

Crop Profile for Sugarcane in Florida

Prepared: May 2008

Production Facts

- In 2006, Florida ranked 1st nationally in value of sugar produced (approximately \$425 million) from sugarcane, which accounted for 50 percent of the total U.S. value of sugar from sugarcane. This equates to over 20 percent of total sugar (from sugar beet + sugarcane) produced in the U.S. annually (1,2).
- The southeast and Hawaii are the only areas in the U.S. where sugarcane is commercially planted. Approximately 400,000 acres of sugarcane are harvested in Florida annually, producing approximately 1.5 million tons of sugar (1,2).
- Sugarcane is Florida's most valuable field crop, worth more than the combined value of the Florida-grown corn, soybean, tobacco, and peanut crops. The crop ranks third in Florida's agricultural economy, behind the greenhouse/nursery and citrus industries (2).
- All Florida sugarcane travels to one of the five mills that operate in southern Florida. The corporate growers comprise about two-thirds of the cane, while cooperative mills comprise the remainder. The raw sugar travels by road, rail, or ship to refineries or it is marketed in its raw state (2).

Production Regions

Sugarcane is adapted to all portions of Florida. However, the commercial sugarcane industry is located in south Florida around the southern tip of Lake Okeechobee. The vast majority (70 percent of the acreage and 75 percent of the tonnage) of sugarcane is produced in Palm Beach County. The remainder is grown in the adjacent counties of Hendry, Glades, and Martin (2). While most sugarcane is grown on muck soils, approximately 20 percent is grown on sandy mineral soils (3).

Production Practices

Sugarcane is propagated vegetatively. It is also a multi-year crop. After the first crop, called the "plant cane" is harvested, the regrowth, or "ratoon cane", is harvested annually until plant condition deteriorates. An average of three annual crops are harvested from a field until it is replanted. When replanting takes place (late August through January), portions of a mature sugarcane field are reserved for "seed cane" and this material is divided into stalk pieces that are planted every two to four years as

dictated by plant condition. In 2005-2006, 30 percent of the crop was plant cane and 70 percent was ratoon cane (2,4).

Sugarcane stalks are cut by hand with a machete into seed cane pieces, laid horizontally in the field in twin rows, and covered with soil three to eight inches deep. If harvest season is early enough in the year (before January), the field will likely be replanted to sugarcane (termed successive planting). If later, a decision may be made to delay replanting until the following season, and instead plant the fallow field to another crop such as rice or sweet corn (termed regular or fallow planting). In 2005-2006, approximately one-third of the sugarcane was planted successively, while the remainder was planted in the regular manner (2,4).

Sugarcane is harvested from late October through mid-April. Sugar yields are typically higher as the weather turns cooler. In order to complete the entire south Florida sugarcane harvest within the optimal time frame, some fields must be harvested before sugarcane plants have reached maximum yield potential. Consequently, much research has gone into examining which cultivars should be harvested in early-, mid-, or late-season. The fields are burned to remove field trash and then mechanically-harvested cane is loaded onto trucks or rail cars to be transported to the mill.

Worker Activities The only part of sugarcane cultivation that requires workers is planting, which is 95 percent conducted manually. Approximately 120,000 acres are typically planted a year, and a single worker may plant up to five acres of seed cane per day (4).

Insect/Mite Management

As a tropical grass, sugarcane has evolved to resist many pests that are common in semi-tropical environments, but there are still key pests for the crop. These pests include: sugarcane borer, white grubs, wireworms, yellow sugarcane aphid, and lesser cornstalk borer on the sugarcane grown on sand. Insect problems vary during the growing season and from one season to the next because of varying factors such as the weather and cultural practices (5).

Sugarcane Borer. The sugarcane borer, *Diatraea saccharalis*, is one of the most important above-ground pests of sugarcane in Florida. Although this moth's principal host is sugarcane, many other grasses have been reported as alternative hosts. Significant damage results from the sugarcane borer larvae tunneling within the stalk. This can cause a loss of stalk weight (tonnage/acre) and sucrose yield. The borer's tunneling into the stalk allows points of entry for secondary invaders. If the tunneling is extensive, death of the terminal growing point of the plant ("dead-heart") may result. Weakened stalks are more subject to breaking and lodging (5).

