PEST MANAGEMENT & CROP DEVELOPMENT BULLETIN

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In This Issue

Issue No. 23 will be October 3.

Hot Topics!

Western corn rootworm beetle densities remain impressive in several east-central Illinois counties. Surveys in counties outside the so-called "epicenter" also have revealed western corn rootworm adults in numbers that should cause some concern for growers during the 1998 season. Densities of beetles in Coles, Logan, and Piatt counties exceeded 0.1 adults per sweep and suggest that egg laying may be occurring in soybean fields. Negligible counts (less than 0.1 beetle per sweep) were found in several counties outside eastern Illinois. These survey efforts suggest that the western corn rootworm "variant" may be spreading its sphere of influence to the west and south in Illinois. **This page.**

Brown stem rot (BSR) and sudden death syndrome (SDS), two mid- to late-season soybean diseases, have prompted numerous calls from throughout the state. An earlier article in the *Bulletin* had noted that, although there were no reports of these two diseases yet, we expected to find them if weather conditions were to change to favor the fungal pathogens. Unfortunately, that has now happened. With the recent rainy spells and a return to cooler weather, both pathogens have become active. Both cause leaf discoloration and loss of yield, depending on time of infection and the stage of crop growth. BSR is more common in northern Illinois. SDS can be found statewide, although it is most commonly seen in the southern third of the state. **Pages 184, 185.**

Soybean producers are also reporting yellowing and dying of the uppermost portions of soybean plants throughout entire fields, particularly in western and northern Illinois. Despite the appearance, control of anthracnose usually is needed only in seed-production fields. **Page 186.**

Hot Topic

INSECTS

Survey Results for Western Corn Rootworm Beetles in Soybean Fields

Surveys of soybean fields in east-central Illinois counties continue to reveal the presence of western corn rootworm adults (Table 1). On August 25, densities of western corn rootworm beetles were very impressive in Iroquois County at two different sites (3.66 and 3.97 beetles per sweep), Livingston County (2.44 beetles per sweep), and McLean County (1.77 beetles per sweep). Although densities of beetles were not as great in Champaign County (0.50 and 0.72 beetles per sweep), we still have several weeks left this season for populations of rootworm adults to surge in certain areas. Several counties outside the "epicenter" of first-year corn problems also

Table 1. Survey results for western corn rootworm (WCR) beetles in soybean fields.

County—Sample Date	*WCR Present or Absent*	*WCR Total per 100 Sweeps*
Champaign—August 13	Present	50
Champaign—August 21	Present	72
Clay—August 25	Absent	0
Coles—August 25	Present	21
Cumberland—August 25	Present	2
DeWitt—August 26	Present	4
Effingham—August 25	Absent	0
Fulton—August 13	Absent	0
Fulton—August 20	Absent	0
Iroquois (Site 1) —August 25	Present	366
Iroquois (Site 2) —August 25	Present	397
Jasper—August 25	Present	1
Livingston—August 21	Present	244
Logan—August 13	Present	35
Logan—August 20	Present	19
Logan—August 26	Present	1
Macon—August 26	Present	9
Mason—August 13	Present	7
Mason—August 20	Present	1
Mason—August 26	Absent	0
McLean—August 13	Present	177
McLean—August 20	Present	85
Menard—August 26	Absent	0
Moultrie—August 25	Present	5
Piatt—August 25	Present	55
Sangamon—August 26	Present	1
Shelby—August 25	Absent	0

have western corn rootworm beetles visiting soybean fields, such as Coles County (0.21 beetles per sweep), Logan County (0.35 beetles per sweep), and Piatt County (0.55 beetles per sweep). Several counties did not have any western corn rootworms in soybean fields, or numbers of beetles per sweep were negligible (less than 0.1 beetle per sweep): in Clay, Cumberland, DeWitt, Effingham, Fulton, Jasper, Macon, Mason, Menard, Moultrie, Sangamon, and Shelby counties.

