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Insects, Mites, and Nematodes

Dust Off the Sweep Net for Potato Leafhopper -
(John Obermeyer and Larry Bledsoe)

- Sample newly cut alfalfa fields for leafhoppers.
- If yellowing has already occurred, it is too late to prevent damage this cutting.
- Management guidelines are given.

Although economic populations of potato leafhoppers have not been observed or reported, populations will be increasing with warmer temperatures. Alfalfa producers should begin sampling their alfalfa shortly after cutting.

Potato leafhoppers are small, wedge-shaped, yellowish-green insects that remove plant sap with their piercing-sucking mouthparts. Leafhopper feeding will often cause the characteristic wedge-shaped yellow area at the leaf tip, which is referred to as "hopper burn." Widespread feeding damage can cause a field to appear yellow throughout. Leafhopper damage reduces yield and forage quality through a loss of protein. If left uncontrolled for several cuttings, potato leafhoppers can also significantly reduce stands.



Hopper burn on alfalfa

Timely scouting and applying insecticides when necessary can prevent potato leafhopper damage. Treatment is preventative rather than curative. Thus, to effectively prevent economic losses, treatments must be applied before yellowing occurs. Usually the best results

are obtained when treating small alfalfa, so be sure to scout the alfalfa regrowth for leafhoppers after cutting.

The need to treat for leafhoppers can be determined prior to the appearance of damage if fields are surveyed on a regular basis. To assess leafhopper populations and the potential for damage, take at least 5 sets of 20 sweeps with a 15" diameter sweep net in representative areas of a field. Carefully examine the contents of the sweep net, count the number of adults and nymphs, and calculate the number of leafhoppers per sweep. Use the guidelines given below to determine the need for treatment. For recommended insecticides see Extension Publication E-220, *Alfalfa Insect Control Recommendations - 2004* which can be viewed at <www.entm.purdue.edu/entomology/ext/targets/e-series/e-list.htm>. A sampling video for potato leafhopper in alfalfa can be viewed at: <www.entm.purdue.edu/entomology/ext/fieldcropsipm/videos.htm>.

Management Thresholds for Potato Leafhoppers	
Leafhoppers(Adults/ Stem Height in Inches	Average Number Nymphs) Per Sweep
under 3	0.2
4 - 6	0.5
7 - 12	1.0
greater than 12	1.5

Slug Damage and Rescue Controls—(John Obermeyer and Larry Bledsoe)

- Slugs are favored by a wet spring with heavy crop residue on the soil surface.
- Crop damage and stand losses are most severe when slugs enter open seed slots.
- Control options are limited.

Several calls have been received concerning slugs damaging both corn and soybean fields. Many areas of fields are so severely damaged that replanting is necessary. On corn, slugs feed on the surface tissue of leaves resulting in narrow, irregular, linear tracks or scars of various lengths. Severe feeding can result in split or tattered leaves that resembles hail damage. Soybean damage is not as predominant on the foliage, but rather on the hypocotyl and cotyledons. Given good growing conditions, plants usually outgrow slug damage once the crop is up. Most damage and stand losses by slugs occur when fields are too wet to plant and seed slots are not properly closed. In this situation, slugs can be found feeding on the seedlings within the slot, day or night. Obviously, once the growing point of corn or soybeans is injured, plant recovery is unlikely.

Chemical control of slugs is difficult, if not impossible. Metaldehyde pelleted baits, Deadline M-Ps and Trail's End LG, are labeled and available for use. The cost for product is about \$10-15 per acre. Spreading the pellets evenly over the field or damaged areas is key to control; using a commercial mechanical dispenser is one possibility. Field trials at Ohio State University have shown promising results when the pellets are evenly distributed. With the significant cost and difficulty of application, consider these baits only as a last resort to protect crop stands in high slug populated areas.

Where replanting is necessary from slug damage, one should strongly consider tilling (disc and/or field cultivator) the area first. This should help dry the area and break-up and bury crop residue. Doing so will discourage further slug activity. Granular and liquid insecticides are ineffective against slugs, as they slime over them. Home remedies, such as spraying plants at night with liquid fertilizer (high salt concentration), have proven futile.



Slug damage to corn and bait pellets

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Armyworm Still Going—(John Obermeyer and Larry Bledsoe)

Reports of severe armyworm feeding in wheat are still being received from pest managers in northern Indiana counties. The damage varies greatly in varieties and plant densities. Greg Shaner, Purdue plant pathologist, noticed significant feeding differences between varieties while out evaluating plots for leaf diseases in Tippecanoe County. We continue to encourage pest managers to evaluate their wheat fields for flag leaf feeding and possible head clipping, especially where stands are thick. Scouting procedures and treatment thresholds have been covered in previous issues of the *Pest&Crop*.

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Stinkbug Like Damage in Corn, Your Observations Needed – (John Obermeyer and Larry Bledsoe)

While monitoring fields, several pest managers have noticed that a small percentage of corn plants have leaf holes with malformed tissue. The transverse, elongated holes are surrounded with yellowish discoloration. Some of the leaves are appearing quite tattered from multiple holes. A few stunted plants with multiple suckers are observed. Many of these symptoms describe stinkbug damage... but, most of these fields are conventionally tilled and most expression is on the upper leaves of V7 corn. That is not typical of stinkbug habitat and/or feeding damage.

