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In This Issue

Asiatic Garden Beetle Damage Reported in Northern Counties

(Christian Krupke) & *(John Obermeyer)*

Grubs of the Asiatic garden beetle have been recently found damaging corn seedlings in northern Indiana counties. As noted in the past, their presence and damage is highly associated with light-textured (i.e. sandy) soils, and is most prevalent in corn following soybean. There are no "rescue treatments" for this pest. In any event, grub damage will be tapering off as they have begun to pupate in the soil. As with many below-ground and cryptic pests, once you see the damage in the field, it's too late to do much about it.

Damaged corn seedling with 3 Asiatic garden beetle grubs.

Grubs compared, Japanese beetle (left) and Asiatic garden beetle (right).

Adults of the Asiatic garden beetle, present mostly in July and August, are somewhat undescribed in terms of their habits, because they are principally active at night. Decades-old literature suggest that the adult has nearly a hundred hosts, including a range of crops, flowers, and many weeds. We have heard stories, and seen video, of damaged plants/weeds being dug up to reveal hundreds of beetles "bubbling" out of the soil.

Research has focused upon what attracts beetles to crop fields to lay eggs in summer, causing grub problems the following spring. As mentioned, it is often soybeans planted on sandy, and or gravelly, soils. Many unknowns, e.g., tillage, growth stage, weeds (prevalence and species), row spacing, fertility, etc., may, or may not be factors in attracting beetles to lay eggs. We do know that the egg-laying period is so extended that attempts to apply foliar insecticides to deter beetles isn't feasible – application timings are not likely to encounter enough of the females to make a dent.

Thanks to those that have called and sent emails/pictures. Happy scouting!

Armyworm Pheromone Trap Report – 2022

(John Obermeyer)

County/Cooperator	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11
Dubois/SIPAC Ag Center	0	0	120	21	8	2	2	12	35		
Jennings/SEPAC Ag Center	0	0	10	2	2	5	0	0	2		

County/Cooperator	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11
Knox/SWPAC Ag Center	0	5	58	24	65	10	12	15	6		
LaPorte/Pinney Ag Center	0	24	11	44	12	16	9	19	5		
Lawrence/Feldun Ag Center	4	31	31	163	306	154	40	150	157		
Randolph/Davis Ag Center	0	0	0	0	23	35	10	43	10		
Tippecanoe/Meigs	0	5	19	70	58	84	3	35	10		
Whitley/NEPAC Ag Center	0	0	15	17	23	155	276	35	18		

Wk 1 = 4/1/22-4/6/22; Wk 2 = 4/7/22-4/13/22; Wk 3 = 4/14/22-4/20/22; Wk 4 = 4/21/22-4/27/22; Wk 5 = 4/28/22-5/4/22; Wk 6 = 5/5/22-5/11/22; Wk 7 = 5/12/22-5/18/22; Wk 8 = 5/19/22 – 5/25/22; Wk 9 = 5/26/22-6/1/22; Wk 10 = 6/2/22-6/8/22; Wk 11 = 6/9/22-6/15/22

A High Number Of Herbicide Drift Samples This Planting Season

(Marcelo Zimmer) & *(Bill Johnson)*

The corn and soybean planting season has been compressed significantly due to the frequent rain showers received during late April and May. Many growers across Indiana were rushing to get crops in the ground or burndown weedy fields during the small windows of suitable field conditions during May. With that said, we noticed that the total number of herbicide drift samples received at the Purdue Plant and Pest Diagnostic Lab (PPDL) has increased substantially for the month of May when compared to previous years (Table 1), especially when compared to 2020 and 2021. This high number observed in 2022 is likely the result of spray operations that were made during windy weather conditions.

Table 1. Total number of herbicide injury plant samples received by May 31 at the Purdue Plant and Pest Diagnostic Lab over the last 5 years.

Year	Number of Samples
2018	36
2019	35
2020	21
2021	19
2022	44

Synthetic auxin herbicides (2,4-D and dicamba) are the most common cause of off-target herbicide injury that we see with burndown herbicide applications. These herbicides can cause injury at very low exposure rates and affect many broadleaf plant species (including trees, ornamental, and garden plants). Symptoms of exposure include mostly leaf curling and stem twisting and affect mostly the newer tissues or growing points (Figure 1). Contact type herbicides such as paraquat (Group #22) and the PPO-inhibiting herbicides (Group #14: saflufenacil, flumioxazin, sulfentrazone, and fomesafen) are also often associated with herbicide drift concerns. Exposure to these herbicides will result in small and round necrotic spots on those leaves that are exposed to the spray droplets (Figure 2). See the publication "Diagnosing Herbicide Injury on Garden and Landscape Plants" for more information on herbicide injury diagnostics.

Figure 1. Synthetic auxin injury on tree leaves. (*Photo Credit: PPDL*)

Injury symptoms caused by drift of contact type herbicides. (*Photo Credit: PPDL*)

Herbicide applications under high wind speeds (above 10-15 miles per hour) can result in herbicide drift. This process can move herbicide particles hundreds of feet away from the application target and onto susceptible vegetation. Synthetic auxin herbicide molecules (2,4-D and dicamba) can also volatilize and move off-target for miles under air temperature inversion conditions. Air temperature inversions are more common within 1 to 2 hours after sunrise and before sunset or whenever wind speeds are below 3 miles per hour and air masses are stable (whenever the weather is "foggy" or smoke gets trapped near the soil surface). Pesticide applicators need to be aware of their surroundings and understand the environmental conditions that favor herbicide off-target movement to minimize this risk moving forward this season. Proper sprayer operation, nozzle selection, and the use of drift-reducing agents can also reduce the risk of pesticide drift. For more information on herbicide drift and volatility check out this article from our colleagues at the University of Missouri: "Off-target pesticide movement: a review of our current understanding of drift due to inversions and secondary movement".

