Pest & Crop

http://www.entm.purdue.edu/Entomology/ext/targets/newslett.htm

May 21, 2004 - No. 10

In This Issue

Insects, Mites, and Nematodes

Critters Near Damaged Seedlings - (*John Obermeyer and Larry Bledsoe*)

- Several bug-like creatures often found while digging in the soil, most are non-economic.
- Pest managers need to keep an open mind when diagnosing field problems.

Several times this week we've examined e-mailed electronic pictures and samples brought to us of corn seedlings that have been in poor health. In each case the agronomists diagnosing the problem field have dug extensively for soil insects because of discolored or damaged mesocotyls and root systems and found very few pests. Upon very close inspection of damaged areas, they've noticed small, translucent, wiggling, critters "causing" the problem. What are they? These stories are true, the names have been omitted to protect the innocent.

Small worms are often falsely accused of feeding on plant tissue

Juvenile ("baby") earthworms and potworms are closely related and common animals found in soils. They are small, often less than 1/4 inch long, and colorless annelids (taxonomic Phylum containing segmented worms). As you would expect, these worms feed on damaged and decaying plant remains, not live tissue. Therefore they are closely associated with the decaying plant parts and surrounding soil and often wrongly accused of damaging seedlings. Pest managers should keep an open mind when diagnosing field problems. As

one submitter confessed, he was so convinced that it was an insect problem and therefore looked for anything moving when he couldn't find grubs or wireworms. After reviewing the facts, very early planted in a wet, low area of the field, he was able to conclude that seedling blights were likely the problem.

Other critters that get falsely accused of causing damage are the millipedes. Millipedes are wireworm-like arthropods (belongs to the Phylum Arthropoda-means "jointed foot"), having two pair of legs per body segment that move quickly above and below the ground. They have become more prevalent with the advent of no-till. When found, their numbers are often high. Millipedes typically feed as scavengers, feeding on dead or decaying materials. Rarely they have been documented as a pest of corn. If very dry conditions exist early in the season, millipedes will feed on corn seedlings, apparently seeking moisture.

Millipedes are sometimes confused with wireworms

There is no comprehensive picture journal to reference these "bugs," although the *Field Crops Pest Management Manual* (IPM-1) covers many of them, see:<www.entm.purdue.edu/entomology/ext/fieldcropsipm/b/ONECP.HTM>. The difficulty is that there are many animal species that may utilize the soil of a cornfield for all or a short period of their life. Most, having nothing to do with the corn being grown.

• • P&C • •

Soybean Aphid Update – (*John Obermeyer and Larry Bledsoe*)

Dave Voegtlin, Illinois Natural History Survey, and Bob O'Neil, Purdue University entomologist, spent two days traveling northern and eastern Indiana for soybean aphid and its overwintering host buckthorn (*Rhamnus* spp.). Except for some previously known plants in northwestern counties, they were mostly unsuccessful in finding buckthorn, especially in eastern counties. In what few plants they were able to find, they did not locate a single aphid (eggs should have begun hatching in late March/early April).

This strengthens our thought that the 2003 overwintering soybean aphid is probably not a factor in our 2004 summer population. Therefore, our risk to soybean aphid is dependent on their movement from areas of high infestation (e.g., Minnesota) and colonizing our soybean at a vulnerable growth stage (i.e., early reproductive). We will continue to monitor the soybean aphid situation and share this in future issues of the *Pest&Crop*.

• • P&C • •

European Corn Borer Moths Flying – (*John Obermeyer and Larry Bledsoe*) –

The first ECB moths were captured in the Dubois County black light trap this past week, refer to "Black Light Trap Catch Report." It is too early to draw any conclusions from this first occurrence for the season. Soon it will be time to inspect the tallest corn in the area for corn borer eggs and moth activity in grassy areas surrounding these fields. More on this pest in future issues of the *Pest&Crop*.

Black Cutworm Adult Pheromone Trap Report
Week 1 = /6/04 - 5/12/04 Week 2 = 5/13/04 - 5/19/04

