in masses of 100 to 150, and each moth may lay over a thousand eggs in total. Control at the egg stage is extremely difficult, due to the protective covering over the mass and its position on the underside of leaves. Although they may also feed on foliage, silks and ears, the larvae feed most often on the tender tissue of the whorl. Protected from insecticide sprays there, they can cause severe damage. When feeding on the ears, fall armyworm larvae enter from the side, feeding throughout the ear. After approximately two to three weeks, each larva drops to the ground and forms a pupa in the soil, at a depth of about 1 to 3 inches (2 to 8 cm). In Florida, the pupal stage lasts about eight to nine days during the summer and about 20 to 30 days during the winter. Although the life cycle of the fall armyworm can be completed in about 30 days during the summer, it can take 60 days in the spring and fall and up to 90 days during the winter (11,12).

Monitoring of fall armyworm populations is important for adequately timing control measures (12). For example, researchers have shown that early infestation of fall armyworm (during the pre-whorl to mid-whorl stages of the corn plant's development) does not produce loss of marketable sweet corn ears (13). However, as larvae grow and enter the later stages of development, damage to the whorl increases significantly. Mean densities of 0.2 to 0.8 larvae per plant during the late whorl stage have been found to reduce yield by 5 to 20 percent in Florida sweet corn (14). Results of further field studies show that insecticidal treatments are less effective in reducing numbers of older fall armyworm larvae in sweet corn whorls than in reducing numbers of younger larvae (15).

#### **CORN EARWORM (*Helicoverpa zea*).**

Another of the most important insect pests of sweet

corn in Florida is the corn earworm. These caterpillars, also called tomato fruitworms and cotton bollworms, attack a wide variety of vegetable and field crops. Although they occasionally feed on foliage, the principal damage that corn earworms inflict results from boring into and feeding upon the ears. After migratory flights, moths arriving on corn plants lay eggs on the silks. Upon hatching, the larvae feed on the silk and then enter the ear to feed directly on kernels, primarily at the silk end of the cob. Greatest economic damage occurs when larval feeding peaks during the silking stage. Florida sweet corn has sustained damage to as much as 60 percent of ears when time of moth flights coincides with silking. The cannibalistic habit of the larvae limits them to 1 to 2 individuals per ear, still sufficient to inflict substantial cosmetic damage. There are 2 to 3 generations per season, and timing of control measures is critical, since this pest cannot be controlled once it enters the ear. Insecticide management is important, since the corn earworm has a history of developing resistance to various insecticides in several classes. Additionally, the use of broad-spectrum insecticides against this pest has led to many cases of pest outbreaks by what were previously minor pests, one example being mites (12).

**CORN SILKFLY (*Euxesta stigmatis*).** This picturewing fly is a major pest on sweet corn, particularly in south Florida. In untreated fields, it can cause losses to the crop of up to 95 percent, and economic losses have been reported even after insecticide treatments have been applied. Heavy infestations produce corn with no market value, and light infestations can reduce the grade of the product. Additional host plants of the corn silkfly in southern Florida include field corn, sorghum, sugarcane, guava, banana, orange, atemoya, orchid and potato, but it is most abundant on sweet corn (16,17).

Development time from egg to adult has been found in the laboratory to be 28.3 ± 0.6 days at 86F (30C) and 33.8 ± 1.6 days at 77F (25C). Adult flies were found to live an average of 26.7 ± 8.0 days at room temperature. In the field, adult corn silkflies gather on tassels to mate, mainly at dawn and dusk. The female lays its eggs in groups of 2 to 40 at the tip of the ear, within the silks. Larvae develop and feed inside the corn ear, moving down into the ear in

groups upon hatching from the eggs. Therefore, foliar insecticide applications are not effective against eggs and larvae. In addition, during the later part of the growing season, the thick canopy inhibits adequate insecticide coverage, and by the time ears are mature, few insecticides are available because of the required pre-harvest intervals. Given the difficulty in applying chemical controls to this pest, researchers are in the process of developing a clearer understanding of the corn silkfly's biology in Florida, in order to develop a more effective management strategy (16,17).

### LESSER CORNSTALK BORER

(*Elasmopalpus lignosellus*). A serious pest in some years on Florida sweet corn, the lesser cornstalk borer also attacks over 60 other plant species in the state. Stalk borer populations can build up on previous grass or sod crops. The pest favors sandy soil as well as hot, dry weather. Symptoms on corn plants include distorted, wilted, or curled plants, and entrance holes and tunnels at the base of the plant indicate feeding activity of the larvae, which wriggle strongly when disturbed (12,18).

After emerging from the soil and mating, the female moth deposits its eggs at the base of the corn plant, with each female laying about 125 eggs. Within a week the eggs hatch, and the newly emerged caterpillars feed on the foliage. Later, they burrow into the stem, forming tubes at or just beneath the soil surface. The silk tunnels around their feeding sites protect them during the two to three weeks it takes for them to complete larval development. They pupate in the soil or tunnels, and after another two to three weeks, the adults emerge. There are several generations per year, and overlap of generations occurs in late summer. Timing of control is important, since borers cannot be controlled after entering the stem. Soil insecticides used for stalk borer control must be applied at or just after planting (12,18).