Growth Stage Cutoffs For Herbicide Applications In Corn And Soybean

(Bill Johnson) & *(Marcelo Zimmer)*

After a delayed start to our planting season, we were able to plant both corn and soybean across the state in record or near-record time during May. This coincided with some timely rains and hot weather. This has allowed crops to emerge out of the ground quickly and rapidly progress through growth stages. We already have reports of knee high corn and rapidly growing soybeans across the state. This article serves as a reminder for growth stage, height restrictions, and pre-harvest interval cutoffs for herbicide applications in both crops.

Corn. There are a number of corn fields that did not receive a preemergence herbicide before the crops emerged from the ground. Many of these preemergence herbicides can also be applied postemergence. Some of the earliest cutoff timings are 8-inch corn for broadcast applications of 2,4-D, and any atrazine must be applied before corn reaches 12-inches in height. If corn is 12 inches or taller, the atrazine must be left out of the tank. See table 8 in the weed control guide for height and growth stage restrictions of postemergence herbicides in corn. Table 8 is also included at the end of this article as well.

Soybean. Even though we are still a few weeks away from the summer solstice, we are seeing soybeans starting to bloom in some locations that were able to plant in late April. Shawn Conley at the University of Wisconsin wrote a nice article explaining some causes behind this a few years ago (http://coolbean.info/2018/06/03/soybean-flowering-summer-solstice-fallacy/). What this means for herbicide applications, is that the window of application for some postemergence herbicides has either ended, or is about to end in those fields that are entering reproductive stages. We have heard reports that up to 65% of our soybean acres might be Enlist E3 which means it has the Roundup Ready, Liberty Link, and 2,4-D resistance trait. Up to 25% of our soybean acres could be Roundup Ready Xtendflex varieties, which means it has the Roundup Ready, Liberty Link, and dicamba resistance trait. The cutoff for glufosinate (Liberty, Cheetah, Interline, others) applications in Liberty-Link soybean is R1. In other words, once the soybeans are flowering, applying glufosinate is off-label. The cutoff for Engenia, FeXapan, and Xtendimax in Xtend soybeans is R1, or full flower or June 30th (federal label) or *June 20th if you are in Indiana*. With these flowering soybeans still being small in many areas, it is imperative to include residual herbicides in these postemergence applications to help reduce weed pressure until crop canopy. See table 18 in the weed control guide for the pre-harvest intervals of soybean herbicides. More information on soybean crop growth stage cutoffs can be found in the soybean section of the weed control guide under the short narratives for each herbicide. Table 18 which shows the soybean preharvest intervals is also included in this article.

Table 8. Rainfast Intervals, Spray Additives, and Crop Size for Postemergence Corn Herbicides

This table shows the required time interval between herbicide application and rainfall and summarizes label recommendations for spray additives and maximum crop stage. Check herbicide labels for additive rates. Information in this table applies to field corn only.

