Tennessee Sweet Corn Pest Management Strategic Plan Meeting

Summary of the Workshop held on May 22, 2003

in

Knoxville, TN

Ellington Hall, Plant Sciences Building

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Tennessee Sweet Corn Pest Management Strategic Plan Meeting

Summary of Critical Needs and Priorities for Tennessee Sweet Corn Production

"TO DOs"

Research

- Development of corn earworm resistant varieties that are free of the "Bt" gene.
- Development of varieties that can tolerate and/or resistant to damage caused by corn earworm and European corn borer.
- Development of "Bt" varieties which have greater flavor.
- Investigate products that are effective in controlling both the corn earworm and European corn borer.
- Development of varieties with resistance to the downy mildews. With the possible threat of introduction of Philippine downy mildew (*Peronosclerospora philippinensis*) and brown striped downy mildew (*Sclerophthora rayssiae* var. *zeae*) investigation of resistance should be a priority.
- Develop varieties resistant to rust.
- Develop IMI, glufosinate-consumer-acceptable, and sethoxydim resistant varieties.
- Develop varieties that may tolerate late season pests (insects and diseases).

Regulatory

- Assist in the review process by speeding up the process of obtaining use permits for genetically modified varieties.
- Registration of mesotrione (Callisto) herbicide for annual broadleaf weed control.
- Registration of foramsulfuron (Option) annual and perennial grass and broadleaf weed control.
- Streamlined Section-18 process.

Extension

- Educate and reduce fears of the public concerning genetically modified products and how they are safe, if consumed.
- Inform growers that granular treatments placed within the whorls are more effective than using insecticide sprays for first generation European corn borers. Stress that applications should be made May – early June for control of this pest.
- Inform growers that rotation helps control rootworm larvae and controls for rootworms are not needed, if sweet corn is followed by another crop other than corn.
- Inform growers that white grubs and wireworms are generally more of a problem in corn when planted in areas previously in sod.
- Educate growers concerning importance of application timing for control of common stalk borer and southwestern corn borer.

Background

The purpose of the Pest Management Strategic Plan is to assist growers in continuing profitability in crop production by providing cost-effective alternatives to currently used pest management tools. Attendees of this workshop helped identify gaps and needs that may be used to improve sweet corn production within Tennessee and possibly the southern region. These gaps or needs that have been identified by participants of the workshop have been listed in the "TO DOs" section of each pest listed and in a prioritized listing in the beginning of the document. The "TO DOs" sections have been separated into three categories. These categories include Research, Regulatory and Education.

The information will be used to help identify registration needs and priorities to the Environmental Protection Agency (EPA) and to pesticide registrants. Information included in this document will also serve as a reference indicating where problems exist in sweet corn production in Tennessee. This reference material assists all interested parties by providing them information concerning the importance of each pest. This document may also serve as an informational resource for researchers, regulators and extension personnel.

The development of a Pest Management Strategic Plan (PMSP) is a method of setting pest management priorities for a commodity and demonstrating stakeholder involvement in the process. The USDA's Office of Pest Management Policy (OPMP) developed the PMSP as a planning and priority setting process to facilitate a transition to alternative pest management practices when one or more pesticides used to manage pests on a crop are lost as a result of regulatory review. Land Grant University research and extension specialists or commodity organizations, often with the assistance of personnel from the USDA OPMP, facilitate the development of PMSPs. Growers, commodity representatives, land-grant specialists, food processors, crop consultants, and other stakeholders are generally involved in the process.

Ideally, a PMSP outlines the current state of pest management for a commodity at the state, region, or national level and presents a prioritized list of needs for research, regulatory activity, and extension education to facilitate the transition to alternative pest management practices. The plans take a crop phenology and pest-by-pest approach to identifying and assessing the current management practices (chemical and non-chemical) applied to an area. The stakeholders involved in the PMSP process also identify and prioritize their pest management research, regulatory and extension needs.

Worker's Activities

Land Preparation
Soils are generally freshened prior to planting or during the seeding process. This activity involves one person driving an open-cab or enclosed-cab tractor. Tennessee sweet corn production is done on bare ground and on occasions is produced no-till. Limited production on raised beds with black plastic mulch and trickle irrigation is being utilized.

Fertilizer applications
Fertilizer applications are normally made anywhere from 4 weeks prior to until the day of seeding. Occasionally, some producers (28%) will side dress the crop with a nitrogen source (ammonia nitrate) approximately two – four weeks after plants have emerged. Applications are often made at first cultivation.

Pre-plant incorporated herbicide applications
Pre-plant incorporated herbicide applications are often made 2 two weeks prior to planting until the day of planting. The majority of pre-plant herbicide applications are made from March 22- until April 22nd.

Planting Method and Planting Dates
Seed and fertilizer are placed mechanically at planting. This process requires one operator in an open or enclosed-cab tractor. Due to the excellent germination of sweet corn seed, no thinning operations are performed. Occasionally, when no soil insecticides are used at planting, insects may reduce stands. A very small percentage of the acreage is planted by hand.

To avoid insect and disease problems approximately 80% of the sweet corn is planted as early as possible to avoid damage from pest. To avoid injury from cold weather growers often elect to plant just after the frost free date for their location. In West Tennessee and southern tier counties, producers may plant as early as March 30, if weather conditions favor seed germination. However, the majority of the sweet corn produced is planted after April 15th, to avoid cold injury. The planting dates of approximately 20 percent of the remaining sweet corn crop may be spread from late April until mid-July. Generally, late season plantings include varieties that contain the Bt-gene.

Pre-emergent herbicide applications
Pre-emergent herbicide applications are made prior to the target weed emerging. These applications can be made as early as a week after planting until 3 weeks after planting.

Post-emergent herbicide applications
Post-emergent applications are made after the target weed has emerged. Most producers apply products three to four weeks after seeding. These applications would be spread from late April until late July, however the majority would be applied in the month of May.

Irrigation

Until recently, little, if any irrigation has been utilized in Tennessee sweet corn production. If irrigation was used by growers, overhead systems would generally implemented and start as soil moisture conditions warrant use. Solid set systems setup shortly after planting have been rarely utilized. Solid set irrigation involves setting metal pipes and sprinklers in strategic locations around and through the field. These systems may require from two to eight workers a day or two days to setup. Often these systems must be moved to allow application of crop protectants for insect control. Some traveling gun and center pivot systems have been utilized on limited fresh market acreage and much of the processing acreage. With these systems workers would have little contact with the crop. Trickle irrigations, involves positioning sections of plastic drip tubing throughout the field to insure appropriate coverage. This generally occurs during bed formation, prior to planting. A very small percentage of the acreage would be applied on top of the soil after crop emergence. If irrigation is selected, it may begin any time during the season from seeding until harvest, when soil begins to dry.

Cultivation

Fields are cultivated and side-dressed with fertilizer mechanically once before the corn is higher than the tractor clearance (12 to 18 inches). This process also requires only one operator in an opened or enclosed-cab tractor. Cultivation timing varies depending on the growing conditions (temperature, soil moisture) and herbicide usage. Cultivation occurs as early as two weeks after seeding up until the corn reaches no more than 2 foot in height. Cultivation can not be performed after this height due to possible mechanical injury. Cultivation may occur as early as mid April and extend until late July, however the majority of cultivation occurs in late April until mid-May.

