Pest & Crop

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July 18, 2003 - No. 18

In This Issue

Insects, Mites, and Nematodes

Japanese Beetle Treatment Guidelines - (*John Obermeyer and Larry Bledsoe*) -

- Beetle damage usually looks worse than it is
- Corn and soybean damage particulars and treatment guidelines are given
- Controlling adults to prevent grub damage is impractical
- Don't use "bag-a-bug" type traps

As previously reported, Japanese beetle are emerging and being seen throughout the state. Adults will continue to emerge from the soil for several weeks, causing concern to producers and homeowners alike. The one important thing to remember when it comes to Japanese beetles – their presence and damage usually looks worse than it is.

Eye catching damage to corn silks

Field Corn: Japanese beetle feed on corn leaves, tassels, and silks. Generally leaf and tassel feeding can be ignored. If beetles are present and feeding on corn silks, an insecticide should be applied only if on average the silks are being cut off to less than 1/2 inch before 50% pollination has taken place. This rarely happens on a field-wide basis. Don't be overly excited by this pest's tendency to clump on a few ears within an area and eat the silks down to the husks. With sufficient soil moisture, silks will grow from 1/2 to 1 inch per day during the one to two weeks of pollen shed. Silks only need to be peeking out of the husk to receive pollen. Besides, beetles

Early pollen shed

Late pollen shed

are often attracted to silks that have already completed the fertilization process even though they are still somewhat yellow. Check for pollen shed and silk feeding in several areas of the field, Japanese beetles tend to be present only in the outer rows of the field. Don't be influenced by what you think you may see from windshield surveys! Get out into fields to determine beetle activity.

Soybean: Soybean plants have the amazing ability to withstand considerable damage (defoliation) before yield is impacted. The impact of defoliation is greatest during flowering and pod fill because of the importance of leaf area to photosynthesis, and ultimately to yield. Therefore, nearly 50% soybean defoliation before bloom or 25% defoliation from bloom to pod fill can be tolerated before yields are economically affected. This defoliation must occur for the whole plant, not just the upper canopy. The beetles often congregate in areas of a field where they are first attracted to weeds such as smartweed. Typically if economic damage occurs, it is only in these areas. Therefore, spot treatments should be considered. Don't be overly alarmed by these bright, iridescent beetles that feed on the top canopy of the soybean plants. Consider that as they feed their defoliation allows for better sunlight penetration into the lower plant canopy!

Numerous beetles and soybean defoliation

Grubs: Japanese beetle develop from grubs that fed on organic matter and/or the roots of plants last fall and this spring. Therefore it seems logical that killing adult beetles this year should prevent grub damage in 2004. However it simply doesn't work that way. Researchers' attempts to draw in beetles to encourage them to lay eggs for subsequent grub damage in research plots have generally failed. Entomologists for years have been trying to understand this fickeled creature. Basically, the adults feed, mate, and lay eggs when and where they want to. The grubs are just as unpredictable. Research attempts to correlate grub presence to crop damage have usually shown insignificant differences. Damage does occur, but we are just not usually able to predict when or assess how much. Consider that each beetle mates and lays eggs several times during its oviposition period. To prevent egg laying in a field, one would need to treat multiple times during July and August.

Some producers have purchased Japanese beetle traps and have placed them where beetles have congregated. The "bag-a-bug" type trap can utilize both a pheromone and a floral scent to attract both sexes of the beetle. However, these traps are NOT recommended for beetle management because they attract more beetles than they control, resulting in localized plant damage.

Should controls be needed, refer to publications E-219-W, *Corn Insect Control Recommendations – 2003*, or E-77, *Soybean Insect Control Recommendations – 2003* for labeled products. These and other field crop related publications can be viewed electronically at <http://www.entm.purdue.edu/entomology/ext/targets/e-series/fieldcro.htm>. A Flash animation of the Japanese beetle life cycle can be viewed at <http://www.entm.purdue.edu/entomology/ext/fieldcropsipm/animation.htm>.