County	Cooperator	BCW Trapped		County	Cooperator	BCW Trapped	
		Wk 1	Wk 2			Wk 1	Wk 2
Adams	Roe/Price Ag Services	3	4	Marshall	Shanks/Plymouth Pioneer (2)	12	-
Allen	Gynn/South Wind Farm	4	2	Marshall	Shanks/Plymouth Pioneer (3)	3	-
Benton	Babcock/Jasper Co. Co-op	1	1	Newton	Babcock/Jasper Co. Co-op	0	0
Clay	Smith/Growers Co-op (Brazil)	2	0	Putnam	Nicholson Consulting	18*	-
Clay	Smith/Growers Co-op (Clay City)	0	4	Randolph	Boyer/Davis-Purdue Ag Center	0	1
Elkhart	Kauffman/Crop Tech Inc.	9*	8	Raldolph	Derek Calhoun	-	9
Fayette	Schelle/Spring Valley Farms	0	-	Rush	Tacheny/Pioneer Hi-Bred	23*	-
Fountain	Hutson/Purdue CES	2	-	Shelby	Gabbard/Shelby Co. CES	2	4
Fountain	Mroczkiewicz/Syngenta	1	-	Sullivan	Smith/Growers Co-op (New Lebanon)	0	0
Gibson	Hirsch Farms	-	-	Sullivan	Smith/Growers Co-op (Sullivan E)	2	0
Greene	Maruszewski/Worthington Pioneer	3	3	Sullivan	Smith/Growers Co-op (Sullivan W)	2	0
Johnson	Kessler/Ag Excel	4	-	Tippecanoe	Obermeyer/Purdue CES	15*	3
Knox	Smith/Growers Co-op (Fritchton)	0	0	Tipton	Johnson/Pioneer	0	-
Knox	Smith/Growers Co-op (Oaktown)	3	0	Vermillion	Hutson/Purdue CES	3	0
Lake	Kliene Farms (1)	7	-	Vigo	Smith/Growers Co-op (Terre Haute)	2	0
Lake	Kliene Farms (2)	5	-	Warren	Babcock/Jasper Co. Co-op	0	0
Marshall	Barry/Fulton-Marshall Co-op	4	7	White	Reynolds/Vogel Popcorn	-	-
Marshall	Shanks/Plymouth Pioneer (1)	5	-	Whitley	Walker/NE-Purdue Ag Center	0	5

* = Intensive Capture... an intensive capture occurs when 9 or more moths are caught over a 2-night period.

• • P&C • •

Black Light Trap Catch Report - (John Obermeyer)

County/Cooperator	5/4/04 - 5/10/04							5/11/04 - 5/17/04						
	VC	BCW	ECB	SWCB	CEW	FAW	AW	VC	BCW	ECB	SWCB	CEW	FAW	AW
Dubois/SIPAC		1					13			2				4
Jennings/SEPAC														
Knox/SWPAC	1	1					5	1	2					11
LaPorte/Pinney Ag Center		1					15	1	1					60
Lawrence/Feldun Ag Center									1	1				3
Randolph/Davis Ag Center							2		1					1
Tippecanoe/TPAC Ag Center							13							
Vermillion/Hutson							3	2						
Whitley/NEPAC	4	2					499	1	2					149

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

Postemergence Grass Control in Corn – (*Bill Johnson, Glenn Nice, and Tom Bauman*)

With the recent wet, rainy weather and warm air temperatures, corn is progressing rapidly through it's early growth stages. In fact it is growing so rapidly that it may grow past the latest growth stage allowed by several postemergence herbicides quicker than we realize.

Although several of the postemergence grass herbicides are effective on large weeds, an important point to keep in mind is that most of these herbicides should be applied before the grass weeds are 4 inches tall (except for shattercane and johnsongrass) to assure the most effective control and to minimize yield losses due to weed interference. If soil-applied herbicides are not adequately controlling grassy weeds or if one is utilizing postemergence strategies for grass control, several herbicides are available that are labeled for postemergence grass control in corn.

To avoid crop injury and yield loss, many of the herbicides that contain an ALS inhibitor (Accent, Basis, Basis Gold, Beacon, Celebrity Plus, Equip, Lightning, Northstar, Option, and Steadfast) should not be broadcast over the top of corn after it has 6 or 7 exposed leaf collars. This is the growth stage of corn when reproductive processes are initiated, and disruption of the physiology of corn at this stage can result in incomplete pollination, malformed ears (pinched ear syndrome) and yield losses. A short discussion of each herbicides growth stage restriction and weed size restriction follows.

Accent can be applied as a broadcast spray on corn that is up to 20 inches tall or has up to 6 exposed leaf collars, or it can be applied as a directed spray to corn that is 20 to 36 inches tall or exhibits 9 or fewer exposed leaf collars. Accent controls most annual grasses, except for crabgrass, and also controls johnsongrass and shattercane. The best results will be obtained when it is applied to foxtails, barnyardgrass, and fall panicum 2 to 4 inches tall; shattercane and seedling johnsongrass 4 to 12 inches tall; and rhizome johnsongrass 8 to 18 inches tall. Do not apply to popcorn or seed corn that has been treated with Counter insecticide.

Basis can be applied as a broadcast spray on corn in the spike through the 4-leaf or 2-exposed-collar growth stage. Do not apply to corn that has 3 fully exposed leaf collars or is more than 6 inches tall. Apply to foxtails and fall panicum up to 2 inches tall. Do not apply to seed corn, popcorn, or sweet corn.

Basis Gold can be applied as a broadcast spray on corn that is up to 12 inches tall or has 6 or fewer exposed leaf collars. These herbicides control most of the same grasses that are controlled by Accent alone, but the Accent rate is lower than typically used with Accent alone. Thus, it should be applied earlier to smaller grass weeds for effective control. Basis Gold has slightly more activity on smooth and large crabgrass than Accent because it contains atrazine. Apply to foxtails, barnyardgrass and fall panicum 3 inches tall or less; shattercane 6 inches tall or less; and seedling johnsongrass 8 inches tall or less. Additional Accent or Beacon can be added either as a tankmix or sequentially for additional activity on shattercane and johnsongrass.

