

Crop Profile for Corn (Sweet) in Wisconsin

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General Production Information

Sweet corn is a key crop grown in Wisconsin for both the processing and fresh markets. Wisconsin ranks 8th in the nation for sweet corn acreage and 11th for total production. In 1997 there were 115,800 acres of processing sweet corn planted. Of this acreage, 109,400 acres were harvested with an average yield of 6.56 tons per acre. The value of processing sweet corn for 1997 was \$73.90 per ton with a total value of \$53 million.

An additional 8,700 acres of fresh sweet corn was grown in 1997 with 7,500 of the planted acres harvested. Yield per acre was 75 cwt. Fresh sweet corn sold for \$13.40 per cwt in 1997 with a total crop value of \$7.5 million.

Production Costs

The average cost of production for one acre of processing sweet corn grown in Wisconsin in 1997 was determined to be approximately \$350 per acre. This figure was determined through the use of the Agricultural Budget Calculation Software developed by the University of Wisconsin Center for Dairy Profitability.

Product Regions

Most of the sweet corn grown in Wisconsin is grown in the central, south central, and east central parts of the state; with Columbia, Dane, Dodge, Green Lake, Fond du Lac, Portage, Rock and Waushara counties leading the state in production.

Cultural Practices

Sweet corn is a warm-season crop planted in scheduled plantings. Throughout May and June. This assures a continuous supply of corn throughout the season. Fresh market growers often try to extend the season by planting early crops on plastic mulch in late March and April. This early-planted sweet corn is

typically available for the July 4th market. Temperatures between 65-80F are ideal with 50 being the minimum for development. Temperatures above 89F often result in inferior quality corn. Adequate moisture is also necessary for high quality sweet corn. A minimum of 20 inches of rain or irrigation is necessary to prevent reductions in quality and yield. Sweet corn requires a shorter growing season than other types of corn that are harvested at a mature stage.

Historically, sweet corn varieties were based on the sugary gene and had yellow kernels. These sugary hybrids have between 10-15% sugar at harvest. Newer hybrids with the shrunken-2 and sugary-enhancer genes have sugar levels between 25-35%. These supersweet varieties are unable to convert sugar to starch resulting in a longer harvest period and longer shelf life. These supersweet varieties require a higher soil temperature for adequate germination whereby a minimum soil temperature of 60 is necessary. Because sweet corn is wind pollinated, cross pollination can occur. It is therefore important to isolate "supersweet" types of corn from each other and from other types of corn so that cross pollination doesn't occur. Varieties with white and bicolor kernels are also becoming increasingly common. Kernel color of varieties grown often depends on consumer demand.

Sweet corn should be grown in deep, fertile soil that is free of clods, trash and surface irregularities. Rows are spaced 30-40 inches apart with 7-20 inches between plants in the row. For maximum yield, there should be 16,000-20,000 plants per acre under dryland production and as many as 22,000 on irrigated land.

Sweet corn is highly perishable and must be picked daily to assure the best quality corn available for sale. It is harvested in the milk stage when a kernel punctured by a thumbnail produces a milky juice. Hot temperatures will speed the maturation of the corn from the desirable milk-stage to the less desirable dough stage. Immature ears will not be filled completely while over-mature ears will have doughy kernels. The ears can be harvested mechanically or by hand, depending on the size of the planting and the preference of the grower. Rapid cooling after harvest is necessary to maintain high quality.

Insect Pests

Corn Earworm (*Helicoverpa zea*) is one of the key sweet corn insects that causes damage on an annual basis. Feeding damage caused by the corn earworm typically doesn't reduce yield directly, but causes enough damage to the ear to result in consumer or processor rejection. Damage results when the larvae feed on the tips of the ears, eating kernels and contaminating the ear with frass.

Corn earworms overwinter as pupae in the soil in the southern United States. However, it is suspected that a few corn earworms overwinter in Wisconsin yet to date, this has not been proven. The migrant adults emerge from the pupae in early May and begin their migration northward. After mating, female corn earworms lay their eggs on fresh corn silks, and upon emerging from the eggs, the larvae crawl into the silk channels at the ear tip and begin feeding. Earworm larvae move very little during the larval stage

and as a result, most of the feeding damage is confined to the ear tip. After about two weeks the larvae drop to the ground to pupate.

There are two generations per year in Wisconsin. It is the second generation that does the most damage to sweet corn grown in Wisconsin since it corresponds to the bulk of the late season harvest in August and September. The first generation which appears in late June is damaging primarily to early-planted, fresh market sweet corn that may be silking at that time.