Harvest

The only time agricultural workers come into direct contact with the sweet corn crop is during harvest, which is usually done by hand in the field in early morning. In large operations a mobile platform which has a conveyor with wings is used. Ears are placed on the conveyer. The conveyer belt guides picked ears to packers who are on a platform. Approximately 5 - 10 people walk the rows pulling ears, while 5 - 10 people are grading and packing the corn on the aid and transporting it to the cooler. Workers dress in long-sleeve shirts and pants due to the abrasive nature of the corn foliage. Both packers and pullers wear cotton cloth or leather gloves. If mechanical harvesters are used, workers contact mechanically-harvested corn only during packing. The mechanized harvester is capable of harvesting approximately 80 acres per day. The remaining corn foliage is trampled as the harvesters continue harvesting the area. Plant residue is eventually incorporated into the soil by cultivation. Large acreage of sweet corn may be planted at staggered dates within different fields, so that harvest may occur over several days to weeks. This may prevent loss due to late frosts, insect injury or poor weather during silk and/or harvest. After packing, the corn is immediately cool shipped by truck to the buyer.

The processing acreage in the state of Tennessee is machine harvested and the kernel is removed from the ear in the field. The only human contact is the removal of trash before the grain is deposited in a stainless steel bin. The cut grain is then loaded on stainless steel trucks and transported to the processing plant. Harvest occurs as early as late June and continues until mid-October, however the majority is harvested during last week in June until mid-July.

Scouting

Scouting is conducted twice weekly, farm managers and their assistants review their pest counts and determine the best forms of crop protection methods to utilize. Most pesticides are ground applied and re-entry intervals are posted for scouts, applicators and workers. Very few pesticide applications are made by air in sweet corn production. Scouting usually is necessary to economically control cutworms, armyworms, lesser corn stalk borer. Plants under 12 inches in height are most susceptible to damage by these pests. Sweet corn planted later in the season may require more frequent intervals of scouting.

Integrated Pest Management

Integrated Pest Management (IPM) is a method of pest control which utilizes all forms of control for pests. It is difficult to get a handle on the percent usage of IPM, since some producers utilize all methods of pest control available and others select methods most convenient for their farm. In most instances all Tennessee sweet corn producers have had to select a cultural control (plant early) to avoid injury due mainly from insect infestations and infection from disease organisms. The use of black light or pheromone traps has been used in field corn production in West Tennessee to monitor movements of adult lepidopterous pests. The use of these traps in field corn also helps keep producers of sweet corn aware of insect flights and so they may know when to check their crops for possible insect activity. Also, pheromone traps are used to monitor various insect flights in many counties located across Tennessee. Information concerning black light and pheromone trap catches are available through the weekly published Extension IPM newsletter. This information is available to sweet corn producers. European corn borer, corn earworm and fall armyworm are mid to late season pests. If these pests are not controlled early during pest development, no amount of spraying will make up for damage encountered. Economic thresholds are normally not observed in sweet corn since damage generally is not tolerated and most growers producing products for the fresh market, so growers spray on schedule. A greater amount of damage may be acceptable in processing sweet corn, since damage areas of the ear may be culled. See Table 3, for non-chemical pest management practices commonly used for insect control.

Worker Safety and Re-Entry Intervals

Most large scale sweet corn producers hire migrant workers or individuals located near their community. Tennessee producers are required by federal and state laws to follow safety standards known as the Worker Protection Standards (WPS). The Worker Protection Standards are regulations which cover pesticide usage in agricultural, forest,

nursery and greenhouse production. Any Tennessee producer employing individuals to work in agricultural production must inform and/or train workers concerning the Worker Protection Standards. Worker Protection Standards are standards which are to be followed by employers to help eliminate possible pesticide contamination of pesticide applicators, handlers or workers. Information pertaining to pesticide application must be posted in a central location. Information concerning products used, location of application and re-entry interval is posted at the central location. Also, other items pertaining to safety are provided to workers, applicators and/or handlers. If workers, handlers and/or applicators must enter the field earlier than indicated by the pesticide label, individuals may be required to wear certain personal protective equipment. In most cases this includes boots, gloves, hat, long sleeve shirts, and long legged trousers. The Signal Word indicated by Caution, Warning or Danger are indicators of the level of human hazard which may vary between formulations containing the same active ingredient. The Signal Word lets the applicator, handler or worker know the relative toxicity of a product. Early re-entry is generally not necessary in Tennessee sweet corn production. Treated areas are also posted to inform workers that treatments have been made and re-entry is restricted. If employers and employees follow WPS regulations, harvest interval and re-entry intervals, agricultural workers are less likely to be at risk to pesticide exposure in Tennessee agricultural production.

Biocontrol Using Modified Corn Varieties:

The use of genes known as "Bt" genes have been incorporated into several sweet corn varieties. The gene originated from the bacteria known as *Bacillus thuringensis* . The gene produces a toxin that is deadly to various pests of corn and cotton, however has no effect on humans and/or livestock. Due to consumer fears of the unknown, sweet corn varieties with this gene are rarely selected or grown by producers and are not knowingly accepted by the public. Also, sweet corn varieties which have this gene have had reduced flavor, therefore they are not in high demand by the consumer. Consumer education and development of enhanced or improved flavor of Bt varieties may increase future sales of genetically modified crops. Within the past year growers have been increasing acreage to review improvements within newly developed varieties.

Genetically modified or Bt corn has been shown to control other insect pests besides European corn borer. However, not all of the Bt corn events have been evaluated for control of all corn pests. Levels of control and differences among the technologies similar to that listed for **European corn borer** may be found as well in control of the **southwestern corn borer**. Bt corn is an effective control option for European corn borer and southwestern corn borer. The Bt corn hybrids that use the CryIA(b) and CryIA(c) are not effective against **black cutworm** larvae. Field studies have demonstrated approximately 50 to 70% reduction in tip damage by **corn earworm** on Bt corn that has the MON 810 and BT 11. Little control has been observed with 176. The MON 810 and BT 11 events have been reported to provide 50 to 70% control of **fall armyworm**. At this time, information on other Bt events is too limited. The Indian meal moth is not a

problem in the field in fresh market or processing corn. The MON 810 and BT 11 provide significant control of **Indian meal moth** as shelled grain. Little control has been observed with 176.

INSECTS

Corn Earworm
(*Helicoverpa zea*)

Corn earworms mainly feed at the tip of the ear causing unsightly damage that is not acceptable in the market place. Eggs are laid individually on fresh silks and are very difficult to find. Egg laying can start as early as later part of May and continues until late August. When eggs hatch larvae emerge and corn earworms feed mainly at the tip of the ear. If silking occurs after July 1, insecticides are applied as a preventative measure every other day even though no damage is observed. Consumers of fresh market sweet corn often refuse to purchase damaged ears. See Table 1, for relative efficacy of insecticides.

OP insecticides currently used:

- No OPs are currently used for corn earworm control.

Carbamate insecticides currently used:

- Methomyl (Lannate 90SP, 2.4LV) it provides good control. It also is used to control of European corn borer. Certain hybrid varieties are susceptible to methomyl injury. This product has a 0-day PHI. This is a restricted use product with danger as the signal word.
- Thiodicarb (Larvin 3.2) provides good control. Is a restricted use pesticide. Livestock may not graze treated fields. Not to exceed 7.5 lbs of active ingredient per acre per season. 0-day PHI.
- Carbaryl (Sevin). Generally used in fresh market sweet corn production. Limited to 16 lbs ai per acre per season. Provides fair to good control. This product has a 2-day PHI and a 14-day PHI if remaining stalks are used for forage or grazing.

Pyrethroid insecticides currently used:

- Esfenvalerate (Asana XL) is a restricted use pesticide with warning as the signal word. Provides good control.
- Lamda-cyhalothrin (Warrior T) is a restricted use pesticide with warning as the signal word. Has a 1-day PHI. It is also labeled to control various other insect pests of sweet corn. Treated corn can not be fed to cattle for 21-days after treatment. Provides excellent control.
- Permethrin (Ambush, Pounce) is a restricted use pesticide and has warning as the signal word. Provides excellent control.
- Bifenthrin (Capture) is a restricted use product with Warning as the signal word on the label. Provides excellent control.
- Cyfluthrin (Baythroid) only ten applications may be made per crop. This product has a 0-day PHI. A restricted use product with danger on the label. Provides excellent control.