Beacon can be applied as a broadcast spray to corn that is between 4 and 20 inches tall or has 2 to 6 exposed leaf collars, or up to tasseling if using drop nozzles. Applications to corn less than 4 inches tall can be injurious to the crop. Beacon provides control of johnsongrass and shattercane but is weaker than Accent, Option, and Steadfast on most annual grasses. Apply to shattercane or seedling johnsongrass 4 to 12 inches tall, and rhizome johnsongrass 8 to 16 inches tall.

Celebrity Plus can be applied as a broadcast spray on corn that is between 4 and 24 inches tall. Applications to corn less than 4 inches tall can be injurious to the crop. Since Celebrity contains Accent, it should be applied to foxtails, barnyardgrass, and fall panicum 2 to 4 inches tall; shattercane and seedling johnsongrass 4 to 12 inches tall; and rhizome johnsongrass 8 to 18 inches tall.

Equip can be applied as a broadcast spray on corn that has 1 to 4 exposed collars and up 12 inches tall. It can be applied as a directed spray on corn up to 36 inches tall or 8 exposed collars. Apply to foxtails, fall panicum up to three inches tall, barnyardgrass up to 4 inches tall, johnsongrass and shattercane up to 8 inches tall.

Liberty can be applied as a broadcast spray on Liberty Link corn that is up to 24 inches tall or has up to 7 exposed leaf collars, or it can be used as a directed spray on corn that is 24 to 36 inches tall. Liberty is very effective on large foxtails up to 10 inches tall, but it can be weak on barnyardgrass and yellow foxtail if they are more than 4 inches tall at application. Apply to shattercane and seedling johnsongrass that is 6 inches or less in height.

Liberty ATZ is a premix of Liberty and Atrazine. It can be applied to corn up to 12 inches tall.

Lightning can be applied as a broadcast spray on Clearfield corn that is up to 20 inches tall or has 2 to 6 exposed leaf collars or as a directed spray until 45 days before harvest. Lightning controls many of the same grasses as Accent. Apply Lightning to giant foxtail up to

6 inches tall; green and yellow foxtail and fall panicum up to 3 inches tall; and shattercane, seedling and rhizome johnsongrass up to 8 inches tall.

Northstar can be applied as a broadcast spray to corn that is between 4 and 20 inches tall or has 2 to 6 exposed leaf collars, or with drop nozzles to corn up to the tasseling stage. Applications to corn less than 4 inches tall can be injurious to the crop. Northstar contains Beacon which provides control of johnsongrass and shattercane but is weaker than Accent, Option, or Steadfast based herbicides on most annual grasses. Apply to shattercane or seedling johnsongrass 4 to 12 inches tall, and rhizome johnsongrass 8 to 16 inches tall.

Option can be applied as a broadcast spray to corn that is up to 16 inches tall or has 5 exposed leaf collars. It can be used as a directed spray with drop nozzles on corn that is 16 to 36 inches tall. Option is much like Accent and controls many of our common annual grasses plus johnsongrass and shattercane. The best results will be obtained when it is applied to foxtails, barnyardgrass, and fall panicum 2 to 4 inches tall, and shattercane and johnsongrass 12 to 16 inches tall.

Glyphosate (and other glyphosate formulations labeled for Roundup Ready corn) can be applied as a broadcast spray to Roundup Ready corn that is up to 30 inches tall or has 8 exposed leaf collars. Apply to foxtails up to 20 inches tall, and fall panicum, shattercane, and johnsongrass up to 18 inches tall.

Steadfast can be applied as a broadcast spray on corn that is up to 20 inches tall or has 6 exposed leaf collars. Steadfast controls many of the same grasses as Accent, but it also has some activity on crabgrass. Apply to foxtails, fall panicum, and barnyardgrass, up to 4 inches tall; johnsongrass, up to 8 inches tall; shattercane, up to 6 inches tall; and crabgrass, up to 1 inch tall. Do not apply to popcorn, seed corn, or sweet corn.

Steadfast ATZ is a premix of Steadfast and Atrazine and can be applied on corn up to 12 inches tall or 6 exposed leaf collars, whichever occurs first.

Other Considerations:

1) Check the label to determine if these products can be used on popcorn, seed corn, sweet corn. The information presented in this article is specific to use on field corn.

2) Be sure to use the appropriate adjuvant with these products, particularly when tankmixing with other products for broadleaf weed control. Certain adjuvant systems will increase the activity of these herbicides and the potential for crop injury. Occasionally, different adjuvant systems are required for grass: broadleaf tankmixes versus specific products used alone.

3) Check the label to determine if restrictions exist regarding the use of soil or postemergence insecticides with postemergence grass herbicides. Some insecticides slow the corn plants ability to metabolize (or detoxify) these herbicides and crop injury can result. You may not have planned to use a postemergence grass herbicide and use of certain herbicides may not be allowed after certain soil insecticides.

