Final Report – 2022-23 for the Wyoming Bean Commission

Breeding for High Yield, Early Maturity and Upright Lines Adapted to Wyoming

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Funding Awarded: $17,000

Project Goal

The goal of this project was to further test material that was developed by Jim Heitholt for high yield, earliness, and upright stature as well as continue to make new crosses and phenotype for early maturity in new germplasm received from the USDA-ARS Germplasm Collection.

Objectives

The project had three objectives. The first objective was to advance breeding lines that had shown high yield as well as mid to early maturity and upright stature from the 2021 growing season to the next year of yield testing. The second objective was to make crosses and develop populations for the purpose of creating new breeding material for further testing and evaluation. The third objective was to verify the correlation between canopy temperature and yield in three dry bean families as well as across multiple check varieties.

Methods

For objective one, the yield trial was planted on June 3rd in Sheridan and the field was sprayed with Prowl/Outlook on June 4th. No fertilizer was added to the trial. Plots were two rows each and 20 feet in length with the middle 10 feet harvested from both rows. Row spacing was 30 inches. The experiment was planted in a randomized complete block design with three replications. In Powell, the plots were on 22-inch row spacing with three rows that were 20 feet in length. The field in Powell was fertilized to soil test recommendations. Ten feet were harvested of the middle row. The experimental design was a completely randomized design with two replications. In addition to the experimental test lines, both sites included commercial check cultivars.

For objective two, crosses were made in the field in the summer of 2022 and F1 seed planted in the greenhouse in the fall in 4-gallon pots. F2 seed will be harvested in March.

For objective three, the canopy temperature trial was also planted on June 3rd in Sheridan. The field was sprayed with Prowl/Outlook on June 4th and no fertilizer was added to the trial. Plots were four rows each and 20 feet in length. Ten feet of the middle two rows were harvested for yield. Row spacing was 30 inches and the experiment was planted in a randomized complete block design with three replications. At Powell, the trial was planted on 22-inch rows with six-row plots and was fertilized to

soil test recommendations. Plot length was 20 feet, and ten feet of the middle two rows were harvested for yield. Experimental design was a completely randomized design with two replications. Canopy temperature data were collected using a MI-2H0 Apogee infrared thermometer unit from both locations from the middle two rows of the fully bordered plots. Canopy temperature was recorded for each plot at Powell on July 19th, August 3rd, and August 8th. At Sheridan, canopy temperature data were collected on July 13th, July 18th, July 29th, August 4th, and August 12th. In addition to the experimental test lines, both sites included commercial check cultivars.

A second test within objective three was grown to assess the drought tolerance of five of our experimental lines and three commercial checks. Each of these entries was grown at Powell in one six-row plot for each of three irrigation rates and yield was determined as described above.

Results

Objective 1: For the yield trial at Sheridan, three lines (1016F, 1016C, and 1019C) were not significantly different in yield than Rattler. Two additional lines (422C and 1016D) also performed well and were not significantly different than Monterrey in yield. All five lines yielded greater than 4000 lbs/a (see Table 1 below). At Powell, three of the same lines from Sheridan (1019C, 1016D, and 1016F) were not significantly different than the checks (see Table 2 below). These lines ranged in upright stature rating from a 6 to a 10 and in maturity from 87 to 98 dap. In the combined analysis across both Powell and Sheridan locations, seven lines (including the five lines mentioned above as well as two additional lines, 1016E and 440A) had yields that performed equal to or better than the checks (Table 3). Three of the lines, 1019C, 1016F and 1016E had yields of greater than 4000 lbs/a in the combined analysis.

For the additional yield trial of experimental dry bean lines as well as checks under deficit and full irrigation, results for yield, maturity, upright stature, and percent of pods above 4 cm are shown in Tables 4, 5, 6, and 7 respectively. Some of the experimental lines showed promising results under deficit irrigation and we hope to further evaluate these lines at Sheridan and Powell next summer in a new proposal.

Table 1: Yield (bu/a), upright score (1 to 10 with 1 = prostrate and 10 = upright), and maturity (dap) of experimental lines and checks at the Sheridan R&E Center yield trial location.

