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Pest&Crop newsletter

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In This Issue

Sweep Net Time For Potato Leafhopper

(Christian Krupke) & *(John Obermeyer)*

Potato leafhopper populations have been increasing with the warming temperatures and dry weather in most areas of the state. With their characteristic yellowing-damage, is obvious that management of this pest is being neglected while driving the countryside. Alfalfa pest managers should begin sampling their alfalfa shortly after cutting.

Characteristic yellowing, "hopper burn," damage to alfalfa. (*Photo Credit: John Obermeyer*)

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.

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. Be sure to scout the alfalfa regrowth for leafhoppers shortly after cutting and removal, as this is one of the more critical periods.

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* which can be viewed HERE.

Abbreviated Management Thresholds for Potato Leafhoppers	
Alfalfa Stem Height In Inches	**Leafhoppers (Adults/Nymphs) Average Number Per Sweep**
Under 3	02
4 – 6	0.5
7 – 12	1.0
Greater than 12	1.5

2023 Western Bean Cutworm Pheromone Trap Report

(John Obermeyer)

		WBC Trapped						
County	**Cooperator**	**Wk 1 6/15/23 - 6/21/23**	**Wk 2 6/22/23 - 6/28/23**	**Wk 3 629/23 - 7/5/23**	**Wk 4 7/6/23-7/12/23**	**Wk 5 7/13/23 - 7/19/23**	**Wk 6 7/20/23 - 7/26/23**	**Wk 7 7/27/23 - 8/2/23**
Adams	Roe/Mercer Landmark, Decatur	0	0					
Allen	Anderson/Blue River Organics, Churubusco	2	1					
Allen	Gynn/Southwind Farms, Ft. Wayne	2	0					
Allen	Kneubuhler/G&K Concepts, Harlan	0	1					
Bartholomew	Bush/Pioneer Hybrids, Columbus	0	0					
Benton	Nally/Dairyland Seeds, Remington							
Benton	Vickrey/Advanced Agrilytics, Trap 1	0	3					
Benton	Vickrey/Advanced Agrilytics, Trap 2	0	0					
Benton	Vickrey/Advanced Agrilytics, Trap 3	1	0					

County	Cooperator	WBC Trapped Wk 1 6/15/23 - 6/21/23	Wk 2 6/22/23 - 6/28/23	Wk 3 629/23 - 7/5/23	Wk 4 7/6/23-7/12/23	Wk 5 7/13/23 - 7/19/23	Wk 6 7/20/23 - 7/26/23	Wk 7 7/27/23 - 8/2/23
Benton	Vickrey/Advanced Agrilytics, Trap 4	4	0					
Benton	Vickrey/Advanced Agrilytics, Trap 5	1	0					
Benton	Vickrey/Advanced Agrilytics, Trap 6	2	0					
Benton	Vickrey/Advanced Agrilytics, Trap 7	2	0					
Benton	Vickrey/Advanced Agrilytics, Trap 8	0	0					
Blackford	Thurman/Ceres Solutions, Warren	0	0					
Clay	Mace/Ceres Solutions, Brazil	0	0					
Clay	Fritz/Ceres Solutions, Clay City	0	0					
Daviess	Brackney/Daviess Co. CES, Montgomery							
Dubois	Eck/Dubois Co. CES, Jasper	0	0					
Elkhart	Kauffman/Crop Tech Inc., Millersburg	0	o					
Fountain	Mroczkiewicz/Syngenta, Attica	4	5					
Hamilton	Campbell/Beck's Hybrids	0	0					
Hendricks	Nicholson/Nicholson Consulting, Danville							
Hendricks	Tucker/Bayer, Brownsburg							
Howard	Shanks/Clinton Co. CES, Kokomo	0	0					
Jasper	Overstreet/Jasper Co. CCSI, Wheatfield	1	8					
Jasper	Ritter/Dairyland Seeds, McCoysburg							
Jay	Boyer/Davis PAC, Powers	0	2					
Jay	Shrack/Ran-Del Co-Alliance, Parker City	0	0					
Jennings	Bauerle/SEPAC, Butlerville	0	0					
Knox	Clinkenbeard/Ceres Solutions, Edwardsport	0	3					
Knox	Edwards/Ceres Solutions, Fritchton	0	0					
Kosciusko	Jenkins/Ceres Solutions, Mentone	0	0					
Lake	Kleine/Rose Acre Farms, Cedar Lake	0	0					
Lake	Moyer/Dekalb Hybrids/Shelby	3	1					
Lake	Moyer/Dekalb Hybrids/Schneider	1	1					
LaPorte	Deutscher/Helena Agri, Hudson Lake							
LaPorte	Rocke/Agri-Mgmt. Solutions, Wanatah	1	0					
Miami	Early/Pioneer Hybrids, Macy	0	2					
Montgomery	Delp/Nicholson Consulting, Waynetown	0	0					
Newton	Moyer/Dekalb Hybrids, Lake Village	0	0					
Perry	Lorenz/Lorenz Farms, Rome 1	0	0					
Perry	Lorenz/Lorenz Farms, Rome 2	0	0					
Porter	Boyer/PPAC, Wanatah	0						
Posey	Schmitz/Purdue CCSI, Blairsville	0						
Posey	Schmitz/Purdue CCSI, Cynthiana	0						
Pulaski	Capouch Chaffins/M&R Ag Services, Medaryville	0	0					
Pulaski	Leman/Ceres Solutions, Francesville	0	0					
Putnam	Nicholson/Nicholson Consulting, Greencastle	1	0					
Randolph	Boyer/DPAC, Farmland	0	2					
Rush	Schelle/Falmouth Farm Supply Inc., Carthage	0	0					
Scott	Tom Springstun/Scott Co. CES, Scottsburg	0	1					
Shelby	Fisher/Shelby County Coop, Shelbyville							
St. Joseph	Carbiener, Breman	0						
St. Joseph	Deutscher/Helena , New Carlisle							
Starke	Capouch Chaffins/M&R Ag Services, Monterey	0	0					
Starke	Capouch Chaffins/M&R Ag Services, San Pierre	0	0					
Sullivan	McCullough/Ceres Solutions, Farmersburg	0	0					
Sullivan	McCullough/Ceres Solutions, Dugger	0	0					
Tippecanoe	Bower/Ceres Solutions, Lafayette	10	48					
Tippecanoe	Nagel/Ceres Solutions, W. Lafayette	0	0					
Tippecanoe	Obermeyer/Purdue Entomology, ACRE	0	0					
Tippecanoe	Vickrey/Advanced Agrilytics, Trap 1	1	1					
Tippecanoe	Vickrey/Advanced Agrilytics, Trap 2	0	0					
Tippecanoe	Westerfeld/Bayer Research, W. Lafayette	0	0					
Tipton	Campbell/Beck's Hybrids	0	0					
Vigo	Lynch/Ceres Solutions, Clinton	0	1					
Whitley	Emley/NEPAC/Schrader	0	0					
Whitley	Emley/NEPAC/Kyler	0	0					

* = Intensive Capture…this occurs when 9 or more moths are caught over a 2-night period

Time To Scout For Diseases In Field Crops: What To Look For In Corn

(Darcy Telenko)

We Have NOT Found Active Tar Spot In Indiana yet.

Corn growth stages are quite variable across Indiana but a number of areas with early planted corn about waist high. Recent news that tar spot was found in Iowa, Missouri, and Kansas means that we need to start to monitoring for disease in Indiana to make an informed decision if a fungicide is necessary. The hot and dry conditions in May and most of June kept foliar disease at bay, but **recent rains may have made conditions conducive for many** therefore it is now time to **get out and scout**. As a reminder for disease to occur, three things need to be present **1. Pathogen, 2. Host, and 3. Favorable Environment.** The major diseases we monitor in Indiana such as gray leaf spot, northern corn leaf blight, northern corn leaf spot, and tar spot all might start to make an appearance in the next couple of weeks (figure 1 and 2).

As of June 26, 2023 we have not found or had any reports of tar spot in Indiana.

A few questions to think about when scouting and looking for disease:

1. What is the disease history in the field? How much residue is still present? (What happened in previous years?)
2. What growth stage is the field? Early planting vs. late.
3. Is irrigation being applied? How much and how often? If water is being applied, it can change the environmental conditions and disease risk in a field.