Notes: In late planted corn most of these products must be applied every other day even though no damage is noted to avoid possible heavy infestations and damage.

Non-OP insecticides currently used:

- Spinosad (SpinTor) is a naturalyte insecticide that is very safe to the environment. This product is rarely used due to high cost of the product. It also has a 4-hour REI.
- Polyhedral occlusion bodies (Gemstar LC) is a virus that controls various lepidopterous pests. It provides good to excellent control, however does not persist for long periods of time after application. This product is fairly expensive. This product relatively safe and causes no effect to beneficials.

Non-registered pest management tools:

- Deltamethrin (Decis) is a pyrethroid insecticide and is an OP alternative. Has Danger as the signal word and is a restricted use pesticide. Provides effective control. This product is currently labeled on cotton. It has a 12 hour REI in cotton.
- Novaluron (Rimon, Pedestal) is an IGR with the mode of action effecting chitin synthesis. This product is environmental friendly.

Non-chemcial pest control methods currently used:

- Plant as early as possible to avoid late season pests.
- Pheromone traps may be used as monitors, however cost is high for pheromones, but trap housing may be reused for several years.
- Bt varieties provide some control for this pest.

"**TO DO**s"

Research

- Develop resistant varieties
- Investigate "Bt" that have greater effects on corn earworms

Regulatory

- Speed registration on deltamethrin and novaluron for use in sweet corn production.

Education

- Stress the importance of early planting

European Corn Borer

(*Ostrinia nubilalis*)

European corn borers (ECB) infest many types of plants. Mature larvae overwinter in old plant stubble or other protective plant material. They pupate in the spring during April and May. Adult moths emerge and mate. Each female lays up to 500 eggs in small masses on the undersides of leaves. Egg masses are usually found on the underside of the leaves. They hatch in four to twelve days depending on temperature. Young larvae feed on leaf surfaces and as they mature, begin boring in the midribs of leaves. Larvae may feed anywhere on the ear, stalk, tassel or leaves of the plant. Usually infestations in late planted corn are worse than early planted. This pest may occur as early as the 1st of June if warm weather conditions occur but generally scouting for eggs occurs in late June. Eggs will continue to be laid on developing corn until late September. Normally three to four generations may be observed throughout the growing season.

Organophosphate insecticides currently used:

- Chlorpyrifos (Lorsban 4E) this product is more effective in late planted corn vs. spring planted corn. It provides good to excellent control in late planted corn and good control in spring planted corn. This product has caution as the signal word and is a restricted use pesticide.

Carbamate insecticides currently used:

- Methomyl (Lannate 90SP, 2.4LV) it provides good to excellent control. It also is used to control of corn earworm. Certain hybrid varieties are susceptible to methomyl injury. This product has a 0-day PHI. Not available in granular formulations.
- Thiodicarb (Larvin 3.2) provides good control. Is a restricted use pesticide. Livestock may not graze treated fields. Not to exceed 7.5 lbs of active ingredient per acre per season. This product has a 0-day PHI.
- Carbaryl (Sevin). Generally used in fresh market sweet corn production. Limited to 16 lbs ai per acre per season. Provides fair to good control.

Pyrethroid insecticides currently used:

- Esfenvalerate (Asana XL) provides good control of this pest.
- Lamda-cyhalothrin (Warrior T) Provides good to excellent control of this pest.
- Permethrin (Ambush 2EC, 25W, Pounce 3.2E, 25WP, 1.5G) Granular formulations applied in the whorls are more effective than using sprays for first generation ECB. This product has a 1-day PHI. Provides good to excellent control of this pest.
- Bifenthrin (Capture 2EC) has a 1-day PHI. Provides good to excellent control of this pest.
- Cyfluthrin (Baythroid 2EC) only ten applications may be made per crop. This product has a 0-day PHI. Provides good to excellent control of this pest.

Notes: Generally pyrethroid pesticide applications are needed every other day for control of this pest, especially late season crops.

Non-OP and non-pyrethroid insecticides:

- Indoxacarb (Avaunt 30G) has a 3-day PHI or 14-day if hand harvested. It has a 12 hour REI with caution as the signal word. This product is a sodium channel blocker. This product is extremely expensive.

Biological controls currently used:

- *Bacillus thuringiensis* (Dipel, Full-Bac): Granular materials applied in the whorl are more effective for first generation European corn borers. This product has a 0-day PHI. Provides good control of this pest when applied to the whorl.
- Spinosad (Spin Tor) is a naturalyte insecticide that is very safe to the environment. This product is rarely used due to high cost of the product. Provides good control of this pest.

Non-registered pest management tools:

- Deltamethrin (Decis) is a pyrethroid insecticide with Danger as the signal word. It is a restricted use pesticide however, it is an OP alternative.
- Novaluron (Rimon, Pedestal) is an IGR with the mode of action effecting chitin synthesis.

Non-chemical control currently used:

- Pheromone traps are very effective in determining when populations are increasing and when to spray. However, high cost is a factor in use of this product.
- Planting early will eliminate second and third generation infestations which are normally more difficult to control.

"**TO DO**s"

Research

- Investigate longevity of "Bt" applications.
- Investigate additives to lengthen life of applied "Bts".
- Investigate materials that have longer residual insect control.
- Improve flavor of developed "Bt" varieties.

Regulatory

- Speed registration of deltamethrin and novaluron.

Education

- Stressing the importance of scouting and time of pesticide applications
- On-farm demonstrations using pheromone trapping to determine best times to apply insecticide sprays.

Fall Armyworm

(*Spodoptera frugiperda*)

Adults normally overwinter south of Tennessee, in warmer environments. Adults migrate into the state and have been observed laying eggs in mid-July until late September. Eggs are laid in clusters on leaf surfaces. Larvae are most active early morning or late evening. If populations become large, they may be observed as an army of worms moving from one field to another.

Damage: Fall armyworms feed extensively on the leaves, then usually enter through the side of the husk to feed on the ear. After eggs hatch larvae start feeding on leaves and continue to undeveloped tassels of young plants. Immature ears are attacked near the shank. Larvae often bore into stalks or ears of the plant.

Carbamate insecticides currently used:

- Methomyl (Lannate 90SP, 2.4LV) it provides –control. It also is used to control of European corn borer. Certain hybrid varieties are susceptible to methomyl injury. This product has a 0-day PHI.

- Thiodicarb (Larvin 3.2) provides good control. Is a restricted use pesticide. Livestock may not graze treated fields. Not to exceed 7.5 lbs of active ingredient per acre per season. This product has a 0-day PHI.
- Carbaryl (Sevin) provides fair to good control. Generally used in fresh market sweet corn production. Limited to 16 lbs ai per acre per season.

Pyrethroid insecticides currently used:
- Lamda-cyhalothrin (Warrior T) Provides good control.
- Bifenthrin (Capture 2EC) has a 1-day PHI. Provides good control.
- Cyfluthrin (Baythroid 2EC) only ten applications may be made per crop. This product has a 0-day PHI. Provides good control.

Non-OPs currently used:
- Indoxacarb (Avaunt 30G) has a 3-day PHI or 14-day if hand harvested. It has a 12 hour REI with caution as the signal word. This product is a sodium channel blocker. This product is extremely expensive. Provides good to excellent control.

Biological controls currently used:
- Spinosad (SpinTor) is a naturalyte insecticide that is very safe to the environment. This product is rarely used due to high cost of the product.

Non-chemical controls currently used:
- Planting early as possible often avoids the need to apply insecticides.
- Applying pesticides at the correct times avoids unnecessary multiple applications.

Non-registered pest management tools:
- Novaluron (Rimon, Pedestal) is an IGR with the mode of action effecting chitin synthesis. It has no systemic activity for this pest.

