**2017 University of Kentucky Industrial Hemp Variety Trials for Dual-Purpose Production**

**D.W. Williams (PSS)*, J. Patrick Perry (KTRDC)*, Tom Keene (PSS)***

***(PSS) Plant and Soil Science; (KTRDC) Kentucky Tobacco Research and Development Center**

## Introduction

Variety trials for dual-purpose industrial hemp production were conducted at both the University of Kentucky's Spindletop Farm in Lexington, Fayette County, KY and the Robinson Center for Appalachian Resource Sustainability (UK-RCARS) in Quicksand, Breathitt County, KY. Experimental designs were randomized complete blocks (RCBD) planted independently on 3 May, 2 June, and 28 June 2017 at both locations. Each respective planting date was analyzed as an individual trial. Varieties evaluated are provided in Table 1.

Table 1. Varieties evaluated in 2017 and their owners.

| Variety Name | Owner |
|---|---|
| Santhica 27 | Terres Inovia, Thiverval-Grignon, France (standard entry) |
| Felina 32 | Terres Inovia, Thiverval-Grignon, France (standard entry) |
| Bialobrzeskie | Institute of Natural Fibers, Poznan, Poland, (standard entry) |
| Finola | Finola LLC/OY, Kuopio, Finland (standard entry) |
| NWG 331 | New West Genetics, Fort Collins, CO |
| NWG 452 | New West Genetics, Fort Collins, CO |
| CHY | Ecofibre Industries Operations, Sydney, Australia |
| PR13 | Ecofibre Industries Operations, Sydney, Australia |
| CFX-2 | Hemp Genetics International, Saskatoon, SK, Canada |
| CRS-1 | Hemp Genetics International, Saskatoon, SK, Canada |
| Grandi | Hemp Genetics International, Saskatoon, SK, Canada |
| Katani | Hemp Genetics International, Saskatoon, SK, Canada |
| Picolo | Hemp Genetics International, Saskatoon, SK, Canada |

The soil types at each location were: Maury silt loam at Spindletop and silt loams in the Nolin-Grigsby complex at Quicksand. Fields were prepared using conventional tillage practices. Granulated urea (46-0-0) was applied by broadcast on the day of seeding at a rate of 100 lbs. of N/A. Fertilizer was incorporated into the soil at a depth of 3-4 inches by cultivation. Hemp seed was planted using the Mundell Modified Soybean Plot Planter at a rate of 30 lbs/A. Seeding depth was calibrated to 0.25 inch. No additional pesticides or irrigation were used for the duration of the studies.

Grain was harvested when seed heads contained ~75% brown mature seed. Stalks were cut at the base of the flower using hand pruners from two, independent $1m^2$ sub-plots from within each main plot, careful to avoid plot edges. Harvested flowers were placed in paper bags and air-dried. Once dried, grain was thrashed from harvested flowers by hand and subsequently

cleaned by manual screening to determine dry grain yields. The remaining stalks after grain harvests were also harvested from the same sub-plots using a handheld sickle mower and air dried. Data collected from stalks were plant populations, straw yields measured as dry weight (DW), stalk heights, and stalk diameters at the base. All data were analyzed using the ANOVA procedure of SAS 9.4 (SAS Institute, Cary, NC). Means were separated by a Fisher's Protected LSD ($\alpha$=0.05) where the main effect of variety was significant.

**Results**

The 2 June planting was destroyed at Quicksand due to extreme precipitation very soon after seeding. Additional crop failures resulted in either variety deletions and/or incomplete data collection among planting dates and at both locations. ANOVA statistics for each successful planting date at each location are provided in Table 2. Weather and photoperiod data are presented for both locations in Appendix 1. Data are presented in Figures 1-3 for the May, June and July plantings, respectively. Data are separated by variety and location where location is abbreviated either ST = Spindletop (blue bars, letters) or QS = Quicksand (orange bars, letters). NS= not significant (P>0.05).