Though this damage has been seen in many cornfields, it is a small number of plants (maybe 2-3%) scattered throughout the field. Several field agronomists and extension specialists are stumped. If you are seeing similar damage, refer to pictures below, we'd like to hear from you. Please call 765-494-4563 and let us know.



Symptoms on younger corn leaves



Elongated, transverse holes



Stunted and suckered plant

(Photo credits to Jeff Nagel, Westland Co-op)



Black Light Trap Catch Report - (John Obermeyer)

County/Cooperator	5/18/04 - 5/25/04							5/25/04 - 5/31/04						
	VC	BCW	ECB	SWCB	CEW	FAW	AW	VC	BCW	ECB	SWCB	CEW	FAW	AW
Dubois/SIPAC		1	1											
Jennings/SEPAC										1				
Knox/SWPAC	1	1					12	1	1	4				1
LaPorte/Pinney Ag Center			1				2		1	4				2
Lawrence/Feldun Ag Center			5							3				
Randolph/Davis Ag Center			14							32				
Tippecanoe/TPAC Ag Center			2											
Vermillion/Hutson														2
Whitley/NEPAC														

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

Weather Related Weed Management Items – (Bill Johnson and Glenn Nice)

Recent wet, rainy weather has created some weed management challenges for Indiana growers. In this article we will hit on a few key points to consider based on current challenges. Consult the weed response table in the Ohio/Indiana Weed Control Guide <www.btny.purdue.edu/Pubs/WS/WS-16/CornHerbRating04.pdf> to determine which products are best suited for your corn weed spectrum.

Delayed corn planting or replanting in southern Indiana.

1. Southern Indiana corn growers rely heavily on atrazine premixes in corn. Rain will not have completely washed all of the herbicide away, but may have compromised overall activity. Scout fields as soon as possible to determine if weeds are escaping. Obviously giant ragweed is a big concern, but wet conditions and dilution of atrazine can result in failures to control cocklebur, sunflower, velvetleaf, burcucumber, morningglories, and waterhemp. If corn is less than 12 inches tall and you haven't used all of the atrazine allowed by the label, it would be wise to add atrazine to other broadleaf herbicides to control the above mention weeds and provide some soil residual activity. If corn is more than 12 inches tall, you cannot use any additional atrazine.
2. If no herbicides have been applied and corn is emerged, strongly consider switching to more of a total post program since rains needed for activation of soil applied herbicides tend to become less frequent as we move into summer. Products with good annual grass (foxtail, fall panicum, barnyardgrass, etc.) activity such as Steadfast ATZ, Basis Gold, Celebrity Plus, Option or Equip plus appropriate broadleaf herbicides are effective programs to consider in these situations. You can still add reduced rates (1/3 to 1/2 rates) of the residual herbicides to the post program to extend the weed control interval.

Weed escapes in large corn in all of Indiana. Postemergence corn herbicide options become limited when corn is 12 inches tall, and really limited on corn at the V6 or later growth stage. Also keep in mind that large weeds are much more difficult to control. Keep spray out of whorls, especially with ALS inhibitors and contact products.

In corn between 12 inches tall and the V6 growth stage, grass products that can be used include Accent,

Beacon, Steadfast, Option (up to V5), Equip (up to V4). All of these products can be applied as directed sprays on larger corn with the exception of Celebrity Plus and Steadfast.

Broadleaf products that can be broadcast on corn taller than 12 inches include include Aim, Basagran, Buctril, Callisto, Celebrity Plus, Distinct, Exceed, Glyphosate (RR corn), Hornet, Liberty (LL corn), Lightning (Clearfield corn), Northstar, Permit, Permit + dicamba, Resource, Stinger, Yukon. Broadleaf products that can be applied broadcast on corn at V7-V8 or later include Aim, Basagran, Callisto, Glyphosate (RR corn), Liberty (LL corn), Permit, Permit + dicamba, Resource, Yukon. Consult the Ohio/Indiana Weed Control Guide <www.btny.purdue.edu/Pubs/WS/WS-16/> or the manufacturers label for more information, adjuvants, efficacy, and use precautions of each product.

Be on the lookout for giant ragweed and burcucumber. Every year is a good one for giant ragweed, and frequent rains are good for burcucumber. Both weeds have relative long emergence patterns and herbicides with both foliar and residual activity are needed. If corn is not 12 inches tall, consider adding some atrazine to the postemergence product to extend the residual window of activity on these weeds.

Here is a brief summary of weeds controlled by various products.

Nightshade and jimsonweed are controlled with Aim, atrazine, Banvel/Clarity/Distinct, Buctril, Celebrity Plus, Liberty, Northstar, glyphosate, and Yukon. Basagran also works well on jimsonweed, but not on nightshade.

