In This Issue

Mites In Timothy Hay

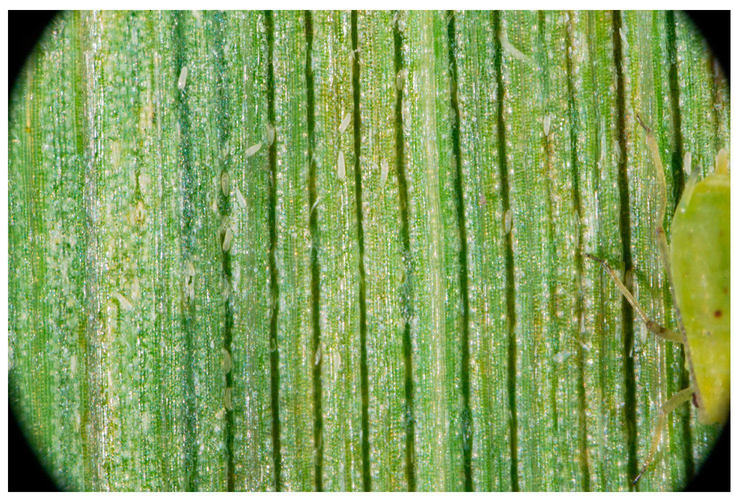
(Christian Krupke) & *(John Obermeyer)*

Samples of timothy hay, with outward symptoms of drought stress, were sent to Purdue's Plant & Pest Diagnostic Lab. Though the timothy had received ample moisture, about 60% of the leaves were reported stunted, curling, and yellowing on the leaf tips. Because some aphids were found, we were asked to inspect the sample. Close inspection of the leaves revealed that they were heavily infested with mites.

Cereal rust mites, *Abacarus hystrix* (Nalepa), are reported as troublesome in timothy in the northeastern states. These very small (<1 mm), light colored, cigar-shaped mites are probably just as abundant in Indiana, but our acreage of pure stands of timothy hay are likely less common, and the mites and their activities seldom noticed. The mites' feeding causes leaf rolling, as plant cells are punctured. Severe feeding, as in this sample, will also stunt the plant and cause yellowing. These symptoms are not diagnostic and could be confused with an array of viruses that are transmitted by aphids. Shaking leaves over sheets of white paper in the field will dislodge mites so they can be seen as moving specks on the paper.

If there is good news with this seldom-seen pest, it is that their damage is worst in the first-cutting of hay. Hopefully, these damaged fields will receive abundant rainfall for the remainder of the season to stimulate growth for additional cuttings. In general, pest mites don't thrive on well-hydrated, healthy plants. Why cereal rust mite populations exploded this year in these fields remains a mystery, and hopefully they don't return in high numbers in future years. But they mite!

Cereal rust mites, on leaf sample, compared in size to an aphid and portion of a penny. (*Photo Credit: John Obermeyer*)



Closer view of timothy leaf tissue with cereal rust mites, compared in size to legs of an aphid. (*Photo Credit: John Obermeyer*)

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			
Jennings/SEPAC Ag Center	0	0	10	2	2	5	0	0			

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			
LaPorte/Pinney Ag Center	0	24	11	44	12	16	9	19			
Lawrence/Feldun Ag Center	4	31	31	163	306	154	40	150			
Randolph/Davis Ag Center	0	0	0	0	23	35	10	43			
Tippecanoe/Meigs	0	5	19	70	58	84	3	35			
Whitley/NEPAC Ag Center	0	0	15	17	23	155	276	35			

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

Is Your Hay Too Hot?

(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**
150°F	**No action needed.**
160°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.
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"!

Environmental Conditions Affect Time To Safe Hay Baling

(Keith Johnson)

The number of hours from cutting to a safe baling moisture varies. Environmental conditions that exist when forages are cut and during the curing process influence the amount of hours that it takes to get to a safe baling moisture. A growing forage will have 75 to 80 percent moisture. A moisture content of 20 percent is considered a safe baling moisture for small rectangular bales and will be slightly less for large round bales and large rectangular bales. The following tables are from the Purdue Forage Field Guide (Purdue publication ID-317) and provide useful information regarding the effects temperature, relative humidity, and soil moisture condition have on the time it takes from cutting to baling.