The foundation of an IPM program for sugarcane borer control is regular scouting. Scouting is necessary to estimate the infestation level and beneficial borer parasites. A regular scouting program will also increase the chances of detecting other pests that may be damaging the crop (5). Fields should be scouted every 2 or 3 weeks from March through November. One Florida sugarcane company scouts each 40-acre field in at least 4 locations. At each location, 5 stalks are randomly sampled from each of 5 stools spaced 10 feet apart (5 stalks/5 stools/location). It is desirable to detect borers before they tunnel into stalks so that, if necessary, control measures can be applied before any damage to stalks occurs. Characteristic signs that plants are infested are pinholes in leaves, tiny holes into midribs, holes into stalks, and frass (light-brown fibrous waste material) at these holes. An infestation of borers cannot be positively identified until the sugarcane borers are actually observed. Scouts should examine leaves, the whorl, and behind leaf-sheaths as well as split stalks to detect borers tunneling inside stalks. Detecting two to three live larvae per 100 sampled stalks is generally thought to be enough to cause concern about economic damage (5).

All varieties of sugarcane currently grown in Florida are susceptible to sugarcane borer infestation, but they exhibit significant variation in damage and yield losses. One study of five commercial varieties showed that an average of one bored internode per stalk reduced sugar yield by an average of 5.6 lb/ton of sugarcane. The range of loss was from 2.3 lb/ton to 6.7 lb/ton for the different varieties examined. Another investigation showed bored internodes produce 45% less sugar than undamaged ones. One interesting observation is that certain regions of the Everglades Agricultural Area, where most of Florida's sugarcane is grown, seem to be considerably less prone to borer infestations. Environmental explanations are presumed, but definite reasons are not clear (6).

White Grubs. White grubs that have been found in Florida sugarcane fields are of the genera *Ligyris*, *Cyclocephala*, *Phyllophaga*, and *Anomala*. Of these grub pests, the species *Ligyris subtropicus* is the most important. It is the most abundant of the grubs affecting Florida sugarcane and causes, by a wide margin, the most damage. *Ligyris subtropicus* tends to infest sugarcane in muck soils and is the white grub of primary economic importance. White grubs damage sugarcane by feeding on roots and underground stems. The first symptom is a yellowing (chlorosis) of the leaves. This is usually followed by stunted growth, dense browning, lodging, plant uprooting, and death in heavily infested areas. Symptoms may be seen as early as September. Damage is usually more severe in ratoon crops and is most evident around the edges of a field. *L. subtropicus* infestation usually starts at the edge of a field and slowly spreads, in an irregular pattern, throughout the field. Infested fields may need to be replanted because ratoon regrowth and productivity can be severely reduced. Heavily infested areas may not be worth harvesting. Growers use cultural control practices for sugarcane grubs. Discing infested fields, reducing the number of ratoon crops, and flooding are the most common methods of grub control in Florida. Discing kills many grubs and allows birds to kill many more. Freshly planted fields usually have little or no grub infestation (5,7).

Wireworms. Wireworms, the larval stage of click beetles, may cause severe damage to numerous crops in Florida. At least twelve species of wireworms have been found in southern Florida, but only the corn wireworm, *Melanotus communis*, is considered to cause significant economic damage to sugarcane. *M. communis* has traditionally been a more important pest in Florida sugarcane grown on muck soil than on sandy soil (5,8).

Generally, wireworms are a pest of newly planted sugarcane and only rarely a pest in ratoon sugarcane. Wireworms feed on the buds and root primordia during germination of sugarcane seed pieces, and on shoots and roots after germination. Most of the injury to young shoots is near the point where the shoots join the seed piece or stubble. Wireworm injury can generally be identified as relatively large, ragged holes cut into seedpieces and buds, or into young shoots. The death of buds or young shoots leads to stand reductions. Wireworm injury has been reported as facilitating the entrance of the fungus that causes sugarcane red rot disease (5,8).

Yellow Sugarcane Aphid. Yellow sugarcane aphid (YSA), *Sipha flava*, is a fairly small, yellow aphid with short legs, antennae and mouth parts. Its body is adorned with short stiff hairs. The pair of tubes (cornicles) that protrude from the top and end of the abdomen of most aphids are reduced to slightly more than pore-like openings on YSA. This aphid takes 2 to 3 weeks to develop to the adult stage at which point it can produce 3 to 5 nymphs per day for another 2 to 3 weeks. Winged forms of the aphid are produced under crowded conditions when plant quality is beginning to be significantly affected. Natural enemies, including 10 species of ladybird beetles, several species of flower flies, and rain can greatly reduce populations, but this may not occur before the aphids have caused plant damage (5).

Yellow sugarcane aphid feeding leads to premature yellowing and death of sugarcane leaves. Feeding on very young plants leads to reduced growth and tillering. YSA feeding results in longer, faster growing leaves and internodes, but also thinner, lighter stalks with shorter node lengths and widths. Prolonged feeding by large populations of YSA can cause plant death. Sugarcane leaf and node lengths approach sizes of uninfested plants after YSA are removed, but node diameter remains lower on previously infested stalks. Sugarcane plants do not compensate for early season YSA damage. Such damage ultimately results in lighter stalks that contain less sugar (5).

