Final Report – 2023-24 for the Wyoming Bean Commission

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

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Funding Awarded: $28,000

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 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 growing seasons to the next year of yield testing and evaluate them against commercial checks in three locations, Powell, Sheridan, and Lingle. 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. 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 1st in Sheridan. Plots were four rows each and 20 feet in length with the middle 10 feet harvested from the middle two 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 six rows that were 20 feet in length and were planted on June 7th. Ten feet were harvested of the middle two rows. 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 also planted at Lingle, WY, but had to be dropped due to heavy weed pressure and planter malfunction.

For objective two, we continued to make crosses in the field and continued population development in the greenhouse over the winter. Specifically, we are making crosses to try to obtain earlier maturing varieties. We also have more advanced material in the pipeline and will begin preliminary yield trials of this material in the summer of 2024.

For objective three, the canopy temperature trials were planted on the same days as the yield trial June 1st (Sheridan) and June 7th (Powell), respectively. Only commercial checks were used in this experiment. In Sheridan, 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. Plot length was 20 feet, and ten feet of the middle two rows were harvested for yield. Experimental design was a randomized complete block with three replications. Canopy temperature data were collected using a MI-2H0 Apogee infrared thermometer unit as well as a thermal drone at Powell and at Sheridan was collected only with the drone. Canopy temperature was recorded approximately every 7 to 10 days beginning in early to mid-July. The test was also grown at Lingle but had to be dropped for the same reasons as mentioned above for the yield trial.

Results

Objective 1: For the yield trial, the WY line, 1016F was the top performing line across both locations. In Powell, 1016F yielded 4456 lbs/a with the next highest yielding line being the check, Monterrey, which yielded 4002 lbs/a. The LSD at Powell was 586 lbs/a, so there was not a significant difference between the two lines, however 1016F was very close to being significantly different. See photo below of the yield trial taken from the DJI drone in Powell. At Sheridan, line 1016F yielded 3801 lbs/a and was significantly different than all other lines in the test. The next highest yielding lines were also WY lines, 1016c, 1016d, and 1019c. The highest yielding check was Cowboy at 3192 lbs/a followed by Monterrey at 3160 lbs/a. The LSD at Sheridan was 247 lbs/a, so all of the WY lines mentioned above were significantly higher in yield than the highest yielding checks. Table 1 below shows the dry bean genotype yields at both locations and Figure 1a and 1b show yield of all 17 lines at both Powell and Sheridan, respectively. The CV at Powell was 10% and the CV at Sheridan was 5%. There was a little more variation at Powell than at Sheridan, but both tests had an excellent CV. Figure 2a shows the variation in yield among the 17 lines at Powell versus Sheridan and 2b shows the levels and variation in yield per line at both locations. Overall, yields were lower in Sheridan than in Powell in 2023.

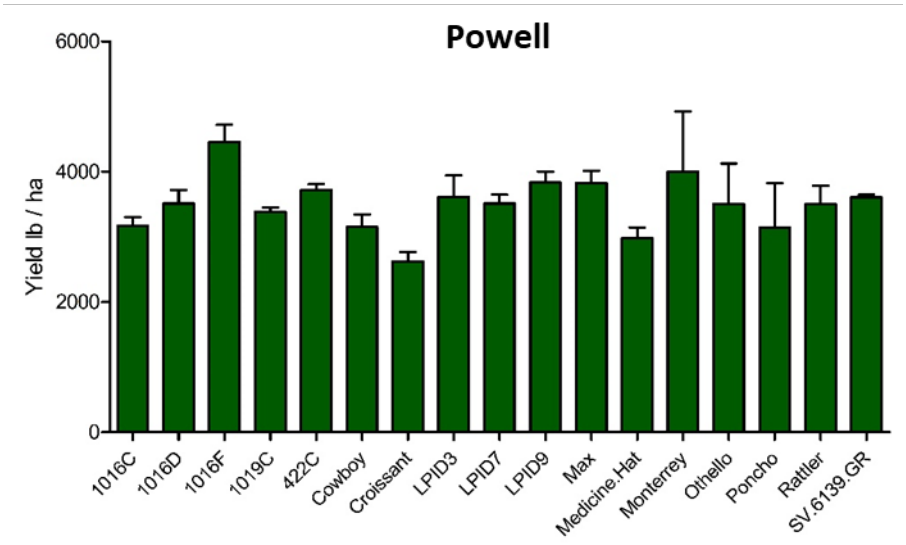
Photo of the yield trial taken from the DJI drone in Powell.

