Integrated Pest & Crop Management

Increased Arrested Development of Corn Kernels May Have Resulted from Cloudy Weather

By Bill Wiebold

Missouri corn farmers might have an unpleasant surprise when corn harvest begins. There have been reports of poor corn pollination and reduced ear size, especially in west and southwest Missouri. Unfortunately, these pollination problems are hidden under several layers of husks and may not be apparent until combining begins.

In general, there are three broad causes of corn ears with fewer than expected kernels: fewer female flowers produced on the ear, poor synchronization between pollen shed and silk receptivity, and aborted kernels. For a deeper explanation of these, please read the three part series "Corn Pollination: the Good the Bad and the Ugly" (part 1, part 2, and part 3).

It is not clear which of the three causes occurred in Missouri this year, and it is likely that all three may have been involved, at least to some extent. Most reports involve what is often called "tip dieback". Unfilled kernels at the tip of the ear are common even with excellent growing conditions. In fact, we ought to manage corn planting rates such that at least some empty or small kernels are observed at ear tips. Distinguishing between unfertilized kernels and aborted kernels (true tip dieback) can be difficult at corn maturity, so checking fields before maturity instead of at harvest will be helpful for diagnosis.

Figure 1. Corn ears from a seeding rate study. Plant population increases from the top ear to the bottom ear. Note small and unfilled kernels on the bottom three ears.

Unfertilized kernels means that pollen was not present when silks were receptive to pollen or something interfered with the growth of the pollen tube inside the silk. Because silks from flowers at the ear tip begin elongation last and their growth rates are slower than on other areas of the ear, they are often the ones that miss pollen. Before physiological maturity, these unfertilized kernels will appear white and blank - no growth of the kernel. Poor synchronization is mostly related to slow silk growth. Although water stress is the most common cause, anything that slows silk growth without delaying pollen shed can lead to unfertilized kernels.

True tip dieback is caused by kernel abortion or arrested development. The kernels were fertilized and at least some growth had occurred. These aborted kernels will vary widely in appearance even on the same ear. Some aborted kernels may look similar to unfertilized kernels because the kernels aborted within a few days after fertilization. Other kernels will have nearly normal shape (tip kernels are normally round and not flat) and color except

Continued on page 60

In This Issue

continued from page 59

they are noticeably smaller than normal. This wide variation in appearance is due to variation in the timing of when kernel development stopped. Most of what we call tip dieback happened early in kernel development, so the kernels remain very small. At maturity, aborted kernels will appear chaffy or will be so small they are difficult to see (Figure 1).

Developing kernels need water, sugar and mineral nutrients to gain weight. Any stress that limits any of these requirements can cause kernel abortion. Unfortunately, kernel abortion is permanent; growth will not resume if the stress is relieved. The majorly of kernel weight is starch, which is manufactured from sugars produced during photosynthesis. Because sugar is important to continued kernel growth, conditions that reduce photosynthesis may lead to increased tip die back. Even cloudy days, if frequent enough can increase tip dieback.

Weather stations located at agebb.missouri.edu/ weather/ measure light energy and record it as total solar radiation for each day. I collected data from three of these stations in an attempt to determine if cloudy weather during kernel filling may have resulted in the reported increased of tip dieback in 2013. Data from the three weather stations are provided in Figure 2. I selected two stations in west Missouri (Buchanan and Barton counties) and one from central Missouri (Columbia). The graph begins on July 1 and continues through August. For Figure 3, I divided each day's total radiation by a constant equal to an estimated maximum. This allows for easier determination of the magnitude of light reduction by clouds. Large fluctuations among days for sunlight are apparent in figures 2 and 3.To smooth the curves, I calculated a moving 5-day average. These data are presented in figure 4. Averaging light energy over a few days is more meaningful than data for individual days because periods of sustained low light should affect plants more than a single day of clouds.