Corn Leaf Aphid (*Rhopalosiphum maidis*) are small, bluish-green to gray, soft-bodied insects about the size of a pinhead. They appear in the upper Midwest in mid-summer as winged forms that migrate up from the south. There may be as many as nine generations per year. Typically, corn leaf aphids don't become economically important until later in the summer.

The aphids have piercing mouthparts which are inserted between plant cells and into vascular tissue. Typically, this causes little direct morphological damage. Under heavy infestations, leaves may curl, wilt, and become chlorotic. As the aphids grow, they shed their skins. In heavy infestations, plants may take on a grayish cast as these skins begin to accumulate. Plants also become sticky with honey dew, a substance excreted from the aphids. Honey dew serves as a medium for sooty mold that grows saprophytically on the honey dew. Large amounts of honey dew can reduce photosynthesis and may attract corn earworm moths. Aphids are also suspected to be a carrier of the maize dwarf mosaic virus.

Corn Rootworms [*Diabrotica barberi* (northern), *Diabrotica virgifera* (western)] There are two species of corn rootworm common in Wisconsin; the northern corn rootworm, and the western corn rootworm. Adults of both are beetles approximately 1/4 inch long. The northern corn rootworm is light green in color while the western is yellow with the females having alternating black and yellow stripes on their wing covers while the males are more uniformly black. People often confuse the female northern corn rootworm beetle with striped cucumber beetles. To distinguish between the two, examine underside of their abdomens - striped cucumber beetles have a black abdomen while the abdomens of northern corn rootworm beetles will be yellow-green.

Both species of corn rootworm beetles overwinter as eggs in the upper soil layers. In the spring the eggs hatch when soil temperatures reach 50-52F. Larvae emerge and begin invading corn roots. The first instar larvae begin feeding on the smaller branching corn roots. Later, the rootworms migrate toward the roots, at the base of the plant. Damage occurs when they tunnel through the corn roots. Evidence of activity includes elongated scars on the root surface, tunnels within the roots and varying degrees of root pruning. Lodging of plants caused by root pruning is common after storms containing heavy rains and high winds.

After 3 weeks, the larvae pupate near the base of the plant. In one to two days adults emerge and begin feeding on pollen. Their attraction for pollen often causes them to migrate out of corn fields and into ornamental flower gardens where they can be seen feeding on the pollen of bedding plants. While feeding on corn pollen, silk clipping often occurs. In some cases the silks can be clipped so close to the

ear tip that pollination is unsuccessful and poor ear fill results. There is one generation per year.

European Corn Borer (*Ostrinia nubilalis*) is another annual pest that is economically-important to Wisconsin sweet corn growers. The European corn borer overwinters as mature 5th instar larvae in crop residue from the previous season. In spring, the larvae complete development and pupate, usually in May. The first adult moths emerge in early June. The moths are straw-colored with a 1 inch wingspan. Males are smaller and darker than the females. They typically fly at night but may be kicked up out of their resting sites in the tall grass along field edges during the day. Adults live for 1-2 weeks depending on weather conditions and rate of development. In most parts of the state there are two distinct generations of European corn borer each year. However, in east-central Wisconsin, there is often an overlap of generations so it appears there is a continuous emergence of new adults.

After mating, the female moths lay eggs near the midrib of lower leaves. Summer adults concentrate egg-laying on the ear leaf and the one leaf above or below the ear leaf. Each female moth is capable of laying two egg masses per night for 7-10 nights with about 23 eggs per mass. Eggs are white and translucent and overlap like fish scales. One day before the eggs are ready to hatch, they become black as the heads of the first instar larvae become apparent. First instar larvae are cream-colored with numerous dark spots along their body.

First generation European corn borer damage is commonly expressed as whorl feeding with stalk boring beginning once the larvae have undergone two molts and reached their 3rd instar. Early leaf feeding appears as pinholes as leaves emerge from the whorls. Growers with sweet corn that has begun silking can concentrate their scouting efforts on the ear leaf and the leaves just above and below. Second generation larvae concentrate their damage on the ear with the first two instars feeding externally on the plant. It's the third instar larvae that begin to bore into the ear or shank. Insecticides are not very effective once the larvae are protected by the ear.

