EFFECTS OF IRRIGATION ON WHEAT CANOPY TEMPERATURE AND YIELD

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This report was completed by an undergraduate student intern as part of the requirement to conduct applied research and extension activities of the USDA-NIFA ELI-REEU 2017-06637 project.

Pivot irrigation system in Logan County, KY. (Photo: C. Knott)

Traditionally in Kentucky, irrigation is unnecessary in winter wheat due to the high precipitation usually experienced in the state. However, with bouts of droughts becoming increasingly frequent in recent years, irrigation is serving as an additional method to ensure crop success for many producers. As a grain crop, wheat favors cooler temperatures and grows best when in the range of 66°to 72° F with a maximum growing temperature of 98° F (Porter and Gawith, 1999). Higher yields are generally associated with lower average canopy temperatures during grain fill in late spring. The goal of this research project was to increase the overall yield of wheat by lowering the canopy temperature during grain fill. The specific objective was to determine whether wheat canopy temperature and grain yield were affected by irrigation of 0.12” at noon on sunny days.

METHODOLOGY

Soft red winter wheat (Pembroke 2016) was planted in late October 2017 under a lateral irrigation system at the University of Kentucky Research and Education Center in Princeton, Kentucky. Plots were managed according to University of Kentucky recommendations.

Alleys were cut to make plots approximately 171 ft by 30 ft. There were two treatments that were replicated four times. One treatment was the application of 0.12" at noon on sunny days. The irrigated treatment required forty-five minutes to complete. The second treatment was the non-irrigated control treatment.

Rain gauges, air temperature sensors, and canopy temperature sensors were placed in the field May 22, 2018. Canopy temperature was measured with Decagon infrared thermometers. The thermometers were 14°half angle ultra-narrow field of view mounted at a 60°angle at a height of 5 feet to measure an area of approximately 6' 11" by 19' 3". EM50 data loggers were used to collect and store canopy temperature once per minute from May 23, 2018 to physiological maturity on June 8, 2018, as determined when the peduncle area closest to the wheat head had turned brown. Irrigation events occurred on May 25, June 1, June 4, June 6, and June 8. Each of these days experienced hot, sunny weather all day.

Grain was harvested June 11 and 12 with a Wintersteiger small plot combine equipped with a Harvest Master weighing system. Yield and test weight were determined and adjusted to 13.5% grain moisture.

Data were analyzed with SAS (version 9.4; PROC MIXED) to determine if differences in yield, test weight and canopy temperature existed.

Wheat harvest in small plot combine, June 2018. (Photo: C. Knott)

RESULTS AND DISCUSSION

The hot conditions during the 2018 growing season were ideal for investigating whether irrigation could reduce canopy temperature and result in a yield increase. The temperatures late in the season were mostly higher than the 30-year average, especially throughout May (Figure 1). While the precipitation amount has stayed true to the 30-year average in May, and was lower than the 30-year average in June (Figure 2).

Canopy temperature began to decrease about 15 minutes after the irrigation treatment began and remained significantly lower than the non-irrigated control for 15 minutes after the irrigation system was turned off (Figure 3 and 4). The average canopy temperature during this forty-five minute period was 85° F for irrigated treatment compared to 91° F for the non-irrigated treatment (Table 1). The range of significant canopy temperature differences between the irrigated and non-irrigated treatments was 3°F to 8°F (Figure 3 and 4).

The irrigated treatment had a 2.5 bushel per acre greater yield than the non-irrigated control (Table 1). This could be a result of the average canopy temperature decrease from 91°F for the non-irrigated control to 85°F for the irrigated treatment, with maximum canopy temperature decreases of 8°F (89°F for the non-irrigated control vs. 81°F for the irrigated treatment) about 50 minutes after the irrigation was started (Table 1 and Figure 4). It has been found in other research that in highly controlled conditions temperatures above 86° F after flowering has the potential to decrease grain fill for wheat and therefore decrease final grain yield (Randall and Moss, 1990).

It is also possible that the additional water or the combination of additional water and reduced canopy temperature of the irrigated treatment could be contributing to the 4% yield increase. The first 11 days of June received only 0.16” of precipitation, which is 1.25” less than the 30 year average. The June irrigation totals were almost 0.5” (Figure 2).

In this study, the test weight, although quite low, did not differ between the irrigated and non-irrigated treatment (Table 1). There were numerous reports of low test weight wheat harvested in Kentucky in 2018. In general, most reports were that test weights were around 51 to 53 lb per bushel, not the 49 to 50 lb per bushel test weights that were found in the study.

Our finding that wheat yield was increased by 4% with several applications of 0.12” of irrigation may possibly provide Kentucky producers with methods to increase yield potential. Although, it is unclear whether yield increases could be observed with a larger irrigation system, which takes much longer than 45 minutes to complete a rotation, this project clearly demonstrates the potential for additional management practices to increase wheat yield.

Table 1: Mean grain yield, test weight, and average canopy temperature for the irrigated and non-irrigated control treatments.

Treatment	Grain Yield (bu per acre)	Test Weight (lb per bu)	Average Canopy Temperature† (°F)
Irrigated	67.1	49.2	85
Non-Irrigated Control	64.6	49.5	91
P - value	0.0163	0.4525	<0.0001

†Average Canopy Temperature from 12:15 to 1:00, the timeframe that canopy temperature differed ($P < 0.05$) between the treatments.