Aphid numbers quickly build to numbers too numerous to count for sampling purposes. Leaf damage symptoms appear to be a good indicator of season long effects on growth and yield and works without having to count aphids. Leaves with <50% green tissue can be quickly counted and averaged over an area to compare long term effects of YSA feeding with the relative size of the infestation. YSA shows a preference for certain cultivars, so resistance appears to be a viable control strategy (5).

Lesser Cornstalk Borer. The larva of the lesser cornstalk borer moth, *Elasmopalpus lignosellus*, is a slender brown worm with creamy white to bluish-green bands 3/4 to 1" long when full grown. The larvae bore into young plants at or below the soil surface and usually cause a "dead-heart" similar to the sugarcane borer or wireworms. When they

feed at or below the growing point, damage above the growing point appears as rows of holes in emerging leaves. The larvae construct a tubular burrow in the soil extending outward from the cane plant. The burrow consists of soil particles which the borer webs together with silk. The larva pupates in this burrow and transforms into a small moth. The presence of these silk tubes and/or a small circular entrance hole distinguishes dead-hearts caused by lesser cornstalk borers from those caused by wireworms.

The life cycle of the lesser cornstalk borer ranges from 38 to 65 days. There is considerable overlapping of generations with no sharp seasonal breaks in populations, although infestations during late summer may be uncommon. Most damage from this pest occurs to young plants during warm, dry periods. Ratoon cane usually recovers better from lesser cornstalk borer attack than young plant cane. Although there are parasites of the lesser cornstalk borer, the protection given by the silk tube may make these inefficient as biological control agents (9).

Cultural Management

For sugarcane borer, it is economically advantageous to use varieties that exhibit resistance to infestation and damage. Varieties highly susceptible to the sugarcane borer are eliminated during the process of developing new varieties for commercial release. Besides growing varieties that show at least moderate resistance, the destruction of infested cane trash and stubble in infested fields and the use of seed pieces free of borer damage are important cultural control tactics (6).

For white grubs, discing infested fields, reducing the number of ratoon crops, and flooding are methods of control. The best time to kill grubs by flooding is in August. At this time, water temperatures are warm, rainfall abundant, and feeding damage by the grubs is just starting (7).

For wireworms, flooding can be effective but is a slow process and may not be practical. Current information suggests a minimum of six weeks of continuous flooding is needed during the summer to obtain wireworm control. Longer flooding durations are needed during colder months. Flooding during late spring and summer will kill the wireworms and also prevent egg-laying by the adult click beetles. Fallow field flooding or growing rice as a rotation crop may eliminate the need to use a soil insecticide at sugarcane planting the following fall (8,10).

For yellow sugarcane aphid, there are several mechanisms of sugarcane resistance to damage. These mechanisms are variety dependent, and include tolerance and antibiotic effects on aphid development. Winged yellow sugarcane aphids usually restrict their primary colonization to susceptible cultivars such as CP61-620, CP72-1210, CP72-2086, CP80-1827 and CP89-2143. Red imported fire ants, predatory earwigs and many species of ladybird beetles exert some control over these aphids. Heavy rains are also important in dislodging and washing aphids from the plants (9).

Biological Management

Alabagrus stigmatera and *Cotesia flavipes* are important wasp parasitoids of the sugarcane borer larvae in Florida. *A. stigmatera* is active all year long while *C. flavipes* is usually most active after July. *C. flavipes* is the most important parasitoid. Eggs of these endoparasites (parasites that grow within the host) are injected directly into the borer larvae. *Alabagrus stigmatera* is a large, solitary (one per host) parasite, whereas *Cotesia flavipes* is a small, gregarious (many per host) parasite. Whenever the economic injury threshold is approached, sugarcane borer larvae from a field should be dissected to determine the level of parasitism. If 50 percent or more of the sugarcane borer's larvae are parasitized, insecticides are not recommended. Insecticide applications may harm the parasite population without gaining additional control of the sugarcane borer. Augmentative releases of *Cotesia* parasitoids has been shown to be highly effective for managing the sugarcane borer in sugarcane within Florida, Brazil and Costa Rica (6).