**WIREWORMS** (Family Elateridae). Several species of wireworms may be present in Florida corn fields, including corn wireworm (*Melanotus communis*), eastern field wireworm (*Limonius agonus*), Gulf wireworm (*Conoderus amplicollis*), southern potato wireworm (*C. falli*) and tobacco wireworm (*C. verpertinus*). While the Gulf wireworm

is the most common in Florida, *C. rudis* is one of the most important and is found throughout the state. *Conoderus* spp. wireworms are present in all sweet corn fields in Florida (12,19).

Wireworms, which are larvae of click beetles, are among the most destructive of soil insect pests. Eggs are laid in the soil near plant roots, and upon hatching, the larvae feed on the nearby roots. The larvae, which can live up to several years, may be present at a soil depth of 1 to 5 feet (0.3 to 1.5 meters). Wireworms damage sweet corn by eating the seeds and feeding upon the roots or stems of seedlings. They may occasionally bore into larger roots. Attacking a wide variety of crops, they can strike quickly and can leave poor stands and weak seedlings. Applying soil insecticides a few weeks before planting is the most common control measure for wireworms in sweet corn (12).

**CORN DELPHACID** (*Peregrinus maidis*). The corn delphacid, also referred to as the corn planthopper, has historically been a severe pest of sweet corn in Florida, particularly on late-planted corn, because it is more abundant in the summer. Once corn plants have reached the tasselling stage, they are less susceptible to planthopper damage. Corn delphacids tend to aggregate in corn leaf axils, with both adults and the immature nymphs feeding together. In addition to direct feeding damage, the corn delphacid is the only known vector of maize mosaic rhabdovirus (MMV) and of maize stripe tenuivirus (MStV), which have the potential to be serious problems in tropical and sub-tropical production areas. Maize stripe tenuivirus was first reported in Florida in 1975, and south Florida experienced a serious outbreak from 1979-1980. The corn delphacid is also a major pest of sorghum and can develop on goosegrass, barnyardgrass, and gamagrass. Itch grass, a serious weed pest, is the most important alternate host for the corn delphacid between growing seasons in south Florida and is also a host of maize stripe tenuivirus (20-22).

**APHIDS**. Several types of aphids can colonize sweet corn in Florida, most commonly the corn leaf aphid (*Rhopalosiphum maidis*), but also the bird cherry-oat aphid (*Rhopalosiphum padi*), the melon aphid (*Aphis gossypii*), the rusty plum aphid (*Hysteroneura setariae*), the potato aphid (

*Macrosiphum euphorbiae*), and the green peach aphid (*Myzus persicae*). The corn leaf aphid frequently infests the sheaths of sweet corn ears. Aphids feed by inserting their needle-like mouthparts into plant tissue and sucking up plant juices. In addition to depleting the plant of nutrients, they can transmit viral diseases and inject toxins that produce abnormal plant growth. For example, several aphid species including the melon aphid and the green peach aphid can transmit maize dwarf mosaic virus, which occasionally affects Florida sweet corn (12,22).

Throughout the state, aphid populations are exclusively female and are able to reproduce abundantly. The immature nymphs feed as well, and within just a few days they mature and begin producing more young. As a result of this rapid reproduction, aphid populations can increase dramatically. When populations are high, winged aphids begin to be produced and fly to new plants. Despite the potential for rapid increase in population, control of aphids is not difficult. Since aphids remain on the exterior of the plant and do not lay eggs, all stages are susceptible. When applying insecticides, complete coverage is necessary, since aphids tend to be more numerous on the underside of leaves and in protected areas of the plant. In addition, there are several natural enemies active in sweet corn fields that help to maintain aphid populations at low levels (12).

### **Chemical Control**

A total of 155,300 pounds of insecticide was applied to 98 percent of sweet corn acreage in 2006 (9). This is nearly a 30 percent reduction in use from the 2000-2004 average (217,000 pounds of active ingredient annually). Insecticides commonly used on Florida sweet corn include methomyl, thiodicarb, lambda-cyhalothrin, chlorpyrifos, and cyfluthrin. Phorate, permethrin, bifenthrin, terbufos, spinosad, esfenvalerate, endosulfan, and carbaryl are used occasionally (9). Other insecticides actively registered in 2007 in Florida for sweet corn include malathion, diazinon, deltamethrin, pyrethrins (+/- rotenone), carbofuran, methyl-parathion, thiamethoxam, tefluthrin, methoxyfenozide, ethoprop, zeta-cypermethrin, indoxacarb, petroleum oil, and azadirachtin.

**METHOMYL.** Methomyl is a restricted-use insecticide used to manage earworms, armyworms, corn rootworms, flea beetles, aphids, and cutworms. Certain hybrids are susceptible to methomyl damage, so a small area should be treated to determine sensitivity. The price of methomyl is \$25 per pound of active ingredient, and the approximate cost of a maximum labeled application (0.45 lb ai/A) is \$11 (4,23,24). The label states that no more than 6.3 lb ai/A can be applied to any one crop and not to make more than 28 applications. The restricted entry interval (REI) is 48 hours and there is no pre-harvest interval (PHI) for ears but the PHI is three days for forage and 21 days for fodder.

In 2006, Florida growers applied an average of 0.33 pound of methomyl per acre at each application to 74 percent of their sweet corn acreage, an average of 8.7 times. Total usage was 69,400 pounds of active ingredient. During the years in which usage data have been collected, sweet corn growers in Florida have applied methomyl at an average rate ranging from 0.28 to 0.33 pound of active ingredient per acre at each application, to between 74 and 99 percent of their acreage. Growers have made an average number of applications ranging from 5.9 to 13.6 each year. Total annual methomyl usage on sweet corn has ranged from 69,400 to 174,600 pounds of active ingredient (9).