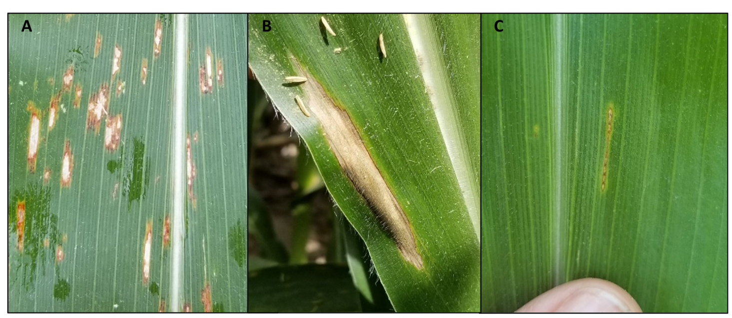


Figure 1. Examples of A- gray leaf spot, B-northern corn leaf blight, and C-northern corn leaf spot lesions on a corn leaf. (*Photo Credits: Darcy Telenko*)

Tar spot continues to be a concern this season. In our scouting rounds last week, we did not find any. Tar spot may be hard to find early Figure 2 shows how small the initial tar spot lesions (stroma) will be. Previously, we usually find the stroma in fully-expanded leaves knee to hip height in the canopy. We will continue to monitor for disease and keep you updated. Again, the recent rains help promote tar spot. See the forecast from the Tarspotter App for June 26 much of the state is red (Fig 3).

I would like to make a few recommendations when using the Tarspotter App.

- If you have a **history of the tar spot** it is time to keep an eye out and make an informed management decision.
- First in order to get it to turn on a **growth stages of V8-R4** must be selected, if you make this selection and your corn is not at V8 you are cheating the model.
- Use the App initially to tell you **to get out and scout** – we have time to apply fungicides if we find tar spot in the lower canopy.
- Our recent research has shown that making an application just after first detection is effective – you just need to be scouting for those early lesions.
- But, if you wait until we have significant disease in the upper canopy then a fungicide application may be too late at that time.

Figure 2. Examples of corn leaves infected by tar spot. The spots (stroma, in black squares) will be embedded in the leaf, raised (bumpy to the touch), and will not rub/wash off. In addition, they may be surround by a slight halo. (*Photo Credits: Darcy Telenko*)

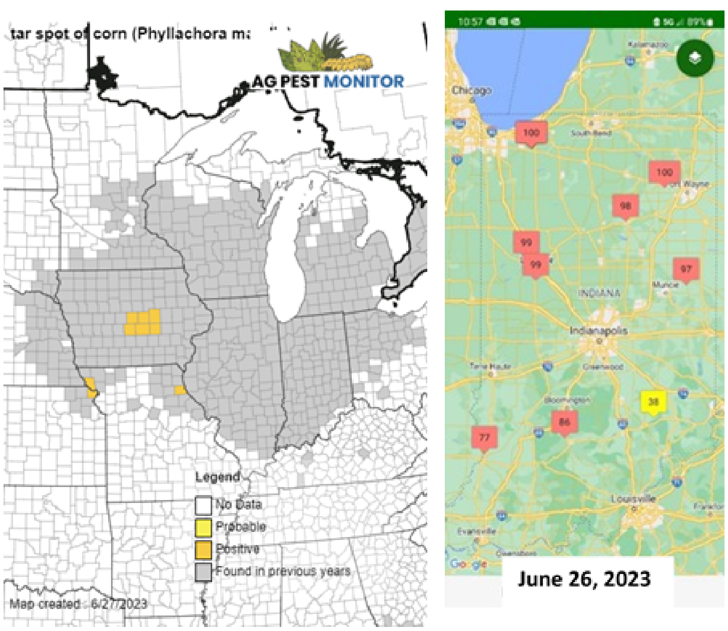


Figure 3. Tar spot map for June 27, 2023 (source https://corn.ipmpipe.org/) and Tarspotter App forecast from June 26, 2023. Red color indicates favorable environmental conditions for tar spot if corn at V8 or older. Source: Tarspotter App v. 0.53.3 Smith, D., et al. ©2022 Board of Regents of the University of Wisconsin System.

I know the next question – should I be putting out a fungicide?

Research has shown the best return on investment in making a fungicide application in corn occurs when the **fungal diseases are active** in the corn canopy. Most of our corn sites across the state are quite clean and disease pressure is minimal, so far this season. It is important to keep scouting, especially after last weekend's rain.

A **well-timed, informed fungicide application** will be important to reduced disease severity when it is needed, and we recommend holding off until the diseases is active in your field and corn is at least nearing VT/R1 (tassel/silk) or even R2 (blister). Scouting will be especially important if the recent rains we have seen continue.

We are working hard to try to understand this new disease to minimize losses. The good news is that we found a number of fungicides are highly efficacious against tar spot here in Indiana when applied from tassel (VT) to R2 (milk). I would recommend picking a product with multiple modes of action. The national Corn Disease Working Group has developed a very useful fungicide efficacy table for corn diseases (see link).

https://cropprotectionnetwork.org/publications/fungicide-efficacy-for-control-of-corn-diseases

We will continue keeping a close eye on tar spot. Please help us track tar spot, contact me if you suspect a field has tar spot and/or send a sample to the Purdue PPDL for confirmation. Research funding from the Indiana Corn Marketing Council is supporting sample processing, therefore there will be no charge for corn tar spot samples submitted to the clinic.

INDIANA CORN Marketing Council

What to look for: Small, black, raised spots (circular or oval) develop on infected plants, and may appear on one or both sides of the leaves, leaf sheaths, and husks. Spots may be found on both healthy (green) and dying (brown) tissue.

I want to ask before you submit a sample you do a quick and dirty "scratch test" to see if you can rub the spot off the leaf, especially if you have leaves with just a few small spots. I have been successful in detecting these false spots by using my nail to scratch as the suspect lesion. This is a quick way to check, but as always if you are unsure send an image or the sample to the Purdue Plant Pest Diagnostic Lab. Please collect several leaves showing the symptoms and send them with a PPDL form https://ag.purdue.edu/department/btny/ppdl/submit-samples/_docs/ppdl-1-w.pdf.

Please wrap the leaves in newspaper, ship in a large envelope, and ship early in the week. If you are sending samples from multiple locations, please label them and provide the date collected, hybrid if known, field zip code or county, and previous crop.

Mail to: Plant and Pest Diagnostic Laboratory, LSPS-Room 116, Purdue University, 915 W. State Street, West Lafayette, Indiana 47907-2054. The lab is operating and the building is open. If dropping off a sample is more convenient than shipping, please call or email the lab prior to stopping by Phone – 765-494-7071 or Email – ppdl-samples@purdue.edu.

In addition, the 2022 tar spot and southern rust maps are live that will be updated when a positive county confirmation is detected. If you are interested in up-to-date information on the current detection of these diseases, the maps are available on the front page of our Extension website https://indianafieldcroppathology.com/.

If you have any question please contact Darcy Telenko (dtelenko@purdue.edu/764-496-5168) or PPDL (ppdl-samples@purdue.edu/765-494-7071).

Forage Considerations If Rainfall Returns

(Keith Johnson)

The weather forecast is desirable for rain the next several days. The following are considerations to heed to improve forage growth and inventory of stored feed for ruminant livestock and equine if the forecast holds true.