Raking hay into a windrow before baling occurs. (*Photo Credit: Keith Johnson*)

When relative humidity is 90 percent, cut hay will never get to a safe baling moisture content of less than 20 percent moisture regardless of temperature (Table 1). With a relative humidity of 70 percent or less, the higher the temperature the lower the predicted moisture will be for hay in storage, although a 70 degree F temperature at 70 percent relative humidity will not achieve a safe baling or storage moisture level.

Effects of soil moisture condition and solar radiation on the number of hours to achieve 20 percent moisture alfalfa are found in Table 2. This research indicates that the number of hours when conditions are cloudy with wet soil moisture are approximately three times longer than when sunny and dry soil conditions occur.

It is critical that environmental conditions be considered when making dry hay. Haymaking conditions are likely to never be the same within a harvest season.

Table 1. Predicted Final Moisture Content of Baled Hay

	Relative Humidity (%)			
Temperature (°F)	**30**	**50**	**70**	**90**
70	10	13	21	39
80	8	12	20	38
85	7	10	18	37
95	5	8	18	36

Source: **Silage and Hay Preservation** (Natural Resource, Agriculture, and Engineering Service publication NRAES-5).

Table 2. Predicted Hours to Dry Alfalfa from 80% to 20% Moisture

		Air Temperature (°F)				
Sun[1]	**Soil Condition[2]**	**50**	**60**	**70**	**80**	**90**
Cloudy	Wet	44	41	38	35	33
Cloudy	Dry	36	34	31	29	27
Sunny	Wet	16	16	15	15	15
Sunny	Dry	14	13	13	12	12

		Air Temperature (°F)				
Sun[1]	Soil Condition[2]	50	60	70	80	90

[1]Cloudy = 100 Btu/hr-ft^2 solar radiation. Sunny = 280 Btu/hr-ft^2 solar radiation.
[2]Wet soil = 20% moisture content. Dry soil = 9% moisture content.
Source: **Silage and Hay Preservation** (Natural Resource, Agriculture, and Engineering Service publication NRAES-5)

Purdue Crop Chat Episode 34, Corn, Soybean, & Wheat Management In Short Fieldwork Windows

(Eric Pfeiffer), *(Shaun Casteel)* & *(Dan Quinn)*

Purdue Extension's Dan Quinn and Shaun Casteel are back for another episode of the Purdue Crop Chat Podcast, a regular podcast from Hoosier Ag Today and the Purdue University Extension Service. This time around we discuss last week's planting progress with some nice weather, but also how the weather likely won't be favorable moving forward.

Dan and Shaun also discuss the different research trials they're working on this year and what questions they'll hopefully answer. Hear the podcast below!

Listen to the podcast here or click the image below.

Emergence Problems In Corn

(Bob Nielsen)

Successful stand establishment of a corn crop relies on many factors, including the successful emergence of the seedlings in the first place. Seedling emergence occurs as a result of the elongation of the mesocotyl (negative gravitropism) that elevates the coleoptile or "spike" toward the soil surface (Rodríguez & Cassab, 2021). If successful, the appearance of the coleoptile at or near the soil surface is synchronized with the emergence of the first true leaf from inside the coleoptile.

Emergence

The mesocotyl is the white tubular stem-like plant part located between the kernel and the base of the coleoptile. Technically, the mesocotyl is the first true stem internode of the young corn seedling (Rodríguez & Cassab, 2021). As the coleoptile nears the soil surface, exposure to the red (and perhaps blue) wavelengths of solar radiation causes a change in the supply of one or more growth hormones from the coleoptile to the mesocotyl tissue and mesocotyl elongation comes to a halt (Rodríguez & Cassab, 2021; Vanderhoef & Briggs, 1978).

If mesocotyl elongation and/or coleoptile emergence are compromised, the emergence of the leaves from the coleoptile may occur underground and the leaves remain trapped by the soil. Such "leafing out underground" is obviously viewed with great consternation by growers who were hopeful for perfect emergence of their crop. Emergence failure directly reduces the productive plant population; one of the major yield components of corn, and so grain yield potential will be decreased if the productive plant population is substantially lower than the optimum population. Uneven seedling emergence and/or development effectively also decreases the productive plant population. See Nielsen et al. (2022) for guidelines on optimum plant populations for corn in Indiana.

