2018 University of Kentucky Industrial Hemp Variety Trials for Dedicated Fiber Production

D.W. Williams, J. Wade Turner, Robert Hounshell, and David Neace
University of Kentucky--Agronomic Industrial Hemp Research
UK Robinson Center for Appalachia Resource Sustainability (UK-RCARS)

Introduction

Variety trials for dedicated fiber production (hemp and kenaf) were conducted at three locations planted on 1 May, 1 Jun, and 1 Jul +/- 5 days as weather and travel permitted. Experimental designs were randomized complete blocks with 3 replications. Each respective planting date and location was analyzed as an individual trial. Locations, soil types, and specific planting dates are provided in Table 1. Varieties evaluated and their owners are provided in Table 2.

Table 1. Locations, soil types, and planting dates for 2018 dedicated fiber variety trials.

Location	Soil Type	Planting Dates
UK-RCARS[1], Breathitt County	Nolin-Grigsby silt loam	1 May, 5 Jun, 11 Jul
UK-LRC[2], Woodford County	Maury silt loam	2 May, 6 Jun, 5 Jul
UK-REC[3], Caldwell County	Crider silt loam	7 May, 11 Jun, 6 Jul

[1]UK Robinson Center for Appalachian Resource Sustainability, Jackson, Breathitt County, KY
[2]UK C. Oran Little Research Center, Versailles, Woodford County, KY
[3]UK Research and Education Center, Princeton, Caldwell County, KY

Table 2. Varieties evaluated in 2018 and their owners.

Variety Name	Owner
AHB18	Atalo Holdings
Elleta Campana	Schiavi Seeds
Fibranova	Schiavi Seeds
Whitten Kenaf	Sunstrand, LLC
K2 Kenaf	Sunstrand, LLC
SS Alpha	Sunstrand, LLC
SS Beta	Sunstrand, LLC
SS Charlie	Sunstrand, LLC

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 50 lbs. (units) of N/A. All seed was planted using the Mundell Modified Soybean Plot Planter at a rate of 60 lbs/A. Seeding depth was calibrated to 0.25 inch. No additional fertilizer, pesticides or irrigation were used for the duration of the studies.

Stalks were harvested using a handheld sickle mower at or as soon as possible after ~20% female flowering from two, randomly selected $1m^2$ sub-plots from within each main plot, careful to avoid plot edges. Plot ends were trimmed before sub-plot definition. All stems were field-retted onsite at the UK-RCARS following harvests. Data collected from stalks were plant

populations, straw yields measured as fresh weight (FW) and dry weight (DW), percent moisture, stem lengths, and stem diameters at the base. Dry weight, stem length, and stem diameter data were collected from field retted stems. 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 (α=0.05) where the main effect of variety was significant.

Results

In general and excepting the July planting at the UK-RCARS, all of the trials were successfully harvested. The July planting at the UK-RCARS was not harvested because harvest at the appropriate growth stage could not be practically completed. Additional crop failures resulted in either variety deletions and/or incomplete data collection among planting dates and at all locations. ANOVA statistics for each successful planting date at each location are provided in Table 3; A-H. Tables 4-11 provide means of the measured parameters separated by F-protected LSD.

Table 3; A-H. ANOVA statistics for the May and June plantings at the UK-RCARS, and the May, June, and July plantings at the UK-LRC and UK-REC.

A. May planting-RCARS

ANOVA Statistic	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
P-Value Model	0.0015	0.0010	0.0002	<0.0001	0.0227	0.1130
P-Value Replication	0.1002	0.0369	0.0117	0.6780	0.4546	0.3478
P-Value Variety	0.0009	0.0008	0.0002	<0.0001	0.0126	0.0858

B. May Planting-LRC

ANOVA Statistic	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
P-Value Model	0.2158	0.0184	<0.0001	<0.0001	0.2006	0.0023
P-Value Replication	0.5946	0.5556	0.9454	0.7400	0.1310	0.3262
P-Value Variety	0.1466	0.0094	<0.0001	<0.0001	0.2784	0.0012