Chemical Management

Soil insecticide products are commonly used on half of the sugarcane acreage in any given year. Ethoprop and phorate are evenly used at about 1 lb ai/A to control wireworms when infestation levels are high. Approximately 2,000 acres are treated yearly with carbofuran at 0.5 lb ai/A to control lesser cornstalk borer when replanting in areas that harbor it. Other insecticides registered for sugarcane in 2008 in Florida were: azadirachtin, B.t., carbaryl, cyfluthrin, cyhalothrin, esfenvalerate, and pyrethrins +/- rotenone, spinosad, and tebufenozide. Methoprene is available for fire ant control.

Disease Management

There are a number of sugarcane diseases known throughout the world. However, very few have affected Florida sugarcane historically. Until 2008, no fungicides were used in this crop and varietal resistance to brown rust kept this disease under economic thresholds. However, orange rust has was found in Florida in 2007, and this disease will require growers of several cultivars to use fungicides to maintain economically acceptable yields.

Disease Pests

Brown Rust. Since 1978, sugarcane production in Florida has been affected by brown rust (*Puccinia melanocephala*). This fungal pathogen is now found almost everywhere sugarcane is grown. The spread of the disease has had considerable economic impact. Screening for resistance has become an integral part of Florida sugarcane breeding programs. However, due to genetic variability within the pathogen population, resistance to the disease has not been stable. An example of this is CP 70-1133, an important variety grown for years without any sporulating pustules developing on it. Now, this same cultivar would be classified as moderately susceptible. Other important

commercial clones have also demonstrated increasing susceptibility to sugarcane rust over time (11).

Yield loss assessment due to rust is difficult, but realistic estimates have been obtained. During 1988, rust was particularly severe on the variety CP 78-1247 in Florida. A comparison of CP 78-1247's yield that year with a variety of equal yield potential revealed yield losses of nearly 40 percent (averaged over 13 different locations where the varieties were grown side-by-side). Another yield loss study, conducted by establishing a near disease-free check using a fungicide as a means for comparison, demonstrated losses of 20-25 percent on a moderately susceptible variety, CP 72-1210. This particular variety dominated the Florida sugarcane industry during the late 1980s, occupying as much as 60 percent of Florida's sugarcane acreage. Based upon the acreage of CP 72-1210 during the 1987 rust epidemic and using a conservative estimate of 20 percent yield loss, economic losses on CP 72-1210 during that single season were estimated as surpassing \$40 million (11).

Brown rust is mainly a disease of the leaf. The earliest symptoms are small, elongated yellowish spots that are visible on both leaf surfaces. The spots increase in length, turn brown to orange-brown or red-brown in color, and develop a slight, but definite, chlorotic halo. Lesions typically range from 2-10 mm in length but occasionally reach 30 mm. They are seldom more than 1-3 mm in width. Infections are usually most numerous toward the leaf tip, becoming less numerous toward the base. Pustules, which produce spores, usually develop on the lower leaf surface. Certain cultivars, however, may have some pustules on the upper surface. Pustules may remain active over a considerable period of time and spore production is highly dependent upon climatic conditions. However, eventually lesions darken and the surrounding leaf tissues become necrotic. On a highly susceptible variety, considerable numbers of pustules may occur on a leaf, coalescing to form large, irregular, necrotic areas. High rust severities may result in premature death of even young leaves. Severe rust has caused reductions in both stalk mass and stalk numbers, thereby reducing cane tonnage (11).

Leaf wetness and atmospheric temperature are the environmental factors most influential for rust development. Several hours of free moisture on the leaf surface at a favorable temperature is necessary for successful spore germination, infection, and spread of the disease. While long dew periods and rainfall events both contribute to leaf wetness, rainfall events are not quite as favorable for rust development. Heavy rains tend to remove spores from the atmosphere, rendering them infective if they land on the soil. Increased soil moisture strongly favors infection by increasing the humidity within the canopy and lengthening the duration of leaf wetness. In Florida, rust is most severe from February to May since its development is favored by cool to moderate temperatures. Plants that are 3 to 6 months old are also prevalent during this period and appear to be most susceptible at this stage (11).

Orange Rust. The causal organism of orange rust (*Puccinia kuehnii*) was found in Florida in 2007 and has also been recently detected in Costa Rica, Guatemala and

Nicaragua. Previously, it had been known as a minor disease of sugarcane in Asia and Australia (12). Orange rust in the late summer of 2007 caused an estimated 10 percent loss on susceptible varieties in Florida. By late spring of 2008, more orange rust was observed and it presented earlier in the season due to weather conditions ideal for early establishment (13).