Methomyl, which is primarily a contact insecticide, provides little residual control of fall armyworm on sweet corn. Therefore, appropriate spray intervals depend mainly on the quantities of fall armyworms present, with frequent applications necessary at higher population densities (25). Researchers have shown methomyl to be less effective against older fall armyworm larvae than against younger larvae and have recommended that information on both the larval stage of the insect and the number of plants infested during the whorl stage of the plant's development be used for spray decisions (15).

**THIODICARB.** Thiodicarb is a restricted-use insecticide used to aid in the management of earworms, armyworms, and corn borer. The median price of thiodicarb is \$15 per pound of active ingredient, and the approximate cost of a maximum

labeled application (0.75 lb ai/A) is \$11 (4,23,24). The label states that no more than 7.5 lb ai/A can be applied in any one season. The REI is 48 hours and there is no pre-harvest interval (PHI) for ears. Fodder and forage may not be fed to animals.

Thiodicarb provides a greater degree of residual control of the fall armyworm than does methomyl. Research has shown residual control by thiodicarb of up to nine days under south Florida conditions (25).

In 2006, Florida growers applied an average of 0.45 pounds of active ingredient per application to 48 percent of their sweet corn acreage, an average of 4.9 times. Total usage was 35,200 pounds of active ingredient. During the years in which usage data have been collected, sweet corn growers in Florida have applied thiodicarb to between 48 and 81 percent of their total sweet corn acreage, at an average rate per application ranging from 0.39 to 0.52 pounds of active ingredient per acre, an average of between 2.6 and 6.8 times. Total annual thiodicarb usage on sweet corn has ranged from 28,300 to 119,400 pounds of active ingredient (9).

#### **LAMBDA-CYHALOTHRIN.**

Lambda-cyhalothrin is a restricted-use pesticide used to manage armyworms, earworms, cutworms, stalk borers, leafhoppers, corn rootworms, sap beetles, aphids, grasshoppers, and mites. The median price of lambda-cyhalothrin is \$260 per pound of active ingredient, and the approximate cost of a maximum labeled application (0.03 lb ai/A) is \$8 (4,23,24). The label states that no more than 0.48 lb ai/A can be applied in any one season. Lambda-cyhalothrin may be applied up to 1 day before harvest (PHI=1 day), and the restricted entry interval (REI) under the Worker Protection Standard is 24 hours. The fodder and forage may not be fed to meat animals until 21 days after the last application.

In 2006, Florida growers applied an average of 0.025 pounds of active ingredient per application to 37 percent of their sweet corn acreage, an average of 6.4 times. Total usage was 2,000 pounds of active ingredient (9). During the years in which usage data have been collected, Florida sweet corn growers applied lambda-cyhalothrin to between 37 and 89 percent of the states total sweet corn acreage at a rate per application of between 0.02 and 0.03 pound of

active ingredient per acre, an average of between 2.9 or 6.9 times. Total lambda-cyhalothrin usage on sweet corn was between 1,400 and 3,900 pounds of active ingredient (9).

**CHLORPYRIFOS.** Chlorpyrifos is an insecticide primarily used to manage armyworms and corn earworms. The median price of chlorpyrifos is \$12 per pound of active ingredient, and the approximate cost of a maximum labeled application (1.0 lb ai/A) is \$12 (4,23,24). Under provisions set by a Florida 24(c) Special Local Need Registration in 1994, the pre-harvest interval for chlorpyrifos has been reduced to 7 days from that of the Section 3 labels 35 days. This label allows one pint to be applied up to 3 times per crop. The REI for chlorpyrifos under the Worker Protection Standard is 24 hours. The fodder and forage may not be fed to meat animals until 14 days after the last application.

In 2006, Florida growers applied an average of 0.65 pounds of active ingredient per application to 36 percent of their sweet corn acreage, an average of 2.0 times. Total usage was 15,600 pounds of active ingredient. During the years in which use data have been collected, sweet corn growers have applied chlorpyrifos to between 22 and 80 percent of their total sweet corn acreage, at an average rate per application ranging from 0.66 to 0.86 pounds of active ingredient per acre. The average number of applications per year has ranged from 1.5 to 4.7. Total chlorpyrifos usage on sweet corn has ranged from 15,600 to 94,000 pounds of active ingredient annually (9).

**CYFLUTHRIN.** Cyfluthrin is a restricted-use insecticide used in most years to manage earworms, armyworms, cutworms, corn rootworms, and grasshoppers. The median price of cyfluthrin is \$230 per pound of active ingredient, and the approximate cost of a maximum labeled application (0.044 lb ai/A) is \$10 (4,24). Cyfluthrin may be applied up to and including the day of harvest, but the restricted entry interval (REI) under the Worker Protection Standard is 12 hours. There is a crop maximum of 10 applications or 0.44 pounds of active ingredient.

In 2006, Florida growers applied an average of 0.039 pound of active ingredient per application to 36 percent of their sweet corn acreage, an average of 3.2

times. Total usage was 1,100 pounds of active ingredient. During the years in which use data have been collected, sweet corn growers have applied cyfluthrin to between 28 and 66 percent of their total sweet corn acreage, at an average rate per application ranging from 0.02 to 0.039 pound of active ingredient per acre. The average number of applications per year has ranged from 3.2 to 7.6. Total cyfluthrin usage on sweet corn has ranged from 1,100 to 2,100 pounds of active ingredient annually (9).