C. May planting-REC

ANOVA Statistic	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
P-Value Model	0.0506	0.0284	0.0136	0.0407	0.0959	0.0071
P-Value Replication	0.1138	0.0768	0.1907	0.1871	0.0172	0.0070
P-Value Variety	0.0457	0.0255	0.0102	0.0329	0.3861	0.0090

D. June planting-RCARS

ANOVA Statistic	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
P-Value Model	0.0011	<0.0001	0.0002	0.0850	0.1094	0.0721
P-Value Replication	0.1427	0.4422	0.5312	0.5309	0.7324	0.6762
P-Value Variety	0.0005	<0.0001	<0.0001	0.0463	0.0553	0.0354

E. June planting-LRC

ANOVA Statistic	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
P-Value Model	0.0079	0.0001	<0.0001	<0.0001	<0.0001	0.0001
P-Value Replication	0.5387	0.4928	0.0622	0.1016	0.7765	0.1417
P-Value Variety	0.0038	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

F. June planting-REC

ANOVA Statistic	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
P-Value Model	<0.0001	<0.0001	<0.0001	0.0001	0.0018	0.0537
P-Value Replication	0.9363	0.5614	0.6290	0.2977	0.4333	0.4713
P-Value Variety	<0.0001	<0.0001	<0.0001	<0.0001	0.0008	0.0325

G. July planting-LRC

ANOVA Statistic	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
P-Value Model	0.0002	<0.0001	<0.0001	0.0002	0.0238	0.1660
P-Value Replication	0.4317	0.5414	0.8889	0.1088	0.1417	0.1998
P-Value Variety	<0.0001	<0.0001	<0.0001	<0.0001	0.0200	0.1761

H. July planting-REC

ANOVA Statistic	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
P-Value Model	<0.0001	<0.0001	0.0010	0.0041	0.0002	0.0032
P-Value Replication	0.1717	0.0600	0.0798	0.6431	0.6846	0.5110
P-Value Variety	<0.0001	<0.0001	0.0007	0.0019	<0.0001	0.0015

All data in tables 4-11 are expressed as the means of:

Dry weight straw yield=pounds of retted straw per acre.
Fresh weight straw yield=pounds of fresh straw per acre measured at harvest.
Percent moisture=100-([dry weight/fresh weight]*100).
Plant population=number of individual plants harvested per acre.
Stem length=crop height measured in inches after retting.
Stem diameter=diameter at the base of the stem measured in millimeters (mm) after retting.
CV=coefficient of variation, a statistical measure of consistency of the data. Single-digit CV values are most desirable. A CV value >25 may indicate excessive variation in the data, thus reducing our confidence in any conclusions derived from that data.

Table 4. UK-RCARS dedicated fiber variety trial-May planting. Means followed by the same letters are not significantly different (α=0.05)

Variety	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
Whitten	13,069 a	68,222 a	80.9 b	161,166 ab	102.4 ab	12.9
Beta	10,574 ab	51,519 ab	79.5 bc	143,633 b	104.6 ab	10.6
Alpha	10,236 abc	47,567 b	78.4 c	147,005 b	110.6 a	10.9
K2	7,849 bcd	39,792 bc	80.2 bc	201,289 a	81.2 c	8.9
Eletta Campana	6,406 cde	39,125 bc	83.6 a	75,525 c	111.3 a	12.0
AHB18	4,275 de	26,225 cd	83.7 a	74,851 c	91.2 bc	10.9
Fibranova	2,630 e	17,654 d	85.1 a	45,855 c	83.7 c	9.7
CV	28.0	23.3	1.53	19.6	10.3	13.5

Table 5. UK-LRC dedicated fiber variety trial-May planting. Means followed by the same letters are not significantly different (α=0.05)