Seed Corn Maggot (*Hylemya platura*) is an occasional pest of sweet corn, however damage is typically not as severe on corn as that found on other vegetables. The seedcorn maggot overwinters as pupae in the soil. Adult flies emerge from early to mid-May, mating within 2-3 days after emergence. Eggs are laid near seeds and seedlings in soils containing high amounts of organic matter. Larval feeding, development and pupation all occur below ground. There are 3-5 generations of seed corn maggot per year in Wisconsin but it is typically the first generation that causes the most damage as it coincides with seed germination.

All parts of sprouting sweet corn seeds are attacked by the maggot larvae, resulting in weakened, stunted plants and poor germination rates. Plants that survive maggot damage often have holes in the cotyledon leaves. Damage often is wide-spread throughout the field.

Chemical Controls for Insect Pests in IPM and Resistance Management Programs:

Sweet corn growers whose product is destined for processing typically have their fields monitored by field scouts employed by the processor. Blacklight traps are used to monitor the developmental progression of the European corn borer through the season and trap catches are used to signal growers when to apply insecticides to target critical life stages of this annual pest. In addition, field scouting for egg masses and larval presence is also key in determining if and when insecticides are needed.

Pheromone traps are used to monitor corn earworm moths. Trap catches in susceptible, silking sweet corn fields indicate when insecticides are necessary. Although processors have been scouting fields for several years, fresh market growers have just recently begun to utilize trapping as a tool to accurately time pesticide applications and reduce unnecessary sprays.

- ***Bacillus thuringiensis*** (Dipel G, ES, Biobit F, WP) is used to control early instar European corn borer larvae at a rate of 1.0 lb a.i./A and can be used up to the day of harvest. Granular formulations are recommended for the first generation only. *Bacillus thuringiensis* is used primarily only on organically-grown, fresh market sweet corn in the state and is applied to less than 1% of the sweet corn acreage.
- **Carbaryl** (Sevin XLR Plus) is registered for the control of armyworms and corn borers, at rate of 1.5 lb a.i./A. Grasshoppers, rootworm beetles, and sap beetles are controlled with only 1.0 lb a.i./A. There is a 0 day pre-harvest interval. Carbaryl is not used in the production of processing sweet corn in Wisconsin but is occasionally used by fresh market growers..
- **Carbofuran** (Furadan F) is a restricted-use pesticide used to control second generation European corn borers. It is applied at a rate of 0.5 lb a.i./A, up to 7 days before the harvest.
- **Chlorethoxyfos** (Fortress G) is a soil insecticide applied at a rate of 0.125 lb a.i./A in a 7-inch band or seed furrow for control of corn rootworm larvae, seed maggots, white grubs, and wireworms. There is a 0 day pre-harvest interval. Chlorethoxyfos is used on 2% of sweet corn grown in Wisconsin.
- **Chlorpyrifos** (Lorsban EC, G, 4E) controls aphids, armyworms, corn borers, cutworm, grasshoppers, rootworm larvae, seed beetles, seed maggots, stalk borers, white grubs, and wireworms at rates between 0.5 - 2.0 lb a.i./A with a 35 day PHI. Ten percent of sweet corn grown in Wisconsin was treated with chlorpyrifos in 1996.
- **Cyfluthrin** (Baythroid EC) is a restricted-use pesticide used to control armyworms, European corn borers, cutworms, earworms, rootworm beetles, and stalk borers. For control of armyworms, European corn borers, corn earworm, corn rootworm beetles, and stalk borers, a rate of 0.025-0.044 lb a.i./A is required. A lower rate of 0.0125-0.025 is needed to control cutworms. Cyfluthrin is applied to 2-5% of the sweet corn acreage.
- **Diazinon** (Diazinon) is used at planting to control seed beetles and seed maggots. One percent of

the sweet corn in Wisconsin is treated with diazinon and this is typically used by those who don't use the full seed treatment before planting.