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Be Alert for Fall Armyworm Damage - (*John Obermeyer and Larry Bledsoe*) -

- Whorl damage in corn could be fall armyworm
- Description of fall armyworm is given
- When necessary, spot treat with a high clearance rig using ample water
- Control decisions discussed below

The variability in corn maturities and heights this season "sets the stage" for fall armyworm infestations. So far we have not received reports of larval damage and black light trap captures have been nonexistent of arriving moths. Consider this more of a head's up to pest managers that will be visiting corn for the remainder of the summer.

Late planted corn is attractive to fall armyworm moths that should start arriving in the state. Arriving moths from southern states will find ample whorl stage corn in which to lay their eggs. Initially, small larvae feed on the leaf surface, causing a "windowpane" effect. Whorl feeding by larger larvae appears as ragged-edged holes with excessive frass (worm poop) being quite evident. Feeding on cornhusks and kernels may also occur later in the season. If whorl damage is noted, sample by examining 20 consecutive plants in at least 5 areas of the field. Count and record the number of plants showing damage in each area. Determine the percentage of fall armyworm-damaged plants for the field. Also, be sure to note whether the fall armyworm larvae are still present and feeding. It may be necessary to pull some whorls and unroll the leaves to find the larvae. Estimate the size (length) of several of the worms.

The head of the fall armyworm is gray, yellow, or brown, with a predominant white, inverted Y-shaped suture on the front. This feature distinguishes the fall armyworm from the similar-appearing true armyworm, whose head is pale gray or greenish-brown in color and covered with a network of dark lines. Once worms are over 1-1/2 inch in length they are soon to complete their larval stage and feeding is nearing completion. Also, one should look for parasitized larvae having elongated white balls (eggs of a parasitic fly) usually near the back of the worm's head. Parasitized larva will reduce feeding and eventually be killed.

Fall armyworm in ear tip, note inverted Y-shaped suture of front of head

Whorl stage corn damaged by fall armyworm

In damaged cornfields where the yield is expected to be at least 60% of the normal yield, an insecticide may be necessary if 75% of the plants exhibit feeding damage and the larvae are less than 1-1/4 inch in length. If applying an insecticide, be sure to apply the insecticide in sufficient water to reach the target area. Fall armyworm will often form a "plug" with their frass in the whorl, making it difficult for insecticide penetration. Ground sprays directed over the row are generally more effective than broadcast sprays. Aerial applications are not recommended. Treatments to control fall armyworm in ear tips are not effective. Because fall armyworm damage is often spotty in fields, consider treating these areas with ground driven high-boys. For insecticides see Extension Publication E-219-W, *Corn Insect Control Recommendations – 2003*, which can be viewed electronically at <http://www.entm.purdue.edu/entomology/ext/targets/e-series/fieldcro.htm>.

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Black Light Trap Catch Report
(Ron Blackwell)

County/Cooperator	7/1/03 - 7/7/03							7/8/03 - 7/14/03						
	VC	BCW	ECB	SWCB	CEW	FAW	AW	VC	BCW	ECB	SWCB	CEW	FAW	AW
Dubois/SIPAC	0	0	0	0	0	0	6	1	1	0	0	0	0	4
Jennings/SEPAC	0	0	0	0	0	0	5	1	2	0	0	0	0	13
Knox/SWPAC	1	0	2	0	0	0	3	0	0	2	0	1	0	1
LaPorte/Pinney Ag Center	3	1	18	0	0	0	10	12	2	0	0	0	0	25
Lawrence/Feldun Ag Center	1	0	0	0	0	0	3	0	0	0	0	0	0	2
Randolph/Davis Ag Center	5	2	0	0	0	0	5							
Tippecanoe/Throckmorton Ag Center	1	0	0	0	0	0	0	3	7	0	0	0	0	11
Whitley/NEPAC	0	1	7	0	0	0	16	40	12	0	0	0	0	47

BCW = Black Cutworm ECB = European Corn Borer SWCB = Southwestern Corn Borer CEW = Corn Earworm
AW = Armyworm FAW = Fall Armyworm VC = Variegated Cutworm

Agronomy Tips

Sex in the Corn Field:Tassel Emergence & Pollen Shed - (*Bob Nielsen*) –

- Corn produces both male and female flowers on the same plant.
- The tassel contains the male flowers of the corn plant.