What do these numbers suggest? First of all, we can expect continued rootworm problems in first-year corn throughout east-central Illinois for the 1998 season. Secondly, western corn rootworms appear to be stretching their "sphere of influence" to the south and west in Illinois. Although densities of western corn rootworm adults in Coles, Logan, and Piatt counties were not as great compared with other counties in eastern Illinois, growers in these counties should be alert to the possibility that rootworms may pose a threat to first-year corn production during 1998. No scientifically established threshold for western corn rootworm beetles in soybean fields exists. Therefore, growers who are aware that western corn rootworm beetles are present in their soybean fields should assume that egg laying may be occurring. Under these circumstances, for 1998, the use of a soil insecticide applied during planting is the best option. This recommendation holds true despite the poor showing of soil insecticides this season.

We intend to continue with our survey efforts and will share results with our readership in future issues of this *Bulletin*. This has been a rootworm season to remember!

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Status of European Corn Borers? Maturity of Corn

Activity of European corn borers continues in some areas of the state. We have received a handful of reports of very large flights of adults in recent days, so these late emergers still pose a threat to corn in localized areas. However, we question if treatment for corn borer control will do any good (economically) in most fields right now. A decision to treat for corn borers at this late date depends upon the maturity of corn. Our management worksheet (issue no. 20 of this *Bulletin*, August 8, 1997) indicates that the potential economic benefits of treatment decline rapidly if infestations occur after corn reaches the blister stage. A recent report of corn maturity indicated that approximately 25 percent of the corn in Illinois had dented, and 75 percent was in the dough stage. Based upon this information, we could not justify treating any more cornfields to control corn borers.

One other point should be made. In our worksheet, the percentages of yield loss attributed to each corn borer are based solely upon physiological yield reduction. These percentages do not account for stalk lodging or ear drop resulting from corn borer infestations. Many of our modern corn hybrids have strong stalks and ear shanks, but yield losses attributable to an inability to harvest ears on the ground are possible if infestations of corn borers are intense. Because we have no guidelines to accommodate this yield loss, we recommend that scouting for corn borers continue solely to determine if certain fields might be susceptible to broken stalks and dropped ears. If these fields are identified, they should be scheduled for early harvest, if possible.

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Preliminary Results of the 1997 Summer Survey for *Bt*-resistant European Corn Borers

Earlier this summer we asked growers for information on their *Bt*-corn fields and for access to those fields so that we might begin what should be periodic surveys of corn borer resistance to *Bt*. We received plenty of responses and were able to get in several days of sampling in the latter part of June and early July. Here's a quick explanation of what we were trying to do and a preliminary report of our findings.

First, let's make clear that in the 1997 summer survey we did not try to address the development of resistance as a result of repeated, low-level doses of exposure to *Bt*. Resistance to *Bt*, if it develops, may result from several generations of repeated selection of individual corn borers that are able to survive slightly higher doses of *Bt* than "average" corn borers. These "slightly resistant corn borers" (really just the upper end of the mortality curve in an existing population) might survive in corn as *Bt* concentrations drop in late season or in specific plant tissues that have low levels of *Bt* toxins. As time and corn borer generations pass, these slightly resistant corn borers will be more and more likely to mate with each other because the more susceptible insects that might otherwise be mates with them will have been killed. The results of this selective breeding program would be a "concentration" of resistance genes in their offspring and perhaps an increased level of resistance that might cause control failures. Although we have started some research on this path, and other researchers around the Midwest have done much more, this scenario was not the topic of our summer survey efforts.

Another possibility that might lead to resistance problems is that extremely rare individual corn borers are already present and able to survive even the very high doses of *Bt* toxins that are in *Bt*-corn plants. If this is true, field problems with resistance might develop from the increasing prevalence or frequency of such individuals instead of or in addition to the gradual selection process described previously. It is this possibility—that borers able to survive very high doses of *Bt* toxins in *Bt*-corn plants already exist—that led us to the "needle-in-the-haystack" survey this summer.

With the help of more than 30 growers, we identified and surveyed *Bt*-corn fields in 23 counties. We walked each field to look for corn borer injury and surviving corn borers at a time when most of the first-generation larvae should have reached second or third instar—this timing was meant to allow them to be killed by the *Bt* if it was present and the larvae were susceptible. To conduct the survey, we walked fields, examining four to six rows per sampler in each pass through the field. Although the area of the fields we worked in totaled more than 2,200 acres, our crews actually covered about 325 acres in this row-by-row manner. Let's assume for a moment that the plant population in those 325 acres averaged about 28,000 plants per acre and that the average first-generation infestation in those fields would have been about 0.5 larva per plant had the borers not been killed by *Bt* (an infestation level based on surveys of nearby non-*Bt* fields on the same days). The 325 acres that we surveyed should have been home to roughly 4.5 million corn borers (28,000 x 325 x 0.5). So what we were able to do was to examine the results of a vast screening program that provided a chance to detect rare, resistant corn borers, even if they were present at a one-in-a-million frequency.

