

Final Report – 2024-25 for the Wyoming Bean Commission
Breeding for High Yield, Early Maturity and Upright Lines Adapted to Wyoming

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Project Goal

The goal of this project was to further test material that was developed for high yield, earliness, and upright stature as well as continue to make new crosses and phenotype for early maturity in newly developed populations.

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 and 2022, and 2023 growing seasons to the next year of yield testing and evaluate them against commercial checks in two locations, Powell and Sheridan. The second objective was to continue to make crosses and develop populations for the purpose of creating new breeding material for further testing and evaluation as well as conduct a preliminary yield trial at Powell and Sheridan on breeding lines in the F₅ generation or later. The third objective was to verify the correlation between canopy temperature and yield using commercial dry bean varieties.

Methods

For objective one, the yield trial was planted on June 4th in Sheridan. Plots were four rows each and 20 feet in length. 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 and were planted on May 31st. Ten feet were harvested from the middle row. The experimental design was a randomized complete block design with three replications. In addition to the experimental test lines, both sites included commercial check cultivars. The test was dropped at our Sheridan, WY location due to a late season hailstorm.

For objective two, we continued to make crosses and continued population development in the greenhouse over the winter. Specifically, we are making crosses to try to obtain earlier maturing varieties. More advanced material (F₅ or later generation) were planted in a preliminary yield trial at both Sheridan and Powell. Planting date, row spacing, and plot dimensions were the same as those in objective one. The preliminary yield trial was a randomized complete block design with two replications at both locations. However, we also lost this test at Sheridan due to the hailstorm.

For objective three, the canopy temperature trials were planted on the same days as the yield trials June 4th (Sheridan) and May 31st (Powell), respectively. Only commercial

checks were used in this experiment. In Sheridan, plots were four rows each and 20 feet in length. 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 three-row plots. Plot length was 20 feet, and ten feet of the middle row was harvested for yield. The experimental design was a randomized complete block with three replications. Canopy temperature data were collected using a thermal drone at Powell and at Sheridan. Canopy temperature was recorded approximately every 7 to 10 days beginning in early to mid-July. Although we collected canopy temperature data on regular intervals at Sheridan, due to the hailstorm we were unable to obtain the yield data.

Results

Objective 1: For the yield trial, the commercial check, SV 6139 GR was the top performing line at Powell yielding 3684 lbs/a with a maturity of 99 dap. Our breeding lines, 1016D and 1016F yielded 3527 lbs/a and 3194 lbs/a respectively. These lines were the top performing UW breeding lines in the test and were not significantly different in yield from SV 6139 GR. The line 1016D yielded significantly higher in yield than the check cultivars Cowboy, Poncho, and Max with an LSD(0.05) value of 491 lbs/a. Table 1 below shows the dry bean genotype yields, maturity, plant height, and lodging scores of all lines and check cultivars within the test. Table 2 shows the average yield of the lines and check cultivars across three environments (Sheridan – 2023, Powell – 2023, and Powell – 2024). We plan to enter the two top performing WY breeding lines into the regional yield trial (cooperative dry bean nursery) for the 2025 growing season.

Table 1: 2024 Yield Trial – Powell Only: Yield (lbs/a), upright score (1 to 10 with 1 = prostrate and 10 = upright) maturity (dap), and plant height (cm) of experimental lines and commercial checks (Powell R&E Center).

Entry	Yield lbs/a	Upright (1-10)	Maturity (dap)	Plant Ht (cm)
SV 6139 GR	3684	8	99	86
1016D	3527	7	102	79
Rattler	3440	8	101	89
1016F	3194	8	100	84
Monterrey	3157	8	102	88
1016C	3098	8	102	80
Cowboy	3036	8	97	82
1019C	2963	7	101	86
422C	2816	9	98	69
Poncho	2722	7	90	69
Max	2596	6	84	66
LSD(0.05)	491	1	3	13

Table 2: Average yield (lbs/a) across three environments (2023-24)

Entry	Yield (lbs/a)
1016F	3662
1016D	3499
SV 6139 GR	3397
Rattler	3377
Monterrey	3369
1016C	3198
1019C	3187
422C	3158
Cowboy	3104
Poncho	2834
Max	2793

Objective 2: A preliminary yield trial was conducted on 52 advanced breeding lines (F5 or later) and 4 commercial cultivars were added as checks. Although we were only able to obtain data from Powell, the results indicate that there are eight new breeding lines that perform as well or better than the commercial checks. Additionally, three of the lines we have been testing over the last three years rose to the top of this test as well (1016F, 1016C, and 1016D). Table 3 below contains the data from this preliminary trial. We also advanced generations of newly developed populations in the greenhouse this winter. Populations will be grown in the field in the summer of 2025 to continue our generation advancement.