Table 1: Dry bean genotype yields and other agronomic data evaluated in two locations in Wyoming.

	Yield		Plant Height		Flowering Date		Maturity	
Entry	Powell	Sheridan	Powell	Sheridan	Powell	Sheridan	Powell	Sheridan
1016c	3169^{def}	3426^{b}	14^{def}	20^{abc}	55^{ab}	50^{ab}	105^{bc}	109^{abc}
1016d	3513^{bcde}	3429^{b}	18^{abc}	19^{bcd}	57^{a}	50^{a}	104^{cd}	108^{bc}
1016f	4456^{a}	3801^{a}	21^{a}	18^{bcd}	54^{abc}	50^{a}	104^{cde}	108^{bc}
1019c	3386^{cde}	3434^{b}	21^{a}	21^{ab}	54^{abc}	48^{cde}	104^{cde}	110^{ab}
422c	3718^{bcd}	3280^{c}	15^{cdef}	18^{bcd}	51^{cd}	47de	106^{b}	106^{cd}
Cowboy	3152^{def}	3192^{c}	17^{abcde}	22^{a}	54^{abc}	50^{ab}	103^{fg}	105de
Croissant	2622^{f}	2448^{e}	16^{bcdef}	22^{a}	54^{abc}	49^{bcd}	103^{efg}	103^{e}
LPID3	3618^{bcd}	2608de	15^{cdef}	19^{bcd}	48de	47de	105^{cd}	106^{cd}
LPID7	3512^{bcde}	2668de	15^{cdef}	18^{bcd}	54 ^{abc}	48^{cde}	105^{cd}	110^{ab}
LPID9	3832^{bc}	2459^{e}	20^{ab}	22^{a}	53^{bc}	50^{ab}	110^{a}	111^{ab}
Max	3828^{bc}	2151^{f}	14^{def}	11^{e}	44^{f}	47^{e}	99^{h}	99^{f}
Medicine Hat	2981^{ef}	2180^{f}	14^{def}	17^{cd}	54^{abc}	49^{abc}	104^{def}	99^{f}
Monterrey	4002^{ab}	3160^{c}	18^{abc}	20^{abc}	55^{ab}	50^{a}	104^{cd}	107^{cd}
Othello	3506^{bcde}	1899^{g}	13^{f}	12^{e}	44^{f}	47de	100^{h}	99^{f}
Poncho	3144^{def}	2748^{d}	14e^{f}	11^{e}	47^{ef}	46^{e}	102^{g}	100^{f}
Rattler	3501^{bcde}	3129^{c}	17^{abcd}	20^{ab}	54^{abc}	50^{a}	109^{a}	112^{a}
SV6139GR	3608^{bcd}	2610de	18 ^{cdef}	16^{d}	54^{abc}	48^{cde}	105^{cd}	107^{cd}
LSD	586	247	1	3	4	2	1	3
CV	10	5	14	10	4	2	1	2
Overall LSD	318							
Overall CV	9							

Values followed by common letters are not significantly different at the 5% level.

Figure 1: A & B: Yield of 17 different entries at Powell and Sheridan in 2023.