- **Esfenvalerate** (Asana XL) is a restricted-use pesticide used to control aphids, armyworms, corn borers, cutworm, earworms, grasshoppers, rootworm beetle, sap beetles, and stalk borers at a rate of 0.03-0.05 lb a.i./A. There is a 1 day PHI. Less than 5% of the sweet corn is treated with esfenvalerate.
- **Ethoprop** (Mocap EC, G) is a restricted-use pesticide used at a rate of 1 lb a.i./A to control corn rootworm larvae and wireworms. Ethoprop hasn't been used in Wisconsin in recent years.
- **Fonofos** (Dyfonate II G) is a restricted-use pesticide used at a rate of 1 lb a.i./A to control seed beetles. It may be applied up to 30 days before the harvest. The manufacturer has voluntarily discontinued the registration of this product on sweet corn.
- **Lambda-cyhalothrin** (Warrior EC) is a restricted-use pesticide used at a rate of 0.02-0.03 lb a.i./A to control the European corn borer, cutworms, corn earworms, grasshoppers, rootworm beetles, and sap beetles. There is a 1 day pre-harvest interval. Lambda-cyhalothrin was used on 25-50% of the sweet corn grown in Wisconsin in 1996.
- **Methomyl** (Lannate L) is a restricted use pesticide used to control armyworms, corn borers, earworms, corn rootworm beetles, and sap beetles at rates between 0.22 - 0.45 lb a.i./A up through the day of harvest. Methomyl is no longer being used in favor of less toxic materials.
- **Methyl Parathion** (Penncap-M) is a restricted-use pesticide used to control aphids, armyworms, second generation corn borers, grasshoppers, rootworm beetle, and sap beetles. It is applied at a rate of 0.5 - 1.0 lb a.i./A up to 3 days before harvest. Methyl parathion was used on 11% of the Wisconsin sweet corn acres in 1996.
- **Permethrin** (Ambush, Pounce EC) is a restricted-use pesticide used to control armyworms, corn borers, cutworm, earworms, rootworm beetles, and stalk borers at a rate of 0.1-0.2 lb a.i./A. It can be applied up to 1 day before harvest. In 1996, permethrin was used on 56% of the sweet corn grown in Wisconsin, however, in recent years usage has dropped.
- **Phorate** (Thimet G) is a restricted-use, soil insecticide used to control rootworm larvae, seed beetles, seed maggots, white grubs, and wireworms. It is applied at a rate of 1.0 lb a.i./A. Thimet is used on 1-2% of Wisconsin corn.
- **Tebupirimphos** (Aztec 2.1G) is a soil- applied, restricted-use insecticide applied at a rate of 0.12 lb a.i./A for the control of seed beetles, seed maggots, white grubs, and wireworm. Two percent of Wisconsin's sweet corn acreage was treated with tebupirimphos.

- **Tefluthrin** (Force G) is used to control seed maggots, white grubs, and wireworms at a rate of 0.10-0.125 lb a.i./A with no pre-harvest interval. In Wisconsin, 6-10% of the sweet corn is treated with tefluthrin and usage of this relatively safe product is expected to increase.
- **Terbufos** (Counter G) is a restricted-use pesticide applied at a rate of 1 - 2lb a.i./A to control seed beetles, seed maggots, white grubs, and wireworms at planting. One to two percent of Wisconsin's corn acreage is treated with terbufos.

Weeds

Weed management is critical for maximum sweet corn yields to be realized. Annual weeds that pose a problem in sweet corn production include common lambsquarters, velvetleaf, pigweed, common ragweed, foxtails and wild proso millet.

Annual Broadleaf Weeds

Common lambsquarters (*Chenopodium album*), velvetleaf (*Abutilon theophrasti*), redroot pigweed (*Amaranthus retroflexus*), and common ragweed (*Ambrosia artemisiifolia*) are annual broadleaf weeds that are commonly found in sweet corn fields. All of these weeds are very competitive with sweet corn because they grow into large weeds with a height similar to sweet corn. During this growth, they compete for light, nutrients and light. Without control, moderate densities of any of these weeds will greatly reduce sweet corn yields. Common lambsquarters and redroot pigweed are highly prolific and produce tens of thousands of seed per plant. Velvetleaf and common ragweed are not quite as prolific, but still produce many thousands of seeds per plant. A percentage of these broadleaf weed seeds will remain dormant in the soil so that infestations continue for many years before the seed bank can be reduced. Some velvetleaf seeds may remain viable in the soil for a few decades and the seed longevity of the other broadleaf weeds can also exceed ten years. As a result, it is impractical to try to eradicate these weeds and control is required annually. Common lambsquarters, velvetleaf, and common ragweed tend to germinate earlier in the spring than redroot pigweed and the peak emergence of these weeds typically occurs by mid-June. However, a percentage of these weeds will still emerge throughout the growing season. Velvetleaf can germinate from deeper in the soil than these other broadleaf weed and is not controlled as effectively by rotary hoeing as a result.

Annual Grasses

Annual grass weeds also pose a problem in the production of sweet corn because of their vigorous growth, potential to reduce yields, and ability to produce copious amounts of seed. They are also very tolerant of moisture and temperature extremes once they become established. All annual grasses should be controlled before they set seed.