Burcucumber is controlled with Beacon, Buctril+atrazine, dicamba+atrazine, Spirit, Northstar.

Cocklebur, common ragweed, giant ragweed, sunflower and velvetleaf are controlled with atrazine, Banvel/Clarity/Distinct, Basagran, Buctril, Celebrity Plus, Hornet, Liberty, Northstar, Permit, glyphosate, Yukon, and 2,4-D. Callisto provides good control of cocklebur and velvetleaf, but is weak on sunflower and the ragweeds. Mixtures of **cocklebur, sunflower, or giant ragweed that are not controlled with ALS inhibitors** (ALS resistant) should be controlled with atrazine, Banvel/Clarity/Distinct, Buctril, Celebrity Plus, Hornet, Liberty, Northstar, glyphosate or 2,4-D.

Common lambsquarters are controlled with Aim, atrazine, Banvel/Clarity/Distinct, Buctril, Callisto, Celebrity Plus, Hornet, Liberty, Northstar, Resource, glyphosate, Yukon, and 2,4-D.

Entireleaf, ivyleaf and pitted morningglory are controlled with atrazine, Banvel/Clarity/Distinct, Buctril, Celebrity Plus, Liberty, glyphosate, Northstar, Yukon, and 2,4-D.

Redroot and smooth pigweed are controlled with Aim, atrazine, Banvel/Clarity/Distinct, Callisto, Celebrity Plus, Permit, glyphosate, Northstar, Yukon, and 2,4-D.

Prickly sida is controlled with atrazine, Banvel/Clarity/Distinct, Celebrity Plus, Callisto, Basagran, Hornet, Liberty, Northstar, Yukon, and glyphosate.

Waterhemp can be controlled with Aim, atrazine, Banvel/Clarity/Distinct, Callisto, Celebrity Plus, glyphosate, Northstar, Yukon, and 2,4-D.

Velvetleaf is controlled with Aim, Callisto, Hornet, Resource, and Yukon.

Keep in mind that most of these herbicides are intended for weeds less than 6 inches tall.

Large weeds in fields intended for soybean. We have observed some fields (both planted and unplanted) with dandelions flowering for the second or third time, cressleaf groundsel in excess of 3 feet tall, common pokeweed, hemp dogbane, and milkweed in excess of 2 feet tall, and flowering thistles. In no-till fields that have not yet been planted, increase glyphosate rates for burndown to at least 1.5 lb. ae/A (44 oz. of Weathermax or 64 oz. of most other glyphosate products) to improve control of large weeds. Wait at least 1 day before pulling a drill or planter through the field to allow the weeds to absorb glyphosate. Since it is late in the spring, if marestalk is present, add FirstRate or Classic to glyphosate rather than 2,4-D unless you know it is ALS resistant.

In fields that will conventionally tilled, consider using no-till instead. It is difficult to completely control large weeds with spring tillage tools other than plows. Disks, field cultivators, and soil finishers will knock down large weeds which then recover and become difficult to control with herbicides. If you do conventional tillage and have weeds in excess of 1 foot tall, apply glyphosate prior to tillage to ensure effective control. Wait at least one day between glyphosate application and tillage for annual weeds, and 2 to 3 days for perennial weeds. The good news is that glyphosate products work much more rapidly when air temperatures are high and knockdown activity will be more rapid than we are used to with early spring applications.

Large weeds in established soybean. We have observed a number of fields with 3 to 6 inch tall soybeans and 6 to 24 inch tall weeds. Unfortunately we also observe when we don't have weather related challenges. Research conducted at a number of Midwest universities has shown that moderate to high densities weeds allowed to reach 9 inches or more almost always result in yield reductions. From a soybean growth stage standpoint, allowing similar densities of weeds to remain with soybean until V3 to V4 almost always results in yield reductions. With good commodity prices, why let weeds take your beans? Keep in mind that the current glyphosate labels recommend a rate of 0.56 to 0.75 lb. ae/A (17 to 22 oz. of Weathermax, or 24 to 32 oz. of 3 lb. ae/gallon formulations) for control of 4 to 8 inch weeds. If weeds are taller than 8 inches increase glyphosate rate accordingly. Weeds that escape the first application of glyphosate can be more difficult to control if they regrow and become drought stressed.

Plant Diseases

Fusarium Head Blight of Wheat - (Gregory Shaner)

- It's starting to look like a bad year for head blight.

Fusarium head blight is becoming severe on wheat in southern Indiana and extending north at least as far as Lafayette. Bleached heads are abundant enough to be seen from the road in many fields. Some heads are totally blighted; others are still only partially blighted, but over the next few days they, too, will become totally blighted. A pink color can be seen at the base of spikelets on blighted heads. This is the result of sporulation of the fungus, *Fusarium graminearum*, on infected tissue.

In the fields and plots I have examined, head blight is scattered uniformly throughout the stand. The

incidence of blighted heads is somewhat greater if corn residue is in the field, but blight is also common in fields with no corn residue. The head blight fungus survives in both wheat and corn residue, but because corn residue persists so much longer, it is the main source of inoculum for wheat. We have been monitoring airborne spores of the fungus throughout May. During the past 3 weeks spores have been abundant. Evidently spores move from field to field in sufficient numbers to cause head blight even if there is no corn residue in the field itself.