Line	Yield (lbs/a)	Upright (1—10)	Maturity (dap)
Rattler	4,983	8	93
1016F	4,548	7	92
1016C	4,408	8	92
1019C	4,375	6	95
Monterrey	4,100	6	93
422C	4,063	7	87
1016D	4,019	7	95
LPID7	3,898	4	95
LPID9	3,617	5	98
Max	3,516	4	85
LPID3	3,487	5	95
Poncho	3,419	4	86
Croissant	3,358	5	96
LSD (0.05)	689		

Table 2: Yield (bu/a), upright score (1 to 10 with 1 = prostrate and 10 = upright), and maturity (dap) of experimental lines and checks at the Powell R&E Center yield trial location.

Line	Yield (lbs/a)	Upright (1—10)	Maturity (dap)
1019C	3995	9	98
1016D	3846	9	97
1016F	3731	10	98
Monterrey	3577	9	98
1016C	3442	9	95
Windbreaker	3293	8	97
Poncho	3143	6	83
Othello	2993	7	79
422C	2851	9	93
LSD(0.05)	1082		

Table 3: Yield (bu/a), upright score (1 to 10 with 1 = prostrate and 10 = upright), and maturity (dap) of experimental lines and checks for the combined analysis across two locations (Powell R&E Center and Sheridan R&E Center).

Line	Yield (lbs/a)	Upright (1—10)	Maturity (dap)
1019C	4280	8	97
1016F	4221	9	95
1016E	4040	8	102
1016D	3950	8	96
1016C	3925	9	94
440A	3806	5	96
Monterrey	3719	8	96
422C	3578	8	90
Poncho	3218	5	85
LSD(0.05)	724		

Table 4. Yield of Experimental Dry Bean Lines under Deficit and Full Irrigation – Powell 2022; lbs/a. All results are from one unreplicated individual plot harvested conventionally. Now with adequate seed amounts, replicated trials are planned for 2023.

Entry	Irrigation			
	60% ET	80% ET	100% ET	Mean
Alexis	1758	2593	2425	2259
LPID-3	1652	2917	1960	2176
LPID-7	1835	1844	2438	2039
LPID-9	1504	1883	1900	1762
Max	1536	2649	2232	2139
Monterrey	1298	2934	2187	2140
Natalie	2060	2153	2644	2286
Rattler	1774	2566	2234	2124
Mean	1677	2442	2252	2124

Table 5. Maturity Dates (dap) of Experimental Dry Bean Lines under Deficit and Full Irrigation – Powell 2022

Entry	Irrigation			
	60% ET	80% ET	100% ET	Mean
Alexis	87	87	87	87
LPID-3	83	96	87	89
LPID-7	87	87	97	90
LPID-9	95	96	96	96
Max	73	76	73	74
Monterrey	87	87	95	90
Natalie	87	87	87	87
Rattler	87	94	96	92
Mean	86	89	90	88

Table 6. Upright Stature of Experimental Dry Bean Lines under Deficit and Full Irrigation – Powell 2022

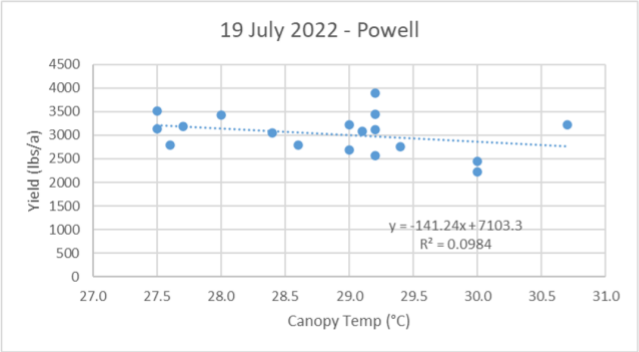
Entry	Irrigation			
	60% ET	80% ET	100% ET	Mean
Alexis	5	3	3	4
LPID-3	9	7	9	8
LPID-7	7	8	6	7
LPID-9	8	6	6	7
Max	9	8	9	9
Monterrey	10	9	9	9
Natalie	10	10	9	10
Rattler	10	9	9	9
Mean	8	7	7	8

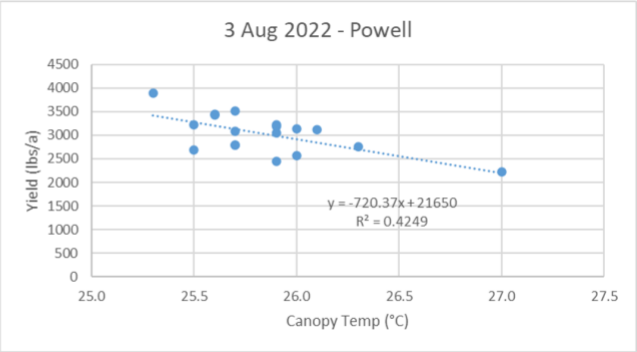
Table 7. Percent of Pods Above 4-cm under Deficit and Full Irrigation – Powell 2022.

