MAPPING YOUR ROUTE TO THE FUTURE

Great Lakes Fruit, Vegetable & Farm Market EXPO
DeVos Place Convention Center
Grand Rapids, MI
December 7-9, 2004

Sweet Corn

Wednesday afternoon 2:00 pm

Where: Grand Gallery Room E-F (lower level)

Recertification credits: 1 (Private, 1B)

CCA Credits: IPM(1) CM(1)

Moderator: Bruce MacKellar, St. Joseph Co. MSU Extension

2:00 p.m. Polymer film in Sweet Corn Production

- John Warner, Agriculture and AgriFood Canada

2:25 p.m. Why use Cover Crops in Sweet Corn

- Ann E. MacGuidwin, Plant Pathology Dept., Univ. Wis

2:50 p.m. If You Grow it, They Might Take a Survey

- Hannah Stevens, Macomb Co. MSU Extension

3:10 p.m. Watching for Worms

- Beth Bishop, Entomology Dept., MSU

3:30 p.m. Common Rust and other Diseases

- Mary Hausbeck, Plant Pathology Dept., MSU

Biodegradable Polymer Mulch Films in Sweet Corn Production

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Many sweet corn growers are using clear plastic (polyethylene) mulch to warm the soil and to advance harvest maturity. The use of clear plastic mulch may also improve seed germination and increase plant stand under cool soil conditions often encountered in the early spring, and may improve the yield and quality of sweet corn. A major disadvantage of the use of plastic is the disposal of the plastic at the end of the season.

Recently, biodegradable polymers have been developed for agricultural uses. Biodegradable films are often thinner than traditional polyethylene, but otherwise are quite similar. They may be made from renewable resources such as starch, cellulose, or degradable polymers. Biodegradable polymer films are degraded by processes involving sunlight, heat and mechanical stress, eliminating the need for pick up and disposal at the end of the season. The polymers are eventually converted through microbial activity in the soil to CO_2, water and natural substances. Biodegradable mulches are not the same as the photodegradable mulches that were previously available that left plastic residues in the fields. Formulation of the film determines the life of the mulch.

An experiment was carried out to compare the effects of clear plastic mulch and biodegradable clear polymer mulch films in sweet corn production on soil warming, plant growth, crop maturity, yield and quality; and to document the degradation of the biodegradable polymers under field use. Four biodegradable mulch films (EcoFilm, Eco-one, EcoWorks and Mater-Bi) were compared to clear polyethylene and bare soil using a randomized complete block design replicated four times. Mulch was laid on April 29 and plots were seeded (cv. Temptation) on April 30. The soil was a Fox sandy loam. Cultural practises were similar to those followed commercially in the area.

The Mater-Bi mulch film was thinner than the other mulches and required extra care in laying so that it did not tear. Some small holes occurred in the Mater-Bi mulch when it was laid. The clear plastic and Eco-one mulch films lasted through the season and were still intact at harvest. The EcoWorks mulch became brittle as the season progressed and tears developed in the mulch, however, at harvest (81 days after the mulch film was laid), over 90% soil cover remained. Breakdown of the Mater-Bi and EcoFilm started with long slits developing in the mulch at the tassel stage of corn development (approximately 50 days after the mulch was laid). By harvest, multiple tears and holes had developed in the mulch and approximately 25 to 50% of the soil was exposed. By late September, all biodegradable mulches were sufficiently degraded that after field discing, few pieces of plastic remained and none were over 5" in size.

Soil temperature under all mulch films was increased compared to bare soil. Soil temperature under the clear mulches (clear polyethylene and Eco-one) was higher compared to the translucent mulch films (EcoFilm, EcoWorks and Mater-Bi). Corn plant emergence from all mulch films occurred ahead of bare soil. This was due to an increase in soil temperature under the mulches. Corn plant emergence from the clear plastic was ahead of the translucent mulch films (EcoFilm and EcoWorks) 10 days after seeding, and was ahead of the EcoWorks mulch 12 days after seeding (Table 1). Again, the differences in plant emergence were due to the differences in soil temperature under the mulches. There was no difference in final plant stand between the treatments. Ear silk formation was earlier for all mulch films compared to bare soil. Corn plant height was taller for all mulch films compared to bare soil.