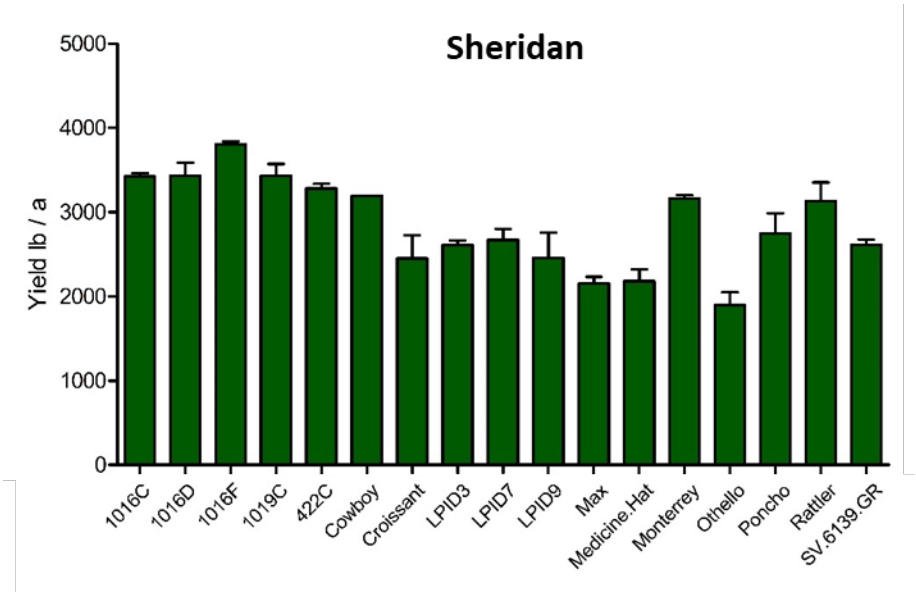
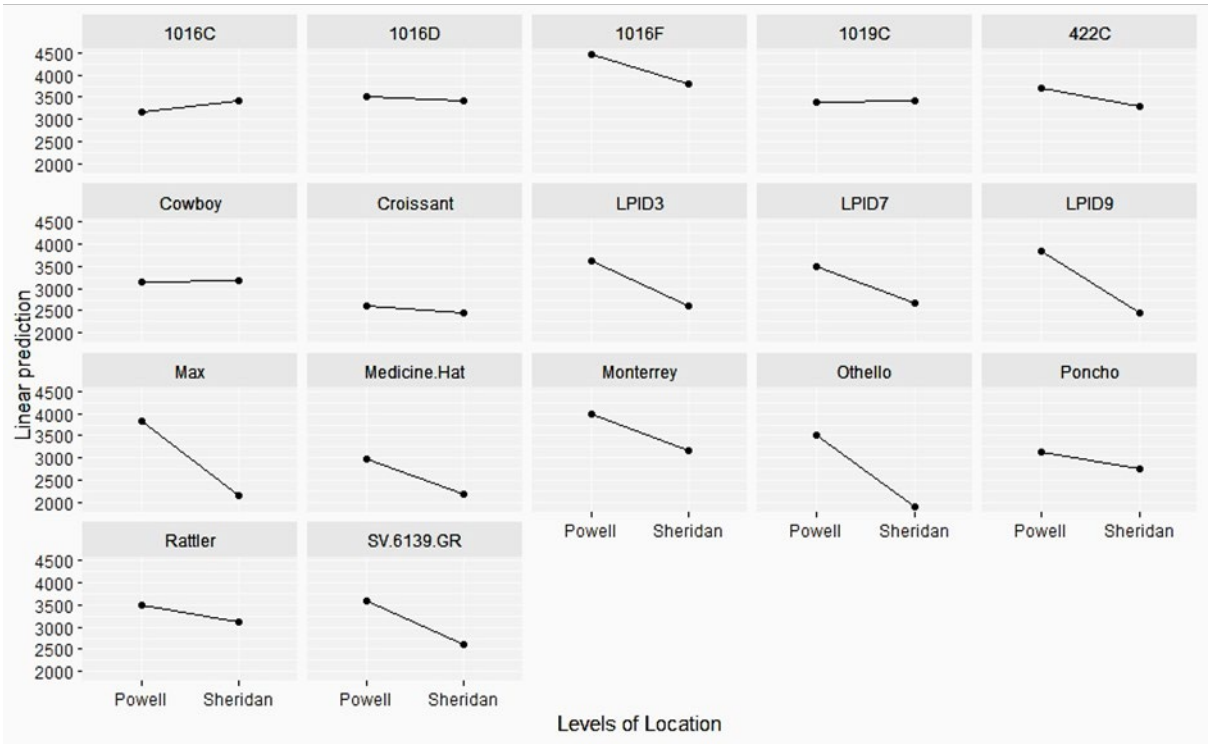
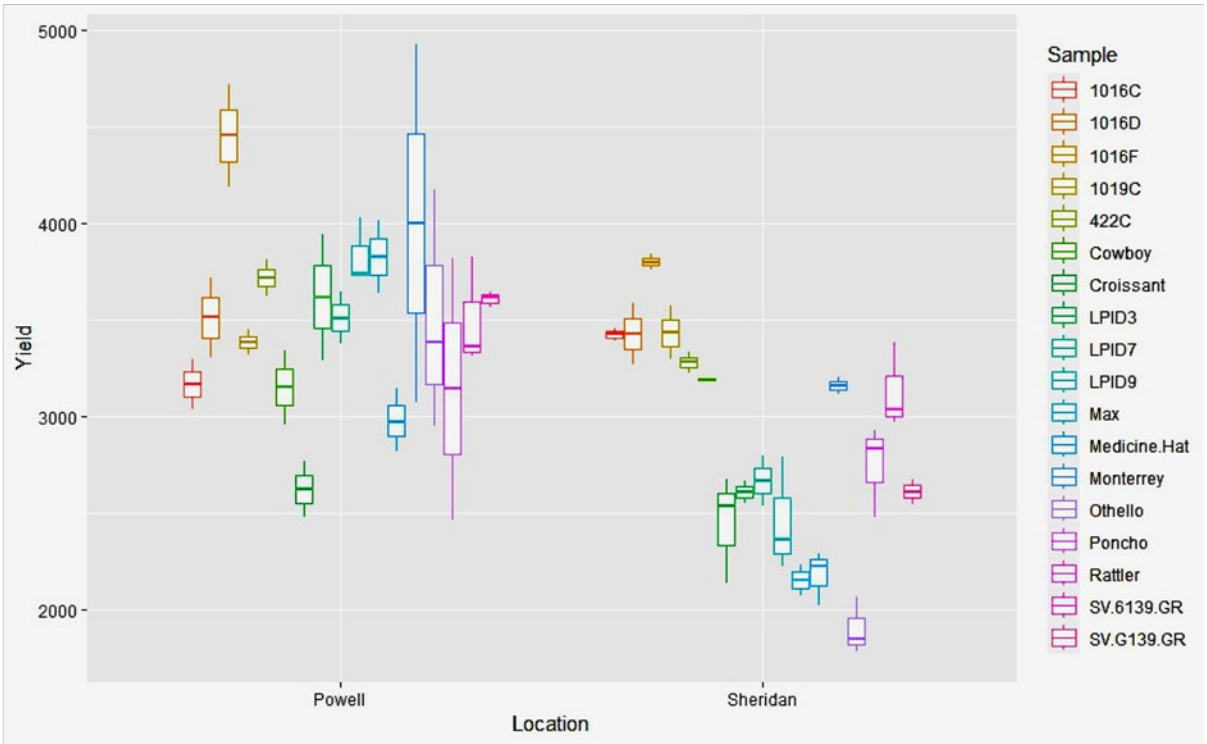