Did we find corn borers surviving in the Bt*-corn fields?* Yes—more than 200. However, all but two were on plants that were not producing *Bt* toxin. Based on data from the seed companies and previous observations, we expected that at least a small portion of the plants in a *Bt*-corn field would not be producing *Bt* toxins. To avoid making an incorrect conclusion that any surviving larvae were *Bt*-resistant, we used a Gene-Check strip (ELISA assay) supplied by Monsanto to determine whether or not the infested plants were *Bt*-positive. All but two of the infested plants were *Bt*-negative: The surviving larvae were not necessarily resistant to *Bt*; they were simply lucky that their mothers placed them (as eggs) on *Bt*-negative plants. Note that the frequency of *Bt*-negative plants in *Bt*-corn fields was extremely low, at least based on the number of infested plants that we were able to detect.

So what about the two larvae from Bt *positive plants?* One was parasitized at the time of collection by *Macrocentrus grandii* ... now a dead end for our interest in resistance. The other, collected as a second instar and placed on artificial diet on June 29, is now, on August 22, a fifth instar. Our intent is to rear this insect to the adult stage, mate it with a lab-colony moth, and then continue to rear subsequent generations for crosses and bioassays. These steps will allow us to determine whether its survival is the result of *Bt* resistance or another factor: It could have moved onto the *Bt*-positive plant just before we collected it; therefore, it may not have fed on the foliage expressing the *Bt* toxin. (We don't think this is true, but it's possible.)

Those who are familiar with corn borer biology probably noted an inconsistency in the preceding paragraph. The prize, needle-in-the-haystack larva that we collected on June 29 still has not pupated and reached the adult stage. It should have done so in late July. The reasons for its failure to develop at a normal rate may be related to whatever unusual trait allowed its survival on a *Bt*-positive plant; its delayed development may instead be related to infection by *Nosema pyrausta*, the microsporidian pathogen that helps regulate corn borer populations in the Midwest.

The bottom line: We found a needle in the haystack, but we don't know yet if it's really the needle we were looking for. We'll keep you updated on our progress.

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Surveys of Soybeans Reveal Activity of Defoliators

In the first article in this issue of the *Bulletin*, Mike Gray described the surveys of soybean fields that are being conducted to determine the presence of western corn rootworm adults. During these surveys, the "team" also has kept track of numbers of some of the other defoliators that occur in soybeans at this time of year. We thought you might find these numbers useful, so we present the numbers of bean leaf beetles and Japanese beetles per 100 sweeps of a net in several counties (Table 2).

So what do these numbers mean? Well, they mean that some defoliators still are present in some soybean fields in some counties in Illinois. Definitive answer, right? The point is this. As soybeans begin to senesce, the threat posed by soybean defoliators diminishes significantly. However, if pods are still filling out in some of these fields infested with defoliators, 20 to 25 percent or more defoliation could result in economic yield loss. Some team members observed 30 to 40 percent defoliation in some of the fields they surveyed (for example, the field in Mason County infested with 485 bean leaf beetles per 100 sweeps, and the field in Piatt County infested with 225 Japanese beetles per 100 sweeps). Based upon these observations, scouting for soybean defoliators is time well spent. Also remember that some defoliators (bean leaf beetles, grasshoppers) also cause injury to pods. Many people do not continue scouting soybeans this late in the growing season, but we recommend otherwise. Refer to issue no. 21 (August 15, 1997) of this *Bulletin* for more specific guidelines for dealing with soybean defoliators and pod feeders.

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Table 2. Bean leaf beetles and Japanese beetles in Illinois, August 13 through 26, 1997.