Herbicide	Rainfast Interval (hours)	Spray Additives/Maximum Crop Size (field corn)
2,4-D Amine	6-8	No additives. Broadcast up to 8-inch corn; directed spray before tassel stage.
2,4-D Ester	2-3	No additives. Broadcast up to 8-inch corn; directed spray before tassel stage.
Accent Q	4	MSO, COC or NIS (Addition of UAN or AMS is recommended). Broadcast up to 6 collars or 20-inch corn; directed spray up to 10 collars or 36-inch field corn.
Acuron GT	1	NIS + AMS. Broadcast up to 30-inch or 8-leaf corn.
Aim/Longbow	1	SURF. AMS or NIS may be added if required by tank-mix partner. Do not use COC or tank-mix with EC formulations of other crop protection chemicals except as specifically directed by label. Apply up to 8-collar corn.
Armezon PRO	1	MSO or COC plus UAN or AMS applied alone. NIS plus UAN or AMS in mixtures. Up to the V8 stage or 30-inch corn.
Atrazine	2	MSO or COC. Apply before corn is 12 inches tall.
Basagran	8	COC + UAN or AMS, depending on weed species present.
Bromoxynil	1	No additives. Apply before tassel emergence.
Bromoxynil + atrazine	2	No additives. Apply before corn is 12 inches tall.
Cadet	4	NIS, COC, or MSO. UAN or AMS can be added. Preplant up to 48 inches tall, and before tassel emergence.
Callisto Xtra	1	COC or NIS + UAN or AMS. Apply up to 12-inch corn.
Capreno	1	COC + UAN or AMS. Apply broadcast from 1-leaf up to 20-inch corn, and prior to V7 stage.
Coyote	1	NIS or COC. UAN or AMS may be added. Apply up to 8-leaf or 30-inch corn.
Dicamba	6-8	Add UAN if velvetleaf is present. NIS, COC, or UAN may be added under dry conditions. Do not apply with COC when corn height exceeds 5 inches. Broadcast up to 5-leaf stage or 8-inch corn; directed spray up to 36-inch corn.
Dicamba/atrazine	6-8	Add UAN if velvetleaf is present. NIS, COC, or UAN may be added under dry conditions. Do not apply with COC when corn height exceeds 5 inches. Apply broadcast up to 5-leaf stage or 8-inch corn.
DiFlexx	6-8	Can add NIS, COC, or MSO + UAN or AMS. Broadcast spray from spike through V10 stage and corn less than 36 inches tall.
DiFlexx DUO	4	COC or MSO is recommended, plus UAN or AMS. HSOC can also be used. Broadcast up to but not including V7 stage, and less than 30 inches tall; directed spray up to V10 or 36 inches tall, or 15 days prior to tassel, whichever occurs first.
Enlist One/Duo	24	See Enlist website for adjuvant information. Broadcast up to V8 or 30 inches, whichever occurs first; directed spray up to 48 inches.
Glufosinate	4	AMS. Broadcast or directed up V6; directed spray up to 36-inch corn.
Halex GT	1	NIS + AMS. Broadcast up to 30-inch or 8-leaf corn.
Halosulfuron	4	NIS, MSO, or COC. UAN or AMS may be added. Apply through layby stage of corn.
Harness Max	1	NIS or COC. UAN or AMS can be added. Popcorn—SURF only. Up to 11-inch corn.
Hornet	2	NIS, COC, or MSO. Include UAN or AMS under dry conditions. Broadcast up to V6 or 20-inch corn; directed spray up to 36-inch corn.
Impact/Armezon	1	MSO or COC + UAN or AMS. NIS can be used in mix with other herbicides. Broadcast or directed up to 45 days before harvest (Impact) or up to V8 stage (Armezon).
ImpactZ	4	MSO + UAN or AMS. NIS can be used in mix with other herbicides. Broadcast up to 12-inch corn
Impact Core	1	MSO or HSMOC + AMS or UAN. In mixtures with other herbicides, use NIS + AMS or UAN. Broadcast up to 11-inch corn.
Katagon	4	MSO, COC, or NIS. MSO is preferred. UAN or AMS can be added. Broadcast up to V5 or 20-inch corn, whichever occurs first.
Laudis	1	MSO + UAN or AMS. Broadcast up to V8 corn.
Laudis + atrazine	2	COC + UAN or AMS. Broadcast up to 12-inch corn
Mesotrione	1	COC + UAN or AMS. Apply up to 30-inch or 8-leaf corn.
Perpetuo	1	COC or MSO plus AMS or UAN. NIS may be used in mixtures. V2 to V6 stage.
Realm Q	4	NIS or COC + UAN or AMS. Broadcast or directed up to 20 inches and prior to the 7-collar stage.
Revulin Q	4	COC or HSOC + UAN or AMS. Broadcast up to V8 stage or 30 inches tall, whichever occurs first.
Resolve Q	4	NIS + UAN or AMS, unless mixed with a glyphosate product or Ignite. Broadcast up to 20-inch or 6 collar corn.
Resource	1	COC. UAN or AMS may be added to improve control of certain species. Apply up to the 10-leaf stage.
Restraint	1	NIS or COC. Broadcast up to 11-inch corn.
Shieldex	1	MSO (preferred) + UAN or AMS. COC or NIS can be used instead of MSO. Broadcast up to V6 or 20-inch corn.
Sinate	4	MSO + AMS. Broadcast up to 24 inches or V7; directed spray up to 36 inches.
Solstice	1	COC or NIS + UAN or AMS. COC is preferred adjuvant. Do not use MSO. Up to V8 or 30-inch corn.
Starane	1	An adjuvant can be used if required by tank-mix partner. Broadcast up to the V5 stage; directed spray after the V5 stage.
Status	4	NIS, COC, or MSO + UAN or AMS. Broadcast from 4- to 36-inch corn (rates up to 5 oz/A) or V2 to V8 stage
Steadfast Q	4	COC, MSO, or NIS + UAN or AMS. COC or MSO is preferred over NIS. Broadcast up to and including 6 collars or 20-inch corn
Stinger	6-8	No additives. Up to 24-inch corn.
Tough	1	NIC or COC; UAN or AMS can be added. Up to V8 stage.
WideMatch	6	No additives. Broadcast up to the V5 stage; directed spray after the V5 stage.
Yukon	4	NIS or COC. UAN or AMS may be added. Apply broadcast or directed up to 36-inch corn.

Table 8. Rainfast Intervals, Spray Additives, and Maximum Crop Size for Postemergence Corn Herbicides from the Weed Control Guide For Ohio, Indiana, and Illinois.

Table 18. Harvest and Feeding Intervals for Soybean Herbicides

Soybean Herbicides	Days to Harvest	
	Grain	Forage
Assure II/Targa	80	Do not feed
Basagran	30	30
Basagran + 2,4-DB	60	60
Basagran + Reflex	Apply prior to bloom	Do not feed
Basagran + Cobra	90	Do not feed
Cadet	60	Do not feed
Classic	Apply 60 days before maturity	Do not feed
Clethodim	60	Do not feed
Cobra	45	Do not feed
Engenia	Apply through June 30	7
Enlist One/Duo	Appy no later than R2 stage	Do not feed
Extreme/Thunder Master	Apply prior to bloom and 85 days before harvest	Do not feed
FirstRate	70	25
Fomesafen	45	Do not feed
Fusilade DX	Apply prior to bloom	Do not feed
Glufosinate	70	Do not feed
InterMoc	Apply prior to bloom	Do not feed
Poast	75	Do not feed[1]
Perpetuo	60	Do not feed
Prefix/Vise	90	Do not feed
Pursuit	85	Do not feed
Raptor	85 and apply prior to bloom	Do not feed
Resource	60	Do not feed
Storm	50	Do not feed
Synchrony XP	Apply 60 days before maturity	Do not feed
Tavium	Apply through V4 or June 30	Do not feed (POST)
Thifensulfuron	60	Do not feed
Torment	85	Do not feed
Ultra Blazer/Avalanche Ultra	50	Do not feed
Warrant Ultra	45	Do not feed
XtendiMax	Apply up to R1 or through June 30	7

[1]Soybean hay may be fed.

Table 18. Harvesting and Feeding Intervals for Soybean Herbicides from the Weed Control Guide For Ohio, Indiana, and Illinois.