"**TO DO**s"

Research
- Investigate new Bts and their effects on fall armyworms

Regulatory
- Speed registration on novaluron.

Education
- Stress the importance of scouting.
- Training for proper identification of adults and eggs.

Corn flea beetle

(*Chaetocnema pulicaria*)

Flea beetles overwinter as adults, thus winter temperatures have been useful in determining spring population pressure of adults. The overwintering adults will feed on weeds and move into corn plants throughout May and June. Larvae feed on roots. But their damage is generally only associated with the early stages of corn, with disease transmission as the most important issue. This pest may be observed from first week of April until mid July. Pesticide application occurs when this pest is observed.

Crop loss may occur due to a bacterial disease transmitted by corn flea beetles. Corn flea beetles transmit a bacteria that causes bacterial wilt (also known as Stewart's wilt) of sweet corn. The bacteria is called *Erwinia stewarti*. The best cultural practice that can prevent wilt problems is to use resistant varieties when possible. This is more important for the early plantings, which typically sustain higher densities of corn flea beetles in sweet corn. There are several species listed as causing damage. They include the corn flea beetle, pale striped flea beetle, the western black flea beetle, the toothed flea beetle, the sweetpotato flea beetle, and the smartweed flea beetle.

Carbamate insecticides currently used:

- Carbofuran (Furadan 4F) provides excellent control, however can be hazardous if not used properly. Normally applied at plant in a 7 inch band over the row.
- Carbaryl (Sevin 50WP, 80WP, 4XLR) has a 0-day PHI. Generally used in fresh market sweet corn production. Limited to 16 lbs ai per acre per season.

Pyrethroid insecticides currently used:

- Bifenthrin (Capture 2E) has a 1-day PHI. Used at an extremely low active ingredient per acre rate.
- Other pyrethroids may provide some control of this pest.

Non-OP insecticides currently used:

- Thiomethoxam (Cruiser) is very environmentally friendly and low toxicity to vertebrates. Is used as a seed treatment and can be expensive to use.
- Imidacloprid (Gaucho) provides good control of this pest. Is used as a seed treatment. Low toxicity to vertebrates.

Non-chemical controls currently used:

- Mow surrounding areas prior to planting may aid in control.

"**TO DO**s"

Research

- Determine what species most often occurs in Tennessee sweet corn production.
- What weeds serve as reservoirs for this pest.

Regulatory

- None at this time.

Education

- Stress the importance of scouting, especially on sunny days.
- Stress the idea that treatments should be made when obvious scarring occurs on 75 percent of the plants.
- On-farm demonstrations of sweet corn varieties and levels of tolerance.

Black cutworm (*Agrotis ipsilon*), **Granulate** (*Feltia subterranea*), **Variegated** (*Peridroma saucia*), and **Spotted cutworm** (*Amathes c-nigrum*)

Sweet corn is very susceptible to damage from several species of cutworms in Tennessee. The black cutworm generally causes the most damage. Small worms chew small holes in the corn leaves. Worms may cut small plants near or at the soil line and pull the plant parts into burrows they dug earlier. Symptoms are usually cut and wilted corn plants.

These often occur in rows bordering the weedy field edge. They are normally observed just after plant emergence and generally do not cause problems 4 weeks after emergence. Control is achieved by using an insecticide at planting or immediately after the first cutworms are observed. Insecticides used for this pest may begin as early as mid-April and continue until later the part July.

OP insecticides currently used:

- Chlorpyrifos (Lorsban 4E, 15G) both formulations provide excellent control. They must be applied just prior to damage or when cutworms are observed. Often fields that are not scouted frequently, receive more damage. Caution is the signal word on the 15G label. The 4E formulation is a restricted use pesticide with warning as the signal word. The 15G label is less likely to drift off target.
- Chlorethoxyfos (Fortress) is a restricted use pesticide with Danger as the signal word. May not be applied as a surface application.

Carbamate insecticides currently used:

- Carbaryl (Sevin, 50WP, 80SP, XLR) provide good to excellent control. Must be applied just prior to damage or when cutworms are observed. Often fields are not scouted frequently receive more damage.
- Thiodicarb (Larvin 3.2) provides good control. Used as a rescue treatment when cutworms have been observed.

Pyrethroid insecticides currently used:

- Esfenvalerate (Asana XL) provides good to excellent control. Has a 12 hour REI.
- Lamda-cyhalothrin (Warrior T) provides excellent control. Has a 24 hour REI.
- Permethrin (Ambush, Pounce) provides good to excellent control. Has a 12 hour REI.
- Bifenthrin (Capture) provides excellent control. Has a 24 hour REI.
- Tebupirimphos and Cyfluthrin (Aztec G) restricted use pesticide with warning as the signal word. Provides good to excellent control.
- Zeta-cypermethrin (Fury, Mustang Max) is a restricted use pesticide with warning as the signal word.
- Tefluthrin (Force) is a restricted use pesticide currently labeled.

Unregistered pest management tools:

- Clothianidin (Poncho) is a neonicoitinoid insecticide and was recently registered after the meeting.
- Deltamethrin (Decis) is a pyrethroid insecticide and an OP alternative. It is a restricted use pesticide with Danger as the signal word.
- Novaluron (Rimon, Pedestal) is an IGR with the mode of action effecting chitin synthesis. This is an OP alternative which has a broad spectrum insect control.

Non-chemical controls currently used:

- Rotation may often help.
- Mow field edged prior to planting.
- Scouting fields frequently until 2 foot in height.
- Treatment usually does not begin until 5 percent or more of the stand shows damage or two worms per 100 plants are present.

"**TO DO**s" list for cutworms:
Research

- Identify resistant varieties.
- Determine if any predators and/or parasites that may be used for control.
- Possible formulation of carbofuran in a seed treatment form.

Regulatory

- Speed registration of deltamethrin and novaluron

Extension

- Educate producers of the importance of scouting and frequency of scouting.
- Educate producers of the importance of mowing field edges prior to planting.
- Educate producers of the economic thresholds.
- On-farm demonstrations to review efficacy of clothianidin.

Stalk borer

(*Papaipema nebris*)

Stalk borer can be in greater numbers in no-till plantings. Larvae may feed on leaves but eventually they tunnel into most any large stemmed plant. Stalk borers are often observed in ragweed. Larvae tunnel upwards severing leaves from below. Infested stalks are usually hollow and generally, healthy leaves soon die. Often tassels and leaves become damaged and suckers form. If infestation occurs when the plant is young, lodging may occur. Damage is usually sporadic but is commonly associated with border rows. Infestation may begin as early as mid-June and continue until through August.

Organophosphate insecticides currently used:

- Chlorpyrifos (Lorsban 4F) effective, but costly compared to weed management.

Other chemical controls:

- Products used for other pests will provide some level of control.

Non-chemical management:

- Destruction of weeds in fields and along fence rows will result in the elimination of possible overwintering sites, therefore reducing possible populations.
- Plant early in the season.

"**TO DO**s"
Research

- Develop resistant varieties

Regulatory

- None at this time.

Education

- Train growers to properly identify and observe damage.
- Stress the importance of scouting.
- Stress the importance of controlling weeds.

Sap Beetles
(*Glishrochilus quadrisignatus*)

Sap beetles are attracted to fermenting sugars and often arrive in large numbers at sweet corn ears that have been previously damage by birds or other insects. Generally, sap beetles are secondary pests which occur after infestation by corn earworms or other ear feeding pests. This pest may be observed from mid-June until mid-August depending on date of planting.

Organophosphate insecticides currently used:

- Tebupirimphos is combined with cyfluthrin, a pyrethroid (Aztec). This is a soil applied insecticide, which is active against wide range of soil inhabiting insects. This product provides effective control.