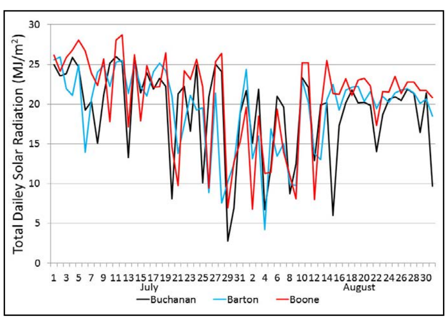

Figure 2. Daily solar radiation totals measured at three Missouri weather stations in 2013.

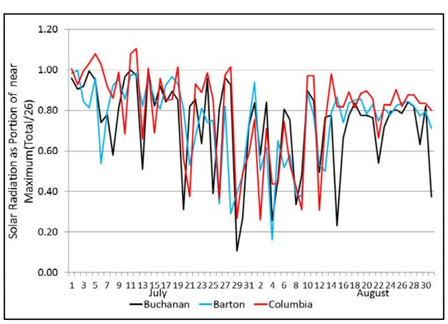

Figure 3. Daily solar radiation totals measured at three Missouri weather stations in 2013.

Corn planting dates in 2013 varied widely among Missouri fields, so silking dates also varied. If fields were planted on a normal date, silking occurred in early July. Because of wet spring weather, corn planting was often delayed. Southwest Missouri experienced the longest wet period and greatest delay. So, silking occurred in the areas represented by these three weather stations from mid to late July. Sugar availability for developing kernels is critical during the kernels entire life, but disruptions within several weeks after fertilization is often related to early kernel abortion and what we call tip dieback. So, light levels from late July through mid-August may be important. Figure 4 shows an apparent reduction in light energy during that period for all three weather stations.

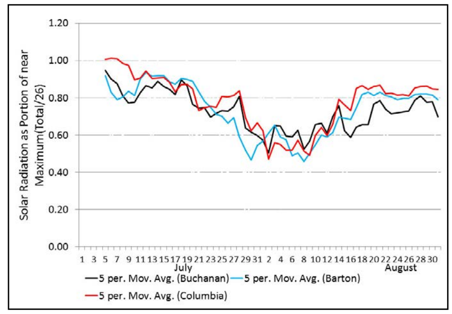

Figure 4. Moving 5-day averages for solar radiation measured at three weather stations in 2013.

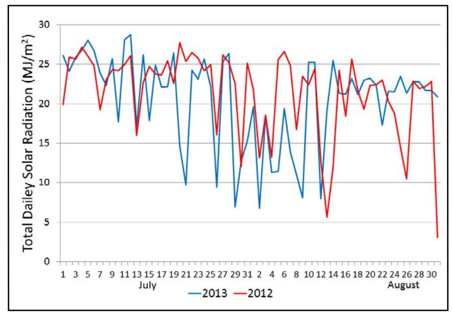

Figure 5. Daily solar radiation measured at Columbia in 2012 and 2013.

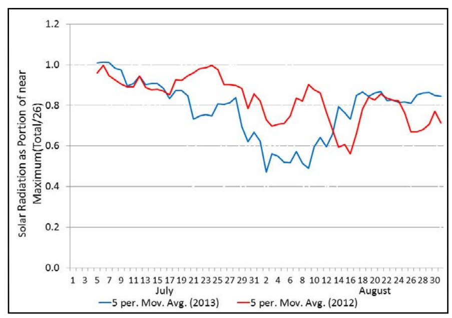

Figure 6. Moving 5-day averages for solar radiation measured at Columbia in 2012 and 2013.

Daily light energy normally decreases after the first day of summer. Day length shortens and sun angle increases. These changes reduce the amount of energy impinging on corn fields. From late June to late August this normal reduction in light energy is about 15%. All three weather stations show light reductions of 40% or more in numerous

Continued on page 61

continued from page 60

5-day periods in early August – a time when continued growth of kernels is easily impacted.