The biology of orange rust is similar to brown rust. Unfortunately, varietal resistance to brown rust does not simultaneously confer resistance to orange rust. The most susceptible varieties (CP80-1743 and CP72-2086) are planted widely in Florida and about a third of the overall acreage in Florida is planted with orange rust susceptible sugarcane (13). The designation 'CP' stands for a variety produced by the Canal Point breeding program followed by the year the cultivar was named, usually 7 to 10 years prior to commercial release (14). The variety CP80-1743 has fairly high resistance to brown rust, but this does not equate to orange rust resistance. It also appears that plant cane is more affected than ratoon cane. Researchers are also determining if orange rust is affecting CP89-2143 in two locations. This variety comprises about 20 percent of the acreage in Florida (13).

Non-Chemical Management

The best means of control for sugarcane rust is to grow resistant varieties. However, resistance has not been stable or durable on certain varieties, presumably because of rust variants. For this reason, it is highly recommended that growers diversify their varietal holdings. In this way, they will not have a predominance of one variety, should a rust variant develop that is capable of infecting that particular variety. Varietal diversification may play an important role in holding down the overall area-wide disease pressure, thereby reducing the natural selection pressure for one particular rust variant. It is believed that this may assist in preserving the durability of host plant resistance in current resistant varieties (11).

Since soil factors have been identified as being associated with rust infection levels on sugarcane, avoid growing susceptible varieties in areas with low soil pH and/or high levels of P and K nutrients. Sugarcane grown in fields receiving recent applications of nutrient amendments is typically very prone to rust. If possible, plant these fields with varieties that have durable rust resistance (11).

Chemical Management

There are few effective disease management tools for sugarcane. Propiconazole is available as a dip treatment for plant cane pieces and phosphorous-based fungicides are registered for foliar application, but neither of these is greatly effective for a leaf disease which attacks the sugarcane 3 to 6 months after planting. To this end, the Florida Department of Agriculture and Consumer Services declared a crisis exemption under section 18 of FIFRA for the use of two fungicides (pyraclostrobin and metconazole). It is envisioned that a 3-year quarantine exemption will be issued by the EPA for this use (13).

As of mid-May 2008, approximately 10,000 acres of sugarcane had been sprayed with pyraclostrobin. The applications cost approximately \$30/acre (\$25/acre for the fungicide and \$5/acre application cost independent of whether it is applied by ground or air).

Weed Management

Weed control is most critical early in the season prior to sugarcane canopy closure over the row middles. Heavy weed infestations can also interfere with sugarcane harvest by adding unnecessary harvesting expenses. A weed that is allowed to mature and produce seed will multiply weed control problems for future years. The most important weed pests in Florida sugarcane production are fall panicum, napiergrass, yellow and purple nutsedge, and pigweeds (15-17).

Weed Pests

NUTSEGE . Yellow nutsedge (*Cyperus esculentus*) and purple nutsedge (*C. rotundus*) are a constant pest of most crops in Florida. Both of these perennial sedges are found in disturbed habitats throughout Florida and the Southeast United States. Yellow nutsedge may produce some seed but reproduces primarily by rhizomes and tubers. The first plant develops rhizomes, which end in bulbs or tubers that produce new plants. Tuber production is favored by low nitrogen levels and high temperatures (80 to 91°F). It is tolerant of high soil moisture but is intolerant of shade. Purple nutsedge is also able to reproduce from tubers when conditions are harsh, making it difficult to control. Unlike the rhizomes of yellow nutsedge, purple nutsedge rhizomes growing off the first plant produce new plants in a series (“tuber-chains”). The plant also reproduces by seed to a limited degree. Although purple nutsedge is also intolerant of shade, it is able to survive a wide range of environmental conditions, growing well in nearly all soil types and over a range of soil moisture, soil pH, and elevation. It is also able to survive extremely high temperatures (17).

PIGWEED. Several species of pigweed are common weeds in Florida, including smooth pigweed (*Amaranthus hybridus*), spiny amaranth (*A. spinosus*) and livid amaranth (*A. lividus*). Pigweeds are summer annuals with taproots. These broadleaf plants reproduce by seed and can reach heights of six feet, creating a very competitive interaction with young sugarcane (17).

FALL PANICUM (*Panicum dichotomiflorum*). Fall Panicum is an annual that primarily emerges in spring and summer, but seed germination can occur almost year-round in Florida sugarcane fields. However, it tends to be sensitive to shading and is typically not found in sugarcane once canopy closure occurs. Fall panicum typically reaches a height of 1.5 to 4 feet, but has been reported to reach over 6 feet in height. Its growth habit can range from erect to sprawling and it can form large loose tufts (15).