Is Your Hay Too Hot? (TABLE REVISION)

(Keith Johnson)

Much hay has been made in Indiana the last two weeks and much forage remains to be harvested. It is important to package hay at the correct moisture content to avoid excessive heating of bales when in storage. Target moisture to begin baling hay without an effective preservative is 20 percent, 18 percent and 17 percent for small rectangular bales, large round bales, and large rectangular bales, respectively. Excessive heating can result in mold formation by microorganisms, the binding of amino acids to soluble sugars that results in reduced available protein, reduced forage quality, and the possibility of storage structure fires.

Moldy hay caused by microorganisms because hay was made at too high a moisture content. (*Photo credit: Brooke Stefancik, Purdue ANR Educator-Sullivan County*)

It is quite normal for a temperature rise to occur after hay is packaged, but anything greater than 125 degrees F should be intently monitored. My observation has been that hay producers are watchful of the possibility of "hot" hay for several days after it is put into storage. After this time, the hay may be assumed to be okay and not monitored again. *With hay storage structure fires, it may take three to four weeks before spontaneous combustion occurs. It is important to note temperature for an extended period of time and not just for a few days.*

Hay in the foreground was removed from the hoop building because it was smoldering. (*Photo Credit: Keith Johnson*)

Temperature probes are available through many agricultural vendors. An online search will provide many resources to consider. The probe should be strong so it can penetrate through tightly packed bales to a length of around six feet preferred. Options for making a probe that permits thermometer insertion on a string can also be found with an online search.

The following table provides temperature values and action steps that should be considered when hay is put into storage.

Critical temperature and action steps for hay in storage.

125°F Or Lower	Action Steps
125°F	**No action needed.**
150°F	**Entering the danger zone.** Check temperature twice daily. If possible, disassemble stacked hay to allow more air to move around and cool heated bales.
160°F	**Reaching the danger zone.** Check temperature every couple of hours. If possible, disassemble stacked hay to allow more air to move around and cool heated bales.
175°F	**Hot spots or fire pockets are likely.** Continue to check temperature frequently. If possible, stop all air movement around hay. Alert fire service of possible hay fire incident.
190°F	**Fire is likely.** Remove hot hay with fire service assistance. The fire service should be prepared for the hay to burst into flames as it contacts fresh air.
200°F or higher	**Fire is imminent.** Remove hot hay with fire service assistance. The fire service should be prepared for the hay to burst into flames as it contacts fresh air.

Source: Extinguishing Fires in Silos and Hay Mows (Natural Resource, Agriculture, and Engineering Service publication NRAES-18).

Much effort goes into the production of high quality hay. Don't let the effort "go up in smoke"!

Effects Of Flooding Or Ponding On Corn Prior To Tasseling

(Bob Nielsen)

BOTTOM LINE: The consequences of flooding, ponding, and saturated soils on young corn depend heavily on the duration of the stress and temperatures.

High water sign. (*Photo Credit: R.L. Nielsen*)

Intense rainfall events (colloquially referred to as "toad stranglers" or "goose drownders") flood low-lying corn fields and create ponding (standing water) in poorly drained areas (depressions, compacted soil) within other fields. Other areas within fields, while technically not flooded or ponded, often remain saturated for lengthy periods of time. Recurrent heavy rainfall events simply "add insult to injury" by re-wetting, re-ponding, and re-flooding the same areas of the fields.

What are the prospects for recently submerged corn fields or plants simply enduring days and days of saturated soils? The flippant answer is that suffering crops will survive until they die.

What I really mean is that no one can tell you with certainty the day after the storm whether a ponded area of a corn field will survive or whether there will be long-term yield consequences until enough time has gone by such that you can assess the actual recovery of the damaged plants. We can, however, talk about the factors that increase or decrease the risks of severe damage or death to flooded soils.

Plant death by submersion. (*Photo Credit: R.L. Nielsen*)

- Plants that are completely submerged are at higher risk than those that are partially submerged.
    - Plants that are only partially submerged may continue to photosynthesize, albeit at limited rates.