Now that wheat is in the late milk to mid dough stages of grain development in central and southern Indiana, it is possible to get some estimate of damage. Kernels on blighted heads are already shriveled, and as they dry down they will shrivel even more. Because the

blighted heads stand out so clearly, there is a tendency to overestimate their frequency. To get a better estimate of damage, count the blighted heads in a sample of 20 heads (about a “handful”) at several places in the field. From these counts, calculate the percentage of blighted heads. There is no precise threshold for saying that a field has a problem, but in the modeling work, epidemiologists have used 10% blighted heads as the dividing line for a “severe” epidemic.

In addition to reduction in yield and test weight, grain from a field with a lot of head blight will likely contain high levels of a toxin produced by the fungus—deoxynivalenol (commonly referred to as DON or vomitoxin). Millers don’t want wheat with high levels of DON (2 ppm is the level where they start to get concerned). If a lot of heads in a field are blighted, it would be a good idea to turn the air up on the combine to blow as many shriveled kernels out with the chaff as possible. This will reduce yield somewhat, but may improve the quality of what is harvested. Unfortunately, there is not a close correlation between the number of blighted heads in a field and the level of DON in grain. However, the lack of correlation is mostly at the lower end of head blight severity. That is, fields with a low frequency of blighted heads may have high, moderate, or low levels of DON. Fields with a high frequency of blighted heads generally have high levels of DON.

We are monitoring wheat plots at several locations throughout the state, for head blight in the field, and for grain quality after harvest. Once we have grain samples, we will know more about the levels of DON in this year’s crop.



Phytophthora Rot of Soybean - (Gregory Shaner, Andreas Westphal, and Scott Abney)

The frequent rains that have fallen on many Indiana fields over the past 3 weeks have created conditions favorable for root rots of soybean. Root rots caused by *Fusarium*, *Rhizoctonia*, and *Phytophthora* can all occur under these conditions. However, extensive stand reduction within a field and late-season plant damage occur more often with *Phytophthora* root rot than with the other root rots. The organism that causes *Phytophthora* root rot, *Phytophthora sojae*, is a fungus-like plant pathogen that thrives in wet soil. *Phytophthora sojae* produces motile zoospores when water fills the spaces between soil particles. Zoospores swim in this water and are attracted to soybean roots. When zoospores contact a root, they attach and then infect. A zoospore probably swims no more than 1 inch. However, flowing water can passively transport zoospores for greater distances.

Shortly after planting, *Phytophthora sojae* can cause seed rot and damping-off. At later growth stages, it can infect roots whenever the soil is saturated. The first indication of a root rot problem is often leaf yellowing between the veins and along the leaf margin. The plants have an overall wilted, “droopy,” appearance. The root systems on these plants will be dark and decayed. The lower few inches of the stem may also be black. Lateral roots, and in severe cases taproots, are destroyed by the time foliar symptoms call attention to a problem. Depending on when the disease develops, yield losses can be minor or severe. Damage is greater the earlier infection occurs.

The pathogen survives as robust spores that are either imbedded in host tissue or released to the soil environment as the plant tissue decays. The spores can easily survive several years without a soybean crop so crop rotation is not a practical means of control. There are soybean cultivars resistant to *Phytophthora sojae*. However, there are many different races of the pathogen. A particular resistance gene will provide protection against some races, but not others. Two commonly used resistance genes—*Rps1c* and *Rps1k*—provide resistance against many common races, but there are fields throughout Indiana that have races of the pathogen that can cause disease on plants with either of these genes. If *Phytophthora* root rot is a problem on a cultivar with a gene for resistance, this is a good indication that there is a race in the field not controlled by that resistance gene. The grower will need to switch to a cultivar with a different gene for resistance.

While plants are small and soil moisture is abundant, there will be little aboveground evidence of a developing root rot problem. As soybean plants move into reproductive stages, wilting and plant death will occur.

Agronomy Tips

Excessive Rainfall and the 2004 Soybean and Wheat Crop – (Ellsworth P. Christmas)

- The effect of wet soils and flooding on soybean and wheat.

Significant quantities of rain have fallen in the past 8 days with the heaviest amounts across the southern one-third of Indiana. Scottsburg reported rainfall in excess of 8.00 inches. Amounts in excess of 5 inches were reported for Freelandville, Grandview, Shoals and Vincennes with Dubois reporting 6.50 inches. Rainfall across the balance of the state was spotty ranging from less than one-half inch to 2.92 inches in Spencer.

The net result of all of this rain is saturated soils in much of the state with significant ponding and some flooding primarily in the river bottoms. Anytime these types of wetness problems occur, the immediate question relates to the length of time that a given crop can survive if covered by water. For soybeans, the length of time that a plant can remain completely submerged and survive is between 2 and 4 days. The length of time is related to temperature and cloud cover. Hot, sunny conditions may result in death of the plant after 2 days while under cool, cloudy conditions soybeans may survive after 4 days or more. If a portion of the plant is exposed, soybeans have been known to survive after 7 days of partial submersion. Once the water recedes, 5 to 7 days will be required before an accurate evaluation of the condition of the plants can be made.

