

**Integrated Pest & Crop Management**

# Weather and Soybean Yields

by William J. Wiebold

I have written several articles this fall describing my concern about the effects of our recent bout with dry weather on soybean yields. With few rain delays soybean harvest has progressed rapidly throughout Missouri. About 80% of the planted acres have been harvested, and many reported yields have been quite good.

So, were my concerns unjustified? The focus of my articles and concern was the portion of Missouri’s soybean acres that were planted very late, after July 1.

Figure 1 presents soybean planting progress in Missouri as number of acres remaining unplanted. I started with USDA estimate of planting intentions of 5.6 million acres and multiplied by the estimated statewide percentage for soybean planted each week. On July 1, nearly 2 million Missouri soybean acres had not been planted. If nearly 1 million acres were never planted, then about 1 million acres were planted after July 1. It was these 1 million acres that was the target of my concern because they needed normal precipitation in September to produce up to their limited potential. That rain did not happen, and yields from late planted soybean acres will be less than the first acres harvested.

Only about 1.3 million acres were planted before June 1, so 2.3 million acres were planted in June. Our research indicates that yield potential, on average, decreases from 10 to 25% as planting is delayed through June. But, as we learn each year, weather conditions during pod-set and early seed-fill stages of soybean plant development greatly influence yield, much more than planting date. These critical stages occur during the first two weeks of August for early May planted soybean, late August for June planted soybean, and early September for July planted soybean. So the critical weather period shifts later as planting is delayed. Except for unusually late planted soybean, August weather is critical.

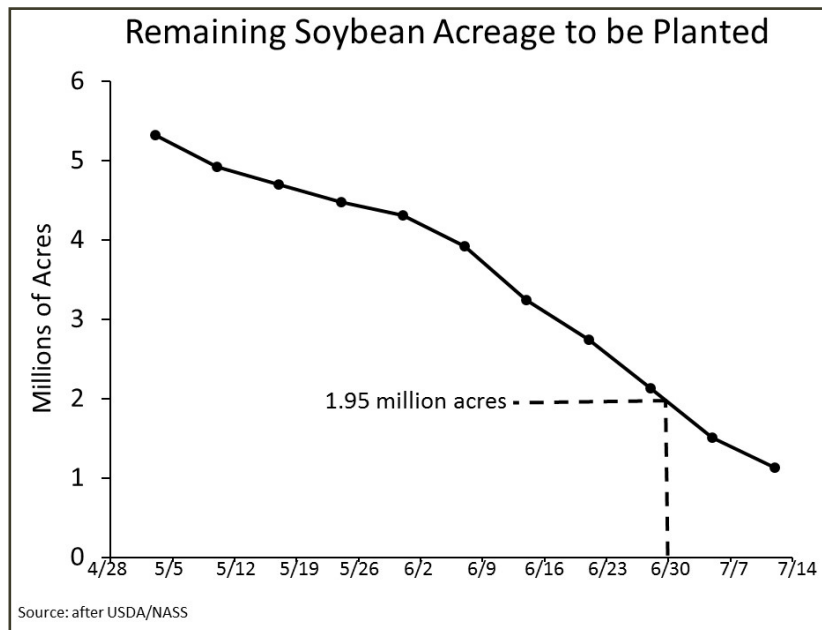


Figure 1.

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Studying August weather conditions may help us understand some of the reported high soybean yields in 2015. Three weather factors greatly affect yield. We have already discussed rain and know that for many parts of Missouri rain essentially stopped after mid-August. However, soils that have good to excellent water holding capacity entered late summer with fully charged soil profiles. Stored water helped maintain yields of May planted soybeans in regions where soils are deep or textures are conducive to storing plant available water. The other two weather factors that affect soybean yield are sunlight and temperature.

Sunlight is important because it drives photosynthesis and photosynthesis produces the energy used to make yield. We often forget about the importance of sunlight. Soybean leaves are displayed to capture sunlight. Leaves need to capture that sun energy, store the captured energy in sugar, and translocate that sugar to seeds and other active parts of the plant. Table 1 compares sunlight energy for the previous five years to sunlight energy in 2015. In the first 2 weeks of August in 2015, sun energy was 10 to 12% higher than the 5-year average for three of the four selected weather stations. The Brunswick area (Carroll County) experienced a slight decrease. Early August is especially important for sunlight. At that time, soybean pod load is adjusted to match sugar production. Increased light capture means greater sugar production. More sugar means more pods retained, and potentially greater yield.

**Table 1. Total light energy in two 2-week periods in August for four counties in central and north Missouri.**

	August 1-15			August 16-31		
County	5-year ave	2015	Difference	5-year ave	2015	Difference
	----- Mj/m2 -----			----- Mj/m2 -----		
Gentry	278	311	+12%	283	277	-2%
Knox	275	304	+11%	294	292	-1%
Audrain	268	295	+10%	306	314	+3%
Carroll	297	285	-4%	313	296	-2%

Temperature is important for two reasons. Water evaporation from leaves is directly related to the temperature of leaves. Bright sun and warm air temperatures increase water evaporation. In 2015, water stored in soil was used, but not replenished by subsequent rains. Cooler temperatures delay depletion of stored water. Temperature is also important in determining yield because of its effect on plant respiration. Some amount of respiration is needed by living plants, but too much respiration reduces yield because sugars are burned up and wasted rather than being used to produce yield.