Variety	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
Whitten	4,450	33,460 a	87.0 a	210,392 cd	62.7	8.34 a
Beta	4,261	18,906 bc	77.5 b	298,056 ab	51.7	5.54 cd
Alpha	4,447	18,542 bc	75.9 b	338,493 a	56.5	6.18 cd
K2	2,913	23,062 ab	87.4 a	178,024 d	60.8	7.97 ab
Eletta Campana	3,291	14,456 bc	78.0 b	242,084 bc	57.6	6.28 c
AHB18	1,982	8,120 c	75.6 b	240,737 bc	48.2	4.94 d
Fibranova	2,117	9,589 c	77.9 b	100,138 e	60.0	6.66 bc
CV	39.1	37.5	1.81	14.4	13.2	11.4

Table 6. UK-REC dedicated fiber variety trial-May planting. Means followed by the same letters are not significantly different (α=0.05)

Variety	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
Whitten	5,246 ab	26,906 ab	79.7 a	202,300 a	52.6	7.74 ab
Beta	3,115 b	11,551 bc	73.0 b	233,657 a	47.7	5.63 d
Alpha	3,358 b	12,138 bc	72.0 b	197,243 a	51.8	6.29 cd
K2	8,213 a	39,469 a	79.0 a	239,726 a	57.2	8.76 a
Fibranova	1,861 b	6,312 c	70.5 b	72,828 b	54.4	6.83 bc
CV	30.8	32.5	1.98	17.6	8.1	5.98

Table 7. UK-RCARS dedicated fiber variety trial-June planting. Means followed by the same letters are not significantly different (α=0.05)

Variety	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
Whitten	6,291 a	40,819 a	84.6 a	405,611 a	66.2 ab	7.34 ab
Beta	5,276 a	19,947 b	73.7 c	320,645 ab	71.6 a	7.17 abc
Alpha	3,682 b	15,557 bc	76.3 bc	315,588 ab	61.8 b	5.84 c
K2	6,379 a	42,078 a	84.9a	414,041 a	71.5 a	8.1 a
Eletta Campana	2,508 b	11,062 c	77.8 b	243,711 b	61.8 b	6.43 bc
CV	14.4	12.2	1.95	18.1	6.62	10.2

Table 8. UK-LRC dedicated fiber variety trial-June planting. Means followed by the same letters are not significantly different (α=0.05)

Variety	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
Whitten	3,297 c	35,524 ab	90.8 a	331,772 b	53.5 d	7.44 d
Beta	6,150 a	28,882 b	78.6 b	283,220 c	75.3 a	8.52 bc
Alpha	4,424 b	19,704 c	77.5 b	236,691 d	67.8 bc	8.03 bcd
K2	3,743 bc	42,706 a	91.5 a	401,566 a	53.7 d	7.51 d
Eletta Campana	4,464 bc	18,436 c	75.7 c	190,836 e	71.9 ab	8.65 b
AHB18	3,461 bc	13,311 c	72.6 d	155,771 e	63.7 c	7.83 cd
Fibranova	4,599 b	19,030 c	75.8 c	109,916 f	76.8 a	10.42 a
CV	15.1	18.7	0.89	8.82	6.16	5.45

Table 9. UK-REC dedicated fiber variety trial-June planting. Means followed by the same letters are not significantly different (α=0.05)

Variety	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
Whitten	5,071 ab	38,248 a	86.7 a	233,944 b	60.0 bc	8.12 a
Beta	4,504 bc	17,883 b	74.7 d	287,266 ab	69.0a	6.72 bc
Alpha	3,601 cd	14,808 b	75.9 cd	211,741 bc	64.1 ab	7.23 abc
K2	5,907 a	39,867 a	85.1 a	320,983 a	56.8 cd	8.00 ab
Eletta Campana	2,954 d	12,907 bc	76.7 bcd	142,284 cd	68.1 a	7.26 abc
AHB18	1,011 e	4,653 d	78.3 bc	63,387 de	50.9 d	6.08 c
Fibranova	1,861 e	8,901 cd	79.0 b	58,667 e	66.8 ab	8.21 a
CV	15.2	14.8	2.13	24.5	6.28	10.0