Both soybeans and wheat require well-aerated soils to grow vigorously. Saturated soils, with no water on the above ground portion of the plant, can result in poor root and plant growth and perhaps death from root rot diseases. After only a few days of saturated soils, expect soybean and wheat plants to become lighter green in color.

In addition to the wet soil conditions, most of the soybean crop is not yet at the V-4 stage of growth and are not fixing an adequate supply of nitrogen for the plant, hence the light green color. Once the excess water drains from the soil, 10 to 14 days will be required for the nodules to reestablish and begin fixing adequate nitrogen to meet the needs of the plant.

At the current stage of growth, wheat can survive ponding or flooding for 2 to 4 days provided the head is not covered. If the head is covered with water, they usually mold or rot as a result and those areas of a field are usually a total loss.

Corn Hybrid Maturity Considerations for Delayed Plantings or Replantings in Southern Indiana - (Bob)Nielsen

What began as a growing season with great promise has turned into a literal quagmire for some corn growers in Indiana, particularly throughout the southern areas of the state. Frequent rainfall throughout May prevented timely planting for some or contributed to extended periods of soggy soils following planting that resulted in seeds rotting in the seedbed. For others, recent torrential rains and subsequent ponding or flooding of fields threaten the survival of emerged crops and may force replanting of fields that ultimately suffer significant stand loss.

Whenever corn planting is delayed or corn replanting occurs at a late date, growers often question whether they should switch to early maturity hybrids with shorter growing season requirements in order to minimize the risk of fall freeze injury to immature corn grain or to guard against excessive grain moisture at harvest. Peter Thomison (Ohio State Univ.) and I published a guide (Purdue Extension Pub. AY-312-W) that goes into greater detail than I will address in this article, but let me summarize that information specifically for southern Indiana corn growers faced with difficult planting decisions.

Corn development is strongly influenced by temperature throughout the growing season. Warmer temperatures translate to faster development, while cooler temperatures slow down development. The accumulation of temperature or heat can be measured in terms of daily "heat units" or "growing degree days" (GDDs) summed from the day of corn planting. In addition to the commonly used "days" maturity rating scheme, seed companies often also define hybrid maturities in terms of the number of heat units required to reach maturity.

The good news about delayed planting of corn is that the crop adjusts by maturing in fewer heat units than when planted in normal time periods. Consequently, adapted hybrid maturities can be planted later than many growers expect with little risk of the crop failing to mature prior to a killing fall freeze. Based on field research conducted in Indiana and Ohio, the following suggestions can be made for southern Indiana growers faced with late planting or replanting of corn. Rather than GDD values, the hybrid maturities are listed in terms of "comparative relative maturity" values that most closely correspond to hybrid maturity definitions used by Pioneer Hi-Bred International, Inc.

Table 1. Approximate "safe" relative hybrid maturities for delayed plantings throughout southern Indiana.

Area of Indiana	Latest "safe" hybrid maturity for planting no later than...		
	June 7	June 14	June 21
Hybrid CRM ratings			
Southwest	118+	118+	117
Southcentral	115+	113	108
Southeast	115+	113	108

The definitions of hybrid CRM (comparative relative maturity) values listed above correspond most closely with those used by Pioneer Hi-Bred International, Inc.

Hybrid maturity recommendations for delayed planting in other areas of Indiana and Ohio can be found in Purdue University Publication AY-312-W.

While a switch to significantly earlier hybrid maturities is not physiologically warranted for a couple more weeks, southern Indiana growers may nonetheless want to consider switching to earlier maturities to reduce their potential grain drying costs in the fall. Long-term plot data from Pioneer Hi-Bred International (Iragavarapu, 2003) indicates that the yield potential for late, medium, and early maturity hybrids becomes very similar as planting is delayed beyond June 10 in the central U.S. Corn Belt. Grain moisture differences at harvest, on the other hand, remain similar among the hybrid maturities, if not more dramatic, as planting is delayed.

Final Note of Caution: Growers who elect to switch to earlier maturity hybrids for mid- to late June plantings in southern Indiana must also remember to select hybrids with acceptable disease tolerance because of the greater risk of leaf diseases with late-planted corn (Vincelli, 2003). This is especially true if you are considering maturities unusually early, and therefore agronomically unadapted, for your location.

Related References

Iragavarapu, Raj. 2003. **Basing Hybrid Maturity Switches on Long-term Data.** Pioneer Hi-Bred International, Inc. Available online at <www.pioneer.com/growingpoint/agronomy/crop_insight/1012.jsp>. (URL verified 6/1/04). **Note that online access to this document requires free registration via Pioneer's GrowingPoint™ Web site.**

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Vincelli, Paul. 2003. **Risk of Leaf Disease in Late-Planted Corn.** Kentucky Pest News. Univ. of Kentucky. Available online at <www.uky.edu/Agriculture/kpn/kpn_03/pi030519.htm>. (URL verified 6/1/04).