Table 2; A-D. ANOVA statistics for the May planting date at Quicksand (A) and the May (B), June (C) and July (D) planting dates at Spindletop; 2017 dual-purpose variety trials.

A. May planting-Quicksand

| ANOVA Statistic | Plant Height | Stem Diameter | Grain Yield | Straw Yield | Plant Density |
|---|---|---|---|---|---|
| P-Value Model | <0.0001 | <0.0001 | 0.0325 | <0.0001 | 0.3677 |
| P-Value Replication | 0.1127 | 0.1347 | 0.2941 | 0.3008 | 0.5947 |
| P-Value Variety | <0.0001 | <0.0001 | 0.0204 | <0.0001 | 0.2702 |
| CV | 7.34 | 8.90 | 25.27 | 22.82 | 22.60 |

B. May planting-Spindletop

| ANOVA Statistic | Plant Height | Stem Diameter | Grain Yield | Straw Yield | Plant Density |
|---|---|---|---|---|---|
| P-Value Model | 0.0014 | 0.1805 | <0.0001 | 0.0064 | <0.0001 |
| P-Value Replication | 0.0916 | 0.3810 | 0.0011 | 0.2935 | 0.0119 |
| P-Value Variety | 0.0004 | 0.1072 | <0.0001 | 0.0018 | <0.0001 |
| CV | 14.55 | 18.12 | 14.27 | 42.81 | 14.55 |

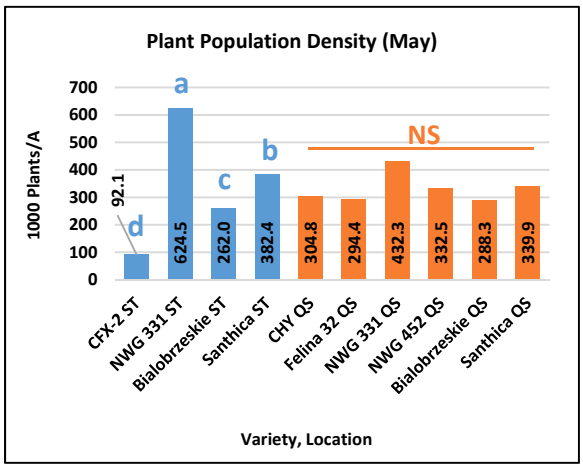
C. June planting-Spindletop

| ANOVA Statistic | Plant Height | Stem Diameter | Grain Yield | Straw Yield | Plant Density |
|---|---|---|---|---|---|
| P-Value Model | 0.2310 | 0.0057 | 0.7298 | 0.0001 | 0.0024 |
| P-Value Replication | 0.5970 | 0.5654 | 0.8299 | 0.8578 | 0.4295 |
| P-Value Variety | 0.0898 | 0.0011 | 0.4347 | <0.0001 | 0.0005 |
| CV | 17.70 | 8.74 | 53.73 | 15.40 | 15.95 |

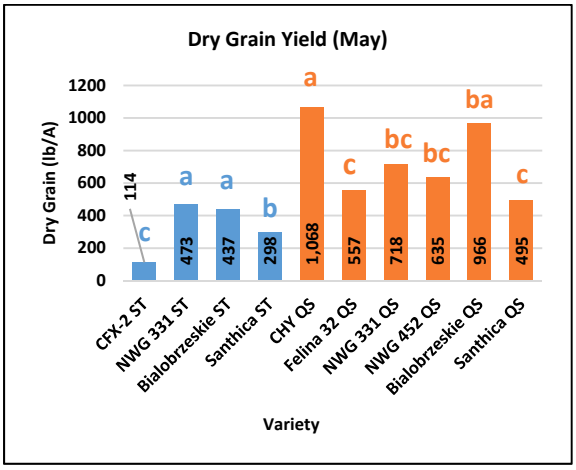
D. July planting-Spindletop

| ANOVA Statistic | Plant Height | Stem Diameter | Grain Yield | Straw Yield | Plant Density |
|---|---|---|---|---|---|
| P-Value Model | 0.0275 | 0.0118 | 0.1381 | <0.0001 | 0.5857 |
| P-Value Replication | 0.3693 | 0.6490 | 0.5756 | 0.0007 | 0.5807 |
| P-Value Variety | 0.0092 | 0.0027 | 0.0551 | <0.0001 | 0.4629 |
| CV | 23.17 | 24.47 | 43.94 | 4.37 | 15.73 |