Light energy in 2012 is a convenient reference because it seemed like the sun shone brightly every day last summer. Figure 5 presents daily total solar radiation at Columbia in 2012 and 2013. Even in 2012 some days were cloudier than others and total light energy fluctuated among days. On August 31, a hurricane approached Missouri and sunlight was dramatically reduced because of heavy clouds. Data in figure 6 are the result of division by the constant, 26, and smoothing with a moving 5-day average. Clear differences between 2012 and 2013 are apparent. Light energy in mid-July through mid-August was greatly reduced in 2013 compared to 2012. That difference between the two years disappeared in late August.

The data I presented are just observations and not part of a controlled experiment. If there is more tip dieback than normal this year, the cause or causes may continue to be unexplained. Kernel development depends on current (daily) photosynthesis, because corn plants do not store large pools of carbohydrates. Reduction in light energy can decrease photosynthesis and the amount of sugar available to kernels. Finally, tip kernels are more susceptible to interruptions in kernel sugar supply because of ear structure, and they are further away for the sugar source. The unusually cloudy weather in 2013 during early stages of kernel filling may have contributed to increased kernel abortion of ear tip kernels.

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2013 is Another Drought Year

By Bill Wiebold

During the past extension winter meeting season I said that the drought of 2012 was in our rear view mirror. I had thought that spring 2013 weather had proven me abundantly correct. But, as corn and soybean plants entered critical seed-filling periods this year, drought returned to some parts of Missouri with a vengeance. Figure 1 presents the weekly rain totals during July and August for five Missouri weather stations. To sustain high yields, corn and soybean crops need at least one inch of rain each week. That 1-inch need is indicate by a line.

Unfortunately, weekly rain totals did not exceed one inch in Albany and Columbia in any of the 9 weeks presented. At Novelty and St. Joseph, only one of nine weeks at each of these two stations exceeded the 1-inch weekly total. So, corn and soybean fields in central and north Missouri were under drought stress for nearly the entire grain-filling periods. Perhaps more striking is the number of weeks with no rain. At Novelty, 7 of the 9 weeks had less than 0.05 inch of rain.

As central and north Missouri soils dried, parts of southwest Missouri experienced flooding because of heavy rain. The weather station near Lamar recoded over 6.3 inches of rain fall during the last week of July and the first week of August. However, precipitation during the last three weeks of August totaled just 0.01 inch.

Because the zero rain totals are hard to detect on a graph, I converted the data to departures from the 1-inch need. Figure 2 presents these data. Crop yield potential cannot be maintained with these low rainfall amounts. In fact, plant health is greatly affected. It is not surprising that corn and soybean plants are dying early rather than proceeding through normal maturity.

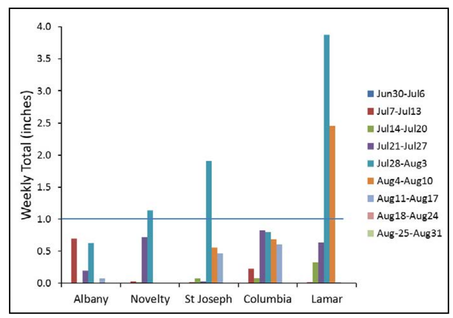

Figure 1. Weekly precipitation totals in July and August for five Missouri weather stations.

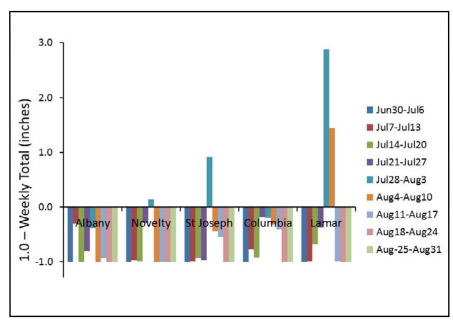

Figure 2. Weekly precipitation totals converted to departures from 1.0 inch.