### **Biological Control**

Eggs of the corn silkworm are eaten by earwigs in the field, as well as by certain mites and hemipteran bugs. Predation in the field has been observed on eggs at both the base of corn plants and at the ear tip (17). Numerous biological control agents are known to cause mortality to other sweet corn insect pests in Florida as well, particularly to corn earworm and fall armyworm. The most important parasites and predators of the corn earworm are those that attack the egg stage. Attempts to rear and release parasites of the corn earworm in other parts of the country have had very limited success. A nematode that attacks the corn earworm has also been released, but whether or not it became established is unknown. Biological control for fall armyworm has been attempted as well. Releases of several fall armyworm pathogens into the southeastern U.S., including the fungus *Nomuraea rileyi*, as well as egg parasite releases in Florida, have had as little success as those for the corn earworm (26).

As is true for the corn earworm, several important egg and larval parasites naturally reduce overwintering populations of fall armyworm in south Florida. Some of those recorded from Florida include the braconid wasp parasites *Cotesia autographae*, *C. marginiventris* and *Chelonus insularis*; the eulophid wasp parasites *Euplectrus comstockii* and *E. plathypenae*; the ichneumonid wasp parasites *Enicospilus merdarius*, *Campoletis flavicincta*, and *Ophion* sp.; and the tachinid fly parasites *Euculetoria armigera* and *Lespesia archipivora*. Fall armyworm predators, which are generalists that attack many other caterpillars, include ground beetles, the striped earwig (*Labidura riparia*, the spined soldier bug (*Podisus maculiventris*), and the insidious flower bug

(*Orius insidiosus*). The most significant pathogens of the fall armyworm are the *S. frugiperda* nuclear polyhedrosis virus (NPV) and the fungi *Entomophaga aulicae*, *N. rileyi*, and *Erynia radicans* (11). The most effective immediate use of biological control is B.t. use by growers that may employ it in the early stages of planting.

### **Cultural Control**

Crop rotation is recommended for a variety of pests, particularly soil insects such as wireworms, grubs, and the lesser cornstalk borer. Stalk borer populations can also be reduced by removing weeds in the fields and along fence rows, often the source of borer populations. Soil insect populations can be reduced by early destruction of previous crop residues and by thorough soil preparation. For example, turning the soil several times reduces wireworm populations by exposing them to the sunlight, a common practice among sweet corn growers in Florida. Pests like armyworms and the corn earworm, which prefer warmer weather, can be avoided to some extent by manipulating planting dates to coincide with cooler weather. In addition to early planting, the use of early maturing varieties can aid in avoiding the higher densities of those pests that occur later in the season (10,11,18,19).

## **Disease Management**

### **Disease Pathogens**

Major diseases of sweet corn in Florida include common and southern rust, northern corn leaf blight, and southern corn leaf blight. Bacterial leaf spot, damping off, and smut are minor diseases, while bacterial stalk rot, Fusarium stalk rot, charcoal root rot, the viral disease maize dwarf mosaic, brown spot, and crazy top are only occasionally seen (27,28).

**RUST** (caused by *Puccinia* spp.). Although both common rust (caused by *Puccinia sorghi*) and southern rust (caused by *Puccinia polysora*) occur on sweet corn in Florida, common rust has become the most important disease on the crop in recent years. These two rust diseases are often difficult to differentiate in the field, but they usually occur at different times of the year. Common rust occurs every spring on sweet corn, and southern rust occurs

nearly every fall. Symptoms can vary depending on the corn variety, strain of the fungus, and environmental conditions such as temperature and light. Common rust produces small yellow spots on both leaf surfaces that later turn rusty or cinnamon brown, while the equivalent pustules produced by southern rust are generally limited to the upper leaf surface. The spores released from these characteristic pustules are easily spread by the wind, although rain and insects can play a role (27,28).

Common rust occurs under cool weather conditions, with optimum temperatures for spore germination occurring at 59 to 63F (15 to 17C). It is therefore considered to be a spring sweet corn disease, because the cooler temperatures of late fall, winter and early spring allow inoculum levels to build up considerably, while the hot weather occurring from the late spring through early fall in southern Florida inhibits disease development. Upon reaching the plant, spores can germinate within 1 to 6 hours, and within 1 to 2 days spots may be seen on the foliage. Generation time ranges from 5 to 16 days, depending on temperature, with most rapid pustule formation occurring at 59 to 68F (15 to 20C). *Oxalis* spp. weeds serve as an alternate host for the common rust fungus, but the significance of their role in the life cycle of *P. sorghi* in Florida is not well understood (28).

Southern rust, which is potentially more serious than common rust in the northern part of the state, is a greater problem in warmer weather. It is considered a fall sweet corn disease, because development of significant levels of inoculum require high temperatures, which are present in early fall throughout Florida. In north Florida, where sweet corn is planted late within a double cropping system, the disease may therefore be more severe. Optimum temperatures for spore germination are between 81 and 82F (27 to 28C). Spots can be seen on the leaf in 6 to 7 days, and within 9 to 14 days, pustule formation occurs. Pustule development stops when temperatures reach 90 F (32C) (28).

Rust diseases are generally not serious on Florida sweet corn unless husks are infected. Severe rust infections are rarely seen, particularly in south Florida, possibly due to the control of potentially

serious leaf blights with fungicides that are also effective against rust organisms (28).