4) This is the time of the year when we will begin to see spray tank contamination problems. If glyphosate was used in the previous load, be sure to properly clean out the tank and empty the sumps. Corn that doesn't not contain the Roundup Ready gene is very sensitive to low rates of glyphosate and the resulting crop injury is sometimes confused with injury from ALS herbicides such as Accent, Option, Steadfast, etc.

5) There are a number of websites available to quickly obtain information from herbicide labels.

Looks like its gonna take awhile to decide which grass herbicide to recommend.

Agronomy Tips

Use Thermal Time to Predict Leaf Stage Development in Corn - *(Bob Nielsen)*

Being able to predict when a field of corn will reach particular leaf stages can be useful for scheduling post-emergence applications of certain herbicides and sidedress N fertilizer, especially if your farming operation is so large that regular field inspections are difficult to work into your busy schedule. Research by one of my former graduate students helps fine-tune our ability to predict the portion of corn phenology that we call leaf stage development.

Review of Concepts. For a refresher on how corn leaf staging is done, be sure to read my accompanying article "*Determining Corn Leaf Stages*" (Nielsen, 2004a). Another topic that probably needs reviewing is the concept of heat units (HUs) or growing degree days (GDDs). The concept is important because corn phenology is very dependent on temperature. Heat unit or GDD calculation for corn phenology is described in another accompanying article "*Heat Unit Concepts Related to Corn Development* (Nielsen, 2004b).

Predicting Corn Phenology. Given an understanding of corn leaf stage development and heat unit calculation, you can predict the leaf stage of development for a particular field given its planting date and temperatures since planting. It is useful if you know when the crop emerged, but if not you can estimate that event also. Corn emergence typically requires about 125 GDDs from planting.

We know that corn leaf development rates can be accurately described by two linear response curves (Wuethrich, 1997). From emergence to leaf stage V10 (ten visible leaf collars), leaf collar emergence occurs at about one leaf every 85 GDDs. From leaf stage V10 to the final leaf, leaf collar emergence occurs more rapidly at approximately one leaf every 50 GDDs.

Example 1: A field was planted on April 28 and emerged on May 5. Since May 5, approximately 535 GDDs have accumulated. Based on our research data, the estimated leaf stage for the crop (without looking at the field, mind you) would be between V6 and V7 (6 leaves x 85 GDDs = 510 GDDs; 7 leaves x 85 GDDs = 595 GDDs).

Example 2: A field was planted on April 28, but you do not know exactly when it emerged. Since planting, approximately 785 GDDs have accumulated. If you assume that the crop emerged in about 125 GDDs, then the estimated leaf stage for the crop would be between V7 and V8. This estimate is calculated by first subtracting 125 from 785 to account for the thermal time to emergence, then dividing the result (660) by 85 (equal to 7.8).

Example 3: A field was planted on April 28 and emerged on May 5. Since May 5, approximately 1200 GDDs have accumulated. Your familiarity with these calculations tells you that the crop is likely beyond V10 (equal to 10 x 85 or 850 GDDs since emergence). So, first subtract 850 from 1200 (knowing the crop is at least at V10). Divide the result (350) by 50 to equal 7 additional leaves; for a total estimated leaf stage of V17.

Keep in mind that estimates of leaf stage development are only that, estimates. One of the factors that most influences the accuracy of these estimates is the existence or not of other growth-limiting stresses. Severe plant stress will generally retard stem and leaf sheath elongation, thus delaying the appearance of leaf collars. However, what I have described here will put you in the proverbial ballpark in determining which fields are at which leaf stages on a given day.

Related References:

- Wuethrich, Kirby. 1997. **Vegetative and Reproductive Phenology of Fourteen Hybrids of Dent Corn (Zea mays L.).** M.S. thesis, Purdue Univ.
- Nielsen, R.L. (Bob). 2004a. **Determining Corn Leaf Stages.** Corny News Network, Purdue Univ. Online at <www.kingcorn.org/news/articles.04/VStageMethods-0515.html>. [URL verified 5/15/04].
- Nielsen, R.L. (Bob). 2004b. **Heat Unit Concepts Related to Corn Development.** Corny News Network, Purdue Univ. Online at <www.kingcorn.org/news/articles.04/HeatUnits-0515.html>. [URL verified 5/15/04].
- Purdue University. 2004. **Corn & Soybean Field Guide (ID-179)**. To order, call Purdue Extension toll-free at (888) 398-4636 and ask for the Media Distribution Center or call them direct at (765) 494-6794. You can also download an order form online at <www.agry.purdue.edu/dtc/guide.html>. [URL verified 5/15/04].