With planning, options can be put in place to reduce the concern caused by the spring and early summer dry period. Beef cows are grazing oats and turnips in the fall at the Southern Indiana Purdue Agricultural Center. (*Photo Credit: Jason Tower, Southern Indiana Purdue Agricultural Center Superintendent*)

- Inventory current forage resources and routinely determine how much more forage, other than what you have at time of assessment, might be needed to get to spring grazing in 2024. If forage inventory continues to be low despite a return for more usual rainfall, strategize a plan to avoid the stress of an immediate crisis. Keep in mind that hay purchase can be expensive if delayed until late winter. The following link has many points of consideration. (Beef Management Practices: When Forages are in Short Supply Because of Drought).
- Scout pasture for weed species present and develop a control plan if they are competing with desired forages and/or are poisonous concerns. An excellent resource for purchase is 2023 Weed Control Guide for Ohio, Indiana, and Illinois (purdue.edu). After selecting potential herbicides to control weeds of concern, read full labels for details.
- While scouting for weeds, evaluate if cool-season grass/legume or cool-season grass pasture growth is less than 4 inches in height. If it is, feed stored forage in a sacrifice lot/paddock to livestock until pasture growth is at least 8 inches tall (An aside – Many pastures look more like golf putting greens). A full bite of forage is the goal; not nibbles. Plants need recovery after use, just like we need recovery after hard days of work.
- If soil tests have not been done on pasture or hay fields, get the task accomplished so the *proper* amount of lime and fertilizer can be applied. Grass-only pasture and hay fields will respond to nitrogen fertilizer, especially if none was applied in late winter or early spring and moisture is no longer limiting growth. When submitting the soil samples to the laboratory, provide name of where the soil was probed, potential yield, and forage types. Preferably sample by soil type and cropping history to a depth of 4 inches on already established forages. The NRCS-USDA Web Soil Survey is a very useful resource in learning about the soils on your farm. (Web Soil Survey – Home (usda.gov))
- If you do not use a rotational grazing system, take time to consider putting one into practice from this point forward. The advantages of a rotational grazing system as compared to a continuous grazing system are:
  - Recovery time for forages results in better plant health
  - Longer grazing system
  - Less hay fed
  - Improved nutrient recycling from feces and urine
  - Reduced spot grazing (Spot grazing is grazing of forage regrowth and avoidance of other forage in the pasture)
  - Opportunity for those that harvest their own hay to make it on a portion of the pasture acreage where it can be safely done in the spring.

Take time to read the information in this link about improving pasture management. Management-Intensive Grazing in Indiana (purdue.edu)

- If winter wheat is part of your farm enterprises, an immediate doublecrop seeding of sudangrass, sorghum-sudangrass, or pearl millet after grain harvest should be considered if forage resource is limiting. These crops can be grazed, made into traditional chopped silage, or ensiled as baleage. Hay can be an option if an extended dry period after cutting occurs to get to a safe moisture content (less than 18 percent in large round bales). The prussic acid concern with use of sorghum-sudangrass and sudangrass at freeze time can be managed with planning.
  AY-378-W — Managing the Prussic Acid Hazard in Sorghum (purdue.edu)
  Reduce the Fear: Managing Prussic Acid in Sorghum, AY-400-WV – YouTube
  Consider brown midrib hybrids/varieties (BMR) if improved digestibility is ideal for the livestock being fed. Another forage option if hay is the desired harvest type is teff.If seeding is delayed until mid-to late-August, a good option for fall grazing is seeding a combination of spring oats and forage turnips. Spring oats alone can be harvested has a stored forage, too.
- If the winter feeding area is currently growing unpalatable plant growth, get the weeds under control and seed one of the forage types mentioned in the previous bullet point.
- Scout alfalfa fields for the insect potato leafhopper and follow through with a control plan if the economic threshold population is exceeded. This pest can significantly reduce yield if a potato leafhopper resistant alfalfa variety was not used and the population is high. Control needs to occur before damage is obvious (potato-leafhopper_forage.pdf (purdue.edu)) and (E-220.pdf (purdue.edu)).

Let’s hope that gentle rain without storms occurs for several nights with blue sky during the days. That likely won’t be how weather unfolds, but doing nothing to make a forage program better is definitely not a wise plan.

Drought Stress And Indiana Corn In 2023

(Dan Quinn)

The biggest challenge so far this year for Indiana corn production has been the dry conditions experienced throughout the state (Figure 1). Despite timely planting progress in 2023 and overall good planting conditions, much of the crop condition has deteriorated over the month of June due to dry conditions. For example, areas of Tippecanoe County have only experienced 0.6 inches of rainfall in June (87% decrease from the 30-yr average; Purdue Univ. Mesonet). In addition, crop condition rated good to excellent has declined from 72% (May 22) to 47% (June 26; Figure 2; USDA-NASS, 2023).

The main question that is often asked is “how much yield potential am I losing?”, which can often be a difficult question to answer because the nature of drought varies one year to another. Figure 2 highlights that in certain drought years (2002 and 2012) large reductions in state yield averages can occur in comparison to trend yield. Whereas, in other drought years (2007 and 2020), state yield averages can still be at or above trend yield. The unknown factor at this point in the 2023 growing season is we do not know how the drought will progress the remainder of the summer. Therefore, it is still difficult to determine where state yield average will be by the end of the season.

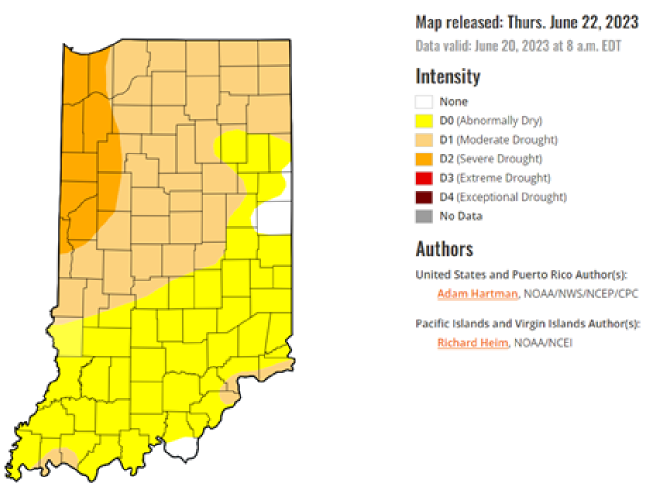


Figure 1. Indiana drought intensity and progress. June 22, 2023. Source: https://droughtmonitor.unl.edu/

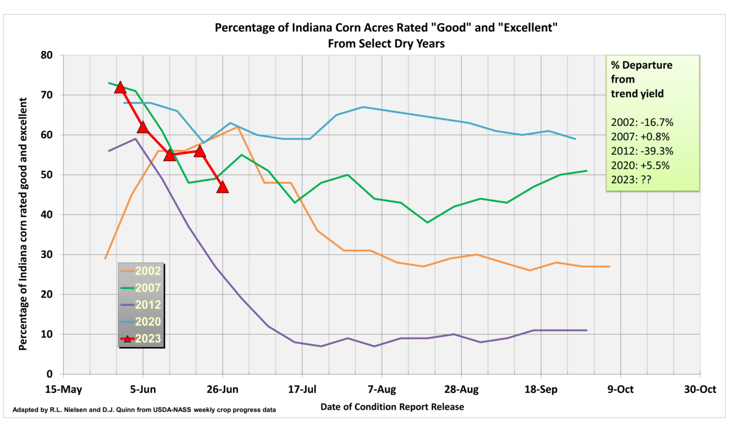


Figure 2. Weekly percentage ratings of corn rated “Good” and “Excellent” from in Indiana, 2023 in comparison to selected dry years (USDA-NASS Weekly Crop Progress, 2023). Red line with triangles highlights current condition ratings for 2023.

Drought Stress Impacts during Vegetative Growth Stages

Corn can be affected by drought conditions at each stage during the plant’s life cycle (Nielsen, 2023). However, corn can also tolerate drought conditions, better or worse, at different growth stages. Therefore, it is important to assess and understand how drought conditions can impact a corn plant at different stages during the season.

One of the biggest observed crop establishment and crop condition differences that has been observed in 2023 has been a function of planting date. Drought conditions did not begin to appear in the state until the last week of May (https://droughtmonitor.unl.edu/) and have continued to persist throughout June. Therefore, much of the corn planted at the beginning of May was well established and had good rooting depth by the time drought conditions began, which should provide some drought tolerance. Whereas, corn planted during the later half of May has become more susceptible to germination and establishment issues caused by the drought conditions.

Overall, corn in early vegetative growth stages is fairly tolerant to high temperatures and drought conditions. Dry conditions can encourage deeper rooting which will likely assist the corn plant with moisture access later in the season. However, issues and yield loss can still occur. Common issues observed in young plants experiencing drought stress include the desiccation and death of nodal root development causing “rootless” or “floppy” corn syndrome (Nielsen, 2022) and in severe cases, the outright death of young plants resulting in plant population losses.