Table 2 shows that 2015 was cooler both during the day and during the night in the last two weeks of August. Average departure from 5-year averages was -5.5% during the day and -4.1% during the night. Optimum temperature for soybean photosynthesis is 86°F. Averaged over 5 years, it is normal for 11 August days to experience temperatures greater than 86°F. In 2015, air temperature reached 86°F or warmer on only 6 August days. The last two weeks of August are important because this is when rapid seed-filling occurs. Sugar that is produced in leaves must be transported to pods where it is transformed into oil, protein and complex carbohydrates. These compounds are stored in seeds to give us yield. If sugar is respired away because of warm temperatures it cannot be used to make yield.

*Table 2. Departure from 5-year average for maximum and minimum air temperatures during two 2-week periods in August.*

	Average daily maximum temperature		Average daily minimum temperature	
	August 1-15	August 16-31	August 1-15	August 16-31
	-----% departure from 5-year average -----			
Gentry	-2.2	-9.8	+1.1	-5.0
Knox	-0.8	-4.7	+1.0	-3.4
Audrain	-0.8	-2.5	+1.1	-4.4
Carroll	+1.2	-5.1	+1.5	-3.7

Like previous stress years, 2015 taught us again that Mother Nature is the most important determiner of soybean yield. We were concerned about decreased yield potential with delayed planting, but also knew that August weather would define our yields. Mother Nature cooperated with soybean acres planted in May and June by providing more light and cooler temperatures at critical stages of plant development. Sunlight and temperatures provided by Mother Nature in September were conducive to better yields for ultra-late planted soybeans. But, almost no rain occurred in September and drought conditions trumped the other weather factors in affecting yield.

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# Weather Data for the Week Ending November 29, 2015

Station	County	Weekly Temperature (°F)						Monthly Precipitation (in.)		Growing Degree Days‡	
		Avg. Max.	Avg. Min.	Extreme High	Extreme Low	Mean	Departure from long term avg.	November 1-29	Departure from long term avg.	Accumulated Since Apr 1	Departure from long term avg.
Corning	Atchison	46	33	61	24	40	+4	3.40	+1.48	3820	+369
St. Joseph	Buchanan	49	34	62	28	41	+4	3.83	+2.01	3723	+281
Brunswick	Carroll	52	36	67	33	44	+5	5.89	+3.20	3973	+480
Albany	Gentry	48	33	60	25	40	+3	4.13	+2.15	3449	+99
Auxvasse	Audrain	53	37	70	33	45	+5	7.84	+4.61	3815	+255
Vandalia	Audrain	53	36	69	31	44	+4	6.10	+3.08	3775	+280
Columbia-Bradford Research and Extension Center	Boone	52	37	69	33	45	+4	7.47	+4.36	3751	+85
Columbia-Capen Park	Boone	56	36	73	24	45	+4	7.84	+4.72	3755	-44
Columbia-Jefferson Farm and Gardens	Boone	53	37	70	33	45	+4	7.68	+4.58	3903	+224
Columbia-Sanborn Field	Boone	54	38	70	34	46	+5	7.98	+4.79	4101	+292
Columbia-South Farms	Boone	53	38	71	33	46	+5	7.57	+4.45	3852	+180
Williamsburg	Callaway	55	38	71	31	45	+5	6.45	+3.00	3801	+305
Novelty	Knox	50	34	65	31	42	+3	5.49	+2.66	3505	+89
Mosow Mills	Lincoln	56	37	71	28	45	+5	6.08	+2.79	*	*
Linneus	Linn	50	34	62	27	42	+4	5.59	+3.20	3612	+255
Monroe City	Monroe	52	35	70	30	44	+5	6.48	+3.34	3688	+211
Versailles	Morgan	53	38	69	34	46	+4	7.92	+4.41	4054	+274
Green Ridge	Pettis	52	36	69	31	44	+4	6.83	+3.74	3856	+319
Unionville	Putnam	47	33	60	29	40	+4	6.58	+4.09	*	*
Lamar	Barton	52	37	68	32	45	+2	7.29	+3.50	4070	+114
Butler	Bates	51	36	67	31	44	+3	7.32	+4.28	*	*
Cook Station	Crawford	56	39	66	27	46	+3	7.87	+3.67	3740	-20
Round Spring	Shannon	56	35	64	21	45	+3	8.64	+4.52	3630	+32
Mountain Grove	Wright	54	39	63	32	46	+4	9.21	+4.83	3642	+63
Delta	Cape Girardeau	54	39	63	28	47	+2	9.41	+4.68	4039	-137
Cardwell	Dunklin	60	43	68	30	50	+3	12.13	+7.47	4483	-83
Clarkton	Dunklin	58	41	68	30	49	+3	10.22	+5.92	4447	-45
Glennonville	Dunklin	57	43	66	32	49	+3	10.38	+6.09	4483	+26
Charleston	Mississippi	59	42	69	29	50	+4	8.80	+4.68	4435	+212
Hayward	Pemiscot	59	44	70	33	51	+4	12.39	+8.11	4608	+105
Portageville	Pemiscot	60	44	71	31	51	+4	12.36	+8.09	4702	+163
Steele	Pemiscot	60	43	71	28	50	+3	12.70	+8.07	4557	+6

‡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.

Weather Data provided by Pat Guinan | GuinanP@missouri.edu | (573) 882-5908

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