**NORTHERN CORN LEAF BLIGHT** (caused by *Exserohilum turcicum*). Northern corn leaf blight was for many years considered the most important sweet corn disease in southern Florida, incurring losses of up to 80 percent. It is still significant, occurring every spring and occasionally at the end of the fall. However, varietal improvements in host plant resistance have reduced its impact. Initial symptoms of the disease include yellow spots that develop on the foliage, eventually enlarging to form tan or straw-colored dead areas about 4 to 6 inches long and one-half inch wide. Progressively moving higher on the plant, the disease does not infect ears, although it may produce lesions on the husk. If the disease begins before silking and is severe, yield losses may occur, but later initiation of the disease produces little yield loss. Northern corn leaf blight is a greater problem on spring sweet corn, because the pathogen requires the cooler temperatures of late fall, winter and early spring to build inoculum levels. It develops most rapidly at temperatures of 64 to 80°F (18 to 27°C) and stops development at the high temperatures commonly experienced in south Florida from late spring through early fall. Large amounts of spores can form in humid weather, during which time fungicide applications are recommended (27,28).

**SOUTHERN CORN LEAF BLIGHT** (caused by *Bipolaris maydis*). Southern corn leaf blight may occur simultaneously with northern corn leaf blight, but can be distinguished by the lesions produced, which are smaller, lighter in color, and more parallel-sided than those of northern corn leaf blight. In southern Florida, it occurs nearly every fall and occasionally at the end of the spring. Plants infected with this disease may be more susceptible to stalk rot because of the early death of leaves. Southern corn leaf blight is favored by warm, moist conditions. Therefore, long periods of dry, sunny weather between rains inhibit development of the disease. The fungus survives in crop debris from season to season. Like southern rust, it is considered to be a fall sweet corn disease, because it requires the high temperatures of early fall, and disease development is inhibited by the cooler temperatures occurring during the late fall. Southern corn leaf

blight is generally less severe than northern corn leaf blight, unless weather conditions are very favorable for disease development and the variety is susceptible (27,28).

**BACTERIAL LEAF SPOT** (caused by *Pseudomonas avenae*). Bacterial blight occurs sporadically on sweet corn in Florida, and its presence appears to depend on the sweet corn variety, the occurrence of rainy weather during the appropriate crop stage, and the density of armyworm infestation. Corn that is just pushing the tassel through the whorl appears most susceptible, but any corn in the whorl stage may exhibit new infections. Once the corn stalk has fully expanded and leaves have had time to harden off, bacterial blight is rarely observed (27).

The bacterium responsible for leaf spot can also cause a stalk rot and a basal ear rot. The disease produces dark spots on leaves emerging from the whorl that later turn white or straw-colored and elongate to several inches. Under severe disease conditions, leaves may shred easily. Among other plants attacked by the disease, vaseygrass has been found to be the primary source of inoculum in Florida. The pathogen does not survive, however, in plant debris or soil (27,29).

### **Chemical Control**

The most common fungicide used on Florida sweet corn is mancozeb, which is a protectant and therefore needs to be in place prior to infection to be effective. Due to its low cost, mancozeb is the predominant fungicide used in sweet corn. A total of 86,800 pounds of insecticide was applied to 77 percent of sweet corn acreage in 2006. This is over a 50 percent reduction in use from the 2000-2004 average (196,000 pounds of active ingredient annually). Other important active ingredients commonly used in sweet corn include propiconazole, azoxystrobin, and chlorothalonil (9). Other fungicides registered for use in sweet corn include mefenoxam, difenoconazole, phosphite, pyraclostrobin, trifloxystrobin, coppers, sulfur, maneb, and fludioxonil (seed treatment).

**MANCOZEB.** Mancozeb is the most common fungicide for control of northern and southern leaf

blight, as well as rust. The median price of mancozeb is \$3 per pound of active ingredient, and the approximate cost of a maximum labeled application (1.2 lb ai/A) is \$4 (23,24,30). Mancozeb may be applied up to seven days before harvest (PHI=7 days), and the restricted entry interval (REI) under the Worker Protection Standard is 24 hours. There is a crop maximum of 18 pounds of active ingredient.

In 2006, Florida growers applied an average of 0.9 pound of active ingredient per application to 66 percent of their sweet corn acreage, an average of 3.6 times. Total usage was 72,000 pounds of active ingredient. During the years in which usage data have been collected, Florida sweet corn growers have applied mancozeb at an average rate ranging from 0.83 to 1.0 pound of active ingredient per acre at each application, to between 53 and 74 percent of their sweet corn acreage. Growers have made an average number of applications ranging from 3.2 to 9.9 each year, totaling between 72,000 and 233,600 pounds of active ingredient annually (9).

**PROPICONAZOLE.** Propiconazole is another compound used to control northern and southern leaf blight and rust. Being locally systemic, it will slow down disease development even following infection, and has been shown to have greater efficacy than the broad-spectrum protectant fungicides typically used, such as mancozeb and chlorothalonil. However, because of its cost, propiconazole is generally used only when disease conditions are judged most favorable (31). The median price of propiconazole is \$95 per pound of active ingredient, and the approximate cost of a maximum labeled application (0.11 lb ai/A) is \$10 (23,24,30). Propiconazole may be applied up to 14 days before harvest (PHI=14 days), and the restricted entry interval (REI) under the Worker Protection Standard is 12 hours. There is a crop maximum of 0.45 pound of active ingredient.

