Effects of Irrigation on Wheat Canopy Temperature and Yield

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Summary

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°- 72° F with a maximum growing temperature of 37° C (Porter and Gawith, 1999). Higher yields are generally associated with lower average canopy temperatures. 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.

Rationale

This experiment was conducted because of the increase occurrence of droughts in the state, and more producers are implementing pivot irrigation to effectively care for their crops. Although most producers utilize irrigation to maximize profitability of grain crops, it can be useful in many other ways as well. Since wheat is a winter crop in this part of the country and prefers mild temperatures, it produces a better yield when the canopy temperatures are lower than what is generally experienced during grain fill. This experiment was conducted to determine if running irrigation during the heat of the day would lower wheat canopy temperatures and ultimately impact grain yield.

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: one with 0.12" water irrigated to it at noon every day if it was sunny, and the other received no irrigation. These treatments were replicated four times.

Rain gauges, air temperature sensors, and canopy temperature sensors were placed in the field May 22nd, 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 23rd, 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 the dates of May 25th, June 1st, June 4th, June 6th, and June 8th. Each of these days experienced hot, sunny weather all day.

Grain was harvested June 11th and 12th 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 was analyzed with SAS (version 9.4; PROC MIXED) to determine if differences in yield, test weight and canopy temperature existed.

Results and Discussion

The environmental conditions experienced during this 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 was reduced by up to 7 degrees Fahrenheit on the days when the lateral irrigation was ran at high noon with a total of .12" of water (Figure 3 and 4). One of the most interesting findings is that the temperature did not begin to decrease until 15 minutes after the irrigation began to run through the field and continued 15 minutes after it exited the field (Figure 3 and 4). You can see that although there was a yield increase, it increased yield by about 4% (Table 1). On average, canopy temperature from 15 minutes after irrigation began to 15 minutes after the irrigation was turned off was 85.3° F for irrigated treatment compared to 91° F for the non-irrigated treatment (Table 1). The test weight, although quite low, did not differ between the irrigated and non-irrigated treatment (Table 1).

Treatment	**Grain Yield (bu/A)**	**Test Weight (lb/bu)**	**Canopy Temperature** (°F) From 12:15-1:00
Irrigated	67.1	49.2	85.3
Untreated Control	64.6	49.5	91
P - value	0.0163	0.4525	<0.0001

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

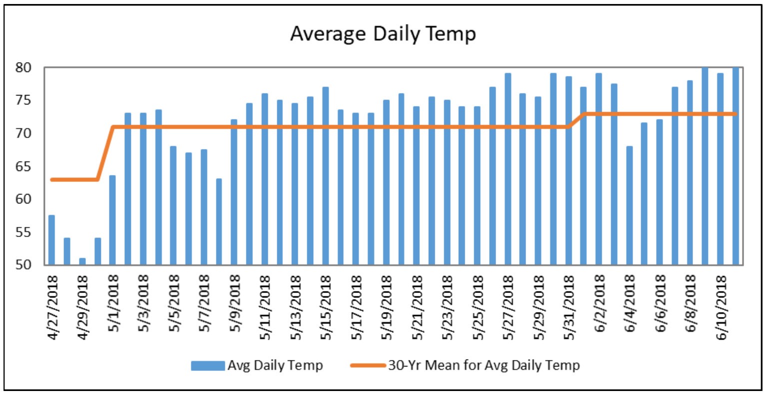

Figure 1: Average daily temperature from April 27th- June 11th and the 30 year mean.

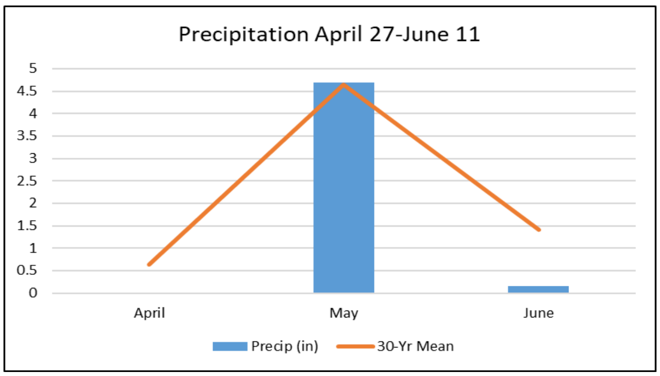

Figure 2: Precipitation from April 27th- June 11th and the 30 year average for the same time frame.