Slowly and surely, the Indiana corn crop is moving into the critical flowering stages of pollen shed and silk emergence. While some early planted corn is already pollinating (13% as of 16 July according to USDA-NASS), much of the state's crop will pollinate during the next three weeks. Success or failure during this period of the corn plant's life will greatly influence the potential yield at harvest time.

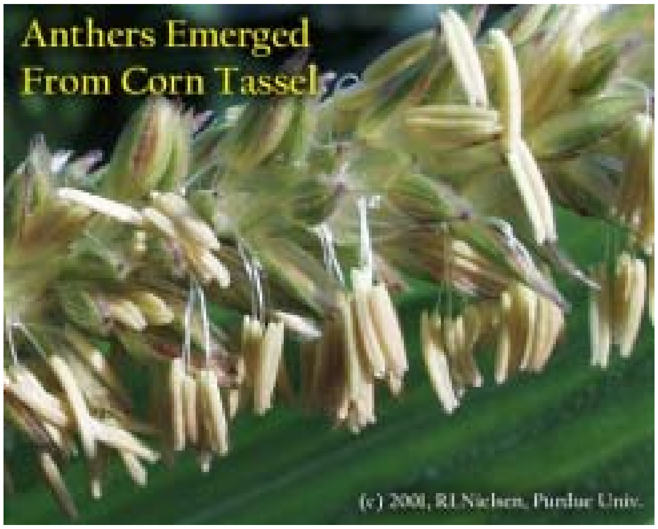
As important as this process is to the determination of grain yield, it is surprising how little some folks know about the whole thing. Rather than leaving you to learn about such things "in the streets", I've developed this article and the accompanying one on silking that describe the ins and outs of sex in the corn field.

Remember that corn has both male flowers and female flowers on the same plant (a flowering habit called monoecious for you trivia fans.) Interestingly, both flowers are initially bisexual (aka 'perfect'), but during the course of development the female components (gynoecia) of the male flowers and the male components (stamens) of the female flowers abort, resulting in tassel (male) and ear (female) development.

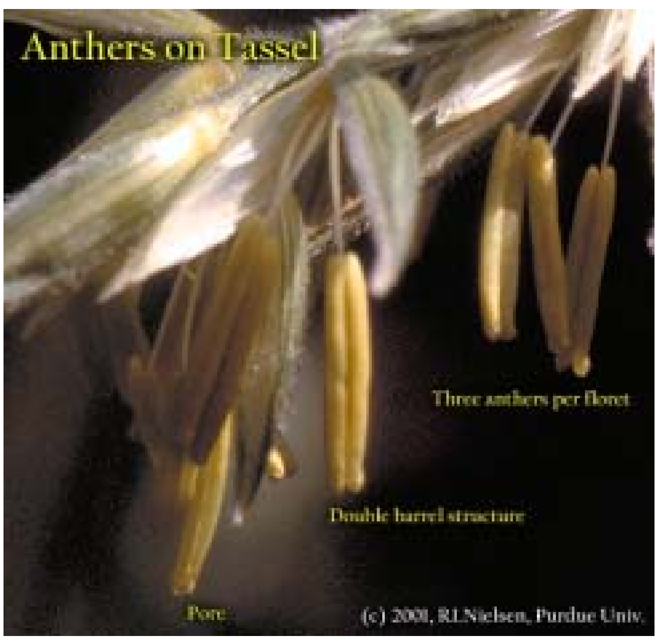
Technically, growth stage VT occurs when the last branch of the tassel emerges from the whorl (Ritchie et. al., 1993). Portions of the tassel may be visible before the maximum leaf stage (final visible leaf collar) has occurred. Plant height is nearly at its maximum at growth stage VT. Pollen shed may begin before the tassel has completely emerged from the whorl.

The corn plant is most vulnerable to hail damage at growth stage VT since all of its leaves have emerged. Complete (100%) leaf loss at growth stage VT will usually result in complete (100%) yield loss by harvest. Even if pollination is successful, the ear shoots will usually die because few leaves remain to produce the necessary carbohydrates (by photosynthesis) to complete grain fill.