- The longer an area remains ponded, the higher the risk of plant death.
    - Soil oxygen is depleted within about 48 hours of soil saturation. Without oxygen, the plants cannot perform critical life sustaining functions; e.g. nutrient and water uptake is impaired and root growth is inhibited (Wiebold, 2013).
    - Many agronomists will tell you that young corn can survive up to about 4 days of outright ponding if temperatures are relatively cool (mid-70's F or cooler); fewer days if temperatures are warm (mid-70's F or warmer).
- Even when surface water subsides quickly, the likelihood of dense surface crusts that form as the soil dries increases the risk of emergence failure for recently planted crops.
    - Be prepared with a rotary hoe to break up the crust and aid emergence. For those "youngsters" among you who do not know how to use a rotary hoe, see Hanna et al. (2001).
- The greater the deposition of mud or old crop residues on plants as the water subsides, the greater the stress on the plants due to reduced photosynthesis.
    - Ironically, such situations would benefit from another rainfall event to wash the mud deposits from the leaves.
- Mud and crud that cakes the leaves and stalks encourage subsequent development of fungal and bacterial diseases in damaged plant tissue. In particular, bacterial ear rot can develop when flood waters rise up to or above the developing ears of corn plants (Nielsen, 2003).
- Corn younger than about V6 (six fully exposed leaf collars) is more susceptible to ponding damage than is corn older than V6.
    - This is partly because young plants are more easily submerged than older taller plants and partly because the corn plant's growing point remains below ground until about V6. The health of the growing point can be assessed initially by splitting stalks and visually examining the lower portion of the stem (Nielsen, 2019a). Within 3 to 5 days after water drains from the ponded area, look for the appearance of fresh leaves from the whorls of the plants.
- Extended periods of saturated soils AFTER the surface water subsides will take their toll on the overall vigor of the crop.
    - Some root death will occur and new root growth will be stunted until the soil dries to acceptable moisture contents. As a result, plants may be subject to greater injury during a subsequently dry summer due to their restricted root systems.
    - Nutrients like nitrogen are rapidly remobilized from lower leaves to upper, newer leaves; resulting in a rapid development of orange or yellow lower leaves.
    - Because root function in saturated soils deteriorates, less photosynthate is utilized by the root system and more accumulates in the upper plant parts. The higher concentration of photosynthate in the stems and leaves often results in dramatic purpling of those above-ground plant parts (Nielsen, 2017).
    - As more of the root system dies, the ability of the affected plants to take up water decreases and, ironically, the plants begin to show signs of drought stress (leaf rolling, plant wilting, leaf death).
    - Damage to the root system today will predispose the crop to the development of root and stalk rots later by virtue of the photosynthetic stress imposed by the limited root system during the important grain filling period following pollination. Monitor affected fields later in August and early September for the possible development of stalk rots and modify harvest-timing strategies accordingly.
- Concomitant (I found a new word in the dictionary!) with the direct stress of saturated soils on a corn crop, flooding and ponding can cause significant losses of soil nitrogen (N) from either denitrification of nitrate-N in heavier soils or leaching of nitrate-N in coarser soils. See Camberato & Nielsen (2017) for advice on sampling soils to estimate remaining soil nitrogen.
    - Significant loss of soil N will cause nitrogen deficiencies and possible additional yield loss.
    - On the other hand, if the corn dies in the ponded areas it probably does not matter how much nitrogen you've lost.
- Lengthy periods of wet soil conditions favor the development of seedling blight diseases in young corn seedlings, especially those caused by Pythium fungi (Sweets, 2014).
    - Fungicidal seed treatments effectively protect the seed and seedling for only about 3 weeks after planting. After that, especially if seedling development has been delayed by cold or excessive soil moisture, the risk of infection increases quickly. Fields that looked acceptable one week can be devastated by seedling blight by the next week if conditions are favorable for the disease and seedling development has not yet reached about V3 to V4.
    - Poorly drained areas of fields are most at risk for the development of these diseases and so will also be risky for potential replant operations.
- The risk of diseases like common smut and crazy top also increases when soils are saturated or plants are submerged and temperatures are cool (Pataky and Snetselaar, 2006; Jackson-Ziems, 2014).
    - The fungus that causes crazy top depends on saturated soil conditions to infect corn seedlings.
    - The common smut fungal organism is ubiquitous in soils and can infect young corn plants through tissue damaged by floodwaters. There is limited hybrid resistance to either of these two diseases and predicting damage is difficult until later in the growing season.
- Wind damage to corn during severe storms results in either stalk breakage (aka "green snap") or root lodging (plants uprooted and laying nearly flat to the ground). The risk of permanent damage is greater during late vegetative development and less with younger plants.
    - The yield effect of "green snap" damage depends on

the percentage of field affected and whether the stalk breakage occurs above or below the ear, but is usually serious regardless. Obviously, stalk breakage below the ear results in zero yield for that plant. Stalk breakage above the ear results in significant yield loss due to the loss of upper canopy photosynthesis capacity for that plant.

- Root lodged corn will recover or straighten up to varying degrees depending on the growth stage of the crop. Generally, younger corn has a greater ability to straighten up with minimal “goose-necking” than older corn. Yield effects of root lodging depend on whether soil moisture remains adequate for root regeneration, the severity of root damage due to the uprooting nature of root lodging, and the degree of “goose-necking” that develops and its effect on the harvestability of the crop.

Orange lower leaves due to rapid remobilization of mobile nutrients to upper canopy. (*Photo Credit: R.L. Nielsen*)

Leaf rolling and wilting above ground in response to roots dying below ground from excessive soil moisture. (*Photo Credit: R.L. Nielsen*)

Related Reading

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Prevalent Purple Plants Perennially Puzzle Producers

(Bob Nielsen)

BOTTOM LINE: Purpling of corn plant tissue, by itself, does not decrease yield. The cause of the purpling determines whether yield loss will eventually occur.

Like the swallows that return every year to San Juan Capistrano, it seems that purpling of young corn plants returns every year to more than a few fields in Indiana. While ornamentally attractive, the sudden appearance of the pretty purplish hue in young corn fields, clearly evident from the window of the pickup tooling down country roads at 60 mph, often causes grief and consternation for landlords and tenants alike because we all know that "*corn ain't supposed to be purple!*".

Biochemical Cause of Purpling. Purpling of corn plant tissue results from the formation of reddish-purple anthocyanin pigments that occur in the form of water-soluble cyanidin glucosides or pelargonidin glucosides (Holton & Cornish, 1995). A hybrid's genetic makeup determines whether corn plants are capable of producing anthocyanin. A hybrid may have none, one, or many genes that can trigger production of anthocyanin. That is the reason why purpling may appear in only one of two hybrids planted in the same field. Purpling can also appear in the silks, anthers and even coleoptile tips of a corn plant. The reddish-purple prevalent in some varieties of Indiana corn also results from anthocyanin accumulation.

Agronomic Cause of Purpling. Well, you may say, that's fine but what triggers the production of the anthocyanin pigments in young corn at this time of year? The answer is not clearly understood, but most agree that these pigments develop in young plants in direct response to a number of stresses that limit the plants' ability to fully utilize the photosynthates produced during the day.