NAPIERGRASS (*Pennisetum purpureum*). Napiergrass is an enormous, weedy, cane-like grass commonly seen growing along canals and roadsides in the sugarcane production area of south Florida. Napiergrass, also known as elephantgrass, has been documented in almost 30 counties throughout Florida. It is of African origin, but has been introduced to all tropical areas of the world because of its ability to quickly produce large amounts of biomass. Currently, napiergrass is widely used in Central America, South America, and Africa as a forage crop. Napiergrass was introduced to south Florida and Texas for use as a forage crop, but it is no longer widely used for this purpose and has become a major weed problem. Napiergrass is now established throughout southern Florida, especially along canal and ditch banks and in disturbed or cultivated areas. Because of the weedy characteristics of napiergrass, it is considered to be one of the world's worst weeds and has been listed as an invasive species by the Florida Exotic Pest Plant Council (16).

Non-chemical Management

Crop Rotation. Crop rotation patterns will affect the weed management of a sugarcane crop. Weed management intensifies in successive planting operations. Traditionally, the fallow period between final ratoon harvest and planting has effectively been used to manage troublesome weed populations. This is accomplished primarily by mechanical cultivation. Flooding fallow fields also aids in weed control through the development of an anaerobic environment in which weed seed germination and seedling growth is impaired. Rice is grown on approximately 10,000 acres in any given year. Herbicide treatment may be more effective after a flooded period as well (10,17).

Crop Competition. Crop competition for sunlight is one of the most important concepts to be utilized in effective weed control. A good stand of sugarcane that emerges rapidly and uniformly and forms a complete canopy that shades the row middles early in the season is very helpful in reducing weed competition. The loss of cane plants in ratoon crops due to rodent, insect, or harvest damage will create open spaces in the sugarcane canopy in which weeds can proliferate. A concentrated effort to maintain maximum cane populations throughout all phases of production will benefit weed control efforts (17).

Cultivation. Cultivation can be an economical means of suppressing weed growth. To assure that the sugarcane plants get the early advantage in the competition for sunlight, a height differential must be established between cane plants and weeds. Only when the cane plants are growing taller than competing weeds can mechanical cultivation be effective. However, cultivation when weeds are not present due to application of a herbicide or previous cultivation is not recommended. Cultivation when weeds are not present can encourage germination of additional weed seeds, and can remove the layer of herbicide present when soil-applied herbicides are used. In ratoon crops, mechanical cultivators must be able to cut through surface debris and thoroughly mix the soil (17).

Chemical Management

Herbicides are used on all of the sugarcane grown in Florida. The most commonly used materials include atrazine, 2,4-D, asulam, and ametryn. Other herbicides used on less than 10 percent of the sugarcane acreage are metribuzin, halosulfuron, and pendimethalin (18,19). Other herbicides registered for use in Florida sugarcane as of 2008 are carfentrazone, dicamba, diuron +/- hexazinone, flumioxazin, glyphosate, paraquat, and trifloxysulfuron (17).

ATRAZINE. Atrazine is a restricted-use pesticide that is the main herbicide used by sugarcane growers. It is applied to nearly all of the sugarcane as a preemergence treatment and sometimes early postemergent. It controls most annual grass and broadleaf weeds. Atrazine is applied at a rate of 3 lb ai/A. The price of atrazine is approximately \$3.50 per pound of active ingredient, and the approximate cost of a maximum labeled application (4.0 lb ai/A) is \$14 (20,21). A special local needs registration allows up to 10 lb of ai/A per crop.

2,4-D. The herbicide 2,4-D is selective against broadleaf weeds when sprayed on the foliage. It is used primarily for the management of weeds such as spiny amaranth, ragweed, morningglory, and many others. Higher rates are used for large or difficult-to-control weeds, such as alligatorweed. It is applied by ground or air to approximately three-quarters of Florida's sugarcane acreage at a rate of 1.9 lb ai/A (18,19). The price of 2,4-D is approximately \$3 per pound of active ingredient, and the approximate cost of a maximum labeled application (2.0 lb ai/A) is \$6 (17,20).

AMETRYN. Ametryn is applied as a directional or semi-directional spray to annual grass and broadleaf weed seedlings. It is especially effective against alexandergrass. It is applied to approximately 40 percent of Florida's sugarcane acreage. It is applied by ground or air at a rate of approximately 0.5 lb ai/A (19). The price of ametryn is approximately \$7 per pound of active ingredient, and the approximate cost of a maximum labeled application (1.1 lb ai/A) is \$8 (17,20).

ASULAM. Asulam is a herbicide applied to foliage of immature seedling grasses. Application may be broadcast overall, directed, or semi-directed in sugarcane at least 14 inches tall. It is applied only once per season. Asulam controls alexandergrass, broadleaf panicum, and other annual grasses but response is slow. It is applied by ground or air to approximately 20 percent of Florida's sugarcane acreage. It is applied at a rate of approximately 1 lb ai/A (19). The price of asulam is approximately \$12 per pound of active ingredient, and the approximate cost of a maximum labeled application (3.3 lb ai/A) is \$40 (17,20).