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Soggy Soils, N Loss, & Supplemental Nitrogen Fertilizer for Corn - (Bob Nielsen)

Bottom Line

- Estimating N loss due to soggy soil events is a complicated procedure and not terribly accurate.
- Decisions about supplemental N fertilizer are further complicated when stand loss or plant stunting reduce the overall yield potential of a flood- or ponding-damaged field.
- Fields that eventually exhibit obvious N deficiency symptoms prior to pollination may benefit from a supplemental application of 30 to 50 lbs. of fertilizer N.
- Read on only if you want the gory details.

Torrential rainfall events in the past few weeks, particularly in southern Indiana, have caused some corn growers to question whether supplemental nitrogen fertilizer may be required because of their concern that some of the pre-plant nitrogen has been "lost" by leaching or denitrification. The question is a valid one because soil nitrogen in the nitrate form can disappear at rates as high as 5% per day of ponding or saturated soil conditions.

Unfortunately, the answer to the question is often clouded by many complicating factors. Among them are nitrogen fertilizer source, time of fertilizer application, soil temperatures since the time of application, use or not of a nitrification inhibitor, use or not of an urease inhibitor, calendar time since time of application, amount of rainfall, timing of rainfall, duration of saturated soil conditions, soil temperatures during the period of saturated soil conditions, and soil



texture. Add to this list the uncertainty regarding the yield potential of the corn that survived the soggy conditions.

Nitrogen fertilizer exists in several forms; including ammonium, urea, and nitrate. Since the nitrate form of soil nitrogen is the one vulnerable to loss by leaching or denitrification, estimating how much of the applied nitrogen fertilizer was in the nitrate form when the rainy period began is important to estimating how much nitrogen may have been lost.

Ammonium and urea forms of nitrogen eventually convert to the nitrate form via soil microbial processes. The rates of conversion are dependent on soil temperature and aeration. About one-fourth of urea-ammonium-nitrate solution (28% UAN) is already in the nitrate form and is susceptible to leaching or denitrification loss as soon as the material is applied to the field.

Urea can convert to the ammonium form of nitrogen in 4 to 7 days with warm soil temperatures and adequate soil moisture (Kissel, 1988). Once in the ammonium form, conversion to the nitrate form can occur in only one to two weeks with continued warm temperatures and, importantly, aerated soils (Brouder & Joern, 1998). Given that soil temperatures have averaged well above 60°F since early May for most of central Indiana and perhaps mid-April in parts of southern Indiana (Scheeringa, 2004), it is likely that UAN applied in March and April had converted nearly completely to the nitrate form of nitrogen prior to the soggy soil events of the last couple weeks.

Conversion of anhydrous ammonia to nitrate occurs more slowly because the anhydrous band itself is toxic to the soil microbes responsible for the conversion. The soil microbial population must rebuild over a several week period before the conversion to nitrate can begin and so nitrification is delayed from two to six

Table 4. Rate of conversion of ammonium to nitrate from date of application until May 25, 2004, for three Illinois locations.

Date of ammonia application	Percent of ammonia nitrified (present as nitrate at end of period)					
	Ammonia without N-Serve			Ammonia with N-Serve		
	DeKalb	Bondville	Brownstown	DeKalb	Bondville	Brownstown
November 1	85	90	100	55	65	88
December 1	60	65	100	45	55	70
March 15	50	60	100	20	30	53
April 1	35	40	48	15	20	48

Table originally published in Hoefl, 2004.

weeks (Brouder & Joern, 1998). Recognize that conversion of ammonium to nitrate is interrupted when soils become saturated.

Having said all that, let's return to the question of how much nitrogen loss has likely occurred so far this spring. Since the conversion of ammonium to nitrate is strongly temperature dependent, one can estimate conversion rates based on soil temperatures since the time of fertilizer application. Bob Hoefl (Univ. of Illinois) offers the following estimates of conversion from ammonium to nitrate forms of nitrogen for anhydrous ammonia application applied at four dates at three Illinois locations. The locations in the table represent northern (DeKalb), central (Bondville), and southern (Brownstown) areas of Illinois.

Acknowledging state-to-state differences in geography, soils, and climate; Indiana growers can nevertheless use the Illinois data to approximate rates of ammonium conversion to nitrate for areas of Indiana that correspond north/south with those areas of Illinois.

The next step in this tortuous estimation process is to predict the rate of denitrification loss during the past couple of weeks. According to Univ. of Illinois data (Hoefl, 2004), denitrification rates range from 1 to 2% per day at soil temperatures less than 55°F, 2 to 3% per day at soil temperatures between 55 and 65°F, and 4 to 5% per day at soil temperatures greater than 65°F. The latter, higher, rates are applicable to soggy soil events throughout most of Indiana during the past couple of weeks since soil temperatures have averaged 65°F or greater during that time period (Scheeringa, 2004).