Sweet corn harvest was advanced by approximately 3 days using the mulch films compared to bare soil (Table 2). Marketable yield was slightly higher and ear size was slightly larger for all mulch films compared to bare soil, although the differences were not statistically significant at the 5% level (Table 2). No significant differences in other quality parameters (tip cover, tip fill) occurred between the treatments.

Weed control must be good under the mulch as weeds will grow through the biodegradable films rather than being smothered as often occurs under the stronger polyethylene films.

Table 1: Effect of Soil Cover on Plant emergence of Sweet Corn at Harrow, Ontario, 2004

	Percent plant emergence (days after seeding)		
Soil cover	10	12	14
Bare soil	0 d[z]	68.2 c	79.7
Clear plastic	80.1 a	86.3 a	87.7
EcoFilm	65.8 b	85.5 ab	88.3
Eco-one	70.4 ab	81.6 ab	86.4
EcoWorks	51.2 c	77.1 bc	83.8
Mater-Bi	68.9 ab	82.7 ab	84.4

[z] Means followed by the same letter within each column not significantly different using LSD ($P \leq 0.05$). Absence of letters indicates no significant difference.

Table 2: Effect of Soil Cover on Harvest Date, Marketable Yield and Ear Size of Sweet Corn at Harrow, Ontario, 2004

		Marketable yield		Ear size
Soil cover	Harvest date	Dozens per acre[z]	Tons per acre[z]	(g/ear)[z]
Bare soil	July 22	1694	6.6	252.2
Clear plastic	July 19	1919	7.7	269.8
EcoFilm	July 19	2120	8.8	270.2
Eco-one	July 19	1887	7.9	269.5
EcoWorks	July 19	1895	7.8	266.3
Mater-Bi	July 19	1975	8.2	265.8

[z] No significant difference in yield or ear size between treatments using LSD ($P \leq 0.05$).

Cover crops, nematodes, and sweet corn

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Cover crops have many benefits such as reducing erosion, weed management, and increasing soil organic matter. Many factors are considered when choosing a cover crop such as timing, nutrient demands and contributions, and growth habit. One attribute that's sometimes forgotten is the impact of the crop on soil diseases. Most cover crops that are used in vegetable rotations are likely to have a neutral impact on sweet corn diseases. An exception to this statement is root lesion nematodes. All cover crops are host to root lesion nematodes, *Pratylenchus* spp., but there is a tremendous range in the potential of different cover crops to support nematode populations. Knowing which cover crop to plant in soils with nematode disease potential can provide the necessary edge to boost sweet corn yields.

Sweet corn is an excellent host for root lesion nematodes. This fact is often not appreciated because nematode-infected plants may not have noticeable symptoms except reduced yields or the symptoms may be mistaken for nutrient deficiency. The damage potential of nematodes is related to population densities the day corn is planted. Damage thresholds have been established for each state in the Midwest and vary with soil types, climates, and planting dates. Measures to reduce root lesion nematodes before planting have a beneficial impact on the sweet corn crop when nematode population densities, as indicated by a soil assay, exceed the threshold level. There are no sweet corn varieties resistant to root lesion nematodes, making it all the more important to start the season with as few nematodes as possible.

Despite being susceptible to feeding by nematodes, some cover crops can decrease nematode population densities. For rapeseed and other *Brassica* spp. the nematicidal action is due to a combination of biological activity and chemical compounds released as the cover crop decomposes in the soil. Other cover crops such as forage pearl millet can reduce the impact of root lesion nematodes even though nematode population densities may be unchanged. Even excellent hosts, such as red clover and alfalfa, may not contribute to the increase of nematode populations if they're planted as late season cover crops

The potential impact of cover crops on root lesion nematode population densities should be a consideration for sweet corn growers. Surveys in Wisconsin show the majority of sweet corn fields are at risk for yield loss due to root lesion nematodes. This pest is widespread throughout the Midwest so every field should be tested periodically. Other nematodes damaging to corn include needle (*Longidorus breviannulatus*), dagger (*Xiphinema* spp.), and lance (*Hoplolaimus* spp). Corn needle nematodes can be a very serious problem in sandy soils with damage thresholds as low as 10 nematodes per 100 cc soil. Knowing which nematodes are present is important because sorghum-sudangrass and certain other cover crops can be hosts for corn needle nematodes.