Table 3: 2024 Preliminary Yield Trial – Powell Only: Yield (lbs/a), upright score (1 to 10 with 1 = prostrate and 10 = upright), maturity (dap), and plant height (cm) of experimental lines and commercial checks (Powell R&E Center)

Entry	Yield (lbs/a)	Upright (1-10)	Maturity (dap)	Plant Ht (cm)
1016F	3677	8	101	81
1016C	3567	9	100	89
1016D	3384	9	98	76
NTL-3	3166	9	101	79
ALF-1	2994	8	98	75
LPID-3-1	2962	9	98	84
GRT-3	2889	9	95	64
RUE-2	2802	9	101	78
VAL-2	2784	6	97	65
PED-1	2724	7	92	86
RAM-1	2682	7	98	70
Max	2666	6	92	73
Medicine Hat	2440	9	87	56
Monterrey	2360	8	103	80
Poncho	1964	7	83	62
LSD(0.05)	787	2	6	17

Objective 3: For the canopy temperature yield trial, a DJI thermal drone was used to measure canopy temperature across three time points from July 24th through August 21st and a handheld unit (MI-2Ho Apogee) was used for one additional time point. Also, normalized difference vegetation index (NDVI) data were obtained with a handheld RapidScan CS-45 unit across four time points from June 27th through August 1st. The average canopy temperature and NDVI across time points is shown below in Table 4 for each entry along with yield, lodging scores, maturity, and plant height. Correlations

between canopy temperature and yield were moderate at Powell this year. The total R^2 value when averaged across all dates was 49% and a negative correlation was observed, as expected. Therefore, canopy temperature across these four time points explained 49% of the variation in yield (Figure 1). This is not enough to use canopy temperature as a proxy for yield, even when trying to eliminate the poorest yielding material in early generations. However, we think important steps for the future will be to block tests by maturity and obtain more time points over the course of the season to determine the most important time period(s) for collecting canopy temperature data. NDVI was also correlated with yield with an R^2 value of 24% and a positive correlation between the two traits was observed, as expected (Figure 2). In the future, we would also like to look at combining NDVI and canopy temperature data and perhaps some other measurements collected with the multi-spec drone to determine what combination of traits best correlates with yield.

Table 4: Analysis of canopy temperature test across 12 dry bean varieties grown in Powell, Wyoming in 2024

Entry	Yield (lbs/a)	Upright (1-10)	Maturity (dap)	Plant Ht (cm)	Canopy Temp (°C)	Normalized Difference Vegetation Index (NDVI)
Rattler	3567	8	101	89	27.1	0.5028
PT9-5-6	3555	8	99	89	27.9	0.5101
SV 6139 GR	3434	9	95	72	28.3	0.4816
Cowboy	3098	8	99	75	28.0	0.4550
Othello	2932	7	83	54	29.2	0.4768
Monterrey	2832	8	101	76	27.8	0.4704
Medicine Hat	2754	8	90	58	28.7	0.4922
Poncho	2596	7	89	75	28.9	0.4840
Croissant	2585	8	100	90	28.2	0.4942
Max	2504	7	83	76	28.6	0.4863
CO14330-10	2469	8	98	87	28.4	0.4775
PT11-13-1	2221	9	100	80	28.9	0.4247
LSD(0.05)	759	2	3	21	1	0.426