Figure 1: Average daily temperature and the 30 year mean from April 27th- June 11th.

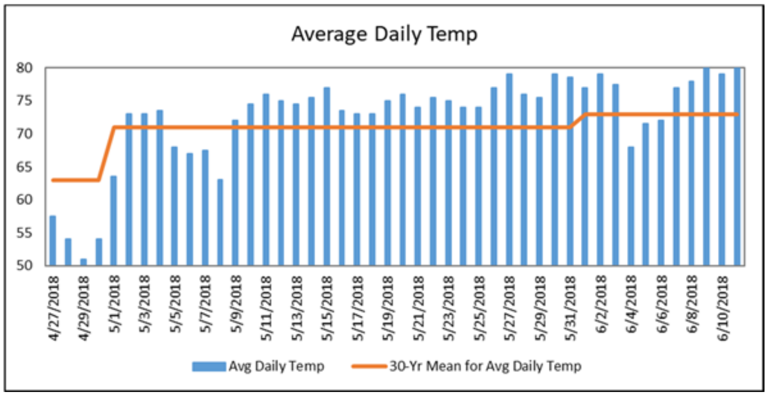


Figure 2: Total precipitation (inches) and the 30 year mean from April 27th- June 11th.

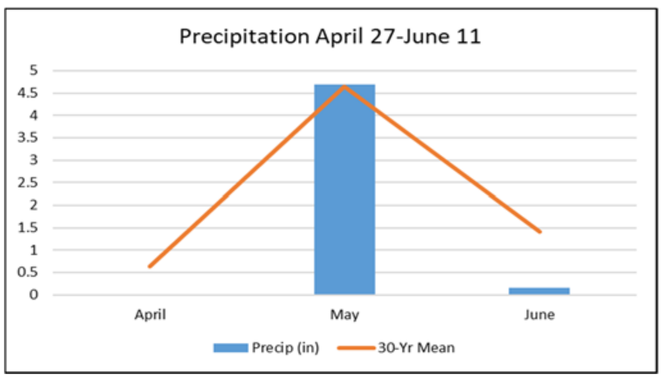


Figure 3. Average canopy temperature for the irrigated and non-irrigated treatments.

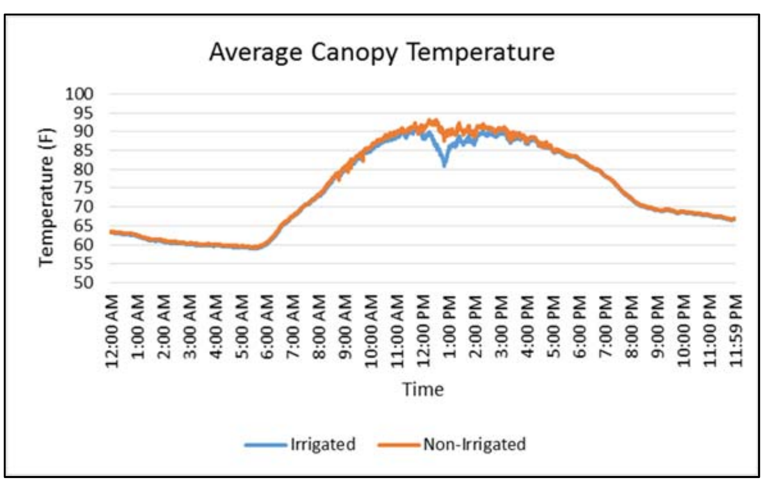
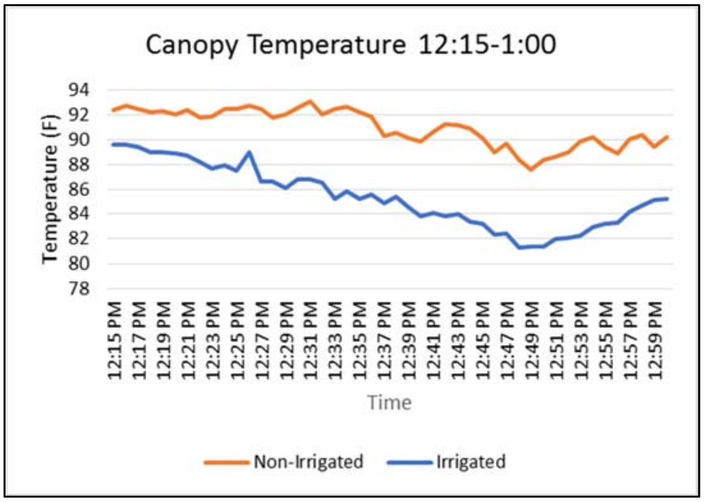


Figure 4: Average canopy temperature for the irrigated and non-irrigated treatments during the forty-five minute timeframe that canopy temperature differed (*P* < 0.05) between the treatments.



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ACKNOWLEDGEMENTS

This work could not have been completed without the assistance Katherine Rod, Conner Raymond, Mary Grace Jackson, and Brad James. Funding provided by Kentucky Small Grain Growers Promotion Council and USDA-NIFA ELI-REEU 2017-06637.