Failure to emerge successfully can be caused by failure of the germination process itself, failure of the mesocotyl to successfully elongate and/or by soil restrictions that hinder successful penetration of the soil by the coleoptile. In extreme cases, elongation of the mesocotyl fails miserably, resulting literally in corkscrewed fiascos. Often, more than one of the following causal factors exist in a problem field and usually interact with each other to amplify the problem.

Herbicide Injury: Certain herbicides, notably cell growth inhibitors like acetochlor, can affect seedling shoot development especially if weather or soil conditions are not conducive for rapid seedling growth. See Hartzler and Anderson (2018) for more information. However when herbicide injury is suspected to be a contributing factor, cool soils and dense soil crusting are often also contributing factors, so is difficult to pin the blame completely on the herbicide injury.

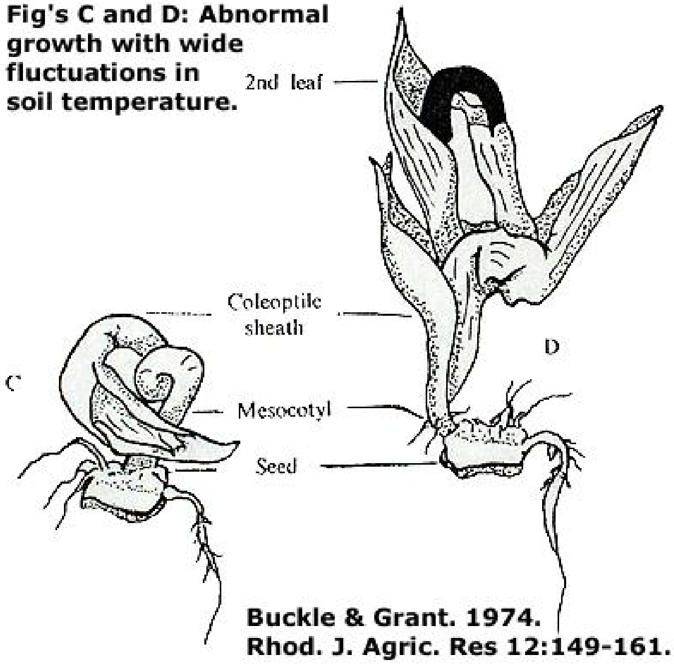
Insect Injury: Certain soil-borne insects like seedcorn maggots (*Delia platura*) and wireworms (*Agriotes*, *Limonius*, etc. spp.) occasionally feed on corn kernels in the seed furrow, destroying or injuring the embryo in the process. Kernel symptoms from this type of injury are fairly obvious. See linked sites below in the Reading List for more information.

Disease Injury: Fungicidal seed treatments effectively prevent most seed rots and seedling blights for 2 to 3 weeks after planting. However, once the seed treatments deteriorate with time, fungal diseases like Pythium and Fusarium may infect the seed or young seedling, causing stunted development or outright death (Sweets, 2015). Kernel or seedling symptoms from these types of diseases are fairly easy to identify.

Kernel Position in Furrow: The coleoptile, the protective covering for the plumule leaves, emerges from the embryo side of the kernel and its accompanying mesocotyl initially elongates toward the direction of the dent end of the kernel. The position of the kernel in the furrow with respect to the embryo face therefore directly influences the initial location where the coleoptile emerges. If the kernel lands with the embryo face down in the furrow, the coleoptile emerges on the bottom side of the kernel, elongates horizontally until the mesocotyl “clears” the end of the kernel, then finally begins its upward ascent. Such an “upside-down” beginning might contribute to a seedling’s susceptibility to other corkscrewing causal factors.

Restricted Emergence: Corkscrewed mesocotyl/coleoptile development can occur when the coleoptile encounters resistance as the mesocotyl elongates. Severe soil crusting or otherwise dense soil surface and cloddy soil surfaces can cause such resistance. A combination of severe sidewall compaction plus press wheel compaction over the furrow can also restrict coleoptile emergence and force the mesocotyl to elongate in unusual directions.

Fig's C and D: Abnormal growth with wide fluctuations in soil temperature.



Buckle & Grant. 1974. Rhod. J. Agric. Res 12:149-161.