It has been my experience that the most common factors that correlate with the development of purple corn plants is the combination of bright, sunny days and less than favorable cool nights (40's to 50's F) when corn plants are in the V3 to V6 stages of development (3- to 6-leaf collar stages). This combination translates to a lot of photosynthate produced during the day, but low rates of photosynthate metabolism during the night. That combination of weather factors results in high concentrations of sugary photosynthates in the leaves. Since the anthocyanin occurs in the form of a sugar-containing glucoside, the availability of high concentrations of sugar in the leaves (photosynthesis during bright, sunny days) encourages the pigment formation. Hybrids with more anthocyanin-producing genes will purple more greatly than those with fewer "purpling" genes. In most cases, the purpling will slowly disappear as temperatures warm and the plants transition into the rapid growth phase (post-V6).

Other stresses that restrict photosynthate metabolism in young corn plants and result in purple corn include several that restrict root growth, including herbicide injury, soil phosphorus deficiency, soil compaction caused by tillage or planter traffic, excessively wet soils, excessively dry soils, insect injury, and disease injury. The negative effects of such root stresses on photosynthate metabolism can amplify the intensity of the purpling already triggered by a combination of cool nights and bright, sunny days.

Does the Leaf Purpling Result in Yield Losses? It is important to recognize that the cause of leaf purpling, not the purpling itself, will determine whether yield loss will occur. If the main cause is simply the combination of bright, sunny days and cool nights, then the purpling will disappear as the plants develop further, with no effects on yield.

If the major contributor to the purpling is restriction of the developing root system, then the potential effects on yield will depend on whether the root restriction is temporary (e.g., cool temperatures and wet soils) or more prolonged (e.g., soil compaction, herbicide injury). Young plants can recover from temporary root restrictions with little to no effect on yield. If the restriction of the root development lingers longer and plants become stunted, then some yield loss may occur… not because of the purpling, but rather because of the effects of the lingering root restriction and eventual stunted plants.

If the primary cause of the purpling is the hybrid's genetic response to the combination of cool nights and bright, sunny days, then the purpling symptoms will be more spatially uniform throughout a field. If other stress factors are also restricting root development and/or function, then the purpling symptoms may be spatially variable throughout the field and correlated to soil type, drainage characteristics, or elevation of the landscape. Spatially variable patterns of purple corn may indicate the potential for lingering, yield-limiting stresses that should be more thoroughly investigated.

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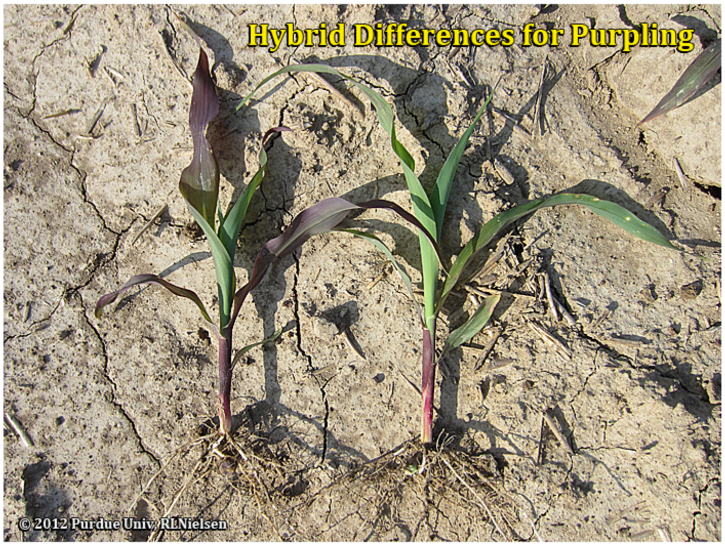
Intense purpling of a leaf.

Purpling of lower few leaves.

Intense purpling of a late V3 plant.

Rows of purple-leafed corn; late V3 stage of development.

Nearby field with no purpling; same leaf stage.



Hybrid differences for purpling; both plants V3.

Spatial field variability for leaf purpling.

Hybrid differences for purpling.

Make Nitrogen Work For You, Not Against The Climate

(Dr. Jeffrey Dukes), (Beth Hall), (Melissa Widhalm), (Hans Schmitz) & *(Austin Pearson)*

Farming for a Better Climate

According to the United States Environmental Protection Agency, soil management practices contribute 68% of total agriculture industry greenhouse gas (GHG) emissions. Tillage and nutrient management influence microbial interactions which cause nitrogen (N2) or nitrous oxide (N2O) emissions through denitrification. Remember our friend, the Nitrogen Cycle? Microbial organisms mineralize nitrogen into usable forms for plant uptake. Depending on weather patterns, these forms can either leach or escape into the atmosphere. Unfortunately escaping N2O can survive in the atmosphere for over 100 years and has a global warming potential 300 times greater than carbon dioxide (CO2). While we can't abandon fertilizers outright due to increasing food demand, we can optimize nutrient management strategies. A concept called the 4R's of Nutrient Management: Right Source, Right Rate, Right Time, and Right Place was developed to optimize the industry's approach. These four components rely upon each other to maximize yield potential, economic opportunity, and reduce negative environmental impacts.

Right Source – This is the fertilizer selected to meet plant nutrient needs, considering soil chemical and physical properties, nutrient interactions, fertilizer blend compatibility, and nutrient forms available to the plant. When considering nitrogen sources there is not a significant difference between fertilizer source and increased N2O emissions, but varying site conditions may be a factor. Wet weather may enhance the denitrification process, leading to greater nitrogen losses. Utilizing slow release fertilizers or nitrogen stabilizers may reduce these losses. Manure applications were shown to have higher N2O and CO2 emissions compared to inorganic fertilizer sources. The largest emission contribution comes during the manufacturing processes, where ammonium nitrate production causes higher methane (CH4), N2O, and CO2 emissions compared to the production of ammonia and urea.