County[1]	Date	Number of bean leaf beetles per 100 sweeps	Number of Japanese beetles per 100 sweeps
Champaign	August 13	42	0
Fulton	August 13	73	0
Logan	August 13	139	0
Mason	August 13	485	0
McLean	August 13	68	0
Fulton	August 20	45	0
Logan	August 20	75	0
Mason	August 20	87	0
McLean	August 20	46	0
Champaign	August 21	39	0
Livingston	August 21	3	52
Clay	August 25	9	0
Coles	August 25	115	49
Cumberland	August 25	1	5
Effingham	August 25	19	14
Iroquois	August 25	11	10
Iroquois	August 25	38	21
Jasper	August 25	3	55
Moultrie	August 25	48	0
Piatt	August 25	21	225
Shelby	August 25	60	0
DeWitt	August 26	13	0
Logan	August 26	21	0
Macon	August 26	34	0
Mason	August 26	9	0
Menard	August 26	42	0
Sangamon	August 26	106	0

[1]One field per county on the date indicated was sampled by taking 100 sweeps of a sweep net.

PLANT DISEASES

Hot Topic

Brown Stem Rot

Brown stem rot, caused by the fungus *Phialophora gregata* (synonym, *Cephalosporium gregatum)*, enters a plant through the roots and lower stem. Losses are greatest when cool weather occurs during the pod-filling stage (late July and the first half of August), followed by hot, dry weather. Losses of 17 to 25 percent may result from lodging, premature death, or the production of fewer and smaller seeds.

Brown stem rot is difficult to recognize before pod set because it has no external symptoms. When the stems of infected plants about midseason are split longitudinally, however, a characteristic, dark reddish brown discoloration of the vascular elements and pith is evident, extending upward from the roots or crown. Occasionally during hot, dry weather in late August or early September, wilting occurs, followed by a "scorching" (browning and dying) of the leaf tissue between the veins. The leaves blight and dry rapidly. Infected plants often look "frosted." The brown stem rot fungus reduces the efficiency of the water-conducting tissues in the stem. However, leaf symptoms may vary and should not be considered in diagnosis without splitting stems.

Disease development is optimum at air temperatures of 59° to 81°F (15° to 27°C). Little or no disease develops at temperatures above 90°F (32°C). Cool weather leads to more internal stem browning.

The brown stem rot fungus survives in soybean debris and in soil to a depth of about one foot. The fungus produces spores on all types of soybean residue except pods. Infection occurs through main and lateral roots, and the pathogen moves into the lower stem early in the growing season. The fungus spreads slowly upward in the water-conducting vessels. The pathogen may plug vessels partially or completely, interfering with the flow of water and nutrients. The fungus has been reported to be seedborne, surviving as mycelium within the seed coat.

1. **Grow soybeans in the same field only once in 3 or 4 years.** Rotate with corn, sorghum, small grains, forage grasses, legumes, or other crops.

2. **Plant resistant cultivars in fields where brown rot is a severe problem**. Cultivars that mature early tend to escape severe infection but generally yield less than later-maturing ones in the absence of the disease.

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Sclerotinia Stem Rot

Sclerotinia stem rot is caused by the soilborne fungus *Sclerotinia sclerotiorum*. The disease is usually a minor one in Illinois, except for local outbreaks (usually where snap beans, canola, or sunflowers have recently been grown) during prolonged wet periods. The disease is most common in areas of fields where air circulation is poor, such as, near woods. The first symptoms, often observed on older plants, are the wilting and withering of the upper leaves. A white, cottony growth appears on the branches, pods, and stems of the soybeans, usually near the soil line and originating at stem nodes. Large survival bodies (sclerotia) that are round to irregular, and eventually hard and black, are formed on and inside the stem, occasionally, in the pods. These sclerotia may be partly covered with the dense cottony fungal growth. Plants die prematurely when the stems are girdled by the fungus. The withered leaves remain attached to the stem for some time. Pod development and podfill above the girdling stem lesions are greatly reduced. Soybean seedlings may be killed before or after emergence by a watery, soft rot. Seeds may become infected within diseased pods. Infected seeds are discolored, flattened, and smaller than healthy seeds and sometimes replaced by black sclerotia.

Sclerotia of the *Sclerotinia* fungus can survive in the soil for long periods and are highly resistant to most fungicides. The sclerotia germinate within 2 inches (5 cm) of the soil surface by producing one to many light tan to brown, funnel-shaped structures (apothecia) during prolonged periods of cool (40° to 59°F, 5° to 15°C), wet weather. Large numbers of asci are formed in the apothecia, which literally eject “clouds” of ascospores under proper conditions. The windborne ascospores germinate and infect soybean blossoms, stems, branches, and pods under very damp conditions.