In 2006, Florida growers applied an average of 0.11 pound of active ingredient per application to 34 percent of their sweet corn acreage, an average of 1.6 times. Total usage was 2,000 pounds of active ingredient. During the years in which usage data have been collected, sweet corn growers in Florida have applied propiconazole at an average rate ranging from 0.11 to 0.16 pound of active ingredient per acre at

each application, to between 32 and 61 percent of their sweet corn acreage. Growers have made an average number of applications ranging from 1.6 to 9.4 each year, totaling between 2,000 and 21,100 pounds of active ingredient annually (9).

**AZOXYSTROBIN.** Azoxystrobin is another compound used to control northern and southern leaf blight and rust. Much like propiconazole, it will slow down disease development following infection, and has been shown to have greater efficacy than the broad-spectrum protectant fungicides. However, because of its high cost, azoxystrobin is generally used only when chemistry needs to be rotated to reduce the chance of resistance. The median price of azoxystrobin is \$120 per pound of active ingredient, and the approximate cost of a maximum labeled application (0.25 lb ai/A) is \$30 (24,30). Azoxystrobin may be applied up to seven days before harvest (PHI=7 days), and the restricted entry interval (REI) under the Worker Protection Standard is 4 hours. There is a crop maximum of 2.0 pounds of active ingredient. In 2006, Florida growers applied an average of 0.14 pound of active ingredient per application to 24 percent of their sweet corn acreage, an average of 2.2 times. Total usage was 2,300 pounds of active ingredient (9).

**CHLOROTHALONIL.** Chlorothalonil is another compound used to control northern and southern leaf blight and rust. The median price of chlorothalonil is \$9 per pound of active ingredient, and the approximate cost of a maximum labeled application (1.5 lb ai/A) is \$14 (23,24,30). Chlorothalonil may be applied up to 14 days before harvest (PHI=14 days), and the restricted entry interval (REI) under the Worker Protection Standard is 12 hours. There is a crop maximum of nine pounds of active ingredient.

In 2006, Florida growers applied an average of 1.4 pounds of active ingredient per application to 5 percent of their sweet corn acreage, an average of 1.7 times. Total usage was 3,500 pounds of active ingredient. During the years in which usage data have been collected, sweet corn growers in Florida have applied chlorothalonil at an average rate ranging from 1.1 to 1.4 pounds of active ingredient per acre at each application, to between 3 and 5 percent of their sweet

corn acreage. Growers have made an average number of applications ranging from 1.7 to 3.0 each year, totaling between 3,500 and 4,900 pounds of active ingredient annually (9).

### **Biological Control**

There are currently several types of biological control available for sweet corn disease suppression. Both *Bacillus subtilis* and *B. pumilus* are registered as fungicides in sweet corn for control of rusts and blights (30).

### **Cultural Control**

A few varieties of sweet corn are now available with good resistance to both northern corn leaf blight and to common rust. These varieties allow growers to reduce fungicide inputs significantly. Resistant varieties have also reduced the severity of damping-off diseases. Varieties resistant to smut are also available and can be used where practical. Many sweet corn hybrids, however, do not exhibit resistance to the southern rust fungus (27,28).

There are currently no practical cultural control tactics recommended for bacterial leaf spot. However, minimization of fall armyworm and corn earworm populations is thought to help, because bacterial leaf spot has been observed to be severe following extensive attack of those insects. Additionally, the disease has been observed to spread into sweet corn fields from ditch banks, particularly those on which vaseygrass is growing, so control of vaseygrass may slow the spread of bacterial leaf blight (27).

Hastening emergence of sweet corn seedlings by avoiding planting in cold and wet soils may reduce the severity of damping-off. Appropriate soil fertility management may be helpful in reducing the severity of smut, which has been observed to be greater in fields with high soil nitrogen. Also, reducing crop debris can aid in minimizing initial infection from leaf blight fungi (27).

### **Post-harvest Diseases**

When sweet corn is graded and pre-cooled properly, post-harvest diseases are not significant. The need to store sweet corn under cool conditions to

prevent reduction in quality from loss of sugar ensures adequate post-harvest handling (5).

## Nematode Management

### *Nematode Pests*

Plant injury from nematode damage is difficult to diagnose, and as a result nematode problems may go undetected. Nematodes injure sweet corn by reducing corn root growth, stalk height and stalk diameter. In most cases, plants weakened by nematodes produce smaller and fewer ears, and plants that are heavily parasitized may produce no ears, resulting in up to 100 percent crop loss (32).

Nematodes affecting sweet corn in Florida include sting, stubby root, stunt, spiral, lesion, lance, and occasionally root-knot nematodes. Corn yield reduction from these nematodes is generally higher in sandier soils, and the most damaging nematode, the sting nematode, is limited to soils with a very high sand content. Stubby root, stunt, and root-knot nematodes are the principal nematode pests in organic soils. General symptoms of nematode injury include stunting, wilting, and nutrient deficiency symptoms, often in patches throughout the field due to irregular distribution of nematodes (32,33).