Cold Soils: Cold soils and/or wide fluctuations in soil temperatures throughout the day during the emergence process are also thought to be major contributing factors for the development of “corkscrewed” mesocotyl development (Buckle & Grant, 1974). The nature of the cold temperature injury appears to be damage to the outer surface layers of the mesocotyl. The elasticity of the damaged tissue is less than healthy tissue. The “corkscrew” elongation of the mesocotyl occurs when the tissue damage occurs unevenly around the circumference of the mesocotyl. The exact minimum soil temperatures that can cause such corkscrewed development are not clearly documented, but clearly it is not uncommon in Indiana for daily soil temperatures to dip as low as 40F (4.5C) during April and early May. Furthermore, bright sunny days can elevate bare soil temperatures quite high but still drop quite low the following night and thus result in a wide diurnal fluctuation in soil temperatures. Dry soils would be more prone than wetter soils to wide swings in daily soil temperatures.

Imbibitional Chilling Injury: Cold temperature injury that results in corkscrewed mesocotyls is not exactly the same as that which is referred to as “imbibitional chilling” injury. The latter refers to cold injury to the seed that occurs during the first 24 to 36 hours after planting as the dry seed imbibes (aka absorbs) water. The seed naturally swells in response to the imbibition of water. Cold seed cell tissue is less elastic and subject to rupturing as the seed swells. The threshold seed tissue temperature below which imbibitional chilling injury may occur is not clearly defined in the research literature, but appears to be temperatures cooler than 50F (10C). The most common symptom of imbibitional chilling damage is often simply swollen seed with little to no evidence of sustained germination progress. In contrast, seedlings with corkscrewed mesocotyls probably germinated successfully and **subsequently** experienced cold temperature injury to the mesocotyl tissue that interfered with normal mesocotyl elongation.

Related reading

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Natural mesocotyl elongation when seed placed embryo face down.

Deformed mesocotyl elongation caused primarily by seed furrow compaction.

Leafing out underground; caused primarily by dense surface soil crust.

Leafing out underground; caused primarily by dense surface soil crust.

Deformed mesocotyl elongation caused primarily by cold soil temperatures.

Partial leafing out underground; caused primarily by dense surface soil crust.

Deformed mesocotyl elongation caused primarily by cold soil temperatures.

Deformed mesocotyl elongation caused primarily by cold soil temperatures.

Deformed mesocotyl elongation caused primarily by cold soil temperatures.

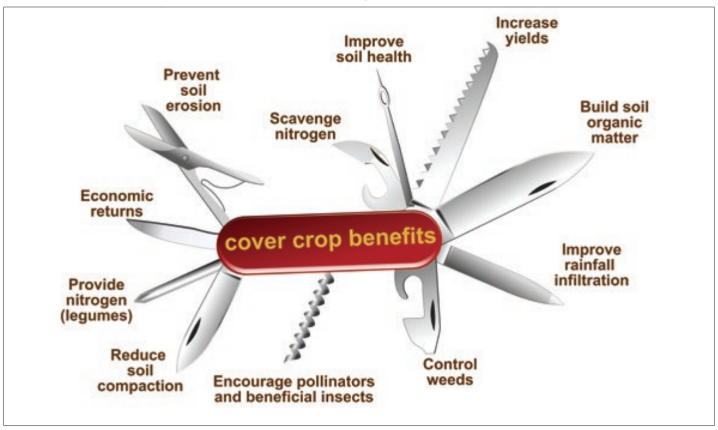
Nobody Wants To See Your Soil — Cover Crops And Climate

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

Cover crops are nothing new, but their relationship to a changing climate might be new to many farmers. Keeping the soil covered with plants and filled with living roots builds soil carbon, keeping heat-trapping carbon dioxide out of the air.

Compared to many of our neighboring states, cover crops have been heavily adopted in Indiana. According to 2021 Natural Resource Conservation Service data, 1.59 million acres of cover were planted across the state last year (including the winter wheat cash crop). St. Joseph County led the way in the state, with over half of their acres surveyed planted to some kind of cover.

Many cover crops are planted in an attempt to control soil erosion, promote soil health, or combat pests and weeds. However, the ability of cover crops to help soils store carbon is an important component of their management as well. Bare soils still have organic matter in which microorganisms are actively working, feeding, and growing. Those microorganisms break down carbon (and nitrogen) which are released into the air as greenhouse gasses. The resultant organic matter percentage in that bare soil declines. When fields are kept with growing plants year-round, and decaying plant matter is kept on the field, microbes release fewer greenhouse gases into the air, and organic matter in the soil increases.