One of the most noticeable symptoms of drought stress is leaf rolling, which is due to plants closing leaf stomates to limit the transpiration of moisture through the plants. Although the attempt to limit transpiration of moisture can help a stressed corn plant, stomates closed for a prolonged period can reduce plant photosynthesis due to reduced carbon dioxide accumulation. Severely drought stressed plants actually start to turn gray, which indicates death of the chlorophyll and a severe reduction in photosynthesis. The earlier leaf rolling occurs in the day and the longer the duration of leaf rolling is observed, the more stress the plant is under, and the more potential yield loss can occur. Yield loss estimates from previous research when drought stress and leaf rolling occur for four consecutive days or more are provided in Table 1.

With persistent drought stress and leaf rolling causing reduction in photosynthesis, drought stress during the vegetative growth stages can reduce overall plant and leaf size. For example, previous research has observed upwards of 28-32% reductions in final plant dry matter weight with persistent drought conditions during the rapid vegetative growth period (e.g., V6 – V14; Cakir, 2004). Reductions in plant and leaf size can reduce the overall photosynthetic “factory” of the plant, thus limiting optimum photosynthate production for kernel formation and grain weight later in the season.

Significant drought stress during vegetative growth can also reduce yield due to kernel number reductions caused by restricted ovule (potential kernel) formation during the rapid growth period (potential kernel number per row is more sensitive to environmental stress than kernel row number per ear). In addition, since dry soil conditions limit water uptake of a corn plant, nutrient uptake can also be limited. For example, potassium deficiency is often observed under drought stress conditions. Unfortunately, applying more potassium fertilizer will not help alleviate this issue.

Table 1. Corn percent yield loss per day estimates when drought stress for four or more consecutive days (adapted from Classen and Shaw, 1970; Rhoads and Bennett, 1990; Shaw, 1988, Licht and Archontoulis, 2017).

Table 1. Corn percent yield loss per day estimates when drought stress for four or more consecutive days (adapted from Classen and Shaw, 1970; Rhoads and Bennett, 1990; Shaw, 1988, Licht and Archontoulis, 2017).

Corn Growth Stage	Percent estimated yield loss per day of observed drought stress (%)
Early Vegetative Growth (VE – V12)	1 – 3
Late Vegetative Growth (V12 – VT)	2 – 5
Pollination to Blister (R2)	3 – 9
Milk (R3)	3 – 6
Dough (R4)	3 – 5
Dent (R5)	2 – 4
Physiological Maturity (R6)	0

Drought Stress Impacts during Reproductive Growth Stages

As corn approaches maximum height and pollination, this is when the risk of yield loss due to heat and drought stress is the greatest. Corn evapotranspiration increases from as plants get larger and peaks through silking and pollination and until the R2 growth stage (blister) before decreasing (Table 2). Corn needs approximately 0.32 inches per day of water during peak demand but temperature, humidity level, and cloud cover impact daily water use. Yield loss caused by drought conditions during the critical flowering period is often a result of a significant reduction in final kernel number due to failed pollination. Ao et al. (2020) observed a 14% reduction in final kernel number when drought stress began at the V14 growth stage. Significant heat and drought stress that occurs 7-10 days ahead of silking and throughout pollination can result in delayed silk emergence, reduced silk elongation, and silk desiccation. Once pollen shed has begun, a single corn plant will only shed pollen for approximately 7 days. Therefore, delayed silk emergence can cause poor synchrony with pollen shed, resulting in failed opportunities for pollen capture and fertilization of the ovules on the ear. Extreme heat stress (> 100-degrees F) can kill pollen but Indiana rarely experiences such temperatures. Furthermore, pollen shed does not occur on one single day and peak pollen shed typically occurs in the morning when temperatures are lower. Drought stress during the early reproductive stages can cause kernel abortion whereas drought stress after the milk stage of kernel development can reduce plant dry matter partitioning to the grain causing low weight kernels.

Table 2. Average corn evapotranspiration per day at specific growth stages and average total water use needed for each specific growth stage (adapted from Kranz et al., 2008; Jeschke, 2021).

Growth Stage	Daily Evapotranspiration (in)	Total Water Needed per Growth Stage (in)
Emergence (VE)	0.08	0.08
4-leaf (V4)	0.10	1.8
8-leaf (V8)	0.18	2.9
12-leaf (V12)	0.26	1.8
Early Tassel (R1)	0.32	3.8
Silking (R2)	0.32	3.8
Blister Kernel (R3)	0.32	1.9
Beginning Dent (R4)	0.24	3.8
Full Dent (R5.5)	0.20	3.8
Physiological Maturity (R6)	0.10	1.4

Overall, corn is fairly tolerant to heat and drought conditions during early vegetative growth. However, if drought conditions continue to persist and severe plant stress is observed, plant photosynthetic capacity and yield can be lost. Where heat and drought stress can become a significant problem and impact yield the greatest is during pollination and silking due to poor synchrony between silk elongation and pollen shed, resulting in large reductions in final kernel number. In addition, reductions in overall plant and leaf size due to persistent drought conditions during the vegetative and rapid growth phases may also limit kernel formation and grain weight accumulation.

Additional Resources:

Cakir, R., 2004. Effect of water stress at different development stages on vegetative and reproductive growth of corn. Field Crops Res. 89:1-16.

Classen, M.M., and R.H. Shaw. 1970. Water deficit effects on corn. II. Grain components. Agron. J. 62:652-655.

Ao, S., M.P. Russelle, T. Varga, G.W. Feyereisen, and J.A. Coulter. 2020. Drought tolerance in maize is influenced by timing of drought stress initiation. Crop Sci. 60:1590-1606.

Jeschke, M., 2021. How early season drought affects your corn crop. Pioneer Agronomy. https://www.pioneer.com/us/agronomy/early-season-drought-corn.html#:~:text=Corn%20is%20less%20susceptible%20to,of%20kernels%20on%20the%20ear

Kranz, W.L., S. Irmak, S.J. van Donk, C. Dean Yonts, and D.L. Martin. 2008. Irrigation management for corn. Bull. G1850. University of Nebraska-Lincoln Ext. https://extensionpublications.unl.edu/assets/html/g1850/build/g1850.htm#:~:text=In%20Nebraska%2C%20total%20corn%20water,24%20inches%20in%20the%20east.

Lee, C., 2022. Watch corn water use over the next few weeks. University of Kentucky Ext. https://www.kygrains.info/blog/2022/6/16/watch-corn-water-use-over-the-next-few-weeks

Licht, M., and S. Archontoulis. 2017. Influence of drought on corn and soybean. ICM News. Iowa State Univ. Ext. https://crops.extension.iastate.edu/cropnews/2017/07/influence-drought-corn-and-soybean

Nielsen, R.L. 2020a. Early season drought stress in corn. Corny News Network, Purdue Ext. https://www.agry.purdue.edu/ext/corn/news/timeless/EarlySeasonDroughtStress.html

Nielsen, R.L. 2020b. Tassel emergence and pollen shed. Corny News Network, Purdue Ext. https://www.agry.purdue.edu/ext/corn/news/timeless/tassels.html

Nielsen, R.L. 2022. “Rootless” or “Floppy” Corn Syndrome. Corny News Network, Purdue Ext. https://www.agry.purdue.edu/ext/corn/news/timeless/floppycorn.html

Nielsen, R.L. 2023. Corn Responses to Drought Stress. Corny News Network, Purdue Ext. https://www.agry.purdue.edu/ext/corn/news/timeless/CornRespDrought.html

Rhodes, F.M., and J.M. Bennett. 1990. Irrigation of Agricultural Crops, Corn – Ch. 19, 569-596, eds. B.A. Stewart and D.R. Nielsen. Madison, WI. ASA-CSSA-SSSA.