**STUBBY ROOT NEMATODES** (*Trichodorus* spp., *Paratrichodorus* spp.). One of the most important nematode pests of Florida sweet corn, stubby root nematodes are found throughout the state, especially in sandier soils. These externally feeding species have a wide host range that includes vegetable, fruit and grain crops. Their life cycle, spent entirely in the soil, is relatively short, and populations can build up quickly. Their numbers can also decline rapidly, complicating diagnosis through soil sampling. By attacking the growing root tip of the host plant, stubby root nematodes cause severe stunting. Although rarely killed by stubby root nematode attack, corn plants are highly susceptible, and yields can therefore be significantly reduced (29,33).

**STING NEMATODES** (*Belonolaimus* spp.). The sting nematode *Belonolaimus longicaudatus* has been shown to be severely damaging to sweet corn in Florida when the crop is grown on sandy soils. Sting

nematodes are external plant feeders, remaining in the soil throughout their life cycle. They feed at or near the root tip, interfering with root elongation. Feeding damage results in reduced root systems and stubby root symptoms. Plants experience stunting, premature wilting and leaf chlorosis, and plant death may occur. Small populations of the sting nematode can cause considerable plant damage, because while feeding, they inject a toxic enzyme into the root. Since these nematodes are confined to very sandy soils, they are found primarily in peninsular Florida, often occurring together with stubby root nematodes. Constant moisture, such as that encountered under irrigation, may contribute to higher populations of the sting nematode. Yield loss as a result of sting nematode damage to sweet corn may range from limited to total yield loss (29,33).

**ROOT-LESION NEMATODES** (*Pratylenchus* spp.). The lesion nematode *Pratylenchus zeae* is an important nematode pest of corn, as well as numerous other crops, including rice, sugarcane, peach, and sorghum. Its host range includes many other crops and weeds, such as tobacco, turfgrass, crabgrass, onions, wheat, rye, barley, citrus, soybean, sweet potato, and strawberry. Among the smallest of plant feeding nematodes, root-lesion nematodes enter the root to feed and reproduce within. Corn is tolerant to low populations of these nematodes, but at high population levels, stunting, chlorosis, nutrient deficiency symptoms, and blackened roots may be evident (29).

**ROOT-KNOT NEMATODES** (*Meloidogyne* spp.). Root-knot nematodes enter the host plant root as immature larvae and settle within to feed. At the feeding site, their secretions cause the surrounding plant cells to enlarge, producing the characteristic galls associated with root-knot attack. Gall size varies by host plant, and although on some hosts galls can reach a diameter of greater than one inch, galls on corn and other grasses are usually very small. In addition to expending the plants resources, the gall tissue is more susceptible to secondary infections such as root rots. Within the root, the female continues to feed, after several molts developing into a swollen, pear-shaped adult. The adult may live in the host plant for several months, laying hundreds to several thousand eggs that are released into the soil.

Low temperatures or very dry soil conditions can cause eggs to hatch more slowly (29).

### **Chemical Control**

Nematicides are not commonly used on Florida sweet corn, but nematodes are always a potential problem. There are several nematicides available when severe nematode pest problems occur. Chemical treatment of highly infested fields with nematicides has commonly increased sweet corn yields, particularly in fields containing sting nematode. The fumigant nematicide 1,3-dichloropropene is effective against all but stubby root nematodes and is particularly effective in sandy soils. The non-fumigant, organophosphate nematicides/insecticides terbufos and ethoprop are less useful against root-knot nematodes. They are applied at or before planting and are most effective in band applications. The use of terbufos for rootworm control by sweet corn growers has contributed somewhat to reducing the need for nematode management on the crop (33). Carbofuran is also labeled for nematode control in Florida sweet corn. None of these materials were reported as being employed for sweet corn production in Florida in 2006 (9).

### **Cultural Control**

Although nematode resistant germplasm has been identified and released, most commercial sweet corn hybrids, as well as tropical corn hybrids and open-pollinated cultivars, have shown to be excellent hosts for the principal nematode pests of sweet corn (root-knot, sting, and stubby root nematodes). Other useful cultural practices include timely destruction of crops and weeds, particularly roots, and avoiding the spread of nematodes to uninfested fields through contaminated soil or plant parts on machinery. Summer fallow, complemented by periodic cultivation, has proven effective for reducing soil populations of some nematode species such as root-knot, but is of limited value for control of other nematodes, such as sting and stubby root (32).

The wide host range of most of the nematodes attacking corn makes crop rotation difficult. However, when practical, rotation with non-host plants can improve the effectiveness of nematicides

by maintaining pest nematode populations at a low level. For example, in the Sanford area (central Florida), sting and root-knot nematodes have been observed to be greatly reduced by planting hairy indigo as a summer cover crop before fall vegetables. Use of sorghum sudangrass and other cereal grains in cool winters has suppressed root-knot populations but increased others, such as sting and stubby root. In general, the host range of nematodes that attack sweet corn includes most pasture legumes and grasses, cereals, and most commercial fruit, vegetable, and agronomic crops. Therefore, the number of useful rotation crops for sweet corn production is limited. In many cases, crop rotation, like fallow, does not reduce nematode population densities below economically damaging levels after a single nonhost crop, necessitating the integration of other tactics (32).

## **Weed Management**

### **Weed Pests**

Weeds compete with sweet corn for light, water, and nutrients, and may in some cases provide refuge to insect and disease pests. In addition, they may complicate harvest operations. Florida sweet corn growers may encounter a variety of grass (crabgrass, goosegrass, Johnsongrass, sandbur, Texas panicum, annual ryegrass), broadleaf (bristly starbur, cocklebur, Florida beggarweed, Florida pusley, morningglories, pigweed, ragweed, sicklepod) and sedge (purple and yellow nutsedge) weeds (34). However, the major weed pests in sweet corn in the state are amaranths (pigweeds), grasses and purslane (8).