Between 500 to 1000 spikelets form on each tassel. Each spikelet contains two florets. Each floret contains three anthers.

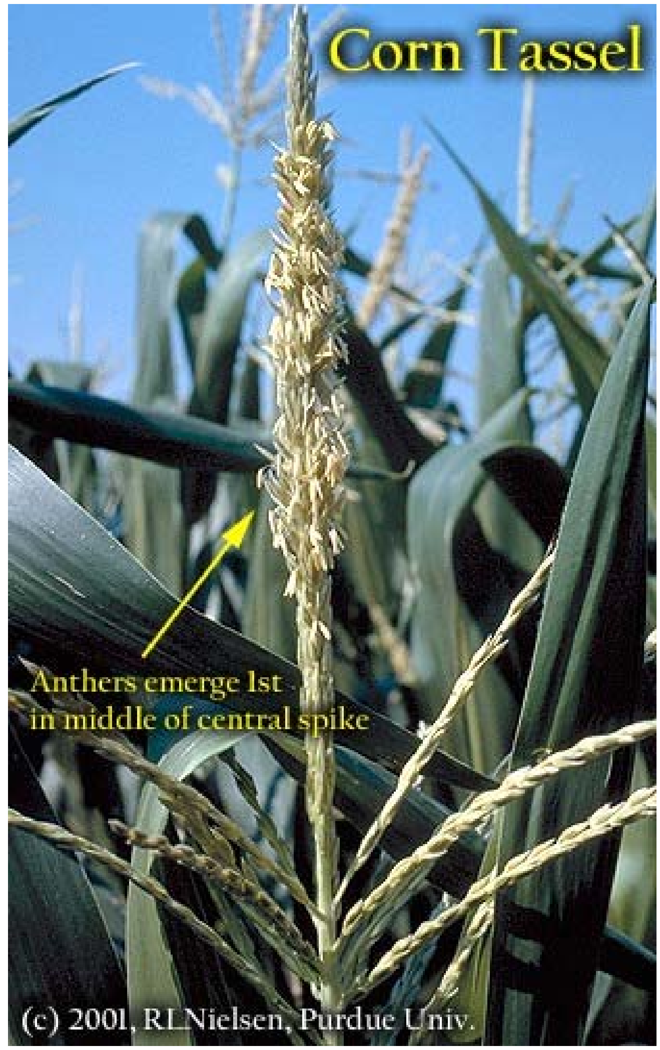


The anthers are those 'thingamajigs' that hang from the tassel during pollination. Under a magnifying lens, anthers look somewhat like the double barrel of a shotgun.



As these florets mature, anthers emerge from the glumes and pollen is dispersed through pores that open at the tips of the anthers. Pollen shed usually begins in the mid-portion of the central tassel spike and then progresses upward, downward and outward over time. Anthers typically emerge from the upper flower first, while those from lower flower typically emerge later the same day or on following days. Spent anthers eventually drop from the tassel and are sometimes mistaken for the pollen itself when observed on the leaves or ground.

The yellow 'dust-like' pollen that falls from a tassel represents millions of individual, nearly microscopic, spherical, yellowish- or whitish translucent pollen grains. Each pollen grain contains the male genetic material necessary for fertilizing the ovary of one potential kernel.



The outer membrane of a pollen grain is very thin. Once dispersed into the atmosphere, pollen grains remain viable for only a few minutes before they desiccate. Yet, with only a 15 mph wind, pollen grains can travel as far as 1/2 mile within those couple of minutes.

Therein lies the concern of the potential for pollen 'drift' from a transgenic corn field to an adjacent non-transgenic corn field and the risk of transgenic 'contamination' of grain intended for non-transgenic sale. The good news is that recent research suggests that the overwhelming majority of a corn field's pollen load is shed in the field itself.

All of the pollen from a single anther may be released in as little as three minutes. All the anthers on an individual tassel may take as long as seven days to finish shedding pollen, although the greatest volume of pollen is typically shed during the second and third day of anther emergence. Because of natural field variability in plant development, a whole field may take as long as 14 days to complete pollen shed.