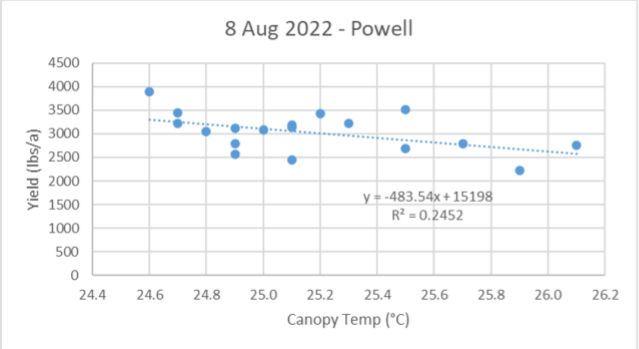
Entry	Irrigation			
	60% ET	80% ET	100% ET	Mean
Alexis	35	30	45	37
LPID-3	45	50	55	50
LPID-7	70	75	60	68
LPID-9	75	75	65	72
Max	30	65	30	42
Monterrey	85	90	90	88
Natalie	95	85	90	90
Rattler	80	85	80	82
Mean	64	69	64	66

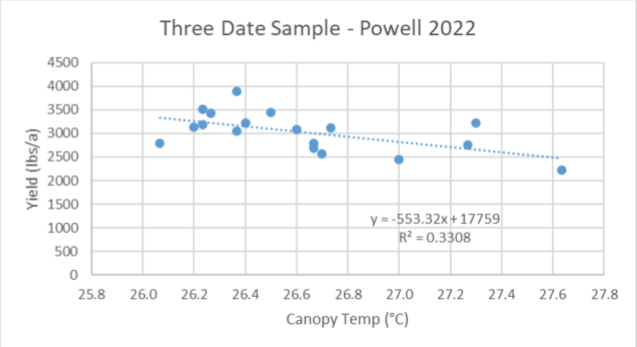
Objective 2: F1 plants are currently being harvested and we will grow F2 individuals to develop these populations in the hope to have some lines ready for preliminary yield testing by the summer of 2024.

Objective 3: For the canopy temperature yield trial at the Powell R&E Center, the percent of the yield variation explained by canopy temperature was 10% on July 19th, 42% on August 3rd, and 25% on August 8th. The average R^2 value across the three dates sampled was 33%. At Sheridan, the percent of the variation explained was 5%, 1%, and 5% on July 13th, 18th, and 29th respectively. However, in August the percent of the yield variation explained increased to 25% and 35% on August 4th and 12th respectively. The R^2 percentage when averaged across the 5 dates at Sheridan was <1%, but when averaged across the dates in August was 45%. When the families (segregating) were excluded from the analysis at Sheridan, and just the commercial checks were analyzed, the R^2 values were still low in July. However, for the two dates in early August, the R^2 values were 71% (August 4th) and 54% (August 12th). When averaged across the two dates in August, the R^2 values for the commercial lines explained 92% of the variation. While maturity could have been a confounding factor, it is important to note that the first maturity rating was not given until August 27th, fifteen days after the last canopy temperature data were collected. See graphs below for results from both Powell and Sheridan.