Some of the most problematic grasses are the foxtails (*Setaria spp.*). Foxtails germinate in the early spring and throughout the growing season. Of these foxtails, giant foxtail (*Setaria faberi*) is a predominant weed in most sweet corn fields. It is also the most competitive foxtail, growing to a height of six feet.

Wild proso millet (*Panicum miliaceum*) is a grass weed that is the most difficult to control grass for sweet corn growers. It is drought-tolerant and adapted to a wide range of soils and climates. Wild proso millet grows very rapidly often reaching maturity in 60-90 days. Seed is often mature at sweet corn harvest and can be spread to uninfested fields by harvest equipment. Wild proso millet grows up to six feet tall and is nearly as competitive as giant foxtail. Wild proso millet is more tolerant of soil-applied grass herbicides than other annual grasses and is more difficult to control.

Crabgrass species (*Digitaria spp.*) are another group of annual grass weeds that are a problem in sweet corn fields. Crabgrass is a more frequent problem on sandier soils. It is well suited for growth in sweet corn because the sweet corn canopy is less dense than other field crops and allows more light to penetrate through to the shorter-statured crabgrass. The worst crabgrass infestations occur after cultivation. Crabgrass germinates anytime from in mid-spring to late summer with an optimum temperature between 68-95F favoring warmer soil temperatures than foxtails.

Chemical Controls for Weeds in IPM and Resistance Management Programs:

Due to groundwater contamination, Wisconsin has enacted atrazine rate restrictions based on surface soil texture, and prior atrazine use, and has prohibited atrazine use in geographic locations relative to atrazine detections in groundwater. In those areas where atrazine is allowed, growers often combine it with other herbicides to enhance control. In the areas where atrazine is prohibited, there are few effective broadleaf herbicide options. Cyanazine has been the principal option in the past, but rate restrictions in 2000 and product cancellation after 2002 limit this option.

Broadleaf Herbicides

- **2,4-D** is a postemergence herbicide used to control annual broadleaf weeds at a rate of 0.33-1.0 pt/A. Because of potential stalk brittleness as a result of 2,4-D, sweet corn should not be cultivated for 8-10 days after 2,4-D has been applied to allow the crop to recover. Because of the risk of injury, less than 5% of the sweet corn acreage in Wisconsin is treated with 2,4-D.
- **Atrazine** (Aatrex 4L) can be applied preemergence or postemergence to control annual broadleaf weeds. Atrazine is applied at a rate of 1.5-3.0 pt/A in areas of the state where its use isn't prohibited. In those areas where atrazine is allowed, growers often combine it with other herbicides to enhance control. Fifty to sixty percent of the Wisconsin sweet corn acreage was treated with atrazine in 1996.

- **Bentazon** (Basagran) is a postemergence herbicide registered for the control of annual broadleaf weeds at a rate of 1.5-2.0 pt/A, along with 2 pt/A crop oil concentrate. It is not effective at controlling lambsquarters or pigweed. Four percent of the sweet corn acreage in Wisconsin was treated with bentazon in 1996.
- **Simazine** (Princep 4L) is used to control annual broadleaf weeds. It is applied at rates of 4 to 8 pt/A. Because of carryover potential, only corn can be planted the year after Princep applications. About 1% of the Wisconsin sweet corn acreage is treated with Princep.
- **Cyanazine** (Bladex 4L) is used to control annual broadleaf weeds, but is less effective on velvetleaf and pigweed. In 2000, its maximum rate will be cut to 1.0 qt/A which will reduce its efficacy on medium-textured soils. It can be tank-mixed with Dual II Magnum, Eradicane, Frontier, Lasso/Micro-Tech/Partner, or Prowl to improve control of annual grasses and pigweed. In 1996, 38% of the Wisconsin sweet corn acreage was treated with cyanazine.