METRIBUZIN. Metribuzin is applied by ground to a small number of sugarcane acres. It controls most annual grass and broadleaf weeds but is often mixed with atrazine or pendimethalin. It is applied at the time of planting or ratooning, but prior to weed emergence. Metribuzin is applied at a rate of 0.8 lb ai/A (19). The price of metribuzin is

approximately \$23 per pound of active ingredient, and the approximate cost of a maximum labeled application (1.9 lb ai/A) is \$44 (17,20).

PENDIMETHALIN. Pendimethalin is applied by ground or air to a small number of sugarcane acres. It controls most annual grass and some broadleaf weeds but is often mixed with metribuzin. It is applied at the time of planting or ratooning, but prior to weed emergence. It can also be applied layby. Rainfall within 7 days of application is needed to incorporate the herbicide into the soil, or activity will be significantly decreased. Pendimethalin is applied at a rate of 3 lb ai/A (19). The price of pendimethalin is approximately \$6 per pound of active ingredient, and the approximate cost of a maximum labeled application (4 lb ai/A) is \$24 (17,20).

HALOSULFURON. Halosulfuron is applied by ground to a small number of sugarcane acres. It controls purple and yellow nutsedge as well as some broadleaf species. It may be applied to any stage of sugarcane growth. Halosulfuron is applied at a rate of 0.05 lb ai/A (19). The price of halosulfuron is approximately \$245 per pound of active ingredient, and the approximate cost of a maximum labeled application (0.06 lb ai/A) is \$15 (17,20).

Nematode Management

Plant-parasitic nematodes are microscopic roundworms found in soil. Ectoparasitic nematodes feed from the exterior of the root, while endoparasitic nematodes enter the plant tissue to feed. General symptoms of nematode damage include stunting, premature wilting, leaf yellowing and related symptoms characteristic of nutrient deficiencies. Stunting and poor stand development tend to occur in patches throughout the field as a result of the irregular distribution of nematodes within the soil. Damage is usually greater on ratoon cane (22).

Nematode Pests

Sting nematode (*Belonolaimus longicaudatus*), an ectoparasite, is the most damaging nematode to sugarcane in Florida. Stubby-root (*Trichodorus* and *Paratrichodorus* spp.), ring (*Criconemoides* and related genera), and stunt (*Tylenchorhynchus* and *Quinisulcius*) nematodes are other ectoparasites that may damage sugarcane and are common in Florida. Endoparasites that may damage sugarcane in Florida are lesion (*Pratylenchus zaeae*), lance (*Hoplolaimus* spp.), and root-knot (*Meloidogyne* spp.) nematodes. Most species of plant-parasitic nematodes favor sandy conditions and are rarely a problem on muck soils. However, sugarcane grown in sandy areas has the potential for dramatic yield losses from nematodes (22).

Non-chemical Management

Crop Rotation. Rotation with rice can reduce populations of plant-parasitic nematodes. Many of the nematodes that feed on sugarcane are able to feed on rice under dry

conditions. However, because rice is normally grown in standing water, most of the nematodes are killed by the flooded conditions (22).

Flooding. Plant-parasitic nematodes are affected by flooded conditions. In certain areas of Florida, flooding may be used as a nematode management tactic for sugarcane. For best results, the area needs to be flooded for a 4 week period, then drained and left dry for 2 weeks, and then flooded once again for 4 weeks (22).

Soil Amendment. Filtercake or “mud” is the sediment left over following clarification of sugarcane juice. Filtercake can be added as an amendment to sandy areas to reduce nematode damage. Filtercake amendment has been shown to reduce populations of plant-parasitic nematodes on sugarcane. Addition of organic matter to sandy soil can improve plant tolerance and make nematode damage less severe (22).

Chemical Management

Even in sandy soils, nematicides are infrequently used. Ethoprop, in addition to managing wireworms, can affect nematodes, so it may provide nematocidal benefit when it is utilized. The fumigant 1,3-dichloropropene also provides temporary nematode abatement (22).

Vertebrate Management

Several species of rat feed on sugarcane plants and can in some cases become economic pests. A special local needs registration for the rodenticide diphacinone exists for sugarcane growers (21). The material is placed on the ditch banks around seed cane and is used on less than one percent of the acreage in any one year (23).