• • P&C • •

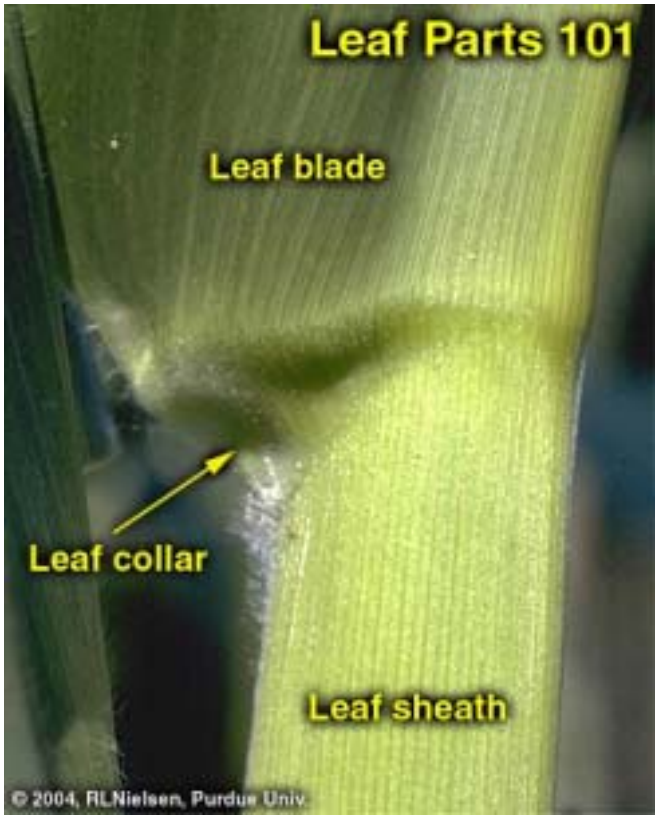
Determining Corn Leaf Stages - (*Bob Nielsen*)

Many of us remember standing against the doorframe in our early years and our parents marking our height with a pencil to measure how much we had grown. Maybe some of you spent more time standing in the corner in your youth, but I won't comment on that.

Because it is difficult to transport corn plants from the field to that doorframe to measure their growth,

agronomists developed other means to measure the phenology or development of corn. Counting the number of leaves would seem to be a simple way to document corn development, but folks still tend to become confused over this simple strategy. There are two basic methods for leaf staging corn in use today.

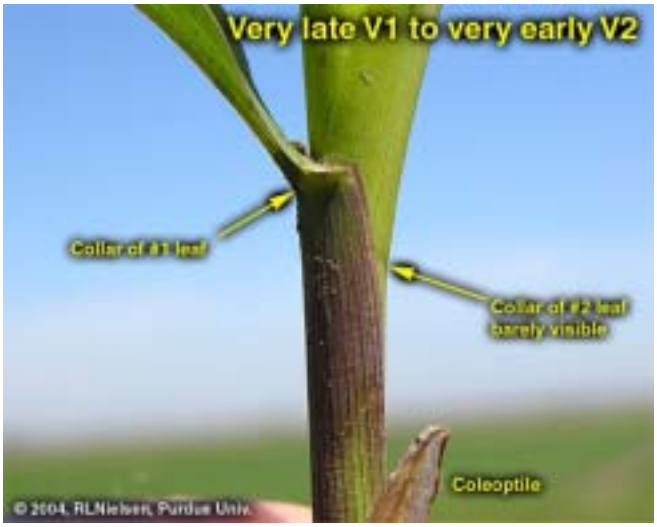
Leaf Collar Method. This method determines leaf stage in corn by counting the number of leaves on a plant with visible leaf collars, beginning with the lowermost, short, rounded-tip true leaf and ending with the uppermost leaf with a visible leaf collar. The leaf collar is the light-colored collar-like "band" located at the base of an exposed leaf blade, near the spot where the leaf blade comes in contact with the stem of the plant.



Corn plant showing leaf parts

Leaves within the whorl, not yet fully expanded and with no visible leaf collar are not included in this leaf staging method. The exception to this statement may be that leaves with barely visible leaf collars can be counted when you are staging plants early in the day, recognizing that the leaf collar may become completely visible by the end of the day.

Leaf stages are usually described as "V" stages, e.g., V2 = two leaves with visible leaf collars. The leaf collar method is generally the most widely used method by university and industry agronomists in the U.S.

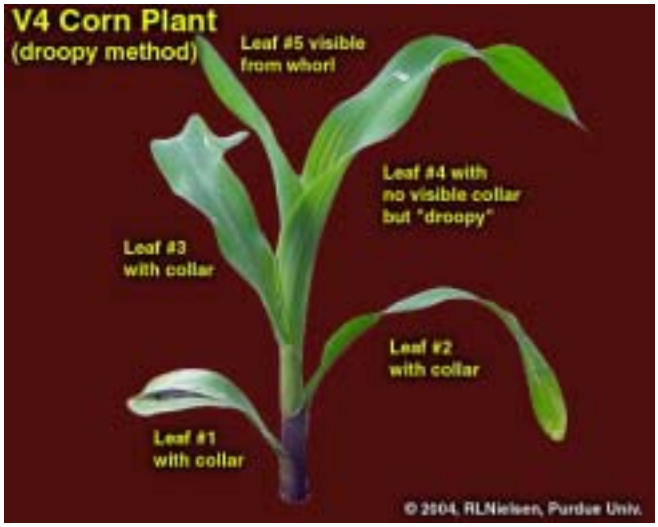


Very late V1 to very early V2

"Droopy" Leaf Method. Crop insurance adjusters, when assessing damage to a corn crop from weather events such as hailstorms, use this leaf staging method. Like the leaf collar method, this method of leaf staging begins with the short first leaf. Leaf counting then differs, though, by ending not with the uppermost leaf with a visible collar, but at that leaf that is at least 40 to 50 percent exposed from the whorl. In knee-high corn or older, the tip of this "indicator" leaf typically also "droops" or hangs down, hence the name "droopy" leaf method.