Grass Herbicides

- **Alachlor** (Partner, Micro-Tech, Lasso) is a grass herbicide that controls foxtails, crabgrass, and fall panicum. It is ineffective against quackgrass and suppresses wild proso millet. Before the sweet corn is planted, Partner is applied at a rate of 3.0-5.3 lb/A, while Micro-Tech and Lasso are applied at a rate of 1.0-7.0 pt/A. After planting, Partner is applied at a rate of 3.0-4.9 lb/A, and Micro-Tech or Lasso are applied at a rate of 4.0-6.5 pt/A. In Wisconsin 38% of the sweet corn acreage is treated with alachlor.
- **Dimethenamid** (Frontier) is a herbicide that provides good to excellent control of foxtails, crabgrass, and fall panicum at a rate of 16-32 oz/A. It is ineffective against quackgrass and suppresses wild proso millet. Sixteen percent of the sweet corn acreage in Wisconsin is treated with dimethenamid.
- **Metolachlor** (Dual II Magnum) provides good to excellent control of foxtails, crabgrass, and fall panicum at the rate of 1.0-2.0 pt/A. It is ineffective against quackgrass and suppresses wild proso millet. In Wisconsin, 26% of the sweet corn acreage was treated with metolachlor in 1996.
- **Nicosulfuron** (Accent) is a postemergence grass herbicide that controls foxtails, barnyardgrass, fall panicum, and wild proso millet on specific sweet corn hybrids that have adequate tolerance. It's applied before weeds exceed a height of 4 inches, at a rate of 0.66 oz/A. In Wisconsin, 15% of the sweet corn acreage is treated with nicosulfuron.
- **Pendimethalin** (Prowl) is a herbicide that is used to control foxtails, crabgrass, and fall panicum. It is ineffective against quackgrass and suppresses wild proso millet. It may only be used in sweet corn grown for processing. Application rate is based on the percentage of organic matter with 1.8-

3.6 pt/A used when organic matter content is less than 1.5%, and a rate of 2.4-4.8 pt/A for fields with organic matter contents above 1.5%. In Wisconsin, 10% of the sweet corn acreage was treated with pendimethalin in 1996.

- **Safened EPTC** (Eradicane) is a pre-plant incorporated herbicide applied to dry soil at a rate of 4.75-7.33 pt/A within 2 weeks of planting for control of foxtails, crabgrass, and fall panicum. Less than 1% of the sweet corn acreage in Wisconsin is treated with Eradicane and the manufacturer has indicated they will discontinue the sale of this product in the future.

Post-directed Herbicides

The following herbicides require specialized application equipment to prevent excessive herbicide injury to the sweet corn. Weeds also need to be suppressed by an earlier treatment so they are shorter than the sweet corn and adequately covered by the herbicide spray. Because of the higher cost, greater time required for application, limited availability of this equipment, post-directed herbicide applications are rarely used.

- **Ametryne** (Evik) is used as a post-directed application to control wild proso millet. Applications are made when the corn is at least 12 inches tall, and before the weeds reach 6 inches tall. Evik is applied at a rate of 2.0-2.5 lb a.i./A. Evik is used on less than 1% of the sweet corn grown in Wisconsin.
- **Linuron** (Lorox DF) is used to control both annual broadleaf weeds and annual grasses when corn is at least 15 inches tall. Lorox DF is applied at a rate of 1.25-3.0 lb/A. Less than 1% of the Wisconsin sweet corn acreage is treated with linuron.
- **Paraquat** (Gramoxone Extra) controls both annual broadleaves and grasses at a rate of 13 oz/A. It is applied when the corn is at least 10" tall and before the weeds reach 6". In Wisconsin 3% of the sweet corn acreage is treated with paraquat.

Diseases

Anthracnose (*Colletotrichum graminicola*) is generally considered a minor disease, but in some cases it may be severe particularly in warm, wet weather. Having become more prevalent on field corn grown in some areas, this disease may become more prevalent on sweet corn in the future. It can cause up to 100% yield loss if environmental conditions favor its development.

Anthracnose spores are carried by wind or splashing rain to young corn seedlings where infection occurs through the leaf epidermis. Symptoms become visible about five days after infection. This disease can

cause seedling blight, crown rot, root rot, leaf blight, top dieback, stalk rot, and kernel infection. Leaf blight is recognizable as small, round to oval, water-soaked yellow spots that occur anywhere on the leaf. Symptoms of stalk rot appear as narrow, vertical, water-soaked lesions on the stalk rind. The lesions become tan to reddish-brown then black, with black specks consisting of fruiting bodies produced in these lesions.

Common Smut (*Ustilago maydis*) is the most widespread disease of sweet corn. It occurs worldwide wherever corn is grown. The symptoms of corn smut are usually conspicuous and easily recognized. Galls appear on any above-ground parts of the plant. When the galls first appear, they are covered with a glistening, greenish to silver-white tissue. The interior of these galls darken with age and become powdery masses of dark, olive-brown to black spores. Galls may be up to 6 inches in diameter. Losses from smut are variable ranging from a trace up to about 15%.