Remember that the estimate of nitrogen loss is equal to the mathematical product of the estimated pounds of available soil nitrate multiplied by the estimated denitrification rate multiplied by the estimated number of days of saturated soil conditions. Example calculations of N loss estimates for three scenarios, each assuming an initial nitrogen fertilizer application rate of 180 lbs. N per acre and seven days of saturated soils, are listed here. Estimates of available nitrate are applicable for the late May time period.

Southern Indiana, UAN applications in late March or early April

- Amount of nitrate nitrogen ~ 180 lbs. total N x 100% = 180 lbs.
- Daily denitrification ~ 180 lbs. nitrate x 4% = 7.2 lbs. per day
- Total nitrogen loss ~ 7.2 lbs per day x 7 days = 50.4 lbs. N

Central Indiana, anhydrous (no inhibitor) applications in early April

- Amount of nitrate nitrogen ~ 180 lbs. total N x 40% = 72 lbs.
- Daily denitrification ~ 72 lbs. nitrate x 4% = 2.9 lbs. per day
- Total nitrogen loss ~ 2.9 lbs. per day x 7 days = 20 lbs. N

All of Indiana, UAN applied just prior to soil saturation (Remember, about 25% of UAN is already nitrate)

- Amount of nitrate nitrogen ~ 180 lbs. total N x 25% = 45 lbs.
- Daily denitrification ~ 45 lbs. nitrate x 4% = 1.8 lbs. per day
- Total nitrogen loss ~ 1.8 lbs. per day x 7 days = 12.6 lbs. N

These estimates of nitrogen loss can then be used to determine the rates of supplemental nitrogen that could be applied to the corn crop. As you might expect by now in this discussion, the decision about supplemental N fertilizer is not straightforward either because of uncertainties involved with the health of corn that has been subjected to ponding or saturated soils.

Frankly, the prospects for corn that has been ponded or subjected to saturated soils for more than three or four consecutive days are not positive at all. Similarly, corn that has suffered repeated ponding or flooding events would not be in good shape. Root death due to oxygen deprivation and/or disease will stunt or kill the waterlogged plants.

The worst of the wet holes or river bottoms will require replanting or will remain barren the remainder of this season. In many cases, the yield potential of the corn crop will be dramatically lower than hoped for and the remaining soil nitrogen levels are probably adequate to support that now lower yield level. Supplemental nitrogen fertilizer application would probably not be beneficial.

If you decide to apply supplemental nitrogen, remember that the very nature of flooding or ponding is spatial in its variability. If supplemental nitrogen fertilizer application was deemed to be economically valuable for the affected crop, the application itself will also need to be spatial and not performed over the entire field. The tire traffic involved with applying supplemental nitrogen to the affected spots in the field may damage otherwise healthy plants in the remainder of the field and create undesirable soil compaction.

You could elect to pull soil samples for a Pre-sidedress Soil Nitrate Test (PSNT) that may help predict the need for supplemental nitrogen. Information about this soil sample test can be found in the Purdue Extension publication AY-314-W (Brouder, 2003). Be aware, however, that the PSNT is best suited for estimating soil nitrogen availability in high organic matter soils or fields that have received manure applications. Use of the test for other situations has its limitations, including the fact that the standard 1-foot soil sample depth will not identify soil nitrate that may have leached to greater depths but is still available to plant roots. Additionally, the challenge of pulling representative soil samples in fields where pre-plant nitrogen fertilizer has already been applied is daunting because of the need to sample sequentially across the nitrogen applicator row widths. For suggestions on soil sampling such fields, read Bob Hoelt's suggestions.

Finally, you could forget all the discussion up to this point and instead monitor the surviving or replanted plants for symptoms of nitrogen deficiency. Areas of fields that exhibit distinct symptoms of nitrogen deficiency (leaf yellowing, especially if approaching ear leaf height) prior to pollination may benefit from roughly 50 lbs. of supplemental nitrogen. Sources and application methods for supplemental fertilizer application to tall corn are discussed in Bob Hoelt's article.

Related References

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Don't forget, this and other timely information about corn can be viewed at the Chat 'n Chew Café 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>.

Bits & Pieces

Diagnostic Training Workshops – (Corey Gerber, Director, Diagnostic Training Center) –

The Purdue University Crop Diagnostic Training and Research Center is known across the Midwest for its unique "hands-on" approach for teaching the art and science of accurately diagnosing agricultural crop problems.

The purpose of a diagnostic training workshop is two-fold. First, a workshop is an excellent way to improve agronomic field trouble-shooting skills. Second, a workshop is designed to increase the knowledge of management skills necessary to provide technical information to clientele.

At this Center, many small plot demonstrations illustrate insect, nematode, weed, disease, soil fertility, and cultural problems associated with corn, soybean, forage, and wheat production. Extension, research, and

teaching staff from Purdue University's departments of Agricultural and Biological Engineering, Agronomy, Botany and Plant Pathology, and Entomology, as well as other leaders in the agricultural community across the U.S., conduct each workshop. The Diagnostic Training Workshops provide pertinent information on interacting factors of nutrient, pest, and environmental stresses.