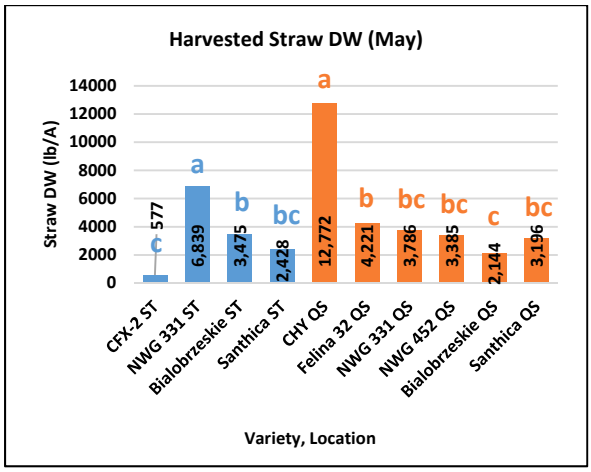
**Figure 1. Dual-purpose trial May planting date. A.** Mean population density (1000 plants/A). **B.** Mean harvested dry grain (lbs/A). **C.** Mean harvested straw DW (lbs/A). **D.** Mean stalk height (inches). **E.** Mean stalk diameters (mm).



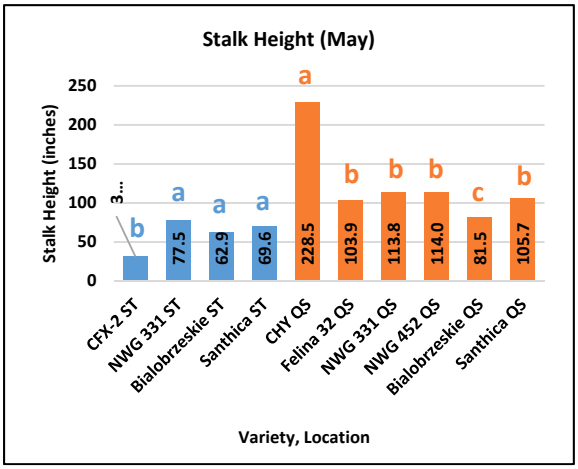

A



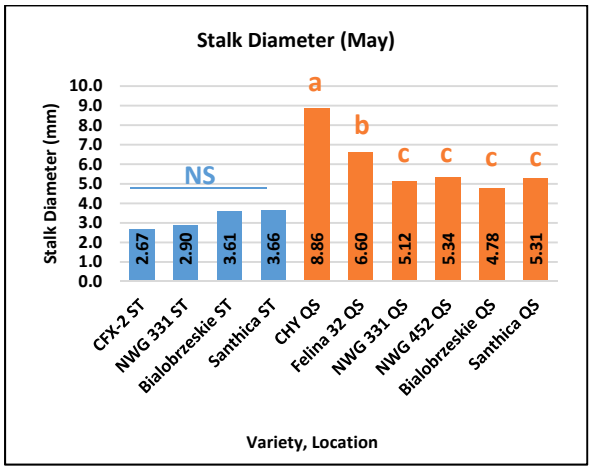

B




C

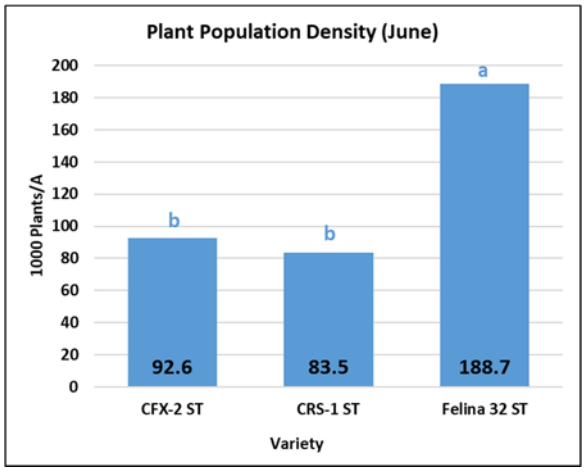



D