If You Grow it, They Might Take a Survey

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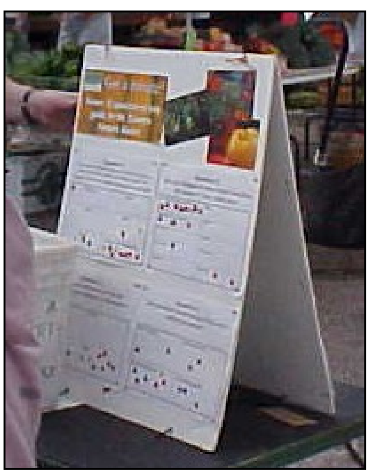
One of the best opportunities a market has to assess customer attitudes and attributes is by capturing this information from them while they are shopping. Business booms during sweet corn season but marketers are as busy, with little extra time to conduct interviews.

The "Dot Survey" concept, developed by Larry Lev, Linda Brewer and Garry Stephenson at Oregon State University, is a useful, low cost survey tool that has shown excellent participation rates and an accurate assessment of consumer preferences and behavior. Customers enjoy doing it and like to contribute their suggestions and thoughts. While it was developed for a farmers market it is just as useful for a farm market and requires only two sheets of poster board or foam core, a table or tripod, some colorful self-adhesive dots from an office supply store and your questions. These are customized for your operation. What do you need to know to change and improve your retail operation? The original studies included attendance counts and other ways to assess the market and, while you may not choose to include these other methods, you do need to give careful thought to what the results of your dot-survey mean. For example, if 70% of your customers say they would pay more for organic produce, will they follow through if you make the shift to organic? If 30% of your customers would like to see you carry dairy products, does this mean you will see a net profit if you carry dairy products?

This summer the Mount Clemens Farmers Market and MSU Extension conducted a dot survey on four Saturdays during sweet corn season. Several hundred customers enjoyed taking the survey and the market gained some insights. These included the following information about the survey respondents:



- 50% visited the market weekly
- 58% shopped for 2-3 people while only 11% shopped for more than 5 people
- 46% traveled 5-10 miles to shop at the market but 3% traveled as many as 20-30 miles
- 48% spent $10-20, 21% spent $5-10, 20-30% spent $20-30 while only 6% spent more than $30.
- 98% indicated that it was "somewhat" to "very" important to buy locally grown produce. 86% said it was "very" important.
- While half of the market customers felt they should pay the same price or less for products at the farmers market versus the supermarket, an equal number would pay more, or didn't even consider the price when shopping at the market.
- Sweet corn preferences showed that 66% preferred bi-color corn and 20% had no preferences. The remainder preferred either white or yellow.
- 46% of those who peeled back the husks on sweet corn did so because they were looking for worms while the rest were checking for maturity or freshness.

Watching for Worms

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Despite the popularity of the television show "Fear Factor", or, perhaps because of it, the presence of "worms" in sweet corn ears is very distasteful to consumers. A number of different "worms", or, more properly, caterpillars, infest sweet corn grown in the Great Lakes region. The most significant of these, European corn borer and corn earworm, differ in their life history, seasonal occurrence, and tactics for control. Understanding when to expect each pest, and how to manage it is the secret to "worm-free" sweet corn.

European corn borer females lays eggs on corn leaves, usually the lower surface. Eggs are laid in groups and look like white, overlapping fish scales. Larvae hatch and feed for a short period of time on the outer surface of the plant, usually the leaf. Subsequently they move to the whorl, leaf collar, or ear, depending on the growth stage of the corn plant. Larvae may also bore into the stem or leaf midrib. Pupation occurs within the plant and adults emerge and produce the next generation.

The European corn borer is a permanent resident of the Great Lakes region. It spends the winter as a mature larva, in corn stalks or other plant residue. As weather warms in the spring, larvae continue their development, forming pupae and ultimately emerging as adults. Adults mate and lay eggs, producing the first generation of larvae. Development is temperature-driven. Consequently, we can use a measurement of accumulated heat, degree-days, to predict when European corn borer moths will occur, when eggs will be laid, and how fast larvae will grow.

European corn borer has 2 to 3 generations a year in the Great Lakes region. Gross predictions of when these generations will occur can be made using degree-days. The first moth flight (and egg laying) is expected at approximately 450 to 500 degree days (base 50). The next moth flight is expected at approximately 1450 to 1500 degree days, and subsequent generations are expected at 1000 degree-day intervals. The predictions are fairly general, since local environmental conditions and other weather parameters (e.g., moisture), may affect the timing of these events. Also, degree-days can only predict timing of generations, not population abundance.