Table 10. UK-LRC dedicated fiber variety trial-July planting. Means followed by the same letters are not significantly different (α=0.05)

Variety	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
Whitten	4,734 b	48,269 b	90.2 a	167,235 b	67.9 bc	10.62 a
Beta	3,506 bc	23,804 c	85.1 b	132,169 bcd	80.3 a	10.29 ab
Alpha	2,320 cd	15,820 cd	85.6 b	94,407 de	68.2 bc	9.81 ab
K2	6,055 a	63,320 a	90.4 a	277,151 a	64.1 c	9.10 ab
Eletta Campana	2,657 cd	19,097 cd	86.0 b	95,755 cde	73.0 ab	10.30 ab
AHB18	1,639 d	10,439 d	84.2 b	62,713 e	64.2 c	8.31 b
Charlie	2,333 cd	18,086 cd	85.2 b	153,748 bc	66.7 bc	8.64 ab
CV	21.4	19.4	1.15	23.6	7.09	12.1

Table 11. UK-REC dedicated fiber variety trial-July planting. Means followed by the same letters are not significantly different (α=0.05)

Variety	Dry Weight Straw Yield	Fresh Weight Straw Yield	Percent Moisture	Plant Population	Stem Length	Stem Diameter
Whitten	4,248 a	37,587 a	88.7 ab	199,266 a	60.0 b	8.36 b
Beta	3,237 bc	19,313 b	82.8 d	155,097 ab	67.6 a	8.04 bc
Alpha	2,387 de	17,330 bcd	86.2 bc	135,541 ab	65.4 a	7.48 cd
K2	3,884 ab	35,335 a	89.0 a	200,951 a	52.5 b	8.21 bc
Eletta Campana	2,252 de	13,837 cd	82.0 d	97,778 bc	65.3 a	8.55 ab
AHB18	1,038 f	8,416 e	87.6 abc	60,690 c	48.9 b	6.93 d
Fibranova	1,740 ef	12,340 de	85.8 c	53,610 c	63.1 a	9.30 a
Charlie	2,616 cd	18,086 bc	85.7 c	147,005 ab	65.3 a	8.03 bc
CV	15.0	14.2	1.69	30.0	6.18	5.90

Conclusions

Yields of hemp DM from the May planted trial at the UK-RCARS were higher than ever recorded in hemp research at UK (Table 4). Based on current economics, profit from hemp fiber production can be competitive with standard commodity crops when DM yields meet or exceed 5 tons/A, which was accomplished for the first time ever this year in this trial. Previous work has indicated 5+ tons/A DM yields from Whitten kenaf, which was also the case in this current trial. This is the first report from a replicated study in Kentucky of hemp varieties meeting this yield threshold and competing successfully with kenaf yields. All mean yields from May plantings at the LRC and REC locations were much lower, including both hemp and kenaf. This was due to differences in environmental conditions affecting stand establishment and reduced stand vigor (due in part to standing water) over the course of the growing season (Appendix 1).

In general, DM yields were lower in the June and July planted trials than would be desired. The data indicate that yields from June plantings will consistently reach 2-3 tons/A, and 1-2 tons/A from July plantings. These yields would not generally be considered economically competitive with other potential crops (e.g., soybeans) planted in June.

This work also provides useful data on measured parameters that affect both potential harvestability and processability (e.g., stem lengths and diameters). Significant differences ($P<0.5$) were recorded among varieties in nearly all measured parameters at all locations and planting dates (Table 3; A-H). It is clear that variety selection has a highly significant impact on all measured parameters. Work to evaluate varietal performance will continue within the UK agronomic hemp research program.

There's little doubt that the lack of any pesticide applications (insecticides on kenaf, and herbicides on both kenaf and hemp) has a significant impact on crop development and ultimate yields. Hopefully, research efforts will move forward in the near future allowing for the inclusion of these two crops on appropriate pesticide labels. Use of appropriate pesticides will have a large and significant impact on ultimate yields.