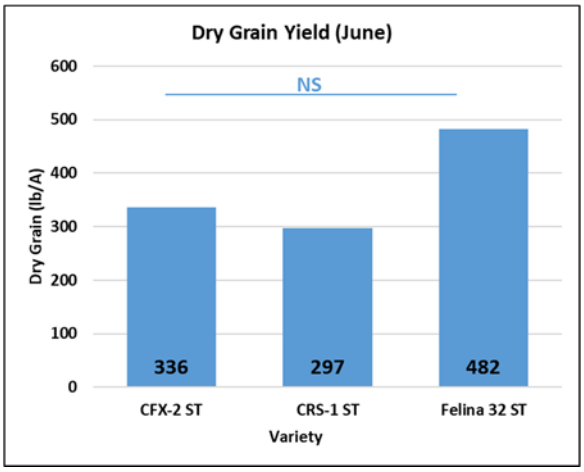



E

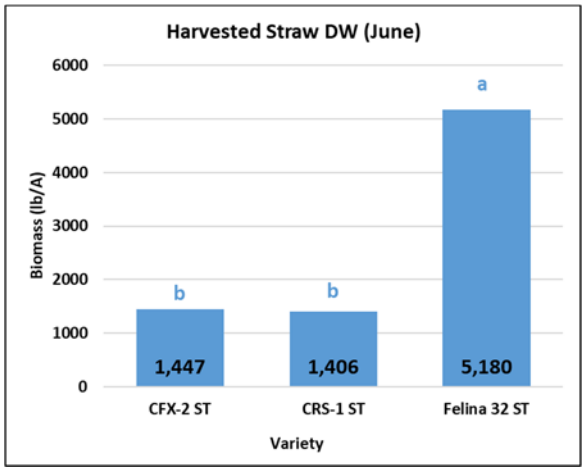
**Figure 2. Dual-purpose trial June planting date**. Note: the entire June planting at the Quicksand location was destroyed by flooding. Data are for Spindletop location only. **A.** Mean population density (1000 plants/A). **B.** Mean harvested dry grain (lbs/A). **C.** Mean harvested straw DW (lbs/A). **D.** Mean stalk height (inches). **E.** Mean stalk diameters (mm).