Maize Dwarf Mosaic Many varieties of sweet corn are very susceptible to maize dwarf mosaic (MDMV). There are at least 6 different strains (MDMV-A, -B, -C, -D, -E, & -F) of the virus which vary in their host ranges. Plants can be infected with one or more strains simultaneously. MDMV-A and MDMV-B are the most common strains of MDMV. They overwinter in perennial grasses and are transmitted by aphids to the sweet corn. The symptoms of MDMV first appear on the youngest leaves as an irregular, striped, light and dark green mosaic. As the diseased leaves mature, they appear to have a finely stippled mosaic of light and dark green. Plants with these symptoms are sometimes stunted. Severely infected plants may tiller excessively, have multiple ear shoots, and show poor seed set or may be barren. Symptoms are more severe on plants infected in juvenile stages; those infected at silking or later may appear normal.

Northern Corn Leaf Blight (*Exserohilum turcicum*) is often referred to as "leaf stripe" and produces long, straw-colored or tan lesions on corn leaves that can be up to 6 inches long and 1 inch wide. At least three races of the fungus have been identified to date. Infected plants are weaker than non-infected plants. Plants can withstand up to 20% leaf blight at tassel stage before yield is significantly reduced.

Northern corn leaf blight causes several types of leaf lesions, depending on the genetic make-up of the host plant. The fungus overwinters as resting spores called chlamydospores in the soil or on plant debris. These spores are wind-borne and cause early season infection. Very susceptible varieties can have yield losses up to 100%.

Northern Rust (*Puccinia sorghi*) may be economically damaging on sweet corn and may result in losses of up to 10%. The fungus overwinters as teliospores, which germinate and infect the alternate host, *Oxalis* sp. in the spring. After cross fertilization of the fungus has occurred, aeciospores are wind-borne to corn. Rust symptoms are characterized by elongated, cinnamon lesions located on both the upper and lower leaf surfaces, husks, and tassels. Dusty spore masses may be easily scraped off the lesions surfaces. These rusty red spores are wind-borne and multiple cycles of disease can occur during the growing season. Plants infected with maize dwarf mosaic virus are more susceptible to rust.

Stewart's Disease (*Erwinia stewartii*) is a widespread disorder in sweet corn although it is uncommon in Wisconsin. The bacteria that causes the disease survives from year to year and is transmitted throughout the season by the corn flea beetle. The bacteria overwinters in the beetles and is transmitted into the plant in the spring when the beetles begin to feed. Warm winter temperatures favor survival of the corn flea beetle and early season pathogen dissemination. Stewart's wilt bacteria can also be seedborne resulting in disease dissemination over long distances.

The first symptoms of the disease are irregular, pale green to yellow streaks that develop on the leaves. The streaked areas, which originate from the feeding wounds of the corn flea beetle, become straw-colored and usually die quickly. When leaves die prematurely, yield is reduced and the weakened plants become more susceptible to stalk rots. Plants with stalk rot wilt rapidly and resemble those suffering from drought, insect injury, nutritional deficiency, or seedling blight.

Chemical Controls in IPM and Resistance Management Programs

- **Chlorothalonil** (Bravo, Echo, Ensign, Terranil) is a broad-spectrum, protectant fungicide used to control leaf rust when applied at 4-7 day intervals until 14 days before harvest. Bravo 720, Echo 720, Ensign 720, and Terranil 6L are applied at a rate of 0.75-2 pt/A, while Bravo Ultrex 82.5WDG is applied at a rate of 0.7-1.8 lb/A. Echo 90DF and Terranil 90DF are applied at a rate of 0.65-1.6 lb/A. In Wisconsin, 2% of the sweet corn is treated with chlorothalonil.
- **Maneb** (Maneb 80WP, Maneb plus Zinc F4, Manex F4) is a broad-spectrum, protectant fungicide registered to control leaf rust at a rate of either 1.5 lb a.i./A or 1.2 qt a.i./A. It is applied at 5-10 day intervals until 7 days before harvest. Maneb is used on 1% of the sweet corn grown in Wisconsin.
- **Mancozeb** (Dithane, Manzate, Penncozeb) is used to control leaf rust. Dithane F-45 is applied at a rate of 1.2 qt a.i./A while Dithane M-45 80WP, 75DF, WSP; Manzate 200 75DF, and Penncozeb 80WP, 75DF are applied at a rate of 1.5 lb a.i./A. Mancozeb is applied every 5-10 days based on weather conditions and disease pressure. There is a 7 day pre-harvest interval. Mancozeb was applied to 5% of the sweet corn in Wisconsin.
- **Propiconazole** (Tilt) is used to control leaf rust at a rate of 4 fl oz/A for a total of up to 16 fl. oz/A/season. Applications begin when the disease first appears, and continues every 7-14 days. Propiconazole can be applied up until 14 days before harvest. In Wisconsin, propiconazole is applied to 10% of the sweet corn acreage.