Peak pollen shed usually occurs in mid-morning. Some research indicates that pollen shed decreases after temperatures surpass 86°F. A second 'flush' of pollen often occurs in late afternoon or evening as temperatures cool. Pollen shed may occur throughout most of the day under relatively cool, cloudy conditions.

Weather conditions influence pollen shed

If the anthers are wet, the pores will not open and pollen will not be released. Thus, on an average Indiana summer morning following a heavy evening dew, pollen shed will not begin until the dew dries and the anther pores open. Similarly, pollen is not shed during rainy conditions. Cool, humid temperatures delay pollen shed, while hot, dry conditions hasten pollen shed.

Extreme heat stress (100°F or greater) can kill corn pollen, but fortunately the plant avoids significant pollen loss by virtue of two developmental characteristics. First of all, corn pollen does not mature or shed all at once. Pollen maturity and shed occur over several days and up to two weeks. Therefore, a day or two of extreme heat usually does not affect the entire pollen supply. More importantly, the majority of daily pollen shed occurs in the morning hours when air temperature is much more moderate.

Some Related References:

Ritchie, S.W., J.J. Hanway, and G.O. Benson. 1993. How a Corn Plant Develops. Iowa State Univ. Sp. Rpt. No. 48. On the Web at <http://maize.agron.iastate.edu/corngrows.html> (last verified 7/16/03).

Russell, W.A. and A.R. Hallauer. 1980. Corn. (a chapter in) Hybridization of Crop Plants. American Soc. of Agronomy-Crop Science Soc. of America. Madison, WI..

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Sex in the Corn Field: Silk Emergence - (*Bob Nielsen*)

- Corn produces both male and female flowers on the same plant.
- The ear contains the female flowers of the corn plant.
- Severe soil moisture deficits can delay silk emergence and disrupt the synchrony of pollen shed and silk availability, resulting in poor kernel set.

As important as the process of pollination is to the determination of grain yield in corn, it is surprising how little some folks know about the details of sex in the corn field. Rather than leaving you to learn about such things "in the streets", I've developed this article and the accompanying one on tassels and anthers that describe the ins and outs of this critical period of the corn plant's life cycle.

Remember that corn has both male flowers and female flowers on the same plant (a flowering habit called monoecious for you trivia fans.) Interestingly, both flowers are initially bisexual (aka 'perfect'), but during the course of development the female components (gynoecia) of the male flowers and the male components (stamens) of the female flowers abort, resulting in tassel (male) and ear (female) development.

The silks that emerge from the ear shoot are the functional stigmas of the female flowers of a corn plant. Every potential kernel (ovule) on an ear develops its own silk. Each silk must be pollinated in order for the ovule to be fertilized and develop into a kernel. Typically, up to 1000 ovules form per ear, even though we typically harvest only 400 to 600 actual kernels per ear.

Technically, growth stage R1 (Ritchie et. al., 1993) for a given ear is defined when even a single silk strand is visible from the tip of the husk. A field is defined as being at growth stage R1 when silks have emerged on at least 50% of the plants.

Silk Elongation and Emergence

Silks begin to elongate from the ovules about 10 days prior to silk emergence from the husk. Dissection of young developing ears prior to silk emergence from the husk will reveal silk elongation beginning first from the basal ovules of the cob, then proceeding up the ear over time.

In a similar acropetal fashion, silks from the basal (butt) portion of the ear typically emerge first from the husk, while the tip silks generally emerge last. Complete silk emergence from an ear generally occurs within four to eight days after the first silks appear.

As silks first emerge from husk, they lengthen as much as 1-1/2 inches per day for the first day or two, but gradually slow over the next several days. Silk elongation occurs by expansion of existing cells, so elongation rate slows as more and more cells reach maximum size.

Silk elongation stops about 10 days after silk emergence, regardless of whether pollination occurs, due to senescence of the silk tissue. Unusually long silks can be a diagnostic symptom that the ear was not successfully pollinated.