1. **Do not rotate soybeans with garden beans, snap beans (*Phaseolus* spp.), canola, or sunflowers**. Control broadleaf weeds that may serve as hosts.

2. **Thoroughly clean contaminated seed lots to screen out some of the sclerotia**. At a foreign port of entry, even a few sclerotia in a shipment intended for human consumption are grounds for rejection.

3. **Grow soybean cultivars that do not lodge readily**.

4. **Avoid planting soybeans in narrow rows** (less than 30 inches or 76 cm) in fields with a history of Sclerotinia stem rot.

5. **Avoid irrigation at flowering**. High humidity in the canopy at this time increases disease levels.

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Hot Topic

Sudden Death Syndrome

Sudden death syndrome (SDS), caused by a strain of the soilborne fungus *Fusarium solani* generally appears about midsummer in soybeans with high yield potential, usually after blooming. The disease can result in minor or severe yield loss, depending on when it develops. SDS is identified by the appearance of small, scattered yellow spots or blotches, usually on the upper leaves. These spots enlarge and merge, and the tissues turn brown between the veins; however, the veinal tissues remain green. Leaflets may curl upward or drop prematurely, leaving the petioles firmly attached. Severe foliar symptoms give affected areas in a field a tan to brown cast and may be the first evidence of the disease. Flowers and pods may abort and pods drop or not fill. The first pods to set may have a few beans in them that remain small. Later pods may not fill or may have immature green seed. One characteristic of SDS is that the interior of the stem (the pith region) remains white. There may be a slight gray-brown discoloration of the vascular system just inside the outer “bark” of the stem, but the pith remains white. If the pith is discolored, it may indicate the presence of brown stem rot. Root symptoms preclude foliar symptoms and result in deterioration of the topmost lateral roots and of nitrogen-fixing nodules. Fields in which the disease is present are likely to develop SDS in subsequent years, although there are no accurate methods of assessing possible disease levels.

The *Fusarium* fungus overseasons as thick-walled chlamydospores or mycelium in crop debris or in soil. SDS is affected by weather conditions. The disease is more severe during cool, wet growing seasons. It is commonly found in association with soybean cyst nematodes (SCN) and in lower areas of fields. Nematodes are believed to act as a stress factor, rather than being directly involved with the disease. However, work in Mississippi has shown that SCN can act to spread the fungus. This research demonstrated that the *Fusarium* fungus was present both on and in the cysts of soybean cyst nematode. Therefore, direct or indirect movement of the nematode could spread the fungus to new areas. The disease tends to be most severe on well-managed soybeans with a high yield potential. However, tillage and rotation practices seem to have little impact on this disease.

1. **Grow well-adapted, high-yielding varieties in a warm, well-drained, fertile soil. Maintain balanced soil fertility, based on a soil test.**
2. **Control other diseases, weeds, and insects.**
3. Although SDS is not seed-transmitted, seeds from infected plants are small in size and tend to produce weaker seedlings than those from healthy plants. Therefore, **do NOT save seed from SDS-infected areas.**
4. **Crop rotation, although not consistent in greatly reducing levels of the *Fusarium* fungus, is definitely beneficial** in reducing the buildup of other pathogens (especially nematodes) that may weaken the plant.
5. **Sanitation** (for example, cleaning tires, combines, and other equipment of soil and crop debris), although time consuming, **helps to reduce spread of the SDS fungus** as well as other soybean pathogens.

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Hot Topic

Urgent!! Urgent!! Urgent!!

We have over the past few days received calls concerning yellowing and dying of the uppermost portions of soybean plants throughout entire fields. These calls have come from much of the state, particularly western and northern Illinois.

The basic symptoms observed are a discoloration of the leaf margins, followed by entire leaves turning yellow or in some cases actually drying up and dying. The disease is limited to the uppermost leaves and the terminal bud area and does not appear to be economically damaging because it affects only the top leaves.

Soybean anthracnose infections throughout Illinois are much more common along the stems as beans begin to mature. The spores are windblown from crop debris into the upper or lower canopy. The fruiting structures of the causal fungus produce clusters of small hairlike projections (setae) that protrude from the stem or other infection points and can be seen with a hand lens or a microscope. These setae are diagnostic for fungi in the genus *Colletotrichum*.