The Two Methods Compared. Both methods assign a leaf stage to a field on the basis of the leaf stage common to the majority of the plants in the field. Up to the 5- or 6-leaf collar stage, the leaf collar method will typically result in a leaf stage value that is one less than the "droopy" leaf method. After corn reaches 18 to 24 inches in height, the leaf collar method will typically result in a leaf stage value that is two less than the "droopy" leaf method.

V3 plant using leaf collar method



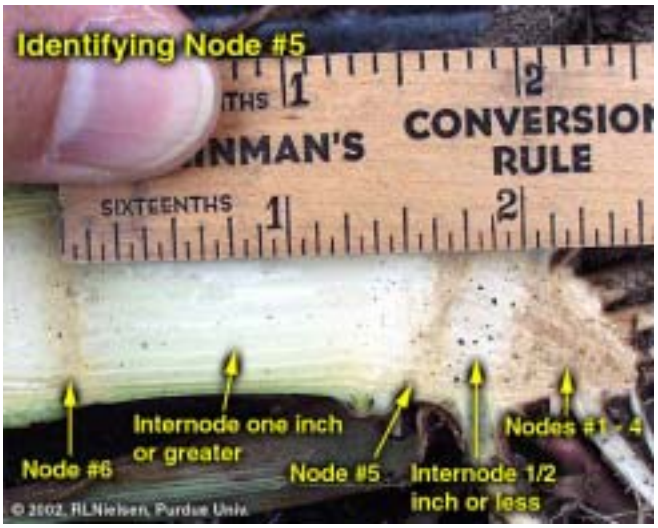
Same plant, but V4 using droopy leaf method

Lower leaves mising from older plants

The usefulness in understanding the differences between these two leaf staging methods lies in the fact that the defoliation/yield loss chart used by hail insurance adjusters is based on the "droopy" leaf method. That chart is reproduced in the Purdue Extension publication ID-179, *Corn & Soybean Field Guide*. Identifying true "droopy" leaves on shredded, hail-damaged corn plants can be quite difficult, whereas leaf collars are often still identifiable. Thus, you can usually stage a damaged crop by the leaf collar method and then add one or two more leaves to the count in order to use the defoliation chart.

What About Herbicide Labels? Growers' confusion with leaf staging often originates with poorly described growth stage restrictions listed on herbicide labels. Label restrictions of older post-emergence herbicides typically ignored the short first leaf with the rounded tip and ended with the uppermost leaf that was at least 50% exposed from whorl. In essence, this was a bastardized "droopy leaf" method that resulted in roughly the same numerical leaf stage as the leaf collar method. Newer labels purport to define leaf stages according to the leaf collar method, but there is still some question about whether the short first leaf with the rounded tip is included. If in doubt with these newer herbicides, check with your chemical technical representative to verify which leaf staging method is appropriate for the herbicide you intend to use.

Staging Older Plants. As corn plants develop, the lower few leaves typically die or rip away from the stem by expansion of the stalk or by developing roots. Consequently, growth stage identification can be difficult on older plants when you aren't sure which leaves to begin counting first. But, not to worry, growth staging can still be accomplished!



Identifying Node #5

Leaf sheath attachment to stalk nodes

First, dig or pull a plant without breaking the stalk. With a knife, carefully split the stalk down the middle, completely through the root ball. Look for the lowermost obvious internode (the whitish area between the "woody" horizontal stalk nodes) above the triangular "woody" base of the stalk. This first internode's length is typically only 1/2 to 3/4 inch.

Determine which leaf corresponds with the node immediately above the first noticeable internode by carefully identifying which leaf sheath attaches to the node. This leaf is usually Leaf #5. Once Leaf #5 is identified, then stage the plant by continuing to count the remainder of the leaves with visible leaf collars above Leaf #5. For example, assume you've identified Leaf #5 and there are six more leaves above that one with visible leaf collars, then the plant is at leaf stage V11 (11 leaves with visible leaf collars).

Related References

- Nielsen, R.L. (Bob). 2004a. **Heat Unit Concepts Related to Corn Development.** Corny News Network, Purdue Univ. Online at <www.kingcorn.org/news/articles.04/HeatUnits-0515.html>. [URL verified 5/15/04].
- Nielsen, R.L. (Bob). 2004b. **Use Thermal Time to Predict Leaf Stage Development in Corn.** Corny News Network, Purdue Univ. Online at <www.kingcorn.org/news/articles.04/VStagePrediction-0515.html>. [URL verified 5/15/04].
- Purdue University. 2004. **Corn & Soybean Field Guide (ID-179)**. To order, call Purdue Extension toll-free at (888) 398-4636 and ask for the Media Distribution Center or call them direct at (765) 494-6794. You can also download an order form online at<www.agry.purdue.edu/dtc/guide.html>. [URL verified 5/15/04].
- Ritchie, S.W., J.J. Hanway, and G.O. Benson. 1992. **How a Corn Plant Develops (SP-48).** Iowa State Univ. Online at <http://maize.agron.iastate.edu/corntitle.html>. [URL verified 5/20/03].