USDA-NASS. 2023. United States Department of Agricultural-National Agricultural Statistics Service. Weekly Crop Progress and Condition Reports.
https://www.nass.usda.gov/Statistics_by_State/Indiana/Publications/Crop_Progress_&_Condition/index.php?_ga=2.30680895.1289289406.1687952912-934772628.1687219608

Be Mindful Of Corn Root Damage Caused By Starter Fertilizer

(Dan Quinn)

Many farmers in Indiana utilize starter fertilizer applications, specifically applied through the planter and in close proximity to the seed, which are known to provide benefits such as early crop access to necessary nutrients, improved and more rapid plant growth, and reduced grain moisture at harvest. However, placing fertilizer close to the seed at planting can increase the potential for root damage and poor crop establishment, especially when improper products and/or rates are used. In addition, these risks can be exacerbated in coarser soil textures and in drier soil conditions that follow planting.

Damage caused by starter fertilizer applications can typically be identified by examining the roots of a corn plant, especially if there are areas of a field with noticeable stand establishment and/or stand loss issues. Most starter fertilizer damage observed can be attributed to in-furrow, or pop-up fertilizer applications due to fertilizer being placed directly on the seed. However, damage can also occur from 2×2 starter fertilizer applications and from pre-plant anhydrous and urea applications if too high of rates, shallow injection depth, and/or dry conditions at planting are observed. Yet, these application methods can greatly reduce the risk of potential injury as compared to an in-furrow application. Starter fertilizer damage is often most noticeable from a damaged radicle (the first root that emerges from the seed as it develops; Figures 1 and 2). The radicle will typically be short and brown/black in color and almost looks like someone may have taken a lighter to it. In addition, significant damage to the mesocotyl (white, root-like tissue between the seed and the base of the plant) can also occur from excessive starter fertilizer rates (Figure 3).

Corn root damage caused by starter fertilizer is often attributed to the salt content present in fertilizers and the fertilizer salt index is often used to promote and sell safer in-furrow options. However, ammonia formation in the rooting zone can also contribute to these observed issues. For example, when high rates of nitrogen are applied close to the seed and rooting zone, ammonia can form and result in injury to the roots. Both the risk of injury from ammonia formation and the risk of salt injury are typically why it is important to limit the amount of N + K_2O applied in a starter application. However, potassium is typically not recommended in a starter fertilizer application unless soil test levels are low (<70 ppm).

According to the Tri-State Fertilizer recommendations (https://agcrops.osu.edu/FertilityResources/tri-state_info), starter fertilizer applications are less risky when applied in a 2×2 application and rates should range from 20 – 40 lbs per acre of N, P_2O_5, and K_2O and should not exceed a rate of 100 lbs per acre of salt fertilizers (N + K_2O). As for in-furrow applications of fertilizers, salt fertilizer (N + K_2O) should not exceed 8 lbs per acre on heavier soils and 5 lbs per acre on sandier soils (<5 CEC). In addition, it is also important to avoid the use of thiosulfate products (e.g, ATS) applied in-furrow due to potential seed germination issues.

Figure 1. Corn radicle damage caused by excessively high in-furrow nitrogen fertilizer application. NW Indiana, 2022.

Figure 2. Corn radicle damage caused by excessively high pre-plant N fertilizer application combined with dry soil conditions. NC Indiana, 2023.

Figure 3. Corn radicle damage caused by excessively high pre-plant N fertilizer application combined with dry soil conditions. NC Indiana, 2023.

Ear Size Determination In Corn

(Bob Nielsen)

- Ear shoots are initiated at multiple stalk nodes very early in a corn plant's development.
- Ear size determination of the uppermost (harvestable) ear begins by the time a corn plant has reached knee-high and finishes 10 to 14 days prior to silk emergence.

The number of harvestable kernels per ear is an important contributor to the grain yield potential of a corn plant. Severe plant stress during ear formation may limit the potential number of kernels, and thus grain yield potential, before pollination has even occurred. Optimum growing conditions set the stage for maximum ear size potential and exceptional grain yields at harvest time. Ear size determination for the uppermost ear shoot of the plant begins shortly after it is initiated at about leaf stage V5 (five leaves with visible leaf collars) and finishes at V12 to V15 (about 10 to 14 days prior to silk emergence).

Ear Shoot Development

An axillary meristem forms behind the leaf sheath at each stalk node beginning at the base of the stalk and continuing toward the top (*acropetally* for you wordsmith fans) except for the upper six to eight nodes of the plant. These meristems replicate the activity of the primary apical meristem of the plant by initiating leaf primordia (husk leaves) and a reproductive structure at the distal tip of the ear shank, i.e., the ear shoot (similar in concept to the tassel at the tip of the main stalk).

By about leaf stage V5 or V6, the main growing point of the corn plant (apical meristem) finishes the task of initiating leaf primordia and completes its developmental responsibilities by initiating the tassel primordium of the plant. At about the same time that the tassel is initiated, the uppermost and final ear shoot is also initiated (Lejeune and Bernier, 1996). For hybrids commonly grown in Indiana, this uppermost ear shoot is located at the 12th to 14th stalk node, corresponding to the 12th to 14th leaf of the plant and will become the ear that is harvested.

Careful removal of each leaf from a stalk, including leaf sheaths, at about leaf stage V10 will usually reveal 8 to 10 identifiable ear shoots. As mentioned earlier, each ear shoot originates from an axillary meristem at a stalk node, behind its respective leaf sheath. At leaf stage V10, these tiny ear shoots consist primarily of husk leaf tissue. The developing ears themselves are only a fraction of an inch in length.

Initially, the ear shoots found at the lower stalk nodes are longer than the ones at the upper stalk nodes simply because the lower ones were initiated earlier and so are physiologically older than the upper ear shoots. As time marches on, the upper one or two ear shoots overtake the lower ones, partly because of hormonal "checks and balances" and partly because the upper ear or two are simply closer to the actively photosynthesizing leaves of the upper canopy.

Ear Size Determination

Row number and kernel number per row are two important yield components in corn. For hybrids commonly grown in Indiana, ovule (potential kernel) row number ranges from about 12 to 22, but most commonly 14 to 18. Number of ovules per row ranges from about 50 to 60. Total number of ovules ranges from about 750 to 1000 per ear. Actual (harvestable) kernel number per ear averages between 400 and 600. For a 16-row ear, one kernel per row is equal to about five bushels per acre at average plant populations.

Ovule row number determination on the uppermost ear occurs very quickly after that ear shoot is initiated (V5 to V7 depending on hybrid) (Abendroth et al., 2011; Strachan, 2016). Once row number has been determined, there will never be more rows that develop. The remainder of the "ear size determination" period is comprised of initiating more ovules per row.

Rows of ovules first initiate as single "ridges" of cells that eventually differentiate into pairs of cells (Postlethwait & Nelson, 1964; Strachan, 2016). Thus, row number on ears of corn is always even unless severe stress disrupts the developmental process. True row number is often difficult to visualize without a microscope in tiny ears dissected from plants younger than about the 12-leaf stage.

Row number is determined strongly by plant genetics and less so by environment. This means that row number for any given hybrid will be quite similar from year to year, regardless of growing conditions. In order for stress to affect row number determination, the stress must reduce photosynthesis severely and suddenly immediately after the ear initiates (V5 to V7 depending on hybrid). Examples of such stress include torrential rainfall and sudden flooded soil conditions, sudden defoliation by hail, sudden defoliation by frost event, and sudden changes in temperature (extreme hot to cold, cold to hot). The strong genetic regulation plus the narrow timeframe of susceptibility (V5 to V7) limits the likelihood of restricted row numbers due to stress.

In contrast, ovule number per row is determined over a longer time period, beginning at V5 to V7 (depending on hybrid) for the uppermost primary ear and ending as early as V12 but at least by V15 (Abendroth et al., 2011; Strachan, 2016). Like so many other processes in the corn plant, ovules develop acropetally on the ear shoot, from base to tip. Ovule number per row (ear length) is not regulated as much by the hybrid's genetics as is row number. The fact that severe stress during the vegetative period more frequently reduces ovule number per row than ovule row number is partly due to the longer time period for determining ovule number per row. In other words, there is simply more time for the crop to experience severe stress. This means that potential ear length can vary dramatically year to year as growing conditions vary. As with row number determination, the effect of severe stress on ovule development per row depends on the suddenness and severity of the reduction in available photosynthate. Interestingly, the prolonged stress caused by extremely high plant populations or extremely low soil nitrogen levels causes surprisingly low reductions in ovules per row (R. Nielsen & J. Camberato, Purdue Univ., unpublished data).