Acknowledgements

The authors express sincere appreciation for the efforts of Mike Clemons, Jarrod Abner, and Erwin Williams for assistance with trial establishment and data collection. We also thank the staff at the UK-LRC and UK-REC for their assistance in this work. It is not possible without them.

Appendix 1: Weather data for each of the 3 locations with variety trials in 2018. We express our direct appreciation to the WKU Mesonet for making these data available for this report.

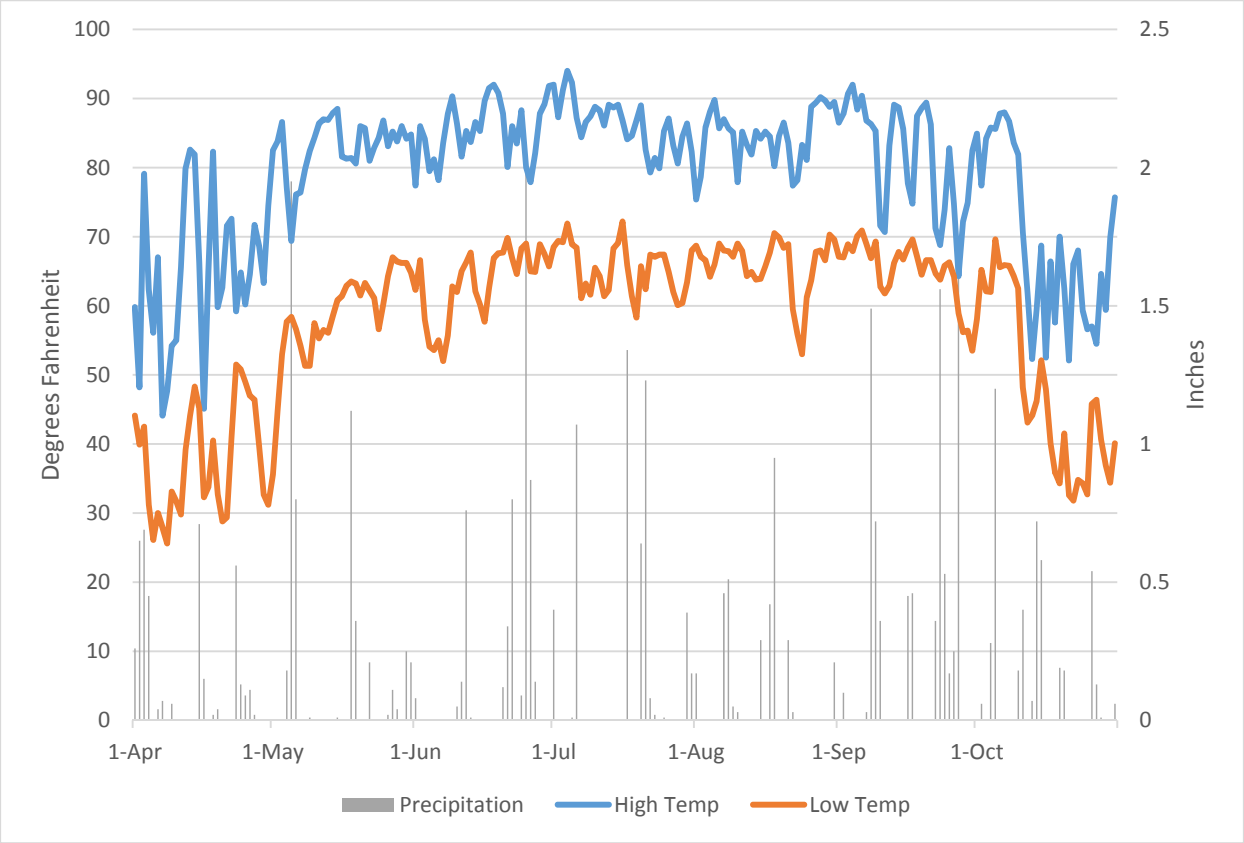

Figure 1. High/low temperature (left axis) and precipitation (right axis) data as a function of date for the UK-RCARS located in Quicksand, KY throughout the 2018 growing season. Low (orange line) and high (blue line) temperatures are expressed as degrees Fahrenheit. Precipitation (gray bars) is expressed in inches. Planting dates were 1 May, 5 Jun, and 11 Jul.

