



2022 Organic Dry Bean Variety Trial



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Dry beans (*Phaseolus vulgaris*), a high-protein pulse crop, have been grown in the Northeast since the 1800's. As the local food movement continues to diversify and expand, consumers are asking stores to carry more locally-produced foods, and dry beans are no exception. Currently, the demand for locally sourced dry beans has far exceeded the supply. Farmers are also looking for high-value crops to diversify their rotations. Modern breeding efforts have expanded the market classes that can be direct harvested, lowering the barrier to entry by reducing the need for specialized equipment. Despite the growing interest, there has been little evaluation of alternative market classes, such as navy, small red, pinto, yellow, and heirloom/specialty beans. These alternative market classes are valued by consumers for their culinary characteristics and visual appeal. To support and expand organic dry bean production throughout the northeast, the University of Vermont Extension Northwest Crops and Soils Program initiated a research trial to evaluate twenty-seven organic dry bean varieties from different market classes to identify varieties suitable for organic production in the Northeast.

MATERIALS AND METHODS

The trial was established at Borderview Research Farm in Alburgh, VT. The experimental design was a randomized complete block with four replications. The treatments were twenty-seven dry bean varieties. Varietal information can be found in Table 1 below. All plots were managed with practices like those used by organic producers in the surrounding areas (Table 2).

Table 1. Varietal information for the twenty-seven dry bean varieties planted in Alburgh, VT, 2022.

| Variety | Seed Source | Market class | Growth habit ⁺ |
|------------------|---------------------------------|------------------|---------------------------|
| Alpena | Central Bean Co. | Navy | IIb |
| Black Tails | Treasure Valley Seeds | Black | IIb |
| Blizzard | Treasure Valley Seeds | Navy | IIb |
| California Early | University of California, Davis | Light Red Kidney | I |
| Calypso | GenTec Seeds LTD | Specialty | I |
| Cayenne | Central Bean Co. | Small Red | IIb |
| Desert Song | GenTec Seeds LTD | Flor de Junio | IIb |
| Dr Wood | Kelley Bean Co. | Pinto | IIb |
| GTS 1701 | GenTec Seeds LTD | Yellow Eye | III |
| Gypsy Rose | GenTec Seeds LTD | Flor de Mayo | III |
| Jacob's Cattle | GenTec Seeds LTD | Specialty | I |
| Lariat | Treasure Valley Seeds | Pinto | III |
| Merlin | Treasure Valley Seeds | Navy | IIa |
| Merlot | Treasure Valley Seeds | Small Red | III |
| ND Palomino | Treasure Valley Seeds | Pinto | III |
| Rojo Chiquito | Central Bean Co. | Small Red | IIb |
| Soldier | GenTec Seeds LTD | Specialty | IIa |

| | | | |
|--------------------|---------------------------------|-----------|-----|
| Tiger's Eye | GenTec Seeds LTD