Due to the "hands-on" nature of these workshops, enrollment is limited to 60 people per day. Concurrent sessions of 20 to 30 registrants will limit class size and provide a better learning atmosphere. Additional information on the Purdue Crop Diagnostic Training and Research Center can be found at: <www.agry.purdue.edu/dtc/>. You can also download the workshop registration form <www.agry.purdue.edu/dtc/regist.html> and review the DTC calendar of events.

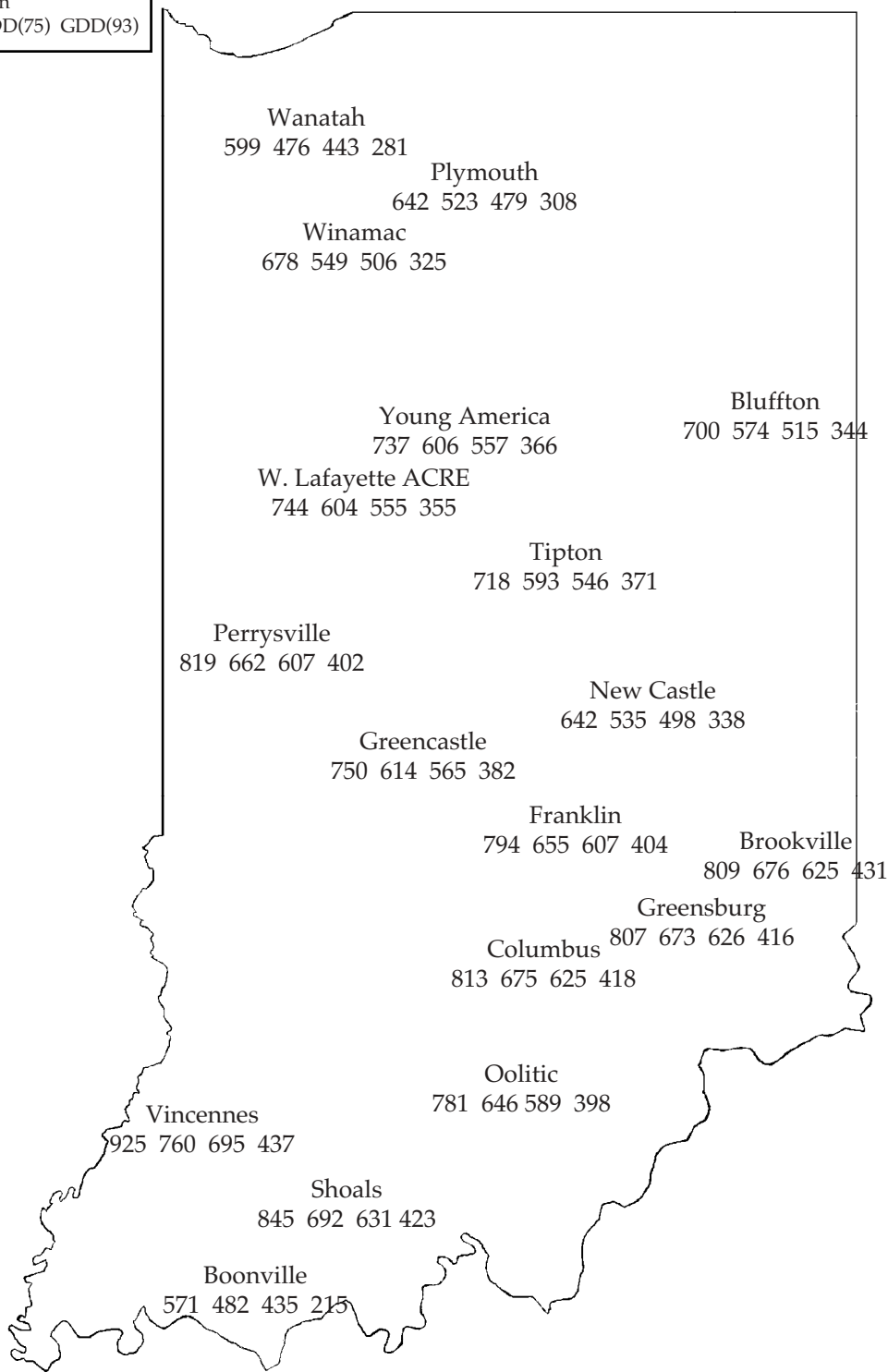
Weather Update

Temperatures as of June 2, 2004

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
 GDD(75) = Growing Degree Days from April 30 (75% of Indiana's corn planted), for corn growth and development
 GDD(93) = Growing Degree Days from May 14 (93% of Indiana's corn planted), for corn growth and development

4" Bare Soil Temperatures 6/3/04

MAP KEY			
Location			
GDD(5)	GDD(42)	GDD(75)	GDD(93)



Location	Max.	Min.
Wanatah	71	57
Winamac	71	60
Bluffton	63	61
Chalmers	68	62
W Laf Acre	76	63
Tipton	72	64
Farmland	69	62
Crawfordsville	73	66
Liberty	79	62

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