Final Comments

Because the initiation of the uppermost (harvestable) ear shoot does not occur until V5 to V7, stress prior to this leaf stage has no direct bearing on ear size determination UNLESS that stress results in a severely stunted or weakened plant. This is particularly true for stress events that damage only the above ground portion of young seedlings without damage to the plants' growing point regions. Such damaged plants usually can recover well with little evidence of the damage some weeks down the road.

Severe stress from about V5 to V12 that severely limits photosynthesis can directly interfere with ear size determination and result in fewer ovule rows (less likely) or fewer ovules per row (more likely). While a reduction in ovule number can be important, recognize that severe stress occurring during or shortly after pollination has a far greater potential to affect ACTUAL kernels per ear and, thus, grain yield at harvest (Nielsen, 2018; Nielsen, 2020).

Related References

Abendroth, L.J., R.W Elmore, M.J. Boyer, and S.K. Marlay. 2011. Corn Growth and Development. Iowa State Univ. Extension Publication #PMR-1009. https://store.extension.iastate.edu/Product/Corn-Growth-and-Development [URL accessed June 2023].

Bonnett, O.T. 1966. Inflorescences of Maize, Wheat, Rye, Barley, and Oats: Their Initiation and Development. Bulletin 721. Univ. of Illinois, College of Ag., Agricultural Expt. Sta.

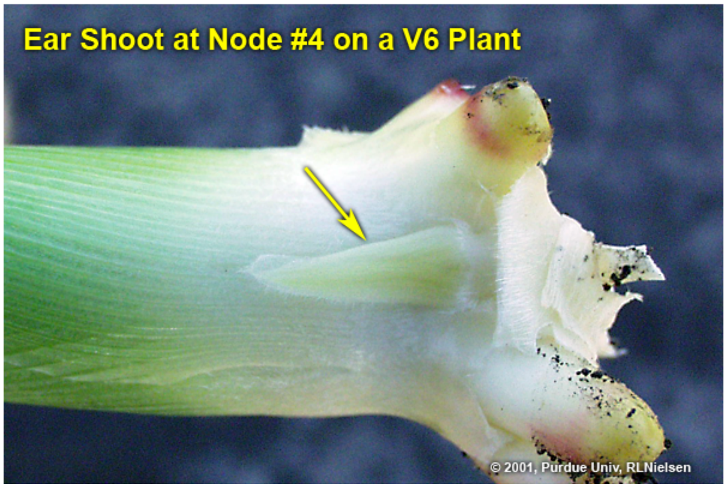
Lejeune, P. and G. Bernier. 1996. Effect of environment on the early steps of ear initiation in maze (Zea mays L.). Plant, Cell and Environment, 19:217-224.

Nielsen, RL (Bob). 2018. Effects of Severe Stress During Grain Filling in Corn. Corny News Network, Purdue Univ. Agronomy Extension. http://www.kingcorn.org/news/timeless/GrainFillStress.html [URL accessed June 2023].

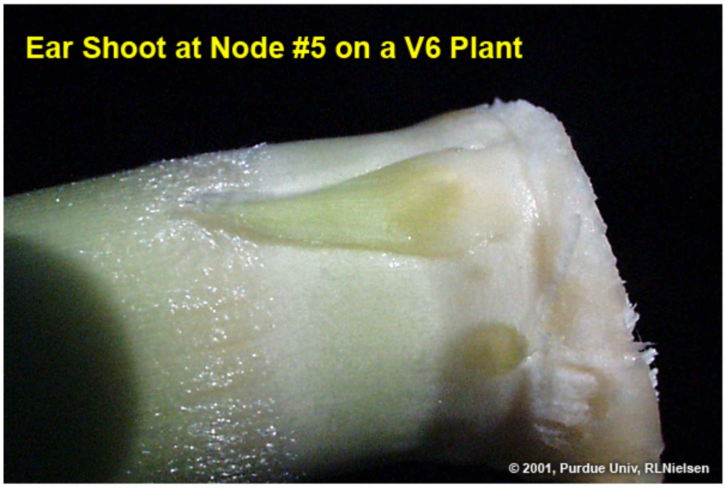
Nielsen, RL (Bob). 2020. Kernel Set Scuttlebutt. Corny News Network, Purdue Univ. Agronomy Extension. http://www.kingcorn.org/news/timeless/KernelSet.html [URL accessed June 2023].

Postlethwait, S. N. and O. E. Nelson. 1964. Characterization of Development in Maize Through the Use of Mutants. I. The Polytypic (Pt) and Ramosa-1 (ra_1) Mutants. Amer. J. Bot. 51(3):238-243.

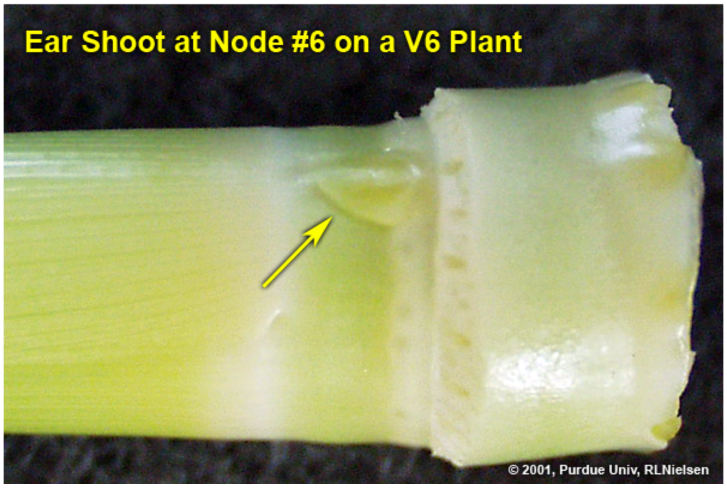
Strachan, Stephen D. 2016. Corn Grain Yield in Relation to Stress During Ear Development. DuPont Pioneer Agronomy Sciences, Crop Insights Vol. 26, No. 9 https://www.pioneer.com/CMRoot/Pioneer/US/Non_Searchable/programs_services/earn-the-right/Corn-Yield-Stress-Ear-Development.pdf [URL accessed June 2023].



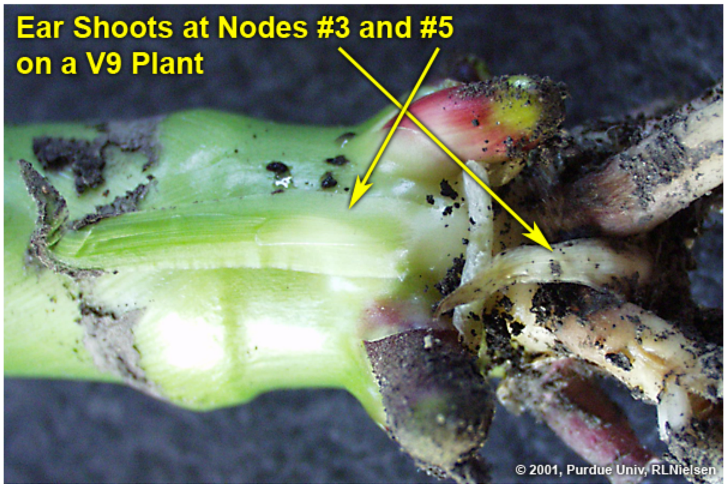
V6: Ear shoot at Node #4.