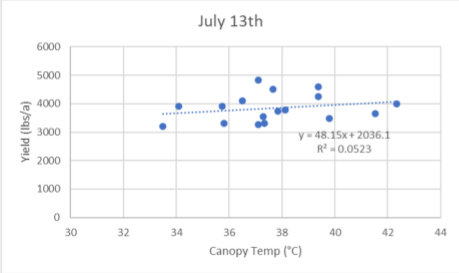

19 July 2022 - Powell
Yield (lbs/a)
Canopy Temp (°C)
y = -141.24x + 7103.3
R² = 0.0984

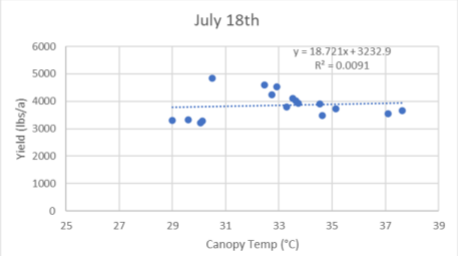

3 Aug 2022 - Powell
Yield (lbs/a)
Canopy Temp (°C)
y = -720.37x + 21650
R² = 0.4249

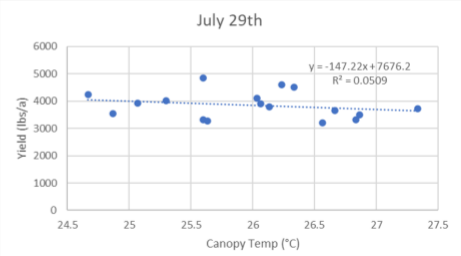

8 Aug 2022 - Powell
Yield (lbs/a)
Canopy Temp (°C)
y = -483.54x + 15198
R² = 0.2452

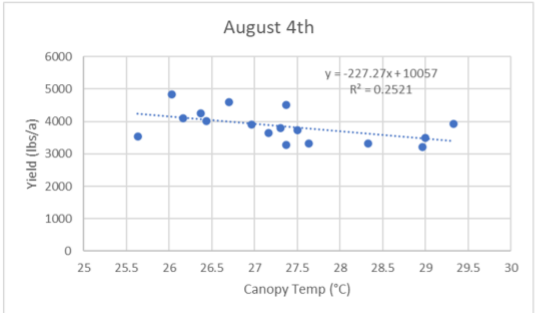

Three Date Sample - Powell 2022
Yield (lbs/a)
Canopy Temp (°C)
y = -553.32x + 17759
R² = 0.3308