The worse possible weather scenario for corn and soybean yields is a wet spring and dry summer. Figure 3 presents Columbia weekly rain totals from the first week of April through the last week of August. Large amounts of rain in April and May delayed corn and soybean planting. That planting delay had reduced our yield potentials. Wet springs also mean greater opportunities for root diseases and increased

Continued on page 62

2013 is Another Drought Year

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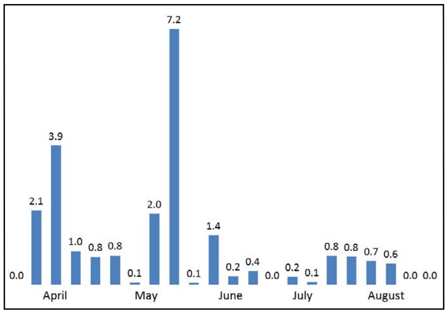

Figure 3. Weekly precipitation totals in April through August at Columbia, MO.

chances of soil compaction. Reduced root health makes the impact from summer drought worse because roots are less capable of extracting water from soil.

As drought first began in Missouri, its effects were easily overlooked. Cool day and night temperatures up until mid-August reduced water evaporation. Visible symptoms of drought stress were not often apparent. When abnormally hot temperatures occurred in late August (and again in September), plants had already removed most the available water stored in soils. The warm temperatures were accompanied with bright sun and low humidity. This combined to increase transpiration from plant leaves and increased water demand. Soils in much of Missouri could not provide water, so crop plants quickly exhibited drought stress.

Yield potentials rapidly declined during late August and continue to be impacted. Last year, a hurricane saved soybean yield in at many Missouri fields. That help will not arrive in 2013. Late planted corn and soybean fields are will suffer the most damage. Unfortunately, the wet spring caused many fields to be planted late. Because drought stress occurred during mid to late summer, the yield component affected most will be seed size. Small corn kernels result in low test weights. Small soybean seeds may not affect test weight, but clearly reduce yields.

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Stalk Nitrate-N Test – A tool for evaluating nitrogen management practices in corn

By Manjula Nathan

With the increase in N fertilizer prices, and growing concern for environment growers are becoming more interested in fine tuning fertilizer N applications for corn production. There are many diagnostic tools that are available for improving N management in corn. Researchers at Iowa Sate University have come up with the stalk nitrate N test as a diagnostic tool in improving N management in corn (www.ncagr.gov/agronomi/pdffiles/cornstalk.pdf?). This test gives you information on how well you have managed your nitrogen and doesn't provide information on how much fertilizer N to apply for the coming season.

The stalk Nitrate N test is done in the lab where a 6" stalk (samples should be cut at 6 -8" above the soil surface, at black layer stage, no leaves included) sample is dried, ground, and processed and analyzed for nitrate-N. The numbers are compared to standards set by Iowa State University researchers based on field research. It is important to note for accurate results samples should be collected at one to three weeks after 80% of the kernels reach black layer stage (physiological maturity) and not after harvest.

After collecting a representative sample 6" stalk samples cut 6 – 8" above the soil surface, make sure to split the sample into two vertically and let it dry before mailing it to the lab. This would quicken the process of drying. It is preferable to sample a least a minimum of 10 stalks from the area of interest to have good representation and reliable results.

Continued on page 63

continued from page 62

In general, larger amount of plant available N in the soil during the time period before plant maturity results in higher concentration of nitrates in the lower portion of the stalk. However, stalk nitrate-N can be greatly influenced by other factors like soil moisture and precipitation.

A stalk NO3-N test value of less than 250 ppm is interpreted as **low**, nitrogen was probably deficient during the growing season. Test values of 250-700 ppm is **marginal**, it is possible that nitrogen shortage limited yield in this range, and 700 -2000 is **optimum**, yield was not limited by a shortage of nitrogen in this range. Values in excess of 2000 ppm means excessive, nitrogen rate was too high or some production factor caused a yield reduction. Factors other than excessive use of N can such as drought and hail damage can lead to excess N in the stalk.