Canopy temperature for the irrigated plots were significantly *(P*<0.05) lower beginning 15 min after the start of irrigation (12:15) and ending 15 min after the end (1:00) (Figure 3 and 4). In the irrigated plots a constant decrease in temperature was observed as long as the irrigation was running (Figure 4). The range of significant canopy temperature differences between the irrigated and non-irrigated treatments was 3.1°F to 7.7°F. In the plots with the lower canopy temperature we were also able to see a 4% increase as compared to the untreated control (Table 1).

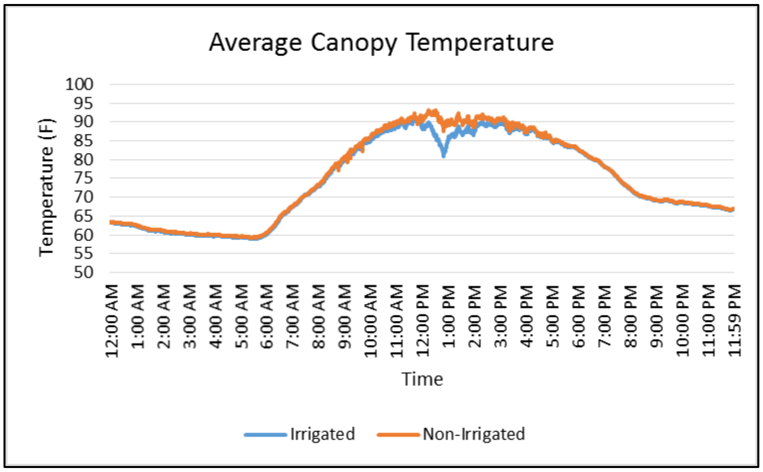

Figure 3. The average canopy temperature for the irrigated and non-irrigated treatments.

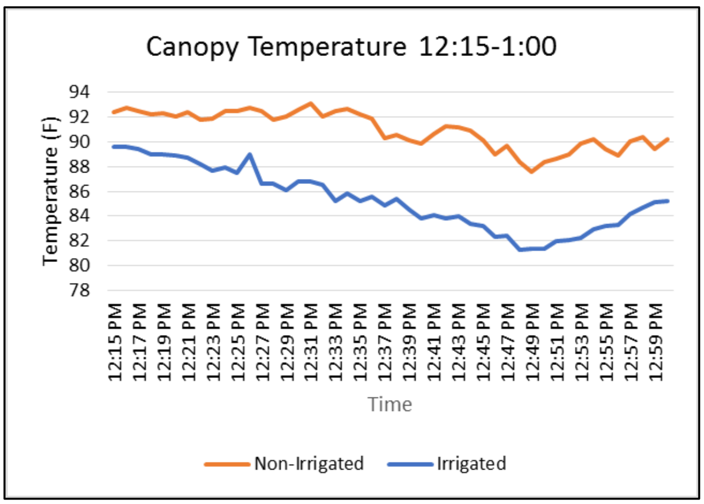

Figure 4: Average canopy temperature, for the irrigated and non-irrigated during the timeframe that canopy temperature was statistically different ($p<0.05$).

This year the weather conditions were perfect for this study; it was very warm in May and early June, which was conductive for this project. Should it have been a cool, wet season such as what was experienced in 2014, the prediction of increased grain yield would most likely have not been observed.

We were able to decrease canopy temperatures and increase yield by 4% with as few as six timely irrigation events. The yield increase is likely due to an increased grain fill period as a result of the lowered canopy temperatures in the heat of the day from 88° F to 81° F. Grain fill length is vitally important as the longer the time allowed, the greater the yield and test weight. Additionally, as temperature increases yields can decrease by as much as 27% (Moot, et al., 1996). Randall and Moss conducted research that indicates that any temperature above 86° F after anthesis has the potential to decrease grain fill for wheat and therefore decrease final grain yield.

Significance of Findings

These results will possibly allow producers to increase their grain fill period, produce more grain, and in turn increase their profit margin.

Implications for Future Work

One question for future research would be observed with a larger irrigation system, and if the time remained equal both before and after the irrigation was stopped. Future work could also include the analysis of the profitability of this work at a large scale.

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