• • P&C • •

Heat Unit Concepts Related to Corn Development - (*Bob Nielsen*)

Growth and development of corn are strongly dependent on temperature. Corn develops faster when temperatures are warmer and more slowly when temperatures are cooler. For example, a string of warmer than normal days in late spring will encourage faster leaf development than normal. Another example is that a cooler than normal grain filling period will delay the calendar date of grain maturity.

The phrases "string of warmer than normal days" and "cooler than normal grain filling period" can be converted mathematically into measures of thermal time by calculating the daily accumulations of heat. Commonly used terms for thermal time are Growing Degree Days (GDDs), Growing Degree Units (GDUs), or heat units (HUs).

Different methods exist for calculating heat units depending on a) the crop or biological organism of interest and b) the whim or personal preference of the researcher. The calculation method most commonly used throughout the U.S. for determining heat unit accumulation relative to corn phenology is the formula first suggested by the National Oceanic and Atmospheric Administration in 1969 and labeled as the 'Modified Growing Degree Day' formula in 1971.

This method calculates daily accumulation of GDDs as the average daily temperature (degrees F) minus 50. The "modification" refers to the limits imposed on the daily maximum and minimum temperatures allowed in the calculation. Daily maximums greater than 86 degrees F are set equal to 86 in the calculation of the daily average temperature. Similarly, daily minimums less than 50 degrees F are set equal to 50 in the calculation.

Example 1: If the daily maximum temperature was 80 degrees F and the minimum was 55°F, the GDD accumulation for the day would be ((80 + 55)/2) – 50 or 17.5 GDDs.

Example 2 (Illustrating the limit on daily maximums): If the daily maximum temperature was 90°F and the minimum was 72°F, the GDD accumulation for the day would be ((86 + 72)/2) – 50 or 29 GDDs.

Example 3 (Illustrating the limit on daily minimums): If the daily maximum temperature was 68°F and the minimum was 41°F, the GDD accumulation for the day would be ((68 + 50)/2) – 50 or 9 GDDs.

In late April to early May, normal daily GDD accumulations for central Indiana are about 10 GDDs. By late July, the normal daily accumulation rises to about 23 GDDs. For a typical corn growing season in central Indiana, say from late April to late September, the total seasonal accumulation of GDDs is about 2800 GDDs. Historical normal GDD accumulations on a weekly basis for Indiana's nine Crop Reporting Districts are available in Purdue's *Corn & Soybean Field Guide*, Extension publication # ID-179. Daily or monthly normal GDD accumulations for Indiana are also available at the Indiana Climate Page Web site (Scheeringa, 2004).

Obviously, the ability to calculate daily heat unit accumulations is dependent on your having access to daily maximum and minimum temperatures. If you do not have your own max/min recording thermometer,

you can guesstimate the daily highs and lows by manually recording the temperatures shortly after sunrise (approximate daily low) and late in the afternoon (approximate daily high).

In lieu of recording your own daily temperatures, you can use those of an official weather reporting station nearest to your location. Daily temperature data for specific locations throughout Indiana are also recorded and reported at the Indiana Climate Page Web site (Scheeringa, 2004). Also, the weekly Purdue Pest & Crop Newsletter lists accumulated GDDs for selected sites across the state based on various start dates.

Related References:

- Nielsen, R.L. (Bob). 2004a. **Determining Corn Leaf Stages.** Corny News Network, Purdue Univ. Online at <www.kingcorn.org/news/articles.04/VStageMethods-0515.html>. [URL verified 5/15/04].
- Nielsen, R.L. (Bob). 2004b. **Use Thermal Time to Predict Leaf Stage Development in Corn.** Corny News Network, Purdue Univ. Online at <www.kingcorn.org/news/articles.04/VStagePrediction-0515.html>. [URL verified 5/15/04].
- Purdue University. 2004. **Corn & Soybean Field Guide (ID-179)**. To order, call Purdue Extension toll-free at (888) 398-4636 and ask for the Media Distribution Center or call them direct at (765) 494-6794. You can also download an order form online at<www.agry.purdue.edu/dtc/guide.html>. [URL verified 5/15/04].
- Purdue University. 2004. **Pest & Crop Newsletter.** Online at <www.entm.purdue.edu/entomology/ext/ext_newsletters.html>. [URL verified 5/15/04].
- Scheeringa, Ken. 2004. **Indiana Climate Page.** Purdue Univ. Online at <shadow.agry.purdue.edu/sc.index.html>. [URL verified 5/15/04].