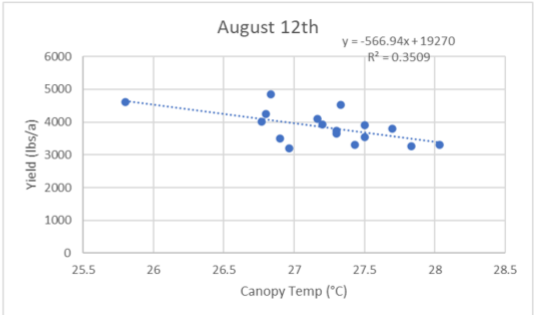
Sheridan


July 13th
Yield (lbs/a)
Canopy Temp (°C)
y = 48.15x + 2036.1
R² = 0.0523

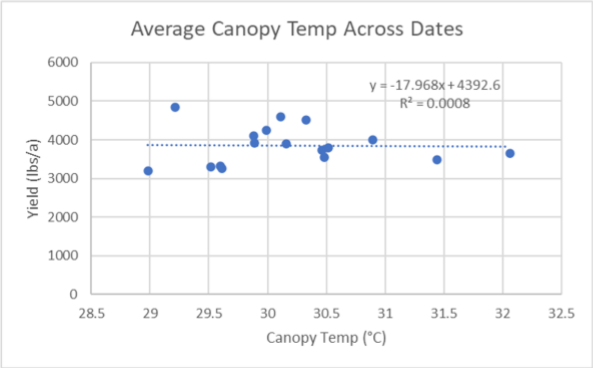

July 18th
Yield (lbs/a)
Canopy Temp (°C)
y = 18.721x + 3232.9
R² = 0.0091

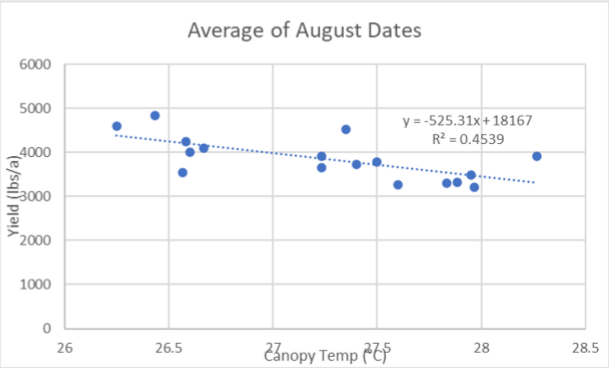

July 29th
Yield (lbs/a)
Canopy Temp (°C)
y = -147.22x + 7676.2
R² = 0.0509


August 4th
Yield (lbs/a)
Canopy Temp (°C)
y = -227.27x + 10057
R² = 0.2521

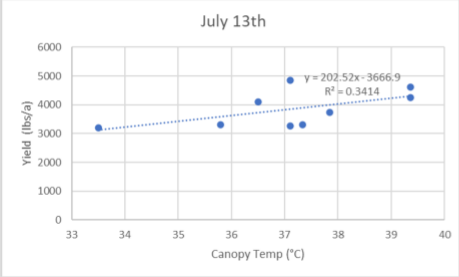

August 12th
Yield (lbs/a)
Canopy Temp (°C)
y = -566.94x + 19270
R² = 0.3509

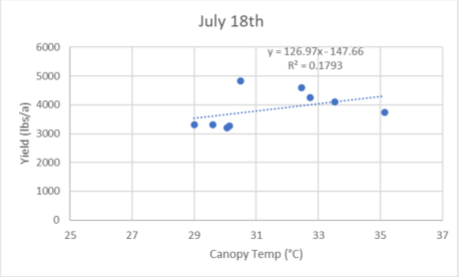
Sheridan

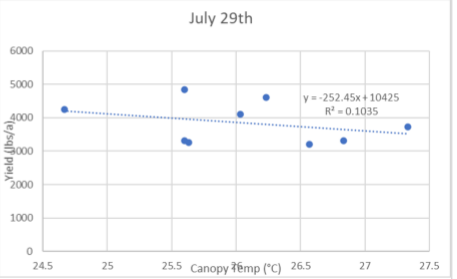


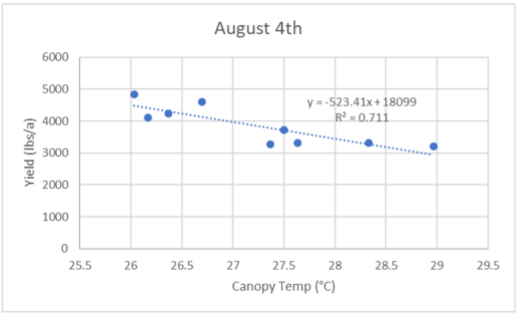


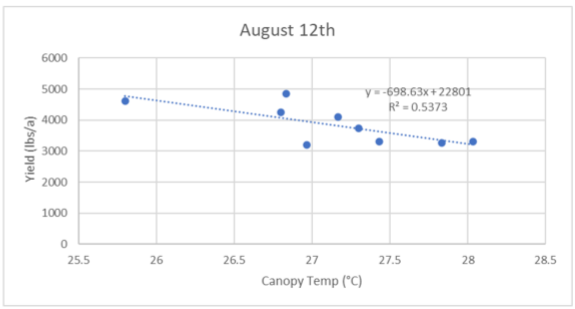
Sheridan (Commercial Cultivars Only)



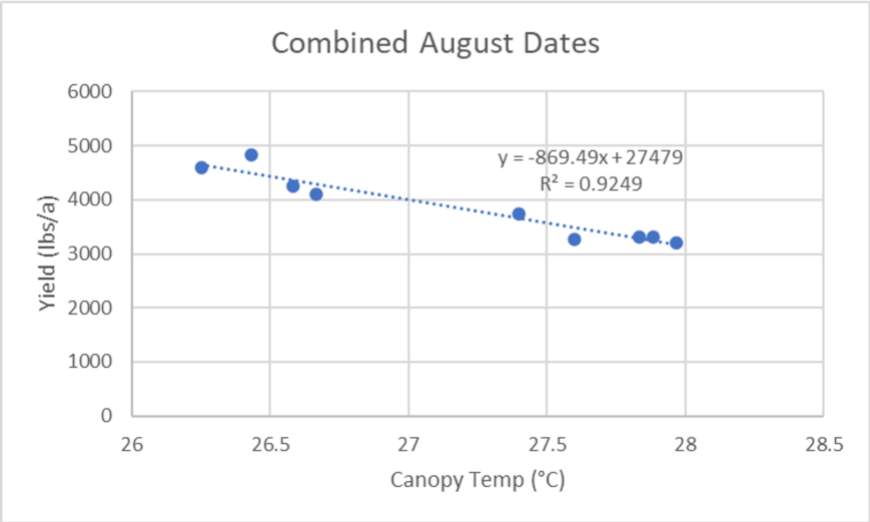








Sheridan (Commercial Cultivars Only)



Future Work

The most promising experimental lines will be retested along with commercial checks at three locations in the summer of 2023 (Powell, Lingle and Sheridan). Additionally, populations being developed for early maturity will be grown at Sheridan in the summer of 2023 and then taken to a winter nursery for further generation advancement with the hopes of being able to do preliminary yield testing in the summer of 2024. The canopy temperature yield trial will be repeated at Sheridan and Powell an additional year and a drone as well as the MI-2H0 Apogee handheld unit will be used to collect canopy temperature data. The data collected by the drone will be compared to the handheld unit to determine accuracy.