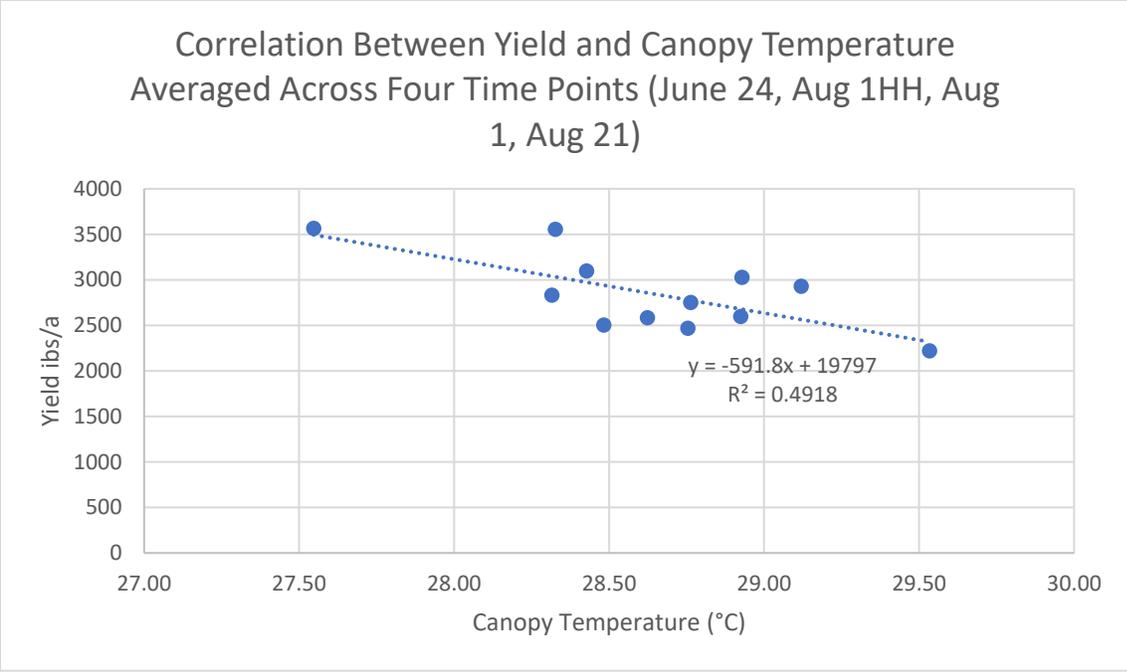


Figure 1: Correlation across four time points of canopy temperature and yield at PREC. Each value is the average of three plots for one entry.

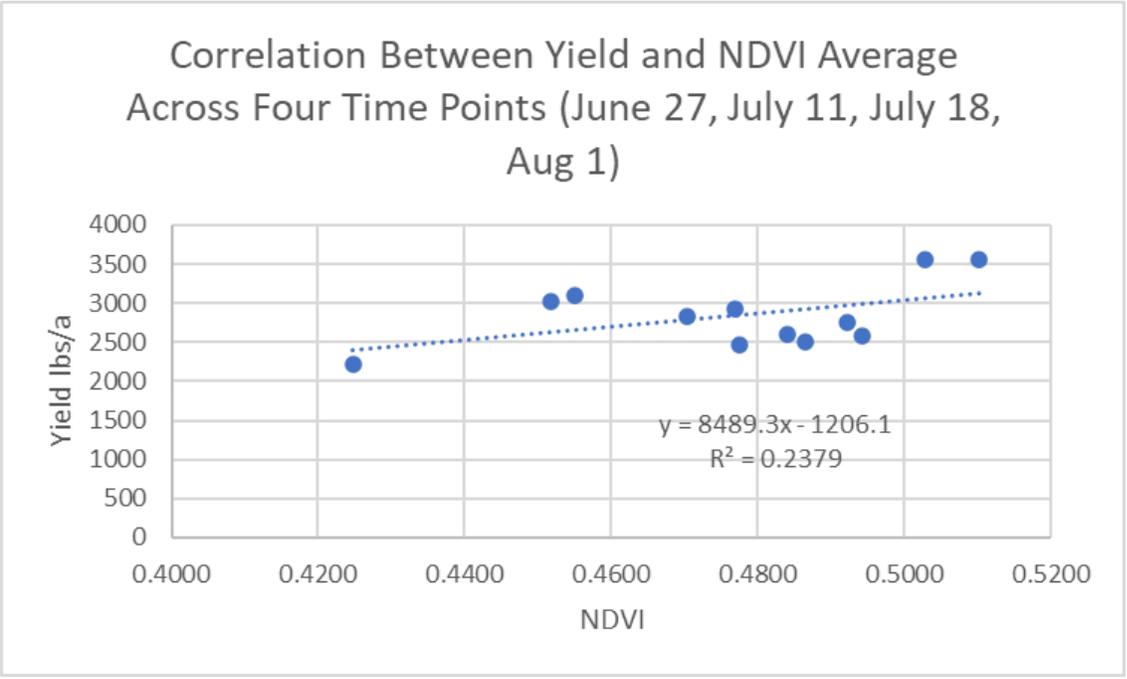


Figure 2: Correlation across four time points of NDVI and yield at PREC. Each value is the average of three plots for one entry.

Future Work

The two most promising experimental lines will be submitted as entries into the 2025 Cooperative Dry Bean Nursery (CDBN) trial to be tested across the 8 CDBN locations. Additionally, populations being developed for early maturity will be grown at Sheridan in the summer and again in the greenhouse in the fall/winter for generation advancement purposes. We will also conduct a second year of yield tests at Sheridan and Powell on the most promising lines that came out of the preliminary yield trial in the 2024 season. The canopy temperature yield trial will be written up for publication, and further research on looking at drone collected data as a possible proxy for yield will be examined in future years.