Alternative Pest Management Strategies

Three non-chemical weed management practices that can be beneficial are cultivation, crop rotation, and

delayed planting. Cultivation is the most effective of these options and is frequently used to supplement the weed control provided by herbicides. A combination of frequent rotary hoeing and cultivation can adequately control low density of weeds without herbicides if weather permits timely operations. Crop rotation, especially growing sweet corn after a few years of alfalfa, can help reduce weed pressure during the year sweet corn is produced. This has been a management recommendation for fields with heavy infestations of wild proso millet. Delayed planting can lessen weed density, but will not eliminate the need for weed control.

To prevent the build up of inoculum and insect populations, a 2-3 year rotation out of corn is recommended.

Cultivars with resistance to multiple diseases are available for rust, smut, maize dwarf mosaic virus, and northern corn leaf blight. Late-planted fields in rust-prone areas should consider use of rust-resistant cultivars.

Critical Pest Control Issues

Broadleaf herbicide availability is the greatest near-term weed management issue. Currently in Wisconsin, atrazine use is prohibited on over 1.2 million acres, which includes areas where sweet corn is grown. The primary herbicide alternative to atrazine has been cyanazine, but cyanazine's registration is being voluntarily canceled in three years. Until that time, the maximum use rate has also been cut to a level of about half of the rate that is typically required for broadleaf weed control. Other labeled broadleaf herbicides have serious limitations in terms of crop safety, weed spectrum, or rotational restrictions.

Herbicide resistant weeds are a longterm concern. Triazine-resistant lambsquarters and pigweed have been a problem in regions of Wisconsin for many years. We have also recently confirmed nicosulfuron-resistant giant foxtail in the sweet corn growing region. The heavy reliance on a limited number of herbicides will likely increase the selection of more herbicide-resistant weeds in the future. For instance, nicosulfuron is frequently used for wild proso millet control because it is the only effective postemergence option and preemergence herbicides often do not provide full season control. With frequent nicosulfuron use, resistance can be predicted and unless other herbicides become available, control will become difficult.

In some years, bird damage can be severe in Wisconsin corn fields. When this occurs, Avitrol is used on between 12,000 - 15,000 acres of sweet corn to prevent damage to the crop.

Outlook for New Registrations

The registration of bifenthrin (Capture) in 1999 provides an excellent insecticide for control of aphids,

flea beetles, cutworms, European corn borer, corn earworm, and the fall armyworm. It has been shown to be more effective in controlling aphids than Warrior, the top product recommended for aphid control prior to the registration of Capture.

New labels for strobilurin and other reduced-risk fungicides is possible but maintenance of current labels is necessary for resistance management.

There are several herbicides being evaluated for registration in sweet corn. Glufosinate (Liberty) received a section 18 in 1999 on glufosinate-resistant hybrids and is very effective on annual grass and broadleaf weeds. Continued development of this technology may depend on consumer acceptance of genetically modified crops. Halosulfuron (Permit) is also being labeled on sweet corn. Halosulfuron is a postemergence broadleaf herbicide, but has two traits that will limit its utility. First, halosulfuron cannot be used on all sweet corn hybrids because some are severely injured by it. It is likely that halosulfuron will be labeled for use on only specific tolerant hybrids, probably the same hybrids that have tolerance to nicosulfuron. Second, the weed spectrum of halosulfuron will also limit use because it does not control common lambsquarters, which is a predominant broadleaf in Wisconsin. It does control velvetleaf, pigweed, and common ragweed. Carfentrazone (Aim) and dicamba plus diflufenzopyr (Distinct) are other field corn herbicides being evaluated for use in sweet corn. Sweet corn tolerance to both herbicides needs to be evaluated further because sweet corn is often more sensitive to herbicide injury than field corn. Both of these herbicides control broadleaf weeds postemergence. Carfentrazone provides excellent control of velvetleaf and good control of pigweed, but control of common ragweed and common lambsquarters appears to be inadequate. Dicamba plus diflufenzopyr controls Wisconsin's major broadleaf weeds postemergence if it can be used at the same rates labeled for field corn. However, lower rates may be required to provide adequate crop tolerance. Broadleaf weed control may be reduced if rates are reduced.

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