Carbamate insecticides currently used:

- Carbaryl (Sevin 50WP, 80WP, 4XLR) has a 0-day PHI. Provides excellent control. Generally used in fresh market sweet corn production. Limited to 16 lbs ai per acre per season.

Pyrethroid insecticides currently used:

- Esfenvalerate (Asana) used for corn earworm, cutworms, grasshoppers, European corn borer, true armyworms and common stalk borer. It has a 21-day PHI.
- Lambda-cyhalothrin (Karate, Warrior) is a foliar insecticide with broad spectrum insect control.
- Tefluthrin (Force) controls a wide range of soil insects including rootworms, cutworms, wireworms and grubs.
- Zeta-cypermethrin (Fury, Mustang) is used to control cutworms, armyworms and other pests. This product is an OP alternative.
- Bifenthrin (Capture 2EC) has a 1-day PHI. Provides excellent control.

Non-chemical management practices used:

- Rotation
- Keep ear damage at a minimum, populations build on over mature and damaged kernels
- Harvest as soon as ears are mature
- Plowing under crop debris
- Selection of varieties that are more resistant to ear feeding pests
- Spray programs that reduce damage to developing ears

"**TO DO**s"

Research

- Determine varieties that are more resistant to damage.

Regulatory

- None at this time.

Education

- Stress importance of keeping ears from being damaged.
- Stressing to harvest crop as soon as ear is ready for market.
- Stress importance of rotation and plowing under old crop debris.

Corn Leaf Aphid
(Rhopalosiphum maidis)

In hot, dry weather, aphids can quickly build up to large numbers, especially on supersweet varieties. Aphids rapidly reproduce forming large colonies. Aphids rarely cause significant yield loss, but they can make ears unsightly and difficult to sell. Feeding by colonies of aphids, causes mottling and discoloration of leaves, therefore reducing energy needed for ear development. Heavy infestations may cause leaves to turn red or yellow, shrivel and die. It is most critical to control aphids during and after flowering. Heavy feeding also promotes release of a sugary substance known as honeydew. Honeydew soon becomes covered with a black sooty mold reducing photosynthesis of the plant. They may be observed just after seedling emergence to late season.

Organophosphate insecticides currently used:

- Malathion (Atrapa 9.9 ULV) has a 5-day PHI is a broad spectrum product. Provides good to excellent control. This product is fairly inexpensive. Possible resistance buildup if multiple applications are made during the season.

Other insecticides used for control:

- Endosulfan (Thiodan) is a chlorinated hydrocarbon insecticide that is fairly toxic. Provides excellent control of this pest.
- Foliar applications of permethrin, esfenvalerate, methomyl or carbofuran used for other pests may provide some control of this pest.

Non-Chemical controls currently used:

- Early planting
- Predators and parasite populations may keep levels under control
- Insecticidal soap (M-Pede) Provides good control however is expensive.

"**TO DO**s"
Research

- Resistant varieties.
- Investigate levels predators and/or parasites needed to obtain control.

Regulatory

- None at this time.

Education

- Stress importance of scouting.

Corn Rootworm Beetles
(*Diabrotica* spp.)

Western corn rootworm (*Diabrotica virgifera*) beetle and the Northern corn rootworm (*Diabrotica barberi*) beetles. Eggs are laid in late summer and overwinter in the soil. Larvae hatch in early spring and feed on roots of various plants. Heavy infestation may cause lodging but rarely occurs. Corn rootworm beetles are active in late summer, feeding on the silks and laying eggs in the soil. High populations can clip all the silks from corn ears, leading to poor pollination. If planting into a field with a past history of infestations, use an in-furrow insecticide application to reduce damage to roots. Insecticides must be sprayed prior to heavy infestations to avoid yield reduction. Insecticide applications are usually made at planting or within the first four weeks of seeding in the event of an infestation.

Organophosphate insecticides currently used:

- Chlorpyrifos (Lorsban) provides excellent control.
- Phorate (Thimet, Rampart) provides good control.
- Terbufos (Counter) provides good control.
- Malathion (Atrapa 9.9 ULV) has a 5-day PHI provides fair control and is inexpensive. Fairly safe.
- Chlorethoxyfos (Fortress) provides good to excellent control.
- Ethoprop (Mocap) provides good control.

Carbamate insecticides currently used:

- Carbofuran (Furadan 4F) provides excellent control. This product can be fairly toxic to users.
- Carbaryl (Sevin). Generally used in fresh market sweet corn production. Limited to 16 lbs ai per acre per season. Provides fair to good control. This product is fairly safe compared to other products used.

Pyrethroid insecticides currently used:

- Cyfluthrin (Aztec) provides excellent control.

Non-chemical management practices currently used:

- Rotation with other crops other than corn.
- Newly developed resistant varieties
- Scouting will keep growers aware of population increases.

"**TO DO**s"

Research

- Investigate parasites of this pest.
- Develop resistant varieties.

Regulatory

- None at this time.

Education

- On-farm demonstration with different varieties to determine which ones tolerate higher populations of pests.
- Stress the importance of scouting for prevention increased pest levels.

WEED CONTROL AND HERBICIDES

Grass and Broadleaf weed controls currently used:

Thiocarbamate herbicides currently used:

- Butylate (Sutan Plus) is difficult to obtain from retailers. Provides suppression of rhizome johnsongrass, bermudagrass, and nutsedge. Also controls several grasses and broadleaf weeds. Must be applied as a pre-plant incorporated (PPI) material. This product is difficult to obtain. Applied from March 25 – July 1, depending when seeding occurs.
- EPTC (Eradicane 6.7EC) is a lipid synthesis inhibitor that provides grass and broadleaf control also. Good johnsongrass control. Applied as a pre-plant incorporated material. May be mixed with atrazine. This product is difficult to obtain. Applied from March 25 – July 1, depending when seeding occurs.

Chloroacetamide herbicides currently used:

- Alachlor (Lasso 4EC, MicroTech 4FME, Partner 65WDG) Provides pre-emergence control of several grasses and several annual, small seeded broadleaf weeds. High rates must be used to control ragweed and lambsquarter. Often applied as a tank mix with simazine, atrazine and occasionally with glyphosate. Must be applied immediately after planting. High amounts of active ingredient are used. Applied from March 30 – July 20, depending when seeding occurs.
- Dimethenamid (Frontier 6EC, Outlook 6EC) is a chloroacetamide herbicide that is applied as a pre-emergence for control of annual grasses and several small seeded broadleaf weeds. Often applied as a tank mix with simazine, atrazine, paraquat, or glyphosate. No yellow nutsedge control. This product is moderately priced and works well controlling grasses. Applied from March 25 – July 20, depending when seeding occurs.
- Metolachlor and Atrazine (Bicep II 6F) Post-emergence control of several annual grasses and broadleaf weeds. Use rate dependent on soil type. These combination active ingredients are expensive. Provides good yellow nutsedge control. Applied from March 30 – July 27, depending when seeding occurs.

Chloroacetanilide herbicides currently used:

- S-Metolachlor (Dual Magnum 7.62EC, Dual II Magnum 7.64EC) Provides pre-emergence control of several annual grasses and several annual small seeded broad leave weeds. Applied to soil surface immediately after planting. May be mixed with atrazine, simazine or glyphosate. This product is expensive. Applied from March 30 – July 27, depending when seeding occurs.

Triazine herbicides currently used:

- Atrazine (Atrazine 4L or 90DF) is a photosystem II inhibitor that does not control certain weeds like fall panicum or smooth crabgrass. It may be tank mixed with alachlor, metolachlor, simazine, glyphosate or paraquat. Applied as a pre-emergent or post-emergent. Has some residual control. This product is inexpensive as compared to other products. Low cost item. Applied from March 25 – July 27, depending when seeding occurs.
- Ametryn (Evik) is a photosynthesis inhibitor used as a post-emergent to control broadleaf weeds and grasses. It controls Crotalaria, mustard, Dallisgrass,

cocklebur, lambsquarters, morningglory, velvetleaf, ragweed, panicum, smartweed, shattercane, nutgrass, wiregrass, goosegrass, crabgrass, sow thistle, purslane, pigweed, foxtail, and many others. Applied from April 10 – July 30, depending when seeding occurs.