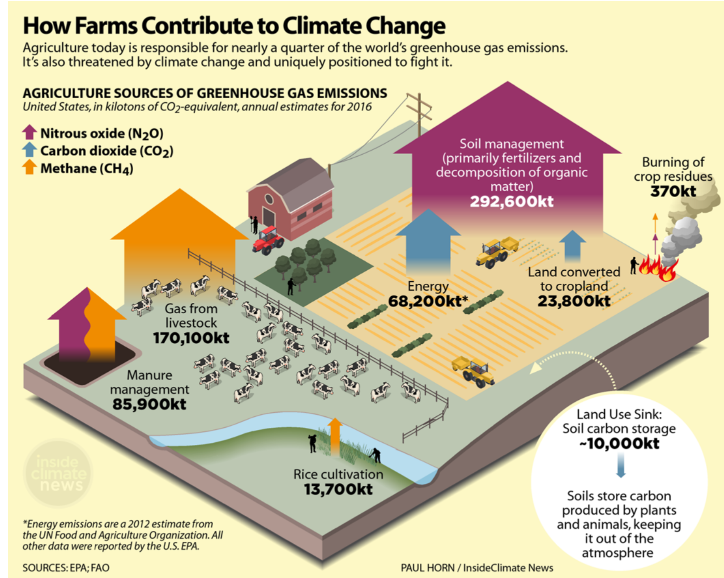
Right Rate – Discusses the amount of fertilizer applied, ideally determined by crop nutrient needs and soil test results. Determining appropriate nitrogen rates is a difficult task that comes down to a balance between the credit from the previous year's crop, how much the crop can uptake, and economics. If nitrogen applications exceed optimum rates, then excessive nutrients may increase GHG emissions and groundwater leaching. Due to rate concerns the Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat, and Alfalfa were developed. Further, each state has different protocols tying fertilizer costs, grain prices, and optimum rates for particular regions.

Right Time – Applying nutrients when needed. Plant growth characteristics, nutrient deficiencies, soil characteristics, weather forecasts, and planting dates should be considered. Limiting the time nutrients spend in the ground before uptake results in less loss. Whether doing a preplant application or side-dress, producers follow this practice to provide timely nitrogen as the crop needs it. Additional applications throughout the growing season may be necessary. Fall nitrogen applications should be avoided.

Right Place – Placing nutrients where crops can access the plant-available form. Placement is dependent on several factors: plant genetics, technology, tillage practices, plant spacing, crop rotations, and weather. Global Position System (GPS) technology has improved and helps prevent skips and over-application. Considering in-furrow, pop up, or 2×2 placement can improve crop use efficiency. Regarding application depth, shallower applications can reduce N2O emissions by 26 percent. It was reported that emissions were lower with 4-8" application depths compared to deeper 12" placement. However, surface applied urea also showed increased N2O emissions compared to shallow applications indicating some soil incorporation was beneficial.

Implementing the 4R's of Nutrient Management makes practical sense as it may reduce input costs and it benefits the environment. There are many resources available if you are considering implementation. All are encouraged to check out the Tri- State Fertilizer Recommendations for Corn, Soybeans, Wheat, and Alfalfa. The Fertilizer Institute's Nutrient Stewardship resources are also an excellent starting point.

Farming for a Better Climate is written in collaboration by the Purdue Extension, the Indiana State Climate Office, and the Purdue Climate Change Research Center. If you have questions about this series, please contact in-sco@purdue.edu.



This graphic shows several ways synthetic fertilizers contribute to climate change and environmental degradation: 1) soil microbial conversion of nitrogen fertilizers to nitrous oxide (a potent greenhouse gas), 2) nitrate runoff into water bodies fueling algal blooms, 3) leaching of nitrates into the soil and contaminating groundwater, and 4) greenhouse gas emissions from the manufacturing of synthetic fertilizers. This graphic appeared in an October 2018 article from Inside Climate News by Paul Horn.

Meteorological Summer Begins

(Beth Hall)

June 1st marked the beginning of meteorological summer (i.e., June, July, and August). Time between sunrise and sunset is still increasing, temperatures are increasing, and vegetation is growing. How did this past spring compare to climatology and what is expected over the next several months?

Let us start with May's climatology. May's average temperature across Indiana was 2-4 degrees warmer than normal. These warmer temperatures were reflected in both the average maximum and minimum temperature, as well. Last month's precipitation total was above normal throughout most of Indiana except for the counties along the Ohio River and the northwestern part of the state. This has led to the US Drought Monitor designating the first introduction of "Abnormally Dry" conditions in Indiana since last October (Figure 1)!

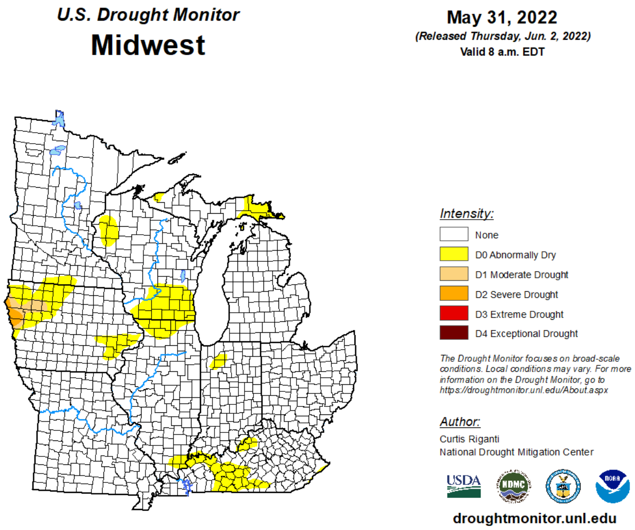


Figure 1. US Drought Monitor showing the introduction of Abnormally Dry (D0) conditions for a few counties in northwestern Indiana and a slight spillover of Abnormally Dry conditions in far southwestern Indiana as of May 31, 2022.