Silks remain receptive to pollen grain germination up to 10 days after silk emergence. After 10 days without being pollinated, silk receptivity decreases rapidly. Natural senescence of silk over time results in collapsed tissue that restricts continued growth of the pollen tube. Silk emergence usually occurs in close synchrony with pollen shed, so that duration of silk receptivity is normally not a concern. Failure of silks to emerge in the first place, however, does not bode well for successful pollination.

Pollination and Fertilization

For those of you serious about semantics, let's review two definitions relevant to sex in the corn field. Pollination is the act of transferring the pollen grains to the silks by wind or insects. Fertilization is the union of the male gametes from the pollen with the female gametes from the ovary. Technically, pollination usually occurs successfully (i.e., the pollen reaches the silks), but unsuccessful fertilization results in poor kernel set on the ears.

Pollen grain germination occurs within minutes after a pollen grain lands on a receptive (moist) silk. A pollen tube, containing the male genetic material, develops and grows inside the silk, and fertilizes the ovary within 24 hours. Pollen grains can land and germinate anywhere along the length of an exposed silk. Many pollen grains can germinate on a receptive silk, but typically only one will successfully fertilize the ovary.

Silk Emergence Failure

Severe Drought Stress. The most common cause of incomplete silk emergence is severe drought stress. Silks have the greatest water content of any corn plant tissue and thus are most sensitive to moisture levels in the plant. Severe moisture deficits will slow silk elongation, causing a delay or failure of silks to emerge from the ear shoot. If the delay is long enough, pollen shed may be almost or completely finished before receptive silks are available; resulting in nearly blank or totally blank cobs. Severe drought stress accompanied by low relative humidity can also desiccate exposed silks and render them unviable to pollen germination.

The severity of drought stress required for significant silk emergence delay or desiccation can probably be characterized by severe leaf rolling that begins early in the morning and continues into the early evening hours.

Such severe leaf rolling is often accompanied by a change in leaf color from "healthy" green to a grayish-tinged green that may eventually die and bleach to a straw color.

Silk Clipping by Insects. Although technically not defined as silk emergence failure, severe silk clipping by insects such as corn rootworm beetle or Japanese beetle nonetheless can interfere with the success of pollination by decreasing or eliminating viable or receptive exposed silk tissue. Fortunately, unless the beetle activity is nonstop for days, continued elongation of silks from the husk will expose undamaged and receptive silk tissue at the rate of about one inch or more per day.

Some Related References:

Ritchie, S.W., J.J. Hanway, and G.O. Benson. 1993. How a Corn Plant Develops. Iowa State Univ. Sp. Rpt. No. 48. On the Web at <http://maize.agron.iastate.edu/corngrows.html> (last verified 7/16/03).

Russell, W.A. and A.R. Hallauer. 1980. Corn. (a chapter in) Hybridization of Crop Plants. American Soc. of Agronomy-Crop Science Soc. of America. Madison, WI.

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A Fast & Accurate Pregnancy Test for Corn - (*Bob Nielsen*) -

- Silk clipping can interfere with pollination success.
- Silks normally detach from fertilized ovules within days of successful pollination and thus can be used as an early indicator of pollination progress and/or success.

As corn rootworm beetles, Japanese beetles, and other obnoxious critters feast on corn pollen, they often unintentionally clip ear silks to an extent that pollen capture may be impeded. While you may be tempted to

apply insecticides at the first sign of these insects, Purdue entomologists tell us that treatment is not necessary unless the silks are being continuously clipped back to less than 1/2 inch long before pollination is 50 percent complete. Silk length is easy to measure, but how do you determine how the progress of pollination?

Within 10 to 14 days after silking, you can easily estimate the success of pollination by inspecting ears for kernel blister development. At that point in time, the developing kernels will resemble white blisters on the cob. But by then, the insect damage has already occurred. Luckily for us, the corn plant has a quicker mechanism for indicating the current progress of pollination.

Silk Detachment From Fertilized Ovules

Remember that each potential kernel (called an ovule) on the ear develops its own silk that elongates and eventually emerges from the tip of the ear shoot. The silks provide the pathway for the pollen to access the ovules.