University of Missouri Soil and Plant Testing lab located at 23 Mumford Hall, UMC, Columbia, MO 65211 offers stalk NO3-N test in corn for $10 per sample. You can reach the lab at 573-882-0623 or get information from the lab's website at http://soilplantlab.missouri.edu/soil on submitting samples. When submitting samples corn stalk Nitrate-N test, use the plant analysis form http://soilplantlab.missouri.edu/soil/forms/index.aspx and select Nitrate-N test. There is sample grinding fee for processing the samples. If you have any other questions about the test you can contact Manjula Nathan at 573-882-3250.

Ref:

1. Blackmer, A.M. and A. Mallarino, 1996. Cornstalk testing to evaluate nitrogen management. University Extension, Iowa State University. Guide: PM 1584. http://www.ncagr.gov/agronomi/pdffiles/cornstalk.pdf
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Considering Fall Herbicide Applications: It's not JUST about the weeds

By Kevin Bradley

As harvest season begins to get underway, some calls are coming in and a number of people are starting to ask about fall herbicide applications. There are a number of factors to consider when deciding whether or not a fall herbicide application might fit your corn or soybean production system, and some of the more important of these are discussed below.

#1. Spring Weather Uncertainty

One of the reasons that this whole concept of fall herbicide applications first came about was because of the desire of some producers and retailers to spread out their workloads and remove at least one of the tasks that we would normally do in the spring back to the fall. As illustrated in Figure 1, there are usually less suitable field workdays in Missouri during the months of March and April when early spring preplant herbicide applications are typically made than in the months of October and November when fall herbicide applications could be made. This is largely due to the excessive rainfall that we usually receive in the spring versus the fall, which often makes timely applications of preplant burndown herbicides very challenging during this time of year.

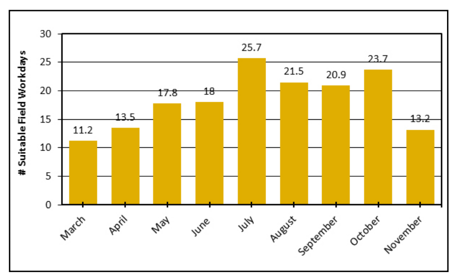

Figure 1. Number of suitable field workdays in Missouri (30-year average).

#2. Impact on Soil Conditions

The removal of winter annual weeds with fall herbicide applications can have a significant impact on the soil conditions experienced at planting. Obviously, dense mats of winter annual weeds can make planting difficult, but the results from our research and from others shows that winter annual weeds can increase soil temperatures, can "wick" significant amounts of moisture from the soil,

Continued on page 64

continued from page 63

and can take up available soil nutrients intended for the developing crop.

As illustrated in Figure 2, we've found that the removal of winter annual weeds with fall herbicide applications resulted in higher soil temperatures when compared to areas with dense infestations of winter annual weeds. In corn, these differences were especially pronounced once soil temperatures reached 50°F (Figure 2). Overall, in our experiments winter annual weed removal achieved through residual fall herbicide applications increased soil temperatures by as much as 5° in corn and by as much as 8° in soybean.

The presence of winter annual weeds also leads to reductions in soil moisture content at the time of planting. In our research, soil moisture content at planting was as much as 13% higher in corn and 6% higher in soybean where winter annual weeds were removed with a fall or early spring preplant herbicide application compared to locations with a dense cover of winter annual weed species.

Lastly, some recent research published by weed scientists at Kansas State University has shown that winter annual weeds are also likely to remove available nitrogen (N) from the soil. When averaged across 14 sites in Kansas, the average N uptake from winter annual weeds was approximately 16 lbs of N per acre. The authors also reported that waiting to remove winter annual weed infestations until spring reduced N uptake in developing corn plants.

#3. Other Pest Interactions

Another significant issue to consider when thinking about fall herbicide applications is that many winter annual weeds can serve as alternate hosts for soybean cyst nematode (SCN). Research has shown that purple deadnettle and henbit are considered strong hosts for SCN while field pennycress has been classified as a moderate host, and shepherd's-purse, small-flowered bittercress, and common chickweed are weak hosts.