This graphic shows the many benefits that cover crops provide over time, which include the ability to better cope with weather extremes (such as improving rainfall infiltration) and slowing climate change (such as building soil organic matter). This graphic originally appeared in Cover Crop Economics, a SARE bulletin published in 2019, and was illustrated by Carlyn Iverson.

Farming 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.

Temperature Swings And Variable Precipitation Continues… Hot, Dry Conditions Forecasted To Return

(Austin Pearson)

A break from the heat has commenced as average temperatures dropped to 2-6˚F below normal this week. From May 8-14, average temperatures ran from 5˚F above normal in the southeast to 13˚F above normal in the northwest. Across the entire Midwest, there were 858 maximum and 659 minimum high temperature records broken or tied (Figure 1). The third week of May also trended warmer with southeastern Indiana 6-7˚F above normal and departures 2-3˚F above normal in northwestern Indiana. These warmer temperatures enhanced vegetation growth, allowed row-crop agriculture to resume planting, and gave modified growing degree day (MGDD) departures to catch up to near normal for most in the state (Figure 2). In fact, central and south-central Indiana is now showing above normal MGDDs.

The northern part of the state received normal precipitation from May 15-22, with heavier amounts falling in southern Indiana. Heavy rains associated with thunderstorms accounted for 175300 percent of normal precipitation for this section of the state (Figure 3). Ten stations in southern Indiana reported that daily precipitation records were broken or tied from May 15-21. Franklin County recorded 5.13 inches of rain, which was 4.07 inches above normal for the week. Their largest single day maximum precipitation (2.80 inches) occurred on May 15. In contrast, there has been some concern with drying along the Indiana/Kentucky border, but not enough to introduce abnormally dry (D0) into the US Drought Monitor. On May 21, there were three confirmed tornadoes that occurred in Brown County (EF-0), Johnson County (EF-0), and Shelby County (EF-1). Fortunately, there were no injuries or deaths reported, but the region did experience damage to building structures and trees. Heavy rains slowed progress of planting across the state. Furthermore, wind continued to present challenges as many stations across Indiana reported wind gusts in excess of 30 mph on May 20.

After widespread opportunities to receive 0.75-1.5 inches of precipitation through May 28, weather models call for a decrease in precipitation, providing an opportunity to finish the 2022 planting season. The 6-10 day outlook (May 30-June 3) and 8-14 day outlook (June 1-7) both call for enhanced confidence in above normal temperatures and below normal precipitation. The Climate Prediction Center June Outlook (Figure 4) also calls for higher confidence in above normal temperatures and equal chances in above or below normal precipitation.

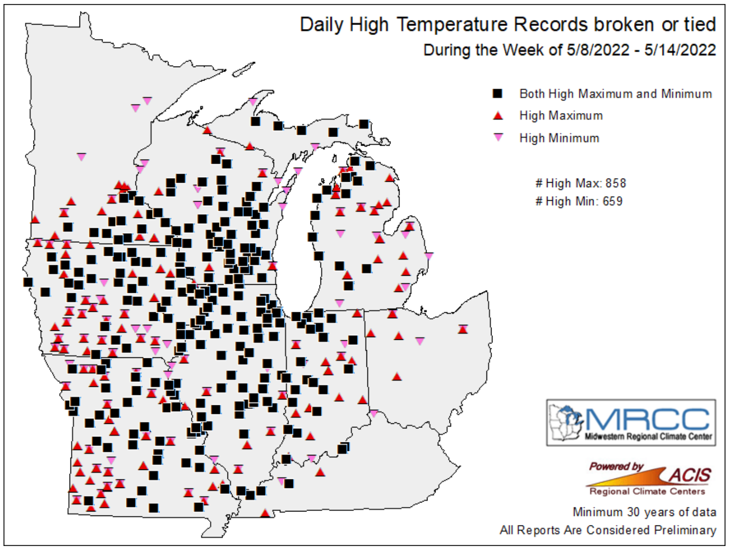


Figure 1. Midwestern daily high temperature records broken or tied from May 8 – 14.