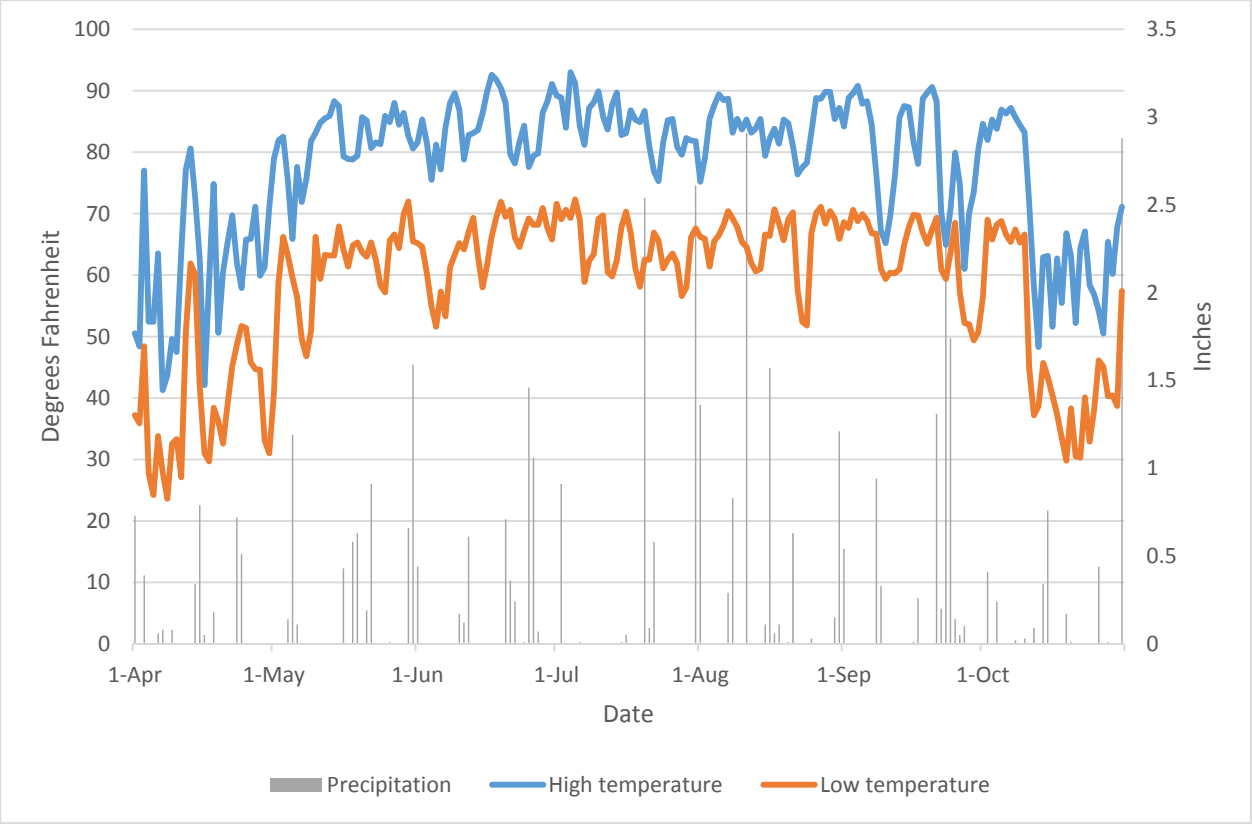

Figure 2. High/low temperature (left axis) and precipitation (right axis) data as a function of date for the UK-LRC located in Woodford County, KY throughout the 2018 growing season. These data were collected from the Kentucky State University Mesonet site in Franklin County. Low (orange line) and high (blue line) temperatures are expressed as degrees Fahrenheit. Precipitation (gray bars) is expressed in inches. Planting dates were 2 May, 6 Jun, and 5 Jul