**PIGWEED** (*Amaranthus* spp). Pigweeds (amaranths) are summer annual broadleaf herbs with erect stems that can grow to 2 meters (6.5 feet) tall. Several species of amaranth are among the most common weeds in Florida sweet corn. The species present in Florida include smooth pigweed (*Amaranthus hybridus*), spiny amaranth (*Amaranthus spinosus*), and occasionally livid amaranth (*Amaranthus lividus*). Pigweeds reproduce solely by seed, producing very small, dark seeds. Smooth pigweed flowers from July to November and spiny amaranth flowers from June to October. Pigweeds prefer open areas with bright sunlight (35,36).

**PURSLANE** (*Portulaca oleracea*). Purslane is a taprooted summer annual with multiple branched stems that often form large mats. It reproduces by seed, flowering from August to October. Being resistant to drought, it is a difficult plant to eliminate (35,36).

**JOHNSONGRASS** (*Sorghum halepense*). Originally introduced from the Mediterranean region and cultivated as a hay and pasture crop, Johnsongrass is one of the most difficult perennial grasses to control because of its thick rhizome system. The plant can grow to approximately six feet and can form dense clumps. It is most common in fields, fence rows, and ditch banks, and it may be toxic to livestock (35,36).

**CRABGRASS** (*Digitaria* spp.). Crabgrasses are annual grass plants that reproduce mainly by seed, but also by spreading and rooting of stems at the base. They germinate during the summer, flowering from June or July to October and quickly establish clumps. The plant thrives in moist soil (35,36).

**GOOSEGRASS** (*Eleusine indica*). Goosegrass is similar in appearance to crabgrass, but grows more densely. It is also a summer annual, and it prefers sunny, moist conditions. Reproducing by seed, it flowers from July to October (35,36).

### **Chemical Control**

Although mechanical cultivation remains common, herbicides have partially or completely replaced cultivation, except where surface crusting or herbicide resistant weeds make it necessary. Care must be taken in herbicide selection as some sweet corn cultivars are sensitive to certain chemicals, such as sulfonyleureas (34). A total of 46,000 pounds of herbicide were applied to 92 percent of the states sweet corn acreage in 2006 (9). The most commonly applied herbicides are atrazine and s-metolachlor. Other herbicides actively registered in 2007 in Florida for sweet corn include dimethenamid, halosulfuron, carfentrazone, pendimethalin, nicosulfuron, pelargonic acid, mesotrione, pyraflufen, tribenuron, oxyfluorfen, thifensulfuron, sethoxydim, simazine, ametryn, linuron, butylate, 2,4-D, bentazon, paraquat, tropamezone, and EPTC.

**ATRAZINE**. Atrazine, a widely used selective herbicide, is applied either pre-emergence or post-emergence to control annual broadleaf and grassy weeds. Atrazine has a high potential for leaching into the groundwater and is therefore not to be applied to very permeable soils or areas with a high water table (34). The median price of atrazine is \$4 per pound of active ingredient, and the approximate cost of a maximum labeled application (3 lb ai/A) is \$12 (23,24,34). The restricted entry interval (REI) under the Worker Protection Standard is 12 hours. Sweet corn forage is not to be fed within 45 days after application.

In 2006, Florida growers applied an average of 1.2 pounds of active ingredient per application to 91 percent of their sweet corn acreage, an average of 1.0 time. Total usage was 36,400 pounds of active ingredient. During the years in which usage data have been collected, sweet corn growers in Florida have applied atrazine at an average rate ranging from 1.1 to 1.4 pounds of active ingredient per acre at each application, to between 64 and 91 percent of their sweet corn acreage. Growers have made an average number of applications ranging from 1.0 to 1.4 each year, totaling between 35,000 and 54,700 pounds of active ingredient annually (9).

**S-METOLACHLOR**. S-Metolachlor is used to control annual grasses, yellow nutsedge, and some broadleaf weeds. It can be applied pre-plant incorporated, pre-plant as a surface treatment, pre-emergence, or post-emergence as a directed spray (34). The median price of metolachlor is \$9 per pound of active ingredient, and the approximate cost of a maximum labeled application (4 lb ai/A) is \$36 (23,24,34). The restricted entry interval (REI) for metolachlor under the Worker Protection Standard is 24 hours.

In 2006, Florida growers applied an average of 1.7 pounds of metolachlor per application to 11 percent of their sweet corn acreage, an average of 1.1 times. Total usage was 6,500 pounds of active ingredient. During the years in which usage data have been collected, sweet corn growers in Florida have applied metolachlor at an average rate ranging from 1.2 to 2.3 pounds of active ingredient per acre at each application, to between 6 and 28 percent of their

sweet corn acreage. State-wide usage has totaled between 5,800 and 26,700 pounds of active ingredient annually (9).

### **Cultural Control**

Crop rotations may favor reduced weed growth and concurrently reduce populations of other types of pests, as can destruction of crop residues and alternate host plants. Crop management practices that improve the ability of sweet corn to compete with weeds, such as maintaining good soil fertility and pH and optimizing corn plant stand, are important weed management strategies. Cultivation is also used occasionally in sweet corn production to control weeds between rows (37).

### **Key Contacts**

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