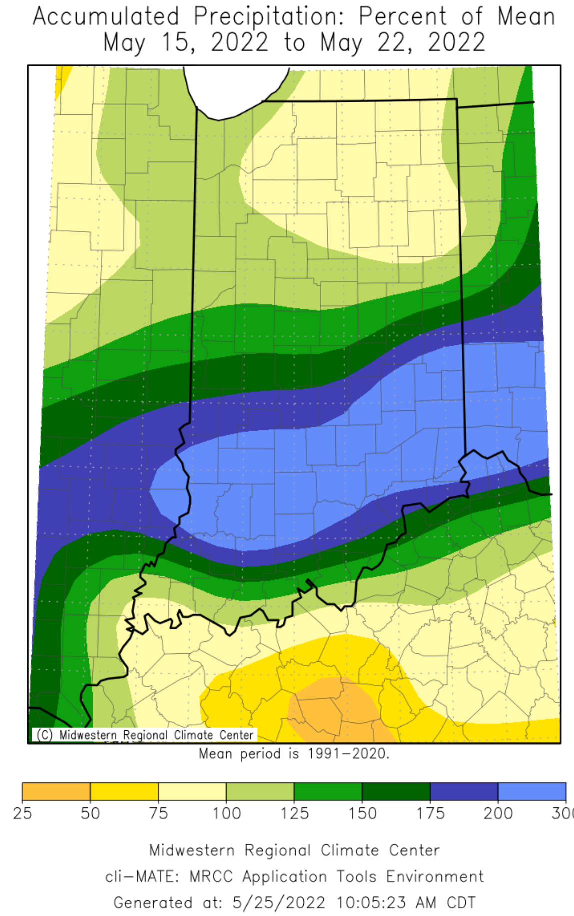


Figure 3. Accumulated precipitation from May 15-22, 2022, represented as a percentage of the 1991-2020 climatological average.

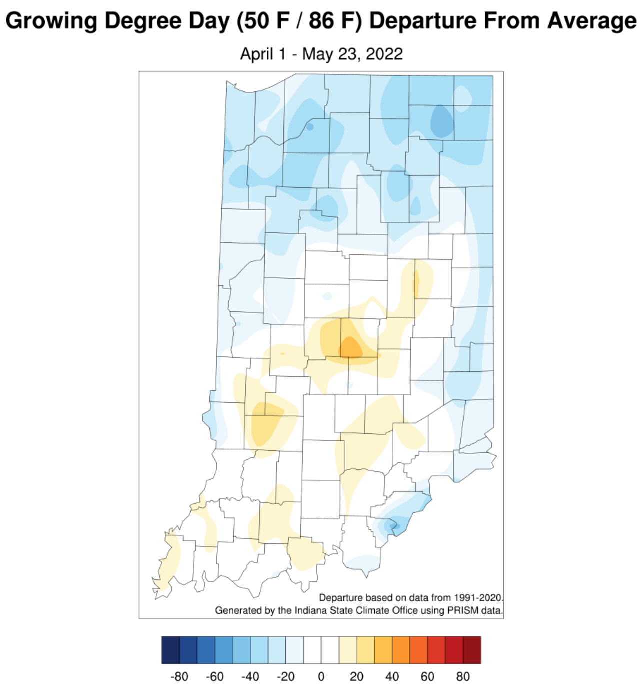


Figure 2. MGDD accumulation from April 1 – May 23, 2022, represented as the departure from the 1991-2020 climatological average.

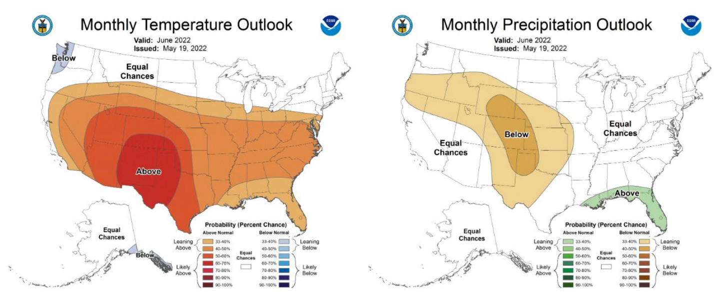


Figure 4. Climate Prediction Center June 2022 temperature and precipitation outlooks.

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