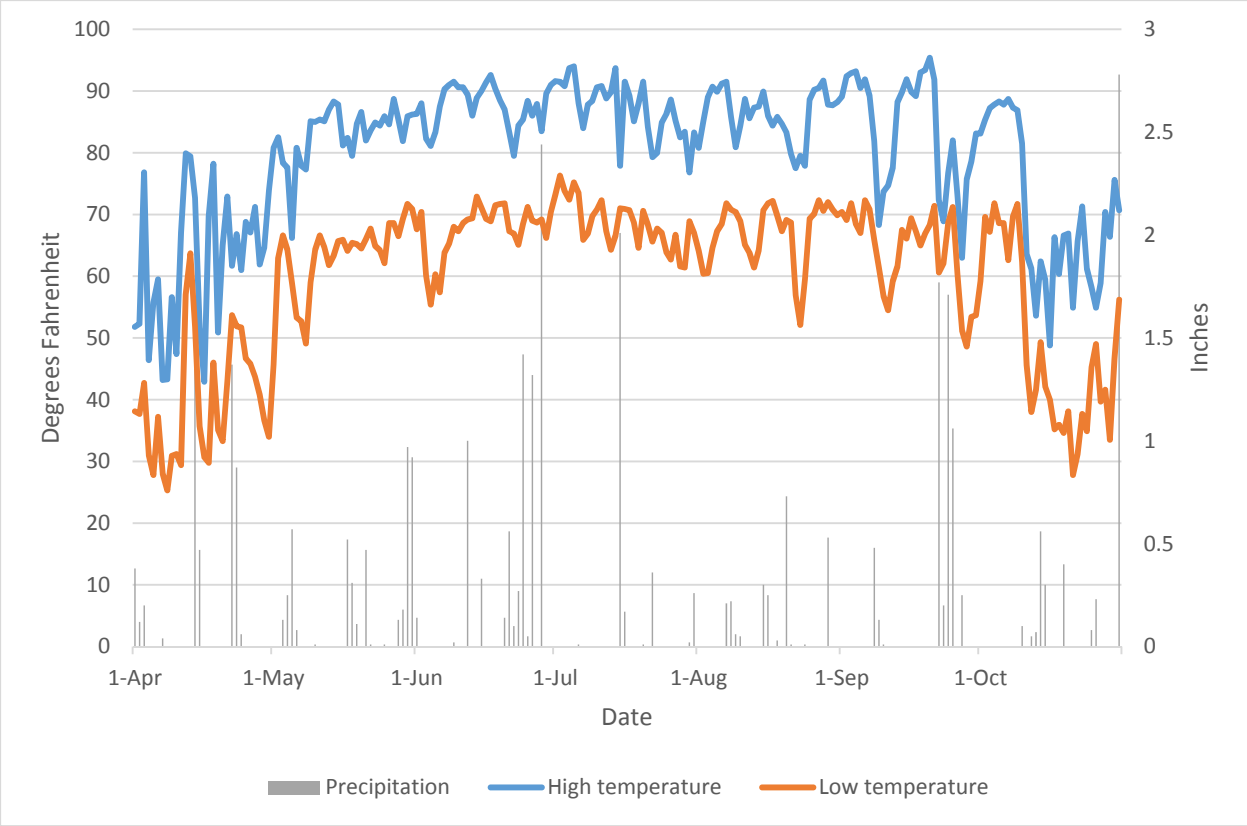

Figure 3. High/low temperature (left axis) and precipitation (right axis) data as a function of date for the UK-REC located in Princeton, KY throughout the 2018 growing season. Low (orange line) and high (blue line) temperatures are expressed as degrees Fahrenheit. Precipitation (gray bars) is expressed in inches. Planting dates were 7 May, 11 Jun, and 6 Jul.