- Simazine (Princep) is a photosystem II inhibitor and is used as a pre-emergence herbicide used for control of broad-leaved (pigweed, purslane, morninglories) and grassy weeds on a variety of deep-rooted crops. This product has a short residual. It is moderately priced. Applied from March 25 – July 15, depending when seeding occurs.
- Atrazine with S-metolachlor (Bicep II Magnum) Applied as a preemergence. Applied immediately after planting. This product is expensive. Gives good yellow nutsedge control. Applied from March 30 – July 20, depending when seeding occurs.

Benzothiadiazole herbicides currently used:

- Bentazon (Basagran 4SL) is an amino acid synthesis inhibitor which provides control of cocklebur, common ragweed, jimsonweed, smartweed, velvetleaf, annual morninglories and yellow nutsedge. It is applied as a post-emergent product. Requires addition of crop oil concentrate at 1 quart per acre. Provides no grass control, however highly effective on yellow nutsedge. This product is moderately priced. Applied from April 7 – July 20, depending when seeding occurs.

Bipyridilium herbicides currently used:

- Paraquat (Boa, Gramoxone Max 3SL) is a restricted use pesticide used for post-directed application only. Crop must be shielded. Non-ionic surfactant must be added. Product may be extremely harmful to user if not applied correctly. Is often applied prior to planting for burn down, but may be used as a post-directed application and would be applied from April 10 – July 30, depending when seeding occurred.

Phenoxy acetic acid herbicides currently used:

- 2,4-D (Amine 3.8SL and others) Post-emergent use. Control cocklebur, lambsquarter, pigweed, morninglories, sicklepod and various others. No surfactant may be added. No cultivation for at least 10 days after application. Reduced rates may be used, if hot and soil is wet. If directed sprays are used, a non-ionic surfactant may be used, but crop must be shielded. Usually applied from April 20th – July 30, however is dependent on seeding date and plant height.

Aryl trazinone herbicides currently used:

- Carfentrazone-ethyl (Aim 40DF, Affinity) is a PPO inhibitor herbicide used for control of lamsquarter, morninglories, nightshade, pigweed and velvetleaf. Applied as a post-emergent. Target pest must be less than 4 inches in height. Must have a non-ionic surfactant added 2 pints per 100 gallons of carrier or a crop oil. May be tank mixed with other herbicides. This product provides no grass control, however is fairly cost effective for broadleaf control. Generally applied from April 15 – July 30th, however is dependent on seeding date and plant height.

Sulfonylurea herbicides currently used:

- Halosulfuron (Permit, Sempra, Sandea) is an ALS inhibitor used to provide post-emergent control of nutsedge, pokeweed, pigweed, smartweed, velvetleaf,

cocklebur, and other broadleaf weeds. Excellent control of nutsedges and active on cocklebur, pigweeds, ragweed and smartweed. Will not control emerged grasses. It is a methyl bromide alternative and is registered on sweet corn. No more than two applications may be made. Extremely safe and is moderately priced. Some plant back restrictions. Usually applied from April 15 – July 30, however is dependent on seeding date.

Glyphosate herbicides currently used:

Glyphosate (Roundup) is an EPSP synthase inhibitor that is non-selective. This product is moderately priced. It is used as a directed spray in the spring or in the fall as a broadcasted burndown. This product can be used on Roundup Ready varieties as an over-the-top when temperatures exceed 70°. Normally applied when target weeds are actively growing from April 1 – July 20.

Products labeled after 2003 planting season:

- Fluroxypyr (Starane F) is classified as a Picolinic acid herbicide and it is registered in sweet corn production. This is a reduced risk product. Product may not be widely available.
- Fluthiacet-methyl (Appeal, Action) is a protox inhibitor used as a post-emergent herbicide for control of velvetleaf, lambsquarter and other broadleaf weeds. It is currently registered on sweet corn. This product would be applied from April 7th until July 30, however application timing would be dependent on seeding date.

Investigated by IR-4 for efficacy in sweet corn production.

- Isoxaflutole (Balance) is an isoxazole herbicide which is registered in other crops, however is pending registration in sweet corn production. It is a soil applied product for many annual grasses and some broadleaf weeds.
- Mesotrione (Callisto) is a Cyclohexanedione herbicide which inhibits p-hydroxyphenlyl-pyruvate dioxygenase (HPPD), ultimately disrupting carotenoid biosynthesis. Used as a pre and post emergence herbicide for control of annual grasses and broadleaf weeds, including some sulfonylurea resistant weeds. It is registered for field corn however has potential for use in sweet corn production.
- Diflufenzopyr (Distinct) is a pyridine herbicide that is an auxin transport inhibitor. This product controls various annual grasses and broadleaf weeds. It controls, redroot pigweed, common ragweed, lambsquarters, wild buckwheat, velvetleaf and others. It is reduced risk pesticide. It is a combination product that includes dicamba.
- Glufosinate (Liberty, Rely) is a butanoic acid herbicide which is registered in several other crops and is pending registration in sweet corn production. When mixed with atrazine it provides good control of pigweed. It provides fair to poor control on pigweed when used alone. It provides enhanced weed control when another pre-emergent herbicide is used in combination with this product.

Non-registered herbicides which may have potential for use in sweet corn production.

- Tridiphane for control of wild prosso millet. This product has recently been canceled and may not be manufactured again.
- *Centaurea maculosa* (Catechin) is a biological control agent which may be used for control of many weeds.
- Clopyralid (Stinger) is a pyridine herbicide which is registered on field corn and controls various broadleaf weeds including Canadian thistle.
- Diclosulam (Strongarm) is a sulfonamide (an ALS inhibitor) herbicide which may aid in control of morningglory, cocklebur, velvet leaf and various other broadleaf weeds.
- Amicarbazone (Dinamic) is a triazolinone herbicide. This product may be applied as a soil preplant or a pre-emergence. It does have burndown activity primarily for broadleaf weeds. Labels are pending for corn, sugarcane and soybean.
- Flufenacet (Define, Axiom) is an oxyacetimide herbicide which is soil applied for control of annual grasses and some broadleaf weeds. It is currently labeled for corn and soybean and is pending use in sweet corn.
- Foramsulfuron (Option) is a sulfonylurea (ALS inhibitor) used a post emergent herbicide for control of annual grasses such as; foxtails, barnyard, Johnsongrass, shatter cane, Panicum spp., and crabgrass.
- Pyridate (Touch, Lentagard) is a pyridazine herbicide that is normally mixed with 2,4-DB. This combination generally enhances sicklepod and common cocklebur, Florida beggarweed, smallflower morningglory, hairy indigo, sicklepod, and common cocklebur control.
- Butafenacil (Rebin, Inspire) is a PPO inhibitor it controls grasses, broadleaf weeds, and sedge weeds. It is an OP replacement which is pending registration in corn.
- Fluazolate (JV 485) is a pyrazole benzoate herbicide used for pre-emergent control of broadleaf weeds and grasses. It is currently registered in field corn.
- Flufenpyr-ethyl (S-3153) is a PPO inhibitor that provides excellent control of velvet leaf and morningglories. It is pending registration of corn and is a reduced risk product.
- Fluroxypyr (Starane F) is a picolinic acid herbicide used as a post emergence application to control annual and perennial broad leaf weeds including nightshade. It is a reduced risk product. This product received registration in 2004.
- Mesotrione (Callisto) is a preemergent and postemergent herbicide used for control of annual broadleaf weeds in field corn, corn grown for silage and yellow popcorn. This product should be very effective in weed control in sweet corn production.