The presence of European corn borer moths can also be detected using traps. Both black light and pheromone traps attract and capture corn borer moths. Pheromone traps are used more than black light traps because they are easier and quicker to evaluate. Pheromone traps use a special chemical that is produced by female moths to attract males; the more moths present in an area the more males will be caught in the trap. Pheromone traps can provide more exact information on the timing of a flight of moths AND provide an estimate of abundance (Figure 1).

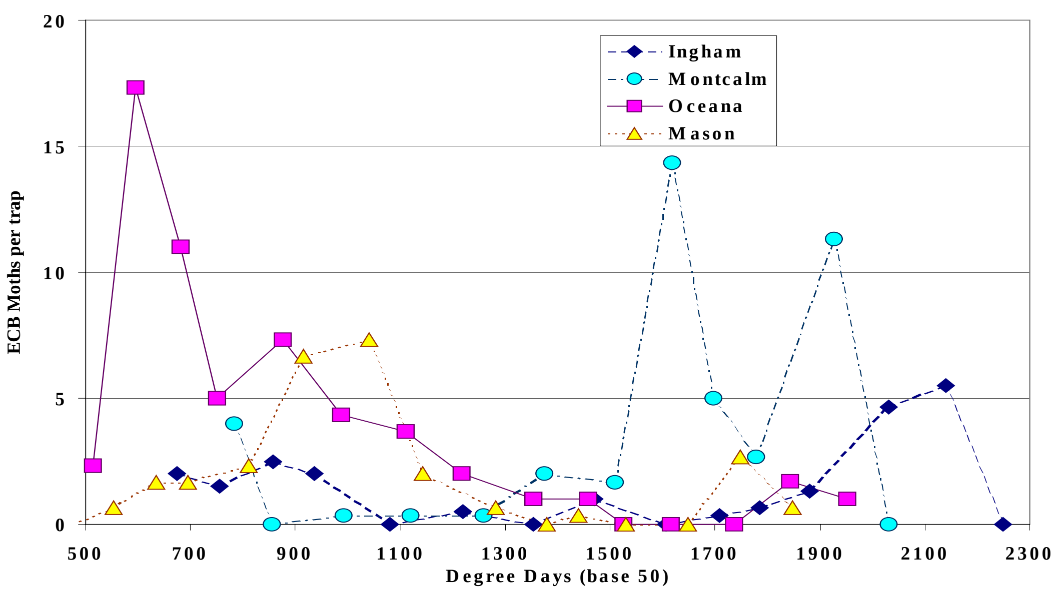
Sweet corn at tassel and beyond is at risk for corn borer damage. Both degree-day predictions and pheromone trap catches, along with field scouting, can alert growers to the timing and severity of the risk. Many effective insecticides are registered for control of European corn borer, but care must be taken to ensure that the insecticides are present during the time when larvae are vulnerable—between hatching and entering the ear or stem. Because the European corn borer does feed a bit on the surface of the plant, insecticides, such as Bt, that must be consumed are effective on this pest.

Corn earworm also infests corn ears. Female corn earworms usually lay eggs on corn silk, so sweet corn is not vulnerable to earworms prior to silking. After hatching, larvae do not feed, before moving to and entering the ear: once inside they begin to feed. Because of this, corn earworm are not controlled by foliar insecticides that must be consumed (such as Bt). Contact insecticides applied to the silk can control adults and newly hatched larvae before they move to the ear. In many cases, a good European corn borer control program will also control corn earworm as long as thorough coverage of the silk is made. Problems arise when corn borer populations are low and corn earworms unexpectedly appear.

Corn earworm cannot overwinter in most areas of the Great Lakes region. However, earworm can and do survive in more southern areas. They are very good travelers and regularly migrate into the area, either gradually moving northward, or being carried in by storm fronts. Consequently, the occurrence of corn earworm each year is unpredictable, as is its abundance. The farther north the location, the more unpredictable it is.

While degree-days are not of any value to predict first occurrence of migrating corn earworm, they can predict subsequent generations. Also, since corn earworm populations can gradually migrate northward, it is advantageous for growers and scouts to stay informed about corn earworm pest status in states to the south. Traps using corn earworm-specific pheromones are useful to predict both occurrence and abundance. Also, being aware of the weather is important. For example, in late August 2004, large numbers of corn earworms suddenly appeared in pheromone traps throughout Michigan. During most of 2004, "worm" pressure in corn was low and growers may have been caught unaware.
Tropical storm fronts that repeated assaulted the southern United States during this period are probably responsible for the influx of corn earworm into Michigan.