Additionally, one of the most studied insect-weed relationships is that of the black cutworm moth. Fields with henbit and other winter annual weeds that are flowering in the early spring are attractive sites for black cutworm moths to lay their eggs, leaving the larvae to hatch and feed on the developing corn crop.

In our own experiments, we have also seen that winter annual weeds can serve as alternative hosts for corn flea beetle and some other Lepidopteran insects in corn. In soybean, removal of winter annual weeds with fall

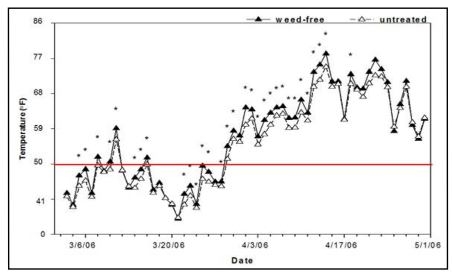

Figure 2. Influence of winter annual weed removal with a residual fall herbicide application on soil temperature prior to corn planting as compared to non-treated plots with a dense cover of winter annual weeds.

Continued on page 65

continued from page 64

herbicide applications reduced total insect populations 10-fold soon after soybean planting compared to areas where winter annual weeds remained until 7 days before planting.

#4. Weed Management

Since fall herbicide applications are supposed to be mostly about the weeds, I will finish with three points about the utility of these programs from a weed management perspective only. The first point is that **all fall herbicide applications are not created equal**. While it may be tempting to cut costs and apply a non-residual herbicide program like glyphosate plus 2,4-D in the fall, it is important to recognize that this kind of approach will only provide control of the winter annual weeds that are present at the time of application. These non-residual herbicide programs don't offer any control of weeds that may emerge after the initial fall application. And in some years, we can get significant germination of winter annual weeds throughout the winter months, depending on the species and the type of weather conditions we are experiencing. This is why I believe residual herbicide applications are generally a more effective option; they offer control of later-germinating winter annual weed species that might not be present at the time of the initial application.

Second, for the most part the fall residual herbicide programs that are commonly promoted by the different companies provide good control of winter annual weeds. In fact, from just a winter annual weed control perspective, it is often difficult to differentiate these programs from one another. These programs are usually differentiated by their price and by their planting restrictions (for example, whether you can plant corn and soybean or just soybean). So my second point is: these fall herbicide programs all generally provide good control of winter annual weeds but **don't expect control of summer annual weeds as well.** There are very few residual herbicides that are applied in the fall that can offer any appreciable level of summer annual weed control, especially in soybeans, and especially in our environment here in Missouri. That may be different in some other states but I believe it is a true statement in Missouri with the winter and spring weather conditions we normally experience. Certain herbicide programs may offer some minor suppression of our earliest emerging summer annual weeds, but minor suppression only, and only for a short period of time.

Figure 3. Inconsistent control of herbicide-resistant horseweed populations like this in the spring may be one reason to consider a fall herbicide application.

My third point is basically an extension of point #2, and that is: **whether or not a residual fall herbicide application "counts" as an additional herbicide mode of action for a resistant weed depends on the weed species**. As discussed above, most fall herbicide programs do not offer any control of summer annual weeds at all, so to count a fall residual herbicide as an additional mode of action on resistant waterhemp, for example, would be a mistake. These products do not provide any control of waterhemp populations that are germinating throughout the summer, so they cannot be included as an effective mode of action on this species, or as part of a program for the management of resistant waterhemp. However, these fall herbicide programs generally do provide excellent control of horseweed (a.k.a. marestail), and so for this weed they should be considered a component of an effective resistant horseweed management program (Figure 3). Some of the more effective fall residual herbicides for the control of horseweed in soybean include the chlorimuron-containing products like Canopy, Canopy EX, Valor XLT, Authority XL, or others. These herbicides should be combined with a base program of either 2,4-D or dicamba (and usually glyphosate) for effective control of seedlings and rosettes that have already emerged at the time of the fall application.