However, another phase of this disease is known as tipblight. This phase is characterized by the upper leaves and pods turning yellow prematurely or turning brown and dying. Other symptoms include death of major veins, leaf rolling and necrosis (death), petiole (leaf stem) cankering, and stunting of plants. Entire fields are affected, and the damage is usually seen after rainy periods. Premature defoliation caused by the fungus girdling and killing the petioles may cause economic losses. Affected plants and the entire field may senesce prematurely, and seed size and number can be reduced.

Plants are susceptible to anthracnose infection in all stages of development, particularly from bloom to podfill. Warm, moist weather favors stem and pod infections. Spores of this fungus cannot survive drying. Five hours of air-drying can reduce spore viability by 98 percent.

Control of anthracnose infections usually is needed only in seed-production fields. Spraying with commercial fungicides is helpful in reducing losses; but, at this time of year and with the limited extent of damage, I do not believe this will be economical in a grain-production field. Although the disease may appear to be quite extensive, a close examination of plants should show that only a small portion of the upper areas is affected and the rest of the plant should be fully productive.

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CROP DEVELOPMENT

Corn Moving Through Grainfill

Rainfall over much of the state in mid-August halted the deterioration in the Illinois corn crop, but the rains came too late to prevent substantial damage in many fields. Dry weather during the pollination period caused problems ranging from minor losses in kernel number to near-complete lack of kernels. The most severe losses in kernel number mostly occurred in fields that experienced problems such as insect damage in addition to lack of soil water.

Where kernels formed on the ears can provide clues to what caused kernel loss. If ears have a normal number of kernel rows (16 to 20), but rows are less than 30 to 35 kernels long, then it is likely that the later-emerging silks, which are those from kernels near the tip of the ear, may have failed to emerge, or may have emerged after pollen had all been shed. In other cases, substantial kernel abortion may have occurred due to continued dry weather after pollination. Such abortion shows up as “empty” kernels visible after abortion has occurred. Some kernel abortion usually occurs, but this year close to half of the kernels aborted in some fields.

Scattered kernels on the ear usually mean that insects actively fed on silks during pollination; or, in rare cases, the hybrid may have shed very little pollen due to high temperatures or dryness, or to genetic factors. If kernels are missing at the base of the ear, very dry weather early in the pollination process may have resulted in silks’ being “nonreceptive,” often as a result of waxy coating or other structural or physiological factors that make it difficult for pollen grains to adhere to the silk or germinate once they land on the silk.

What effect will a return to better soil moisture conditions have on the corn crop? That depends mainly on how many kernels have been set. If kernel number is low—fewer than 500 kernels per ear—then these kernels may well fill out to their maximum size, and yields could be limited by kernel number. What determines maximum kernel size is not very clear, but it is likely that conditions at or soon after pollination can affect the number of cells in the endosperm of the kernels and may limit the size of the cells as well. With normal kernel numbers—700 or so kernels per ear—such limitations may not mean much because yields are usually limited by the amount of photosynthesis during grainfill, and kernels do not reach their maximum size. When filling conditions are excellent, as they were in 1994 and 1996, kernel size increases more than normal, and high yields come from extra-large kernels.

Even with extra-large kernels in fields where kernel numbers are low, very high yields will probably not be possible this year. In fields with normal kernel numbers, very good yields are possible but will require that the canopy remain intact and active through mid-September. Relatively mild weather with a lot of sunshine and relatively infrequent rainfall will most favor high yields in these fields.

While some may be waiting until harvest to see how much their yield potential was affected by weather, others are interested in assessing the potential now. To do this, count the number of ears in 1/1,000th of an acre (17’5" in 30" rows), then take kernel counts on three ears in this row sample. Take the average number of kernels per ear, and multiply this number by the number of ears in the sample to get kernel number per 1/1,000th of an acre. Divide this figure by 90 to estimate bushels per acre. This assumes 90,000 kernels per bushel (zeroes dropped due to the count’s being made on 0.001 acre). A major inaccuracy in this method comes from our inability to know what kernel size will be—size varies from less than 70,000 to more than 100,000 per bushel. Adjustments can be made in this factor—lower it for large kernels and increase it for small kernels—if you think that kernels will be other than normal in size.

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