Figure 1. Average number of European corn borers caught per pheromone trap in different Michigan Counties in 2004.



Sweet Corn: Common Rust and Other Diseases

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Common Rust
Common rust, a serious disease of sweet corn in the Midwest, is caused by the fungus, *Puccinia sorghi*. When common rust is severe, there can be significant losses in sweet corn yield and quality. The disease appears as oval spots or pustules (less than ¼ inch long) on the upper and lower surfaces of the corn leaves. The first 4-5 leaves produced by the corn plant are more susceptible to rust infection than leaves produced later, but pustules can also be found on ears and tassels when disease is severe. Infection usually begins in the leaf axils where moisture accumulates. Pustules are reddish-brown early in the season, when the repeating (uredospores) form and break through the epidermis of the leaf. Later in the season, pustules become brownish-black as overwintering spores (teliospores) form.

Puccinia sorghi has a complex disease cycle, which includes two different plant species and five different spore types. Only one host, corn, is grown in the Midwest and only two of the spore types occur here. The repeating spore (uredospore) is important to sweet corn growers. It is carried by winds from the south (Mexico) where the fungus overwinters, and these windblown spores cause the first infections in sweet corn. When the repeating spore (uredospores) arrives in the Midwest near the middle of the growing season, rust is a problem only on late-planted sweet corn. Recently, rust has been observed in the Midwest in early June, and in 2000, it was seen in late May on sweet corn in Illinois. This is probably due to earlier plantings and larger acreage of field corn grown in the southern United States.

The repeating spores (uredospores) need about 6 hours of moisture to germinate and infect the corn, but can remain viable for long periods under dry conditions. Although 65° to 75°F is optimal, they can germinate, infect and form more repeating spores at a wide range of temperatures (Pataky, 2001). Repeating spores form and can be released 7 days after the initial infection, causing additional infections. This cycle repeats throughout the growing season when the weather is favorable. Disease can increase quickly under ideal environmental conditions, which include cool, moist and humid (98 to 100% relative humidity) weather.

Sweet corn cultivars with resistance to rust are available. The effectiveness of the resistance depends on the type of the resistance, the amount of rust pressure and the weather. General rust resistance is effective against all corn rust, but control is not complete. Sweet corn cultivars are classified as resistant, moderately resistant, moderate, moderately susceptible and susceptible. When weather favors disease development, severity of rust on resistant cultivars usually is 20% or less, moderately resistant or moderate cultivars can have 20-30% severity which reduces yield 12-18%, and moderately susceptible or susceptible cultivars frequently have disease severity greater than 30%.

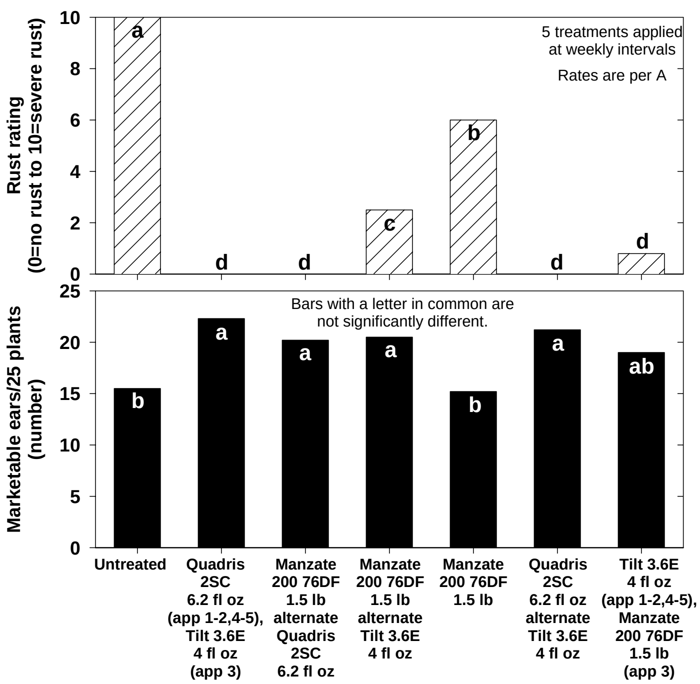
Fungicides are used when genetic resistance alone cannot control rust. The effectiveness of the fungicides depends on the genetics of the sweet corn cultivar, the time of application and the weather. Fungicides must be applied before rust becomes epidemic. Scouting for rust can help determine when to begin fungicide applications. Researchers found that improvements in moisture and sugar content and ear-tip fill occurred when fungicides were used to control rust. The amount of control provided by each level of general resistance is equivalent to one application of fungicide.