NOTES: see Table 2, for expected efficacy of products used in sweet corn production.

Non-chemical pest management tools commonly used for weed control:

- Planting early
- Herbicide resistant varieties
- Cultivation
- Hand hoeing
- Scouting helps by keeping grower informed when to apply product to receive the greatest control.
- Rotation

Notes: see Table 4, for efficacy of non-chemical controls

"**TO DO**s"

Research

- Additional pre-emergent products are needed for control of large seeded weeds.
- Evaluate efficacy of products currently not registered on sweet corn varieties grown in Tennessee.
- Evaluate efficacy and phytoxicity of products labeled on field corn for sweet corn varieties commonly grown in Tennessee.
- Develop IMI, glufosinate-consumer acceptable, and sethoxydim resistant varieties.
- Evaluate products for control of johnsongrass, sicklepod, burcucumber, and morningglories.

Regulatory

- Consider registrations on products listed in IR-4's listing and consider pesticides that may have a potential use in sweet corn production. Products containing mesotrione and foramsulfuron should be investigated.
- Speed registration on isoxaflutole (Balance), flufenacet (Define, Axiom), fluazolate, butafenacil (Rebin, Inspire), flufenpyr-ethyl, pyridate, Clopyralid (Stinger), amicarbazone (Dinamic), and Diclosulam (Strongarm) herbicides.

Education

- Stress to growers that rotation reduces possible build up of resistance within weed population. Rotation also reduces buildup of pesticide chemistries used on the site.
- Train and educate growers how to properly identify weeds to help reduce applications of unwarranted and ineffective herbicides.
- Train growers to properly calibrate sprayer before each use to avoid over application.
- On-farm demonstrations with newer products that have been recently labeled in the market. An example would include fluroxypyr.

DISEASES

There are several diseases which may affect sweet corn. Environmental conditions play a major role in there severity. Over-cast wet weather may cause a fungal pathogen to encompass the entire leaf reducing the photosynthetic process therefore there is limited energy to produce large kernels and reducing yield. Diseases more often affect seedlings, however seed producers have added fungicide seed treatments to help eliminate problems encountered from seedling pests. Foliar diseases rarely cause serious problems in Tennessee, unless the crop is planted late in the season. Recently two mildews that potentially could severely effect corn production have caused concern. These mildews have not been reported within the United States, but do pose a serious threat. The National Plant Diagnostic Network recently has developed an alert system to inform Extension Personnel in the event of an introduction of an agricultural pest. Early notification will allow growers to take measures to slow or eliminate possible infections and/or infestations from introductions of these pests. See table 5, for alternative disease control methods commonly used.

Downy Mildews

(*Sclerophthora rayssiae*), (Peronosclerospora philippinesis)

These downy mildews are fungal diseases which occur in corn in other countries. These diseases generally occur when wet humid conditions exist. Infected plants have lesions which form and elongate. Infected lesions caused by *S. rayssiae* eventually become purple red, and the entire leaf withers. The damage is limited to lower leaves and not so severe now in Japan. Soil temperatures of 30C degrees is suitable for the occurrence of this pest. The pathogen is considered to infect fingergrass, also. Maize downy mildew (Peronosclerospora philippinesis) is another possible threat to sweet corn production.

Chemical controls:

- Several fungicides may be effective however none have been tested for control of this pest within the United States.

Non-chemical controls:

- Increase row and plant spacing
- Plant early in the season

"TO DOs"

Research:

- Evaluate fungicides in other countries
- Develop resistant varieties

Regulatory:

- Be prepared to permit emergency use of fungicides in the event of an outbreak

Education:

- Inform growers to scout fields and report any oddities to local county extension offices and/or state regulatory officials.

Common and Southern Corn Rust (Puccinia sorghi, P. polysora)

Common rust is a fungal pathogen of corn which is often observed in the Southeast in commercial fields and in home gardens. Common rust seldom causes economic losses in sweet corn. Infected leaves have raised spots or pustules formed primarily on the upper surface. The pustules are rectangular to oval, brick red, and may occur in bands on the leaf. Spores are produced in the pustules, which are blown to neighboring leaves where infection can be repeated. Common rust differs from southern rust by the darker, more reddish-brown color of the pustules. Also, pustules of common rust tend to be longer than those of southern rust and they occur more often in scattered clumps on the leaves. Common rust is able to survive the winters in temperate areas because it produces teliospores, which are resistant to weathering. These spores germinate in the spring to produce basidiospores. The basidiospores can infect wood sorrel (*Oxalis* spp.); the spores produced in infections on wood sorrel can complete the life cycle of the fungus by infecting corn.

Damage: Infected tissue will reduce photosynthesis therefore reducing yield. Resistance and tolerance to common rust are prevalent and effective in corn hybrids. This disease is often worse in cool (60-70°F), humid wet years. It is observed from June to late season.

Chemical Controls Currently used:

- Chlorthalonil (Bravo 720, Chlorthalonil): Provides good to excellent control. Cost is mid to high depending on formulation selected.
- Propaconazole (Tilt): Provides good control. Cost is mid range.
- Mancozeb (Dithane): Provides good control and is economically priced.
- Azoxystrobin (Quadris): Provides good to excellent control. Cost is high.

Non-chemical controls:

- Plant early to avoid damage.
- Selecting resistant hybrids and cultivars may effectively control this disease.

"**TO DO**s"

Research

- Look at varieties and resistance

Regulatory

- Streamline Section-18 process

Education

- Stress to growers that planting early is very critical in controlling this pest
- Field demonstrations planted mid-to-late season to evaluate resistance of various varieties.

Maize Dwarf Mosaic or Corn Stunt

The virus is known as Maize Dwarf Mosaic Virus (MDMV) which is transmitted by many species of aphids, including the corn leaf aphid (*Rhopalosiphum maidis),* the greenbug *(Schizaphis graminum),* and the green peach aphid (*Myzus persicae).* Although many grasses are infected by this strain of the virus, the principal overwintering reservoir host is johnsongrass. Controlling the aphid vector is not feasible from a practical standpoint. This disease is normally observed when plants are four weeks to tasseling.

Non-chemical management practices:

- Eradicate any johnsongrass in the fields.
- To avoid infections, plant early and avoid fields heavily infested with johnsongrass.
- Plant tolerant varieties, if johnsongrass is present.
- Mowing field edges prior to planting during plant development may reduce infested areas located near field edges.
- Delaying planting until aphid flights are over.

"**TO DO**s"

Research

- Develop more varieties tolerant of this disease.
- Investigate biological control of aphids

Regulatory

- If a genetically modified line becomes available speed the process to making it available for public use.

Extension

- Educate growers concerning johnsongrass as being a host
- Stress the importance of reducing aphid populations during crop development
- Stress the importance of planting early.
- Prepare more literature on current varieties and levels of resistance

Common Smut

(*Ustilago maydis*)

Common smut is a fungus which is easily found in fields of sweet corn. The fungus overwinters as spores in the soil. Spores of this fungus can survive 2 or 3 years. Spores can also be windborne for long distances. Newly planted seed and younger plants are most susceptible however, any above-ground part is susceptible. Infected ears are most commonly observed in sweet corn fields. Damage from hail may provide open wounds that would greatly increase infection. Galls are formed as the common smut fungus causes cells of the corn plant to increase in size and number. As the gall ages, the membranes break open to reveal a black powdery spore mass underneath making the ear unmarketable. The spores are blown to adjoining corn plants where infection in repeated. The smut fungus is favored by high temperatures and high moisture. Little infection occurs below 61^{o} F. Plants grown in soils high in nitrogen or plants damaged through

cultivation or hail storms are most susceptible to infection. Seed treatments have not been proven to be effective.