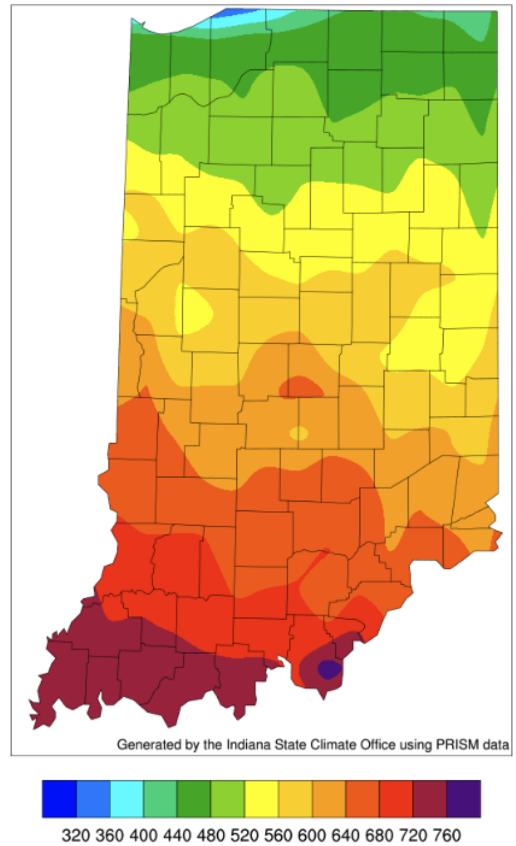


Figure 2. Modified growing degree day (50°F / 86°F) accumulation from April 15-June 1, 2022.

For this past spring (March-April-May), the similar pattern for precipitation occurred as for May where central and northeastern Indiana were near normal to slightly above normal, yet the southern and northwestern counties were drier than normal. What is interesting, however, is while total amounts were near normal, the number of wet days seemed to be greater than normal, meaning fewer field days and chances for the soils to dry up. This was a great example of how the timing and intensity of precipitation may be more important than total amounts, depending upon the application of interest. The average spring temperature was slightly below normal for northwestern Indiana and within 2 degrees above normal across the rest of the state.

Climate outlooks for June are indicating too much uncertainty regarding temperature and precipitation. However, above-normal temperatures are favored for the June-July-August period with equal chances of having above-, below-, or near-normal precipitation amounts. This propensity of uncertainty is likely due to the current La Niña event weakening without fully transitioning to another phase (i.e., Neutral or El Niño). These phases already have weak correlation to weather in the Midwest region, but with the current phase already weak, there are challenges to predicting with high confidence how the climate is likely to be over the next several months.

Modified growing degree-day accumulations are progressing faster in southern Indiana than in northern Indiana when considering a start date of April 15th. Central and southern Indiana has areas where the GDD accumulations are 40-60 units above the 1991-2020 climatological average for this time of year, whereas northern Indiana is only 10-30 units below average (Figures 2 and 3).

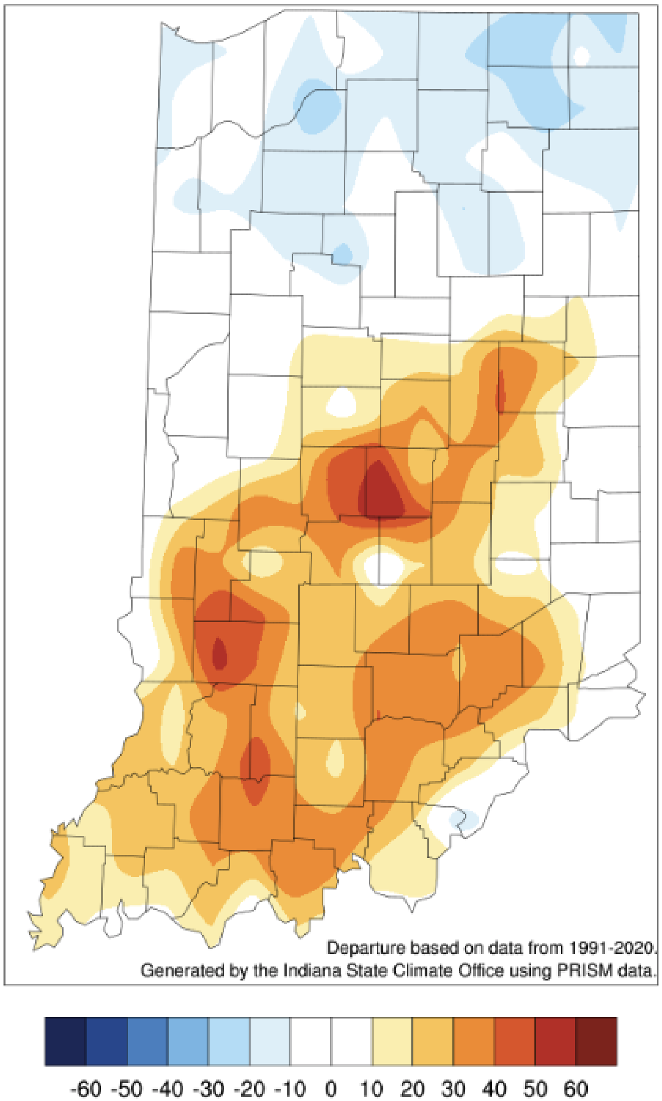


Figure 3. Modified growing degree day (50°F / 86°F) accumulation from April 15-June 1, 2022, represented as the departure from the 1991-2020 climatological average.

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