Once a single pollen grain is "captured" by a silk, the pollen grain germinates and develops a pollen tube that contains the male genetic material. Given adequate moisture and temperature, the pollen tube grows down the length of the silk within 24 hours and fertilizes the ovule.

Within 2 to 3 days after an ovule has been successfully fertilized, the base of the silk will collapse and detach from the immature kernel. The kernel itself will usually not be recognizable to the naked eye at this stage.

Silks of unfertilized ovules remain attached, however, and will continue to lengthen and be receptive to pollen for up to 10 days after emergence from the ear shoot. Even if never fertilized, silks will remain attached to the ovules. Within days of full silk emergence, therefore, pollination progress may be estimated on individual ears by estimating percent silk detachment.

The Ear Shake Technique

For each ear, make a single lengthwise cut from the base of the ear shoot to the tip with a sharp knife, through the husk leaves to the cob. Slowly unwrap the husk leaves, taking care not to rip any silks from the ovules yourself. Then gently shake the ear. Silks of fertilized ovules will drop away, silks from unfertilized ovules will remain attached.

With practice, pollination progress can be easily determined by estimating the percentage of silks that fall away from the cob. Sampling several ears at random throughout a field will provide an indication of the progress of pollination for the whole field.

One Last Comment

While the 'ear shake' technique will tell you how much of the ear has been fertilized, remember that pollination progress is also determined by pollen shed duration. Check the tassels in early to mid-morning hours to determine whether pollen shed is still occurring. If pollen shed is finished, it doesn't matter how badly those nasty insects are clipping silks. Unfertilized ovules will remain unfertilized ovules if there is no pollen left in the field. Spraying the bejeebers out of a field at that point is simply a costly form of revenge!

Don't forget, this and other timely information about corn can be viewed at the Chat 'n Chew CafÈ on the World Wide Web at <http://www.kingcorn.org/cafe>. For other information about corn, take a look at the Corn Growers' Guidebook on the World Wide Web at <http://www.kingcorn.org>.

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Recovery and Yield Potential of Root Lodged Corn

- (*Peter Thomison, from the Ohio C.O.R.N. newsletter*) -

Strong winds and heavy rains associated with severe thunderstorms can lodge or knock corn plants over, especially if the nodal root system is not fully developed. Cool wet soil conditions in May and June may have inhibited good nodal root formation and predisposed plants to such wind injury. Strong winds can pull corn roots part way out of the soil; a condition referred to as root lodging. The problem is more pronounced when soils are saturated by heavy rains accompanying winds. If root lodging occurs before mid-grain fill, plants usually recover at least partly by "kneeing up." This results in the characteristic gooseneck bend in the lower stalk with brace roots providing above ground support. If this stalk bending takes place before pollination, there may be little effect on yield. When lodging occurs later in the season some yield decrease due to partial loss of root activity and reduced light interception may occur. If root lodging occurs shortly before or during pollen shed and pollination, it may interfere with effective fertilization thereby reducing kernel set. Hybrids differ in their ability to resist root lodging.