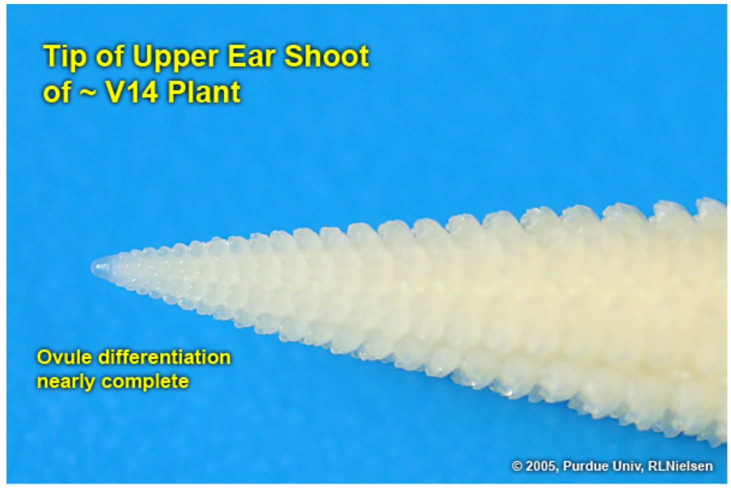
V6: Ear shoot at Node #5.



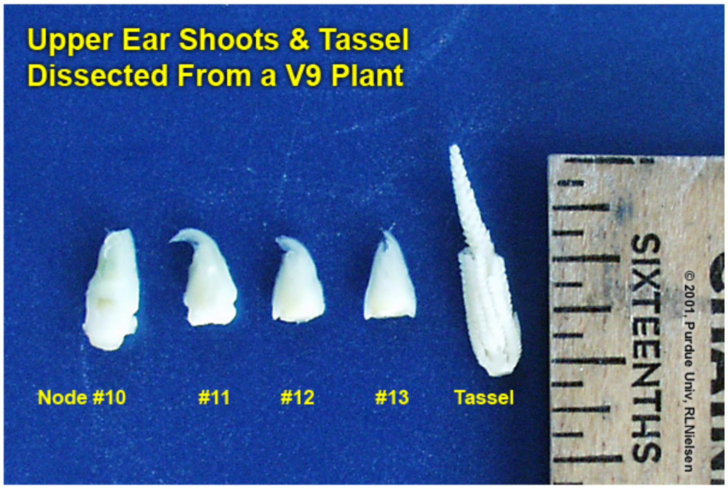
V6: Ear shoot at Node #6.



V9: Ear shoots at Nodes #3 & 5.



V14: Tip of upper ear shoot.



V9: Upper ear shoots & tassel.

Early R1: Tip of upper ear shoot.

V10: Tip of upper ear shoot.

Ear with 14 kernel rows.

Ear with 18 rows of kernels.

Grain And Fiber Hemp Field Day 2023

(Marguerite Bolt, mbolt@purdue.edu)

REGISTER HERE

Field Day Schedule

Tuesday, July 11, 2023
Agronomy Center for Research and Education
4550 US 52 West, West Lafayette, IN 47907
Sign in from 8:30 – 9:00 am EST in the Beck Center
Demonstrations from 9:00 am – 12:00 pm EST

Please join us for the 2023 Grain and Fiber Hemp Field Day!

This half-day, hands-on event will focus on the grain and fiber hemp research being conducted at Purdue as part of a multi-state collaboration. Cost is $20, payable before the event. Registration ends on July 10th. Boxed lunches will be provided at the end of the event. To register, go to https://am.ticketmaster.com/purdue/hempfieldday.

Field day topics include:

Grain and fiber production research
Insect and integrated pest management review
Weed trial information
Regulatory update and pesticide use in hemp
Post-harvest quality testing and food products

Indiana's Winners And Losers With Recent Precipitation

(Beth Hall)

While drought has been on many people's minds lately, Indiana has had several rain events pass through that brought much needed moisture. Unfortunately, the entire state has not benefited evenly from these events. True to most summertime precipitation, where and when the rain falls can be quite spotty. Periodically, a nice front will pass through, but even those tend to only favor some areas leaving others wondering when they'll get a good rain shower. Figure 1 shows how much rain has fallen over the last 14 days (i.e., June 16-29, 2023). While the southeastern and northern counties received over 1.5 inches during this period, other counties such as those along western and southwestern Indiana received less than a quarter of an inch. Figure 2 compares these amounts to what has fallen during that same 14-day period from 1991-2020. Clearly, much of the state is still receiving less than the normal amount (where 100% would be normal) for this time of year. This has led the U.S. Drought Monitor (Figure 3) to continue categorizing much of the state as Abnormally Dry (D0), Moderate Drought (D1), or Severe Drought (D2).

Fortunately, the last few weeks have seen temperatures that have averaged 1-3 degrees below normal. This has kept evapotranspiration relatively moderate for this time of year. This has also meant that accumulated growing degree-days have stayed less than normal across the state for an accumulation start date of April 15 (see Figures 4 and 5).

The short-term forecast is calling for increased rainfall amounts around 1.5 to over 4 inches across much of the state over the next 7 days (Figure 6). Unfortunately, there can be a lot of uncertainty given the type of storm patterns producing these rainfall events. Many forecast products may be offering a probability of precipitation around 50% indicating abiguity in the timing and location of impact. Beyond the next 7 days, climate outlooks are favoring above-normal temperatures and above-normal precipitation over the next few weeks. Confidence for above-normal precipitation is greater after July 8th. This is extraordinarily promising news for our current drought outlook. Stay cautiously optimistic, however, since there is still likely to be much variability in rainfall locations, intensity, and amount. In other words, we may be continuing to see areas across Indiana that are winners with other areas begging for something to help the crops, lawns, and water supplies.

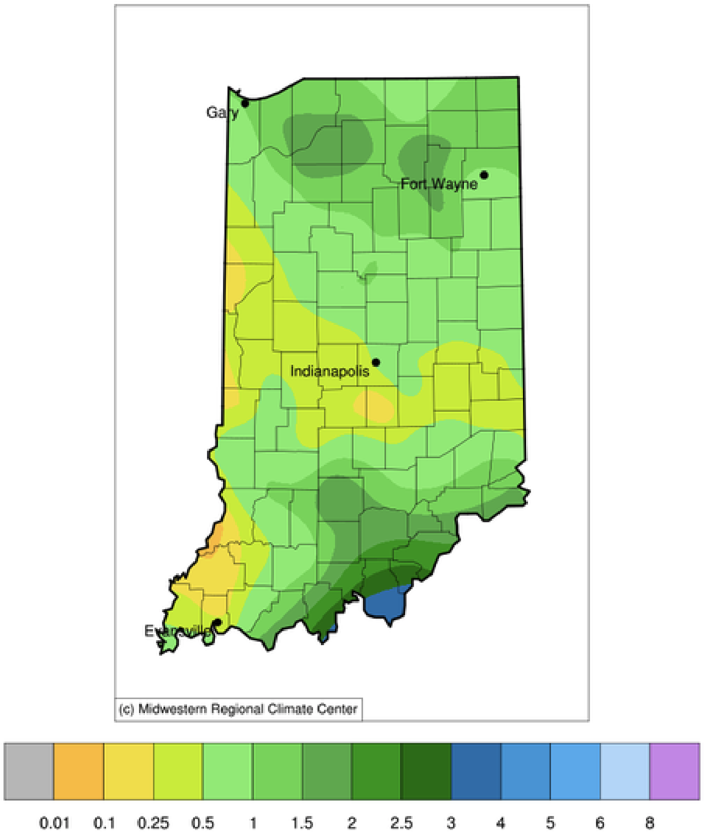


Figure 1. Accumulated precipitation (in inches) from June 14-27, 2023.

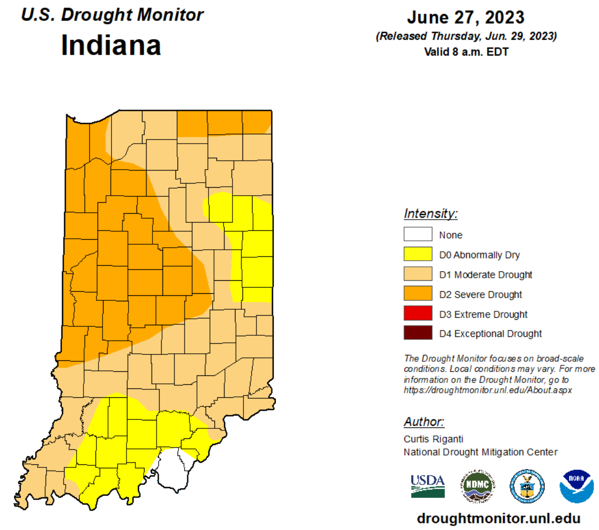


Figure 3. U.S. Drought Monitor representing conditions through June 27, 2023.