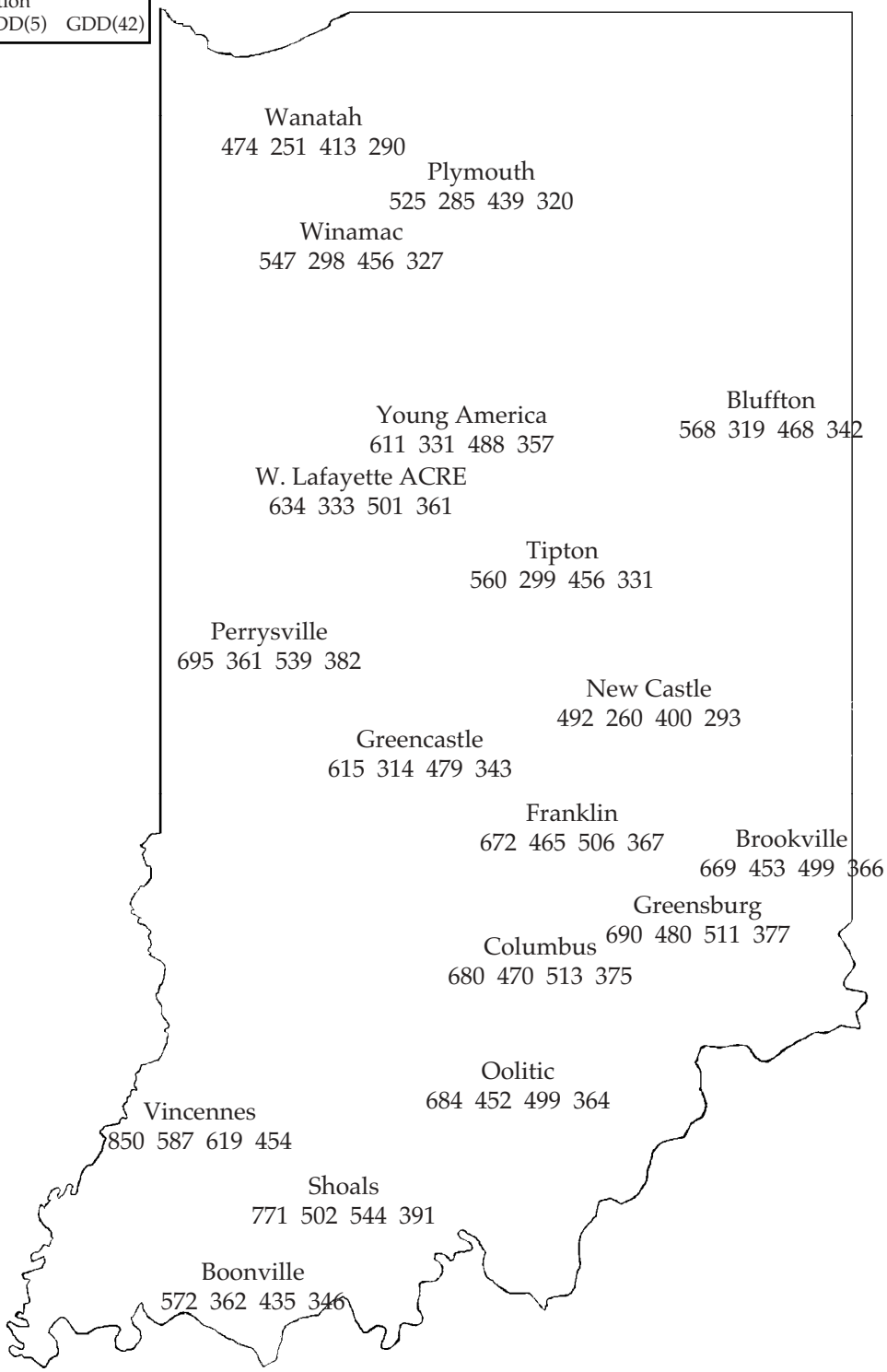
Don't forget, this and other timely information about corn can be viewed at the Chat 'n Chew CafÈ on the Web at <www.kingcorn.org/cafe>. For other information about corn, take a look at the Corn Growers' Guidebook on the Web at <www.kingcorn.org>.

Weather Update

Temperatures as of May 19, 2004

HU48 = heat units at a 48ºF base from Jan. 1, for alfalfa weevil development (begin scouting at 200)
HU50 = heat units at a 50ºF base from date of intensive moth capture, for black cutworm development (larval cutting begins about 300)
GDD(5) = Growing Degree Days from April 7 (5% of Indiana's corn planted), for corn growth and development
GDD(42) = Growing Degree Days from April 21 (42% of Indiana's corn planted), for corn growth and development

MAP KEY			
Location			
HU48	HU50	GDD(5)	GDD(42)



4" Bare Soil Temperatures 5/19/04

Location	Max.	Min.
Wanatah	66	59
Winamac	71	63
Bluffton	67	66
Chalmers	66	61
W Laf Acre	80	67
Tipton	76	66
Farmland	72	66
Perrysville	72	69
Crawfordsville	75	66
Liberty	80	64