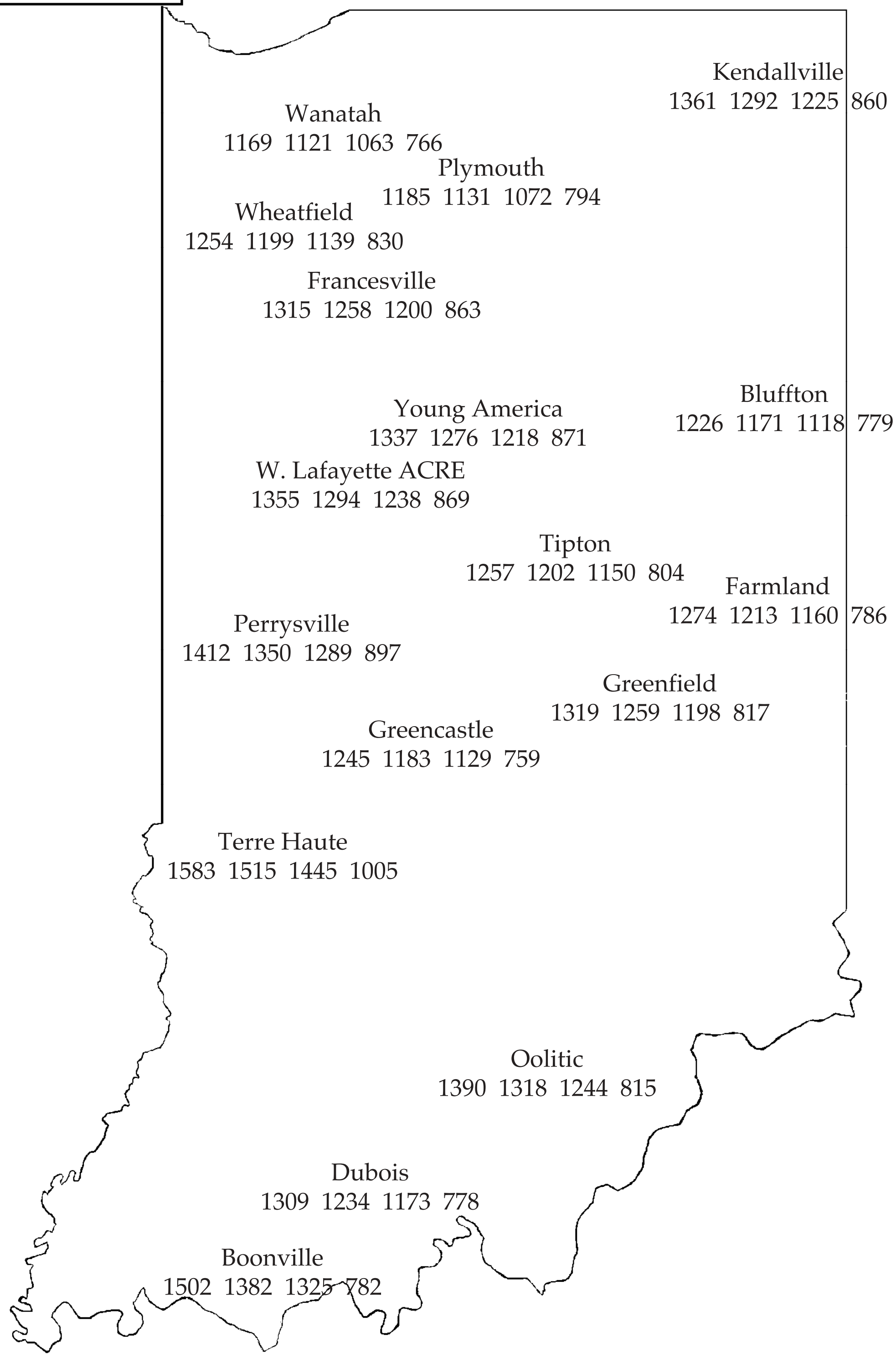
In a University of Wisconsin study, root lodging was simulated by saturating soil with water and manually pushing corn plants over at the base, perpendicular to row direction. Wind damage was simulated at various vegetative stages through silking (V10 to R1). Compared to hand harvested grain yields of control plants, grain yield decreased by 2 to 6%, 5 to 15% and 13 to 31% when the lodging occurred at early (V10-V12), medium (V13-V15) and late (V17-R1) stages.

Weather Update

Temperatures as of July 16, 2003

GDD(9) = Growing Degree Days from April 16 (9% of Indiana's corn planted), for corn growth and development
GDD(26) = Growing Degree Days from April 25 (26% of Indiana's corn planted), for corn growth and development
GDD(50) = Growing Degree Days from April 30 (50% of Indiana's corn planted), for corn growth and development
GDD(85) = Growing Degree Days from June 4 (85% of Indiana's corn planted), for corn growth and development

MAP KEY
Location
GDD(9) GDD(26) GDD(50) GDD(85)



4" Bare Soil Temperatures 7/16/03

Location	Max.	Min.
Wanatah	84	67
Columbia City	74	65
Winamac	75	70
W Laf Agro	78	70
Tipton	78	72
Perrysville	75	72
Terre Haute	77	71
Vincennes	75	69
Oolitic	76	70