Figure 2: (A) variation in yield of 17 entries between Powell & Sheridan, (B) levels and variation of yield for each experimental entry in both locations.

A



B



Objective 2: We did our cross pollinations in the greenhouse this winter and seemed to have more success than what we have had in the field. We also advanced generations of newly developed populations in the greenhouse this winter. Harvest took place in March. Populations will be grown in the field in the summer of 2024 to continue our generation advancement. Also, additional single plant row lines that were selected last year in the field both at Sheridan and Powell will go into the first year of yield testing this summer.

Objective 3: For the canopy temperature yield trial at the Powell R&E Center, a combination of two methods was used to take canopy temperature data. The Apogee handheld unit and the DJI thermal drone. In Figure 3 below, the dates taken with the drone are named as DJI followed by the date. If DJI is not in the name, then the data were collected with the handheld Apogee unit. There is also an average of canopy temperatures taken with the Apogee, an average of canopy temperatures taken with the drone, and a total canopy temperature average taken across all dates and both methods. Correlations between canopy temperature and yield were very low at Powell this year. The total R^2 value when averaged across all dates and methods was 18%. The highest R^2 value was from the DJI unit on August 30th (DJI_30Aug1243) and was 35%. Due to the unusually wet and cool summer, plots matured later than in normal years and the August 30th reading was taken approximately 15 days prior to the first maturity rating. Yield and maturity were positively correlated at Powell (R^2 = 30%) and maturity and

canopy temperature were negatively correlated (R^2 = 56%). At Sheridan, the canopy temperature data were all collected with the DJI thermal drone across 4 dates ranging from August 11th to September 2nd (Figure 4). The total R^2 value when averaged across all dates was 92%. The dates with the highest R^2 values were August 11th and August 24th with values of 94% and 95% respectively. At both Powell and Sheridan in 2023, the highest correlations between canopy temperature and yield were recorded in August. This is also what we experienced in 2022. At Sheridan, there was also a strong negative correlation between canopy temperature and maturity (R^2 = 76%) and a strong positive correlation between yield and maturity (R^2 = 77%). One explanation for the strong positive correlation between yield and maturity is because we harvested all 2023 Sheridan plots on the same day when all had matured, and some of the earlier maturing lines had some shattering that happened as a result. No shattering was observed in Powell in 2023.