Overall, it is clear from the results of our experiments that there are many other factors, other than just weed control, that you should consider when deciding whether or not to make a fall herbicide application. To see more detailed results and recommendations about fall herbicides in Missouri, you can view a slideshow here at http://weedscience.missouri.edu/extension/extension.htm.

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Weather Data for the Week Ending September 29, 2013

By Pat Guinan

Station	County	Weekly Temperature (ºF)						Monthly Precipitation (in.)		Growing Degree Days‡	
		Avg. Max.	Avg. Min.	Extreme High	Extreme Low	Mean	Departure from long term avg.	September 1-29	Departure from long term avg.	Accumulated Since Apr.1	Departure from long term avg.
Corning	Atchison	80	54	88	43	68	+7	2.78	-0.37	3497	+206
St. Joseph	Buchanan	77	56	84	47	66	+4	3.84	-0.18	3386	+109
Brunswick	Carroll	79	54	86	46	66	+5	1.72	-1.53	3536	+217
Albany	Gentry	79	54	87	41	66	+6	3.58	+0.34	3315	+100
Auxvasse	Audrain	81	54	87	48	66	+4	2.08	-1.75	3352	-16
Vandalia	Audrain	80	55	85	49	66	+4	2.44	-1.26	3308	-13
Columbia-Bradford Research and Extension Center	Boone	80	53	85	47	65	+3	1.69	-2.05	3280	-176
Columbia-Capen Park	Boone	80	53	86	47	65	+2	2.82	-0.88	3259	-314
Columbia-Jefferson Farm and Gardens	Boone	80	56	85	51	67	+5	1.81	-1.85	3419	-48
Columbia-Sanborn Field	Boone	79	58	85	53	68	+5	2.70	-1.06	3619	+40
Columbia-South Farms	Boone	79	56	85	50	67	+5	2.00	-1.75	3399	-61
Williamsburg	Callaway	82	54	87	46	66	+4	1.89	-2.28	3360	+50
Novelty	Knox	78	52	83	45	65	+4	3.10	-0.46	3201	-48
Linneus	Linn	79	54	86	42	66	+5	1.98	-1.39	3319	+116
Monroe City	Monroe	79	52	85	45	65	+5	2.81	-0.92	3282	-21
Versailles	Morgan	81	56	87	49	67	+4	2.95	-1.06	3801	+262
Green Ridge	Pettis	77	54	85	45	66	+4	2.74	-1.73	3404	+65
Lamar	Barton	78	55	86	49	66	+3	1.74	-3.12	3593	-101
Cook Station	Crawford	80	52	83	43	65	+3	5.04	+0.89	3247	-279
Round Spring	Shannon	80	53	82	45	64	+2	1.55	-2.29	3180	-213
Mountain Grove	Wright	79	56	82	51	66	+4	2.32	-2.12	3210	-158
Delta	Cape Girardeau	80	54	85	44	66	+1	0.79	-2.53	3579	-319
Cardwell	Dunklin	8	59	89	50	70	+3	1.59	-1.37	3926	-295
Clarkton	Dunklin	81	58	87	47	69	+2	1.19	-2.01	3834	-328
Glennonville	Dunklin	80	59	85	49	69	+3	1.49	-1.64	3912	-223
Charleston	Mississippi	79	59	84	50	68	+3	2.78	-0.36	3819	-119
Portageville-Delta Center	Pemiscot	79	62	83	54	70	+3	1.98	-1.30	4069	-121
Portageville-Lee Farm	Pemiscot	79	61	85	51	70	+3	2.43	-0.91	4041	-119
Steele	Pemiscot	81	61	86	51	71	+4	1.45	-1.64	4103	-94

‡Growing degree days are calculated by subtracting a 50 degree (Fahrenheit) base temperature from the average daily temperature. Thus, if the average temperature for the day is 75 degrees, then 25 growing degree days will have been accumulated.

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