Chemical controls:
Triazole fungicides available for use:

- Propiconazole (Tilt, Stratego) is labled to control powdery mildews, rusts, smuts, Helminthosporium leaf spot and various other fungi.

Non-labeled control:

- Difenoconazole (Dividend) is effective against smuts, bunts, Aspergillis, Fusarium, Penicillium and several other fungi when used in wheat production. It is pending registration on sweet corn.

Non-chemical control:

- Control may be achieved by rotation, sanitation or use of resistant cultivars.
- Breeding for resistance has not been successful since the mechanisms of resistance are not fully understood, however several cultivars have shown tolerance.
- Maintain nitrogen levels at moderate levels in fields with a history of this pest.

"**TO DO**s"
Research

- Determine mechanism of resistance
- Determine half-life and efficacy of propiconazole.

Regulatory

- None at this time
- Speed registration of difenoconazole.

Education

- Stress rotation and use of tolerant cultivars
- Stress keeping nitrogen at moderate levels

Stewart's Wilt
(*Erwinia stewartii*)

Stewart's wilt of sweet corn is a bacterial disease which is occasionally observed in Tennessee. Unlike many fungal diseases of corn, damp weather and heavy dews are not necessary for this disease to spread. The disease gets its name from the symptom of wilting of foliage, which is often associated with infection. In addition to wilting, plants may become stunted, and in severe cases plant death may result. Wilting and stunting are caused by slimy masses of bacteria, which clog the vascular tissue of the foliage and disrupt nutrient flow within the leaves. Symptoms of the disease on sweet corn may appear at any stage in the development of the plant. The most diagnostic symptom of the disease is yellow to brown stripes or streaks in leaf tissue that are parallel to the veins. These streaks may be quite short or may extend the entire length of the leaf. The symptoms of Stewart's wilt may sometimes be confused with those of fungus leaf blights

or with frost injury. Premature death of large areas of leaf tissue also renders the plants more susceptible to stalk rots.

Life Cycle: The bacteria of Stewart's wilt overwinter in the bodies of adult corn flea beetles. Flea beetles overwinter in the soil and, upon emergence in the spring, begin feeding on and contaminate corn seedlings. Uninfested beetles soon pick up the bacteria by feeding on infected plants and then spread the bacteria to healthy plants nearby. These beetles remain able to infect healthy plants for the rest of their lives. An entire field of corn may become infected in a relatively short period of time. Some or all plants die, and severe yield reductions result. The bacteria may survive in infected seed for several months. Infected seed may be important in introducing the bacteria into an area previously free of the disease. Usually this disease occurs after feeding from flea beetles, and infestation may occur as early as seedling emergence to tasseling. Insecticide applications would be applied usually from April 7th until late July and would depend on seeding date.

Chemical controls currently used:

- No viricides are recommended.
- Application of early insecticide sprays for controlling the overwintering flea beetle population. In areas where Stewart's wilt is known to be a potentially severe disease, insecticides should be applied when the corn first breaks ground and should be continued for several applications thereafter until the stand is well established.

Non-Chemical Control:

- Plant tolerant varieties, which will grow and produce well in spite of the presence of this bacteria. In general, later maturing varieties are more tolerant of the disease than earlier maturing ones, although several early maturing varieties are available with good tolerance to Stewart's wilt.

"TO DOs"

Research

- Evaluate more varieties for resistance

Regulatory

- None at this time

Education

- On-farm demonstrations showing variety differences.
- Informing producers the importance of controlling flea beetles.

Seed Rots

(*Pythium* spp. *Macrophomina phaseolina*, *Gibberella zeae*, *Fusarium* spp., *Penicillium oxalicum* and others)

Seed rots and seedling disease are caused primarily by fungi. Both seed rots and seedling disease can cause poor stands. In cold soils, seeds decay and seedlings may die before

they break the soil surface. In warmer soils, seeds more commonly emerge, but may have rotted roots and stems at the soil line. Cool wet soils slow seed germination and development of young seedlings, increasing exposure time to fungi. Low quality seed also produce seedlings that are weak and survive poorly in cold wet soils. Fungicide seed treatments are normally made directly to seed prior to planting.

Chemical controls currently used:

- Captan: Provides fair to good control for a broad spectrum of soilborne diseases.
- Thiram: Provides fair to good control for a broad spectrum of soilborne diseases.
- Carboxin: Provides good control of Rhizoctonia spp. Often combined with other products.
- Mefenoxam (various): provides control for only Pythium spp. Provides excellent control.
- PCNB (various): controls only Rhizoctonia and Fusarium spp. Good to excellent control.
- Pseudomonas fluorescens PRA-25: controls only Pythium. A new product that is expensive and rarely used. A biocontrol agent.

Non-registered chemical controls:

- Mancozeb (Dithane ST) is labeled for field corn and would provide good to excellent control in sweet corn production. This product would be economical.
- Difenconazole (Dividend): control unknown
- Pseudomonas chloroaphis Strain 6328 (AtEze): controls Rhizoctonia and Pythium.
- Streptomyces griesoviridis (Mycostop):
- Streptomyces lydicus WYEC 108: controls soil borne and damping off fungi.
- Bacillus subtilis strain MB1600 (Subtilex): use as a seed treatment.

Non-chemical control:

- Crop rotation with non-grass crops provides fair control
- Control of soil insects and nematodes may provide fair control.
- Sweet corn should be planted on a raised bed when the soil temperature is above 55^{o} F.
- Seed treatments which include insecticides also reduce insect infestation that may provide an entry way for seedling diseases.
- Using high quality seed with high germination potential

"**TO DO**s"

Research

- Look at *Pseudomonas aureofaciens* AB254, a naturally-occurring bacteria isolated from soil, as a seed treatment.
- Evaluate difenconazole (Dividend Extreme) as a possible alternative.

Regulatory

- Labeling for products containing mancozeb.
- Labeling of difenconazole, if determined to be effective.

Education

- On-farm demonstrations using high quality seed vs. fair

- On-farm demonstrations using seed treatment comparisons

Brown Leaf Spot
(*Physoderma maydis*)

This disease is caused by a fungus which occurs in most fields, but seldom causes economic damage. Infection requires high temperatures and presence of surface moisture. The first symptom of the disease is small circular spots. As they mature, they turn dark brown.

Chemical Controls Currently used:

- Foliar fungicides (Chlorothalonil, maneb, mancozeb, azoxystrobin) may also reduce infections by this pathogen, however these are not primarily used for control of this pest but other diseases. These products provide good to excellent control of Physoderma.

Non-Chemical Controls:

- Rotation and deep burial of crop residue will help reduce future losses caused by this disease.
- Some varieties have shown resistance.

"**TO DO**s"
Research

- Develop varieties with high levels of resistance.

Regulatory

- None at this time.

Education

- On-farm demonstrations to evaluate varieties currently used.
- Stress the importance of destroying old crop residue.

Fungicides

Currently Registered fungicides:

Strobilurin fungicides available for use:

- Azoxystrobin (Quadris) has broad spectrum activity against a wide range of fungi.
- Pyraclostrobin (Headline, Cabrio) has broad spectrum activity, it is active on anthracnose, alternaria, downy mildew, Cercospora leaf spot, rust, powdery mildew and various other diseases. This is a reduced risk product.
- Trifloxystrobin (Flint, Stratego) is active against powdery mildew, and leaf spot diseases. Also, provides control against rusts, downy mildew and other diseases.

Biocontrols currently available for use:

- Cinnamaldehyde (Cinnacure) is cinnamaldehyde fungicide which is currently registered. It may be used to control downy and powdery mildews. It also is effective against aphids and mites.
- *Pseudomonas fluorescens* PRA-25 is a biopesticide currently registered for use in sweet corn production. This product may be used to reduce seed rot and damping-off disease cause by Pythium spp. only.