Figure 3: Correlations of traits within the canopy temperature test at Powell in 2023.

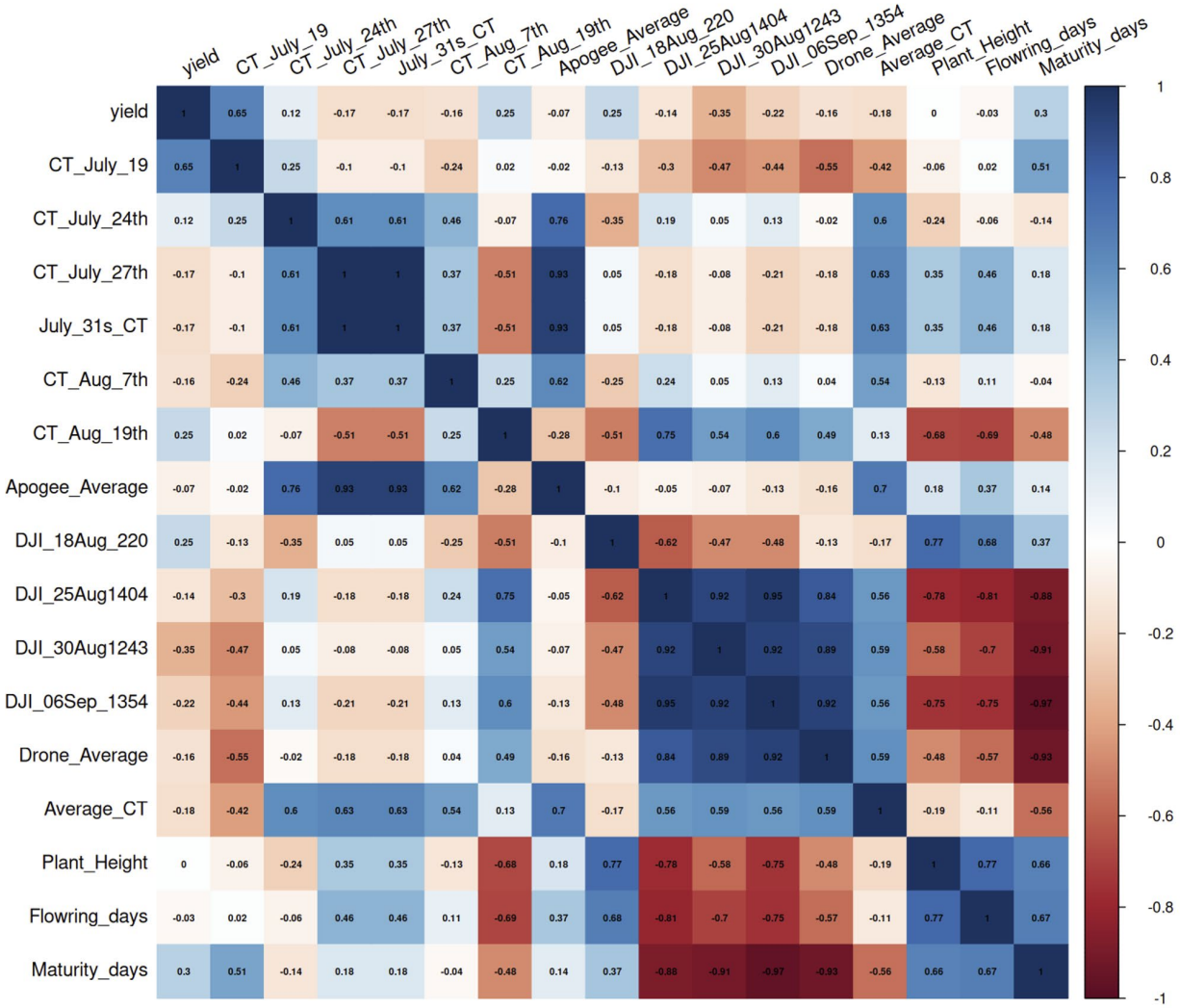
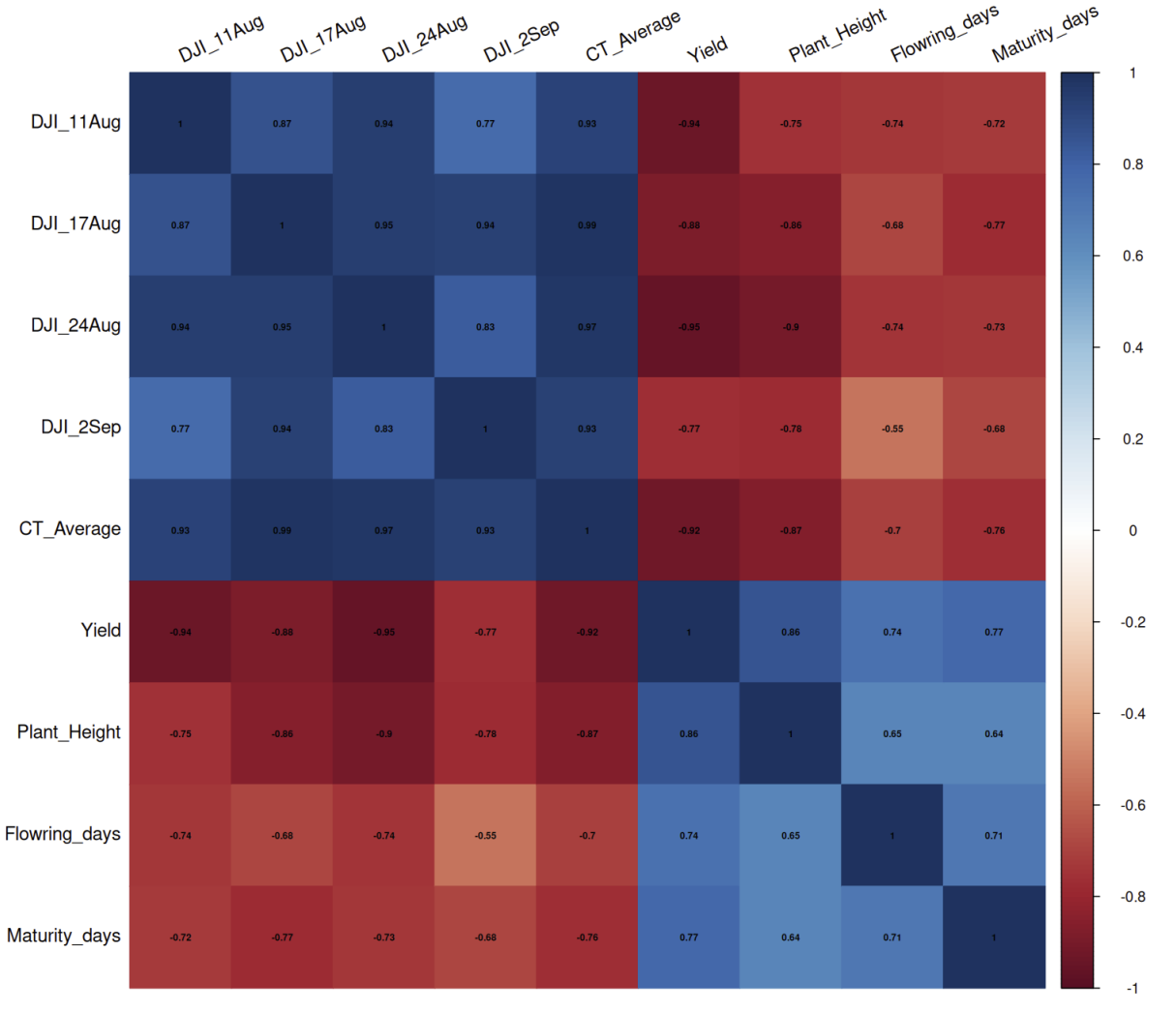


Figure 4. Correlations of traits within the canopy temperature test at Sheridan in 2023.



Future Work

The most promising experimental lines will be retested along with commercial checks at two locations in the summer of 2024 (Powell and Sheridan). For these lines, we will also plan to send seed to Idaho in 2024 for a seed increase and that grow out will allow us to obtain phytosanitary seed that can 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 of 2024. We will also conduct preliminary yield trials at Sheridan and Powell (providing there is enough seed available for both locations) on more advanced breeding material. The canopy temperature yield trial will be repeated at Sheridan and Powell for an additional year.