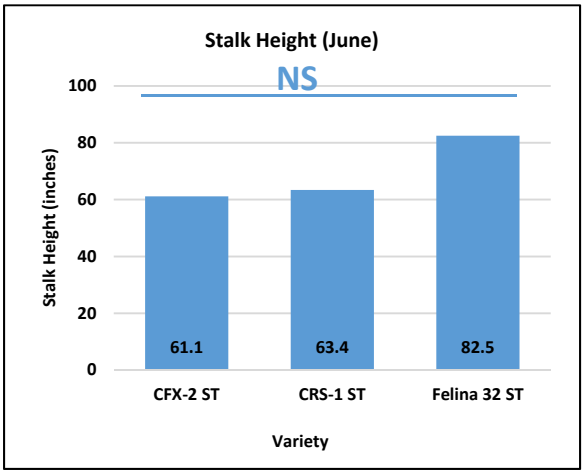

A



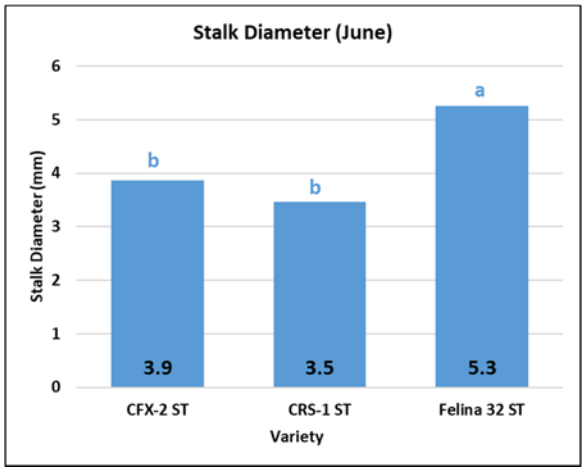

B




C

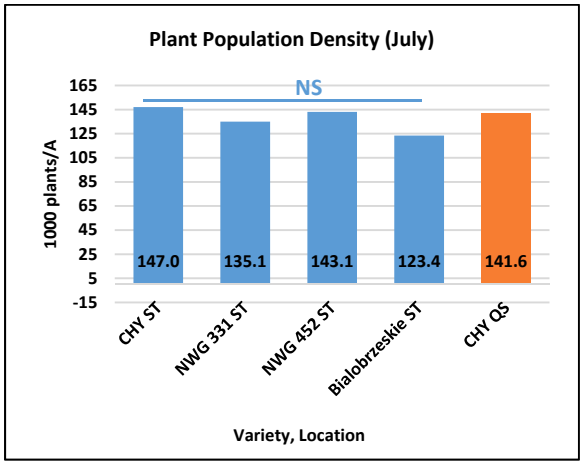



D

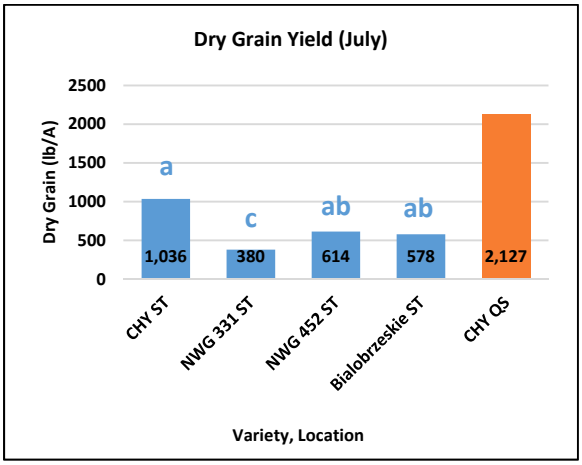



E

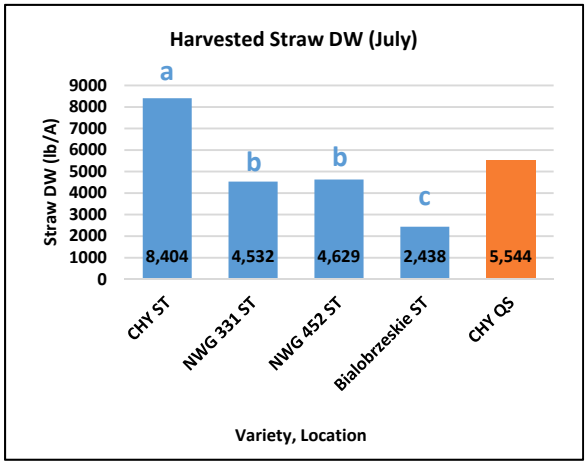
**Figure 3. Dual-purpose trial July planting date.** **A.** Mean population density (1000 plants/A). **B.** Mean harvested dry grain (lbs/A). **C.** Mean harvested straw DW (lbs/A). **D.** Mean stalk height (inches). **E.** Mean stalk diameter (mm).