Key Contacts

Mark Mossler is a Doctor of Plant Medicine in the Agronomy Department’s Pesticide Information Office at the University of Florida’s Institute of Food and Agricultural Sciences. He is responsible for providing pest management and pesticide information to the public and governmental agencies. Dr. Mossler can be reached at UF/IFAS PIO, Box 110710, Gainesville, FL 32611, (352) 392-4721, plantdoc@ufl.edu

References

1) United States Department of Agriculture National Agricultural Statistics Service. 2008. Crop Values 2007 Summary.

- 2) Baucum, L.E., Rice, R.W., and Schueneman, T.J. 2006. An Overview of Florida Sugarcane. Agronomy Department document SS-AGR-232. University of Florida/IFAS, Gainesville, FL 32611.
- 3) Gilbert, R.A., Rice, R.W., and Lentini, R.S. 2008. Characterization of Selected Mineral Soils Used for Sugarcane Production. Agronomy Department document SS-AGR-227. University of Florida/IFAS, Gainesville, FL 32611.
- 4) Glaz, B. and Gilbert, R.A. 2007. Sugarcane Variety Census: Florida 2005. Agronomy Department document SS-AGR-268. University of Florida/IFAS, Gainesville, FL 32611.
- 5) Cherry, R.H., Schueneman, T.J., and Nuessly, G.S. 2001. Insect Management in Sugarcane. Entomology and Nematology Department document ENY-406. University of Florida/IFAS, Gainesville, FL 32611.
- 6) Hall, D.G., Nuessly, G.S., and Gilbert, R.A. 2007. Sugarcane borer in Florida. Entomology and Nematology Department document ENY-666. University of Florida/IFAS, Gainesville, FL 32611.
- 7) Cherry, R.H. and Lentini, R.S. 2002. White Grubs in Florida Sugarcane. Entomology and Nematology Department document ENY-664. University of Florida/IFAS, Gainesville, FL 32611.
- 8) Hall, D.G., Cherry, R.H., Lentini, R.S., and Gilbert, R.A. 2002. Wireworms in Florida Sugarcane. Entomology and Nematology Department document ENY-665. University of Florida/IFAS, Gainesville, FL 32611.
- 9) Hall, D.G., Cherry, R.H., Lentini, R.S., Nuessly, G.S., and Gilbert, R.A. 2002. Miscellaneous Insect Pests of Florida Sugarcane. Entomology and Nematology Department document ENY-667. University of Florida/IFAS, Gainesville, FL 32611.
- 10) Schueneman, T., Rainbolt, C., and Gilbert, R. 2005. Rice in the Crop Rotation. Agronomy Department document SS-AGR-23. University of Florida/IFAS, Gainesville, FL 32611.
- 11) Raid, R.N. and Comstock, J.C.. 2006. Sugarcane Rust Disease. Agronomy Department document SS-AGR-207. University of Florida/IFAS, Gainesville, FL 32611.
- 12) Isakeit, T. 2008. Orange Rust of Sugarcane: A New Disease Threat. Texas A&M Extension document PLPA-FC003-2008. Texas A&M University System.
- 13) United States Department of Agriculture Orange Rust Conference Calls.

- 14) Gilbert, R.A., Shine, J.M., and Rice, R.W. 2007. Performance of CP Sugarcane Cultivars Grown in Different Locations in Florida. Agronomy Department document SS-AGR-285. University of Florida/IFAS, Gainesville, FL 32611.
- 15) Rainbolt, C. and Sellers, B. 2006. Fall Panicum: Biology and Control in Florida Sugarcane. Agronomy Department document SS-AGR-132. University of Florida/IFAS, Gainesville, FL 32611.
- 16) Rainbolt, C. 2005. Napiergrass: Biology and Control in Florida Sugarcane. Agronomy Department document SS-AGR-242. University of Florida/IFAS, Gainesville, FL 32611.
- 17) Rainbolt, C. and Dusky, J.A. 2006. Weed Management in Sugarcane - 2007. Agronomy Department document SS-AGR-09. University of Florida/IFAS, Gainesville, FL 32611.
- 18) Florida Department of Agriculture and Consumer Services. Summary of Agricultural Pesticide Use in Florida: 1999-2002.
- 19) CropLife Foundation - Pesticide use database - 2002 sugarcane data for FL.
- 20) Anonymous pricing data.
- 21) Special Local Needs Registrations FL-020001, FL-020002, and FL-880018.
- 22) Crow, W.T. 2005. Plant-Parasitic Nematodes on Sugarcane in Florida. Entomology and Nematology Department document ENY-053. University of Florida/IFAS, Gainesville, FL 32611.
- 23) Personal communication, J.M Shine, Jr., May 2008.