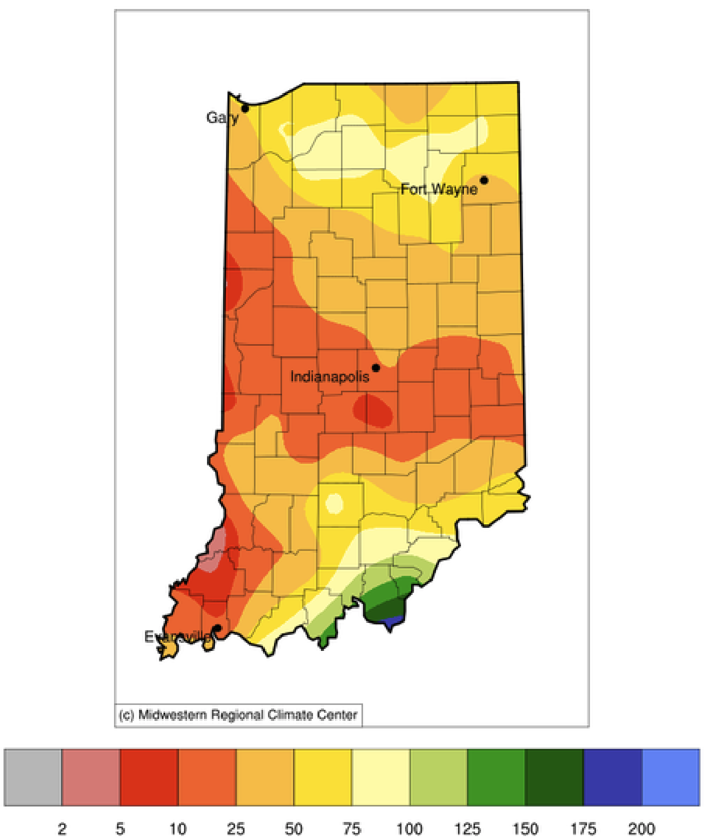


Figure 2. Accumulated precipitation from June 14-27, 2023 compared to the climatological normal amount for that same 7-day period that fell from 1991-2020.

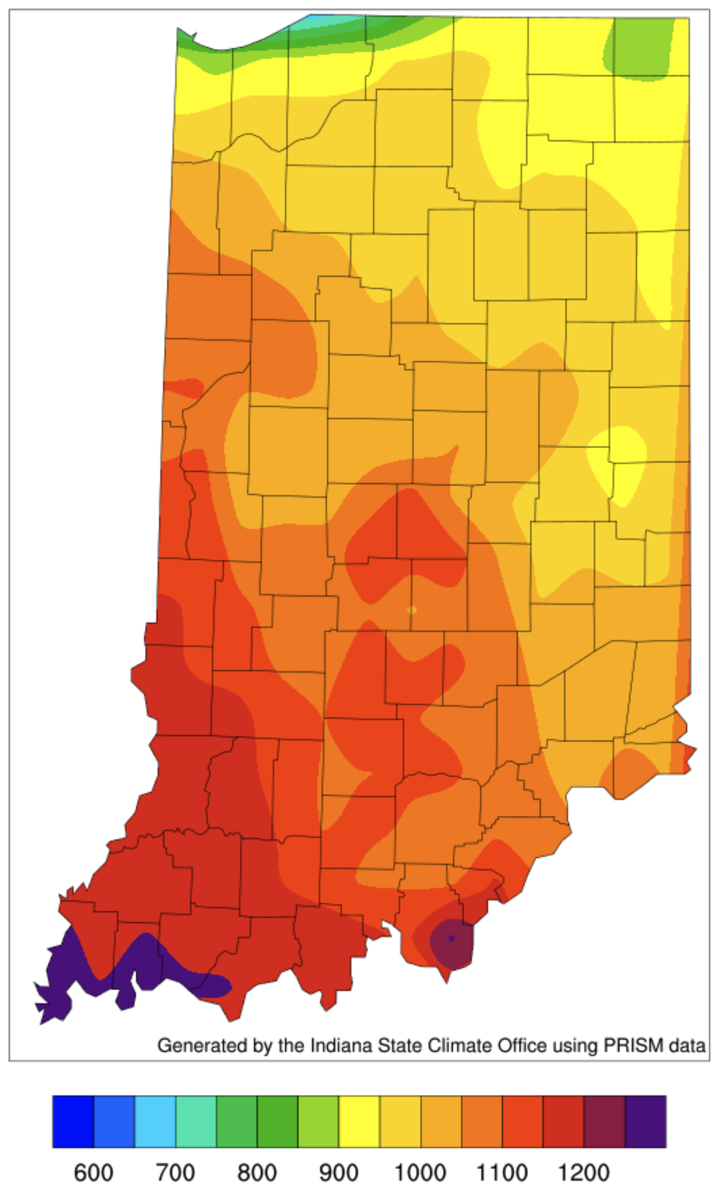


Figure 4. Modified growing degree day (50°F / 86°F) accumulation from April 15-June 28, 2023.

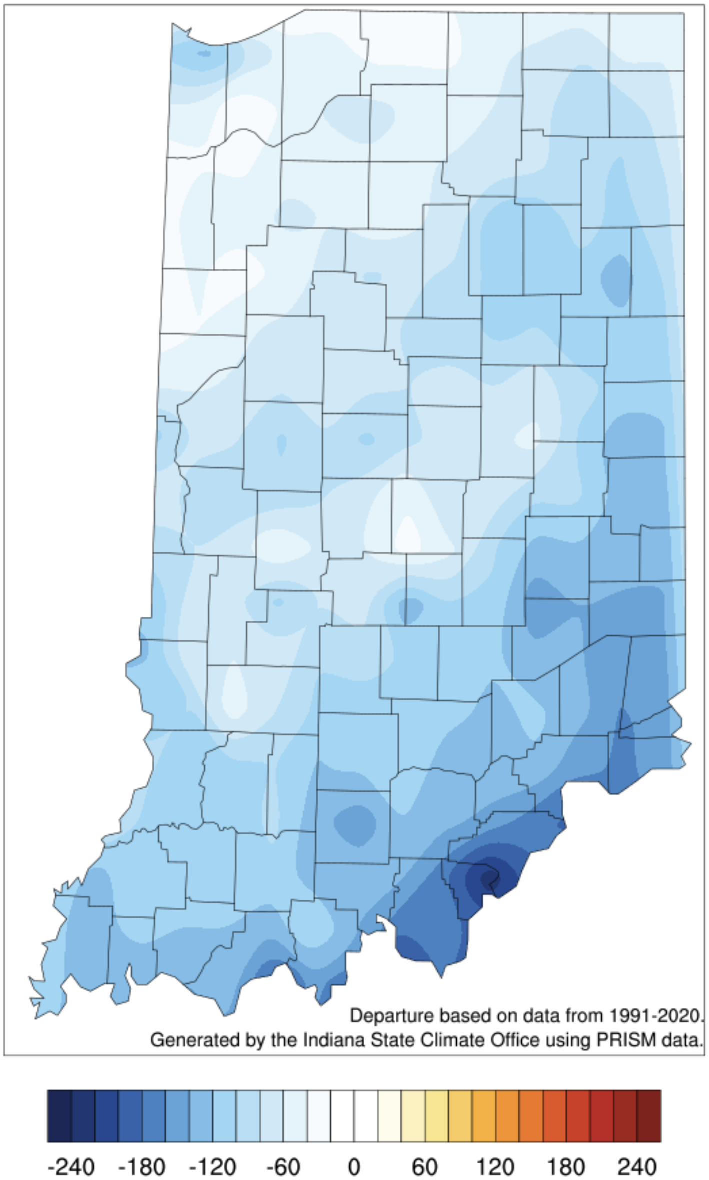


Figure 5. Modified growing degree day (50°F / 86°F) accumulation from April 15-June 28, 2023, represented as the departure from the 1991-2020 climatological average.

Figure 6. Forecasted rainfall amounts (in inches) for June 29 through July 6, 2023.

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