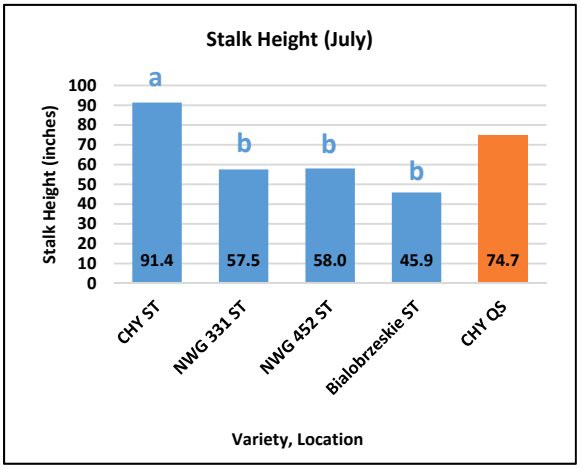

A



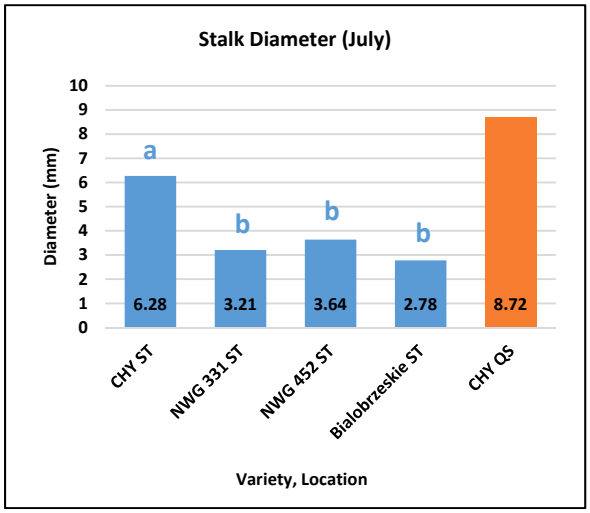

B




C




D




E

## Conclusions

The May planting date was most successful at both locations. Severe weed pressure (not quantified) was experienced which was the leading cause of crop failures among the varieties planted. Weed pressure was high at both locations. Bird pressure was also expected at both locations, hence, nylon bird netting barriers were constructed around trials to prevent bird predation of hemp grain.

As a result of natural pressures, only four varieties were harvested for the May planting date at Spindletop and six at Quicksand (Fig. 1). Significant differences in plant population density were observed at the Spindletop location but not Quicksand (Fig. 1A). Dry grain yields were relatively poor at the Spindletop location (Fig. 1B). In contrast, CHY and Bialobrzeskie yielded favorable amounts of grain at Quicksand with 1,068 and 966 lbs/A, respectively. CHY also had significantly higher straw DW yields compared to all other varieties but with very tall stems and large stalk diameters (Figs. 1C-E). Two U.S.-based varieties, NWG 331 and NWG 452, performed well in terms of grain yield at the Quicksand location.

The entire dual-purpose June planting was destroyed at Quicksand due to extreme rain very soon after seeding. Severe weed pressure at Spindletop reduced data collection to three varieties: CFX-2, CRS-1, and Felina 32 (Fig. 2). Ultimately, data analyses determined that the early June planting date was an abject failure with negligible grain yields and straw DW yields (with the exception of Felina 32 with a moderate 5,180 lbs/A DW) (Figs. 5B,C). Plant heights were not significantly different.