Fungicides registered for use on common rust in Michigan include azoxystrobin, chlorothalonil, mancozeb, maneb, and propiconazole (Table 1). Quadris (azoxystrobin), Manzate (mancozeb), and Tilt (propiconazole) were tested in Florida (Figs. 1 and 2). Programs which alternated these products were significantly more effective than Manzate alone at controlling rust and producing marketable ears.

Table 1. Fungicides registered for use on sweet corn in Michigan.

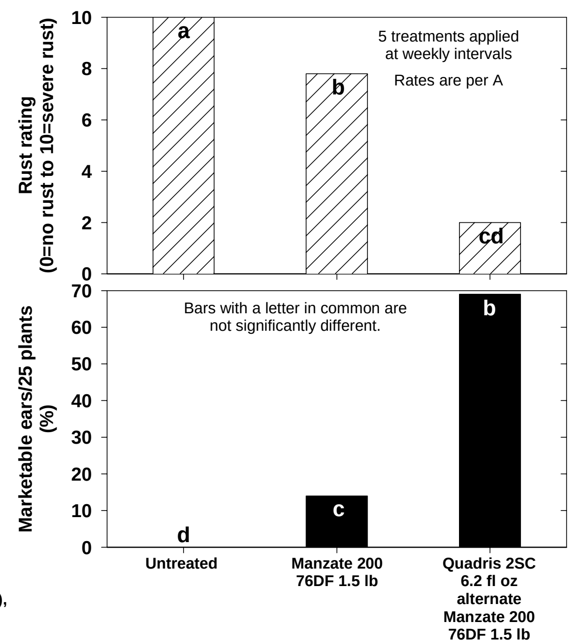
Disease	Active ingredient	Product
Common rust (*Puccinia sorghi*)	azoxystrobin	Amistar, Quadris
	chlorothalonil	Bravo, Echo, Equus, and others
	mancozeb	Dithane, Manzate, Penncozeb, and others
	maneb	Maneb, Manex, and others
	propiconazole	Propiconazole, Tilt, and others

Figure 1. Common Rust on Sweet Corn, FL 2001



Raid, R.N., and R.T. Nagata. 2002. Fungicide and Nematicide Tests 57:V031.

Figure 2. Common Rust on Sweet Corn, FL 2003



Raid, R.N. 2004. Fungicide and Nematicide Tests 59:V147.

Common Smut

The incidence and severity of this disease, caused by the fungus, *Ustilago zeae*, depends on genetic resistance, amount of smut spores, and weather conditions. Infection results in large (up to 5 inches), smooth, shiny, galls on all parts of the plant, but especially on the developing kernels. The fungus overwinters in soil or crop residue. The disease is favored by dry conditions and temperatures between 79 to 93°F. High nitrogen or high organic matter and mechanical injury due to weather, insects or humans also favor smut development. Reduce the incidence of smut by planting tolerant cultivars, maintaining balanced soil fertility, avoiding injury during cultivation/spraying, and avoiding planting near wheat fields.

Bacterial Stalk Rot

Bacterial stalk rot, caused by the bacterium *Enterobacter dissolvens,* is favored by warm (above 86°F) and wet weather. Infected green plants fall over with collapsed, twisted stalks. Water-soaked, slimy and rotted tissue can be found in one or several internodes of the stalk above the soil surface. The bacteria live in crop residue and can infect through natural openings in the leaf. The disease can be spread by humans or animals moving through the fields, contaminated plants and soil, or splashing rain. Use resistant varieties and avoid excessively wet fields to control this disease.

Crazy Top

This disease is caused by the downy mildew fungus, *Sclerophthora macrospora*. Disease symptoms include excessive tillering and twisting of the upper leaves and the tassel. Crazy top occurs in low-lying areas of the field where water accumulates, because the spores are spread in water. Manage the disease by providing good soil drainage or avoiding low-lying areas when planting.