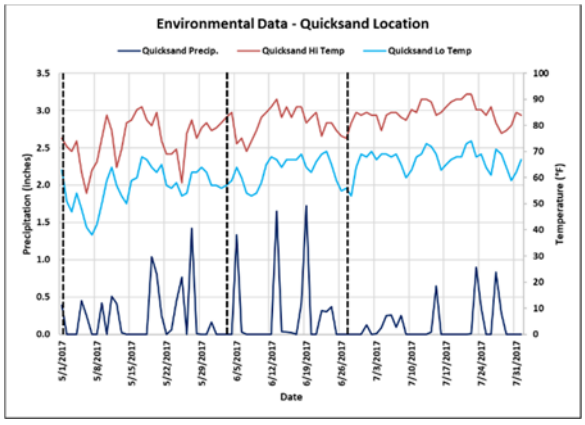
The July planting date had four harvested entries at the Spindletop location and one at the Quicksand location, mostly due to extreme weed pressure at both locations. There were no significant differences among varieties considering population density in the July planting date (range 147-123 thousand plants/A) (Fig. 3A). Mean grain yields at Spindletop were significantly different ($P<0.05$), but considering the extreme coefficient of variation (cv = 43.94), firm conclusions are not appropriate. CHY yielded the highest mean dry grain with 1,036 lbs/A with NWG 452 and Bialobrzeskie performing moderately at 614 and 578 lbs/A, respectively (Fig. 6B). CHY also produced significantly higher straw DW yields compared to all other varieties followed by NWG 331 and NWG 452. (Fig. 6C). CHY yielded an extraordinary amount of grain at Quicksand from the July planting; 2127 pounds/A, but an average amount of dry stems, 5544 pounds/A.

Continued varietal evaluations are an absolute necessity to define the most appropriate genotypes for Kentucky farmers. Anecdotally, producers reported some successes growing varieties in 2017 and in central Kentucky that failed at both locations in these trials. It is noted that among those varieties that failed at both locations, reproductive growth appeared relatively soon after planting thus reducing or prohibiting canopy closure via necessary vegetative growth.

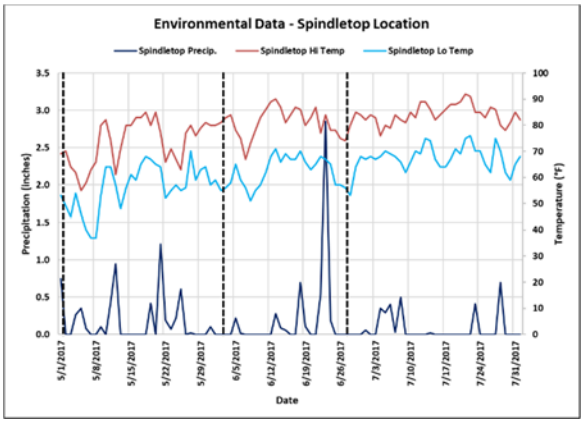
**Acknowledgements**

The authors express sincere appreciation for the efforts of Wade Turner, Robert Hounshell, David Neace, Tyler Goodlett, Weston Erp, and Kathryn Hurst in the establishment, culture, and data collection of these trials at both locations.

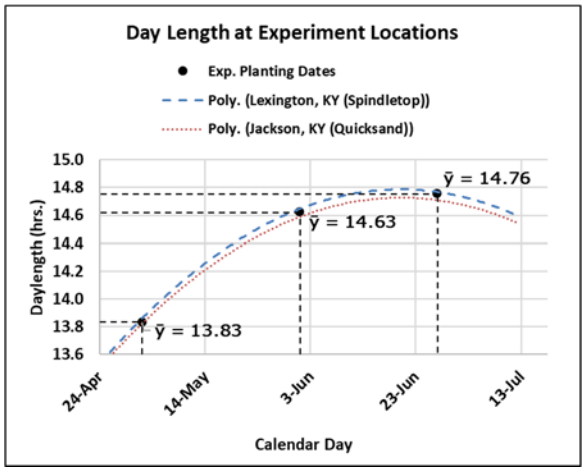
**Appendix 1:** Environmental and day length data from both locations. Vertical dashed lines represent each respective planting date. **A.** Daily precipitation (in), daily high and low temperatures at the Quicksand location. **B.** Daily precipitation (in), daily high and low temperatures at the Spindletop location. **C.** Day length at each location. Actual day length at Spindletop location denoted by blue dashed line. Actual day length at Quicksand denoted by red dotted line. Mean day length (average length between locations in hours) of each planting date denoted by black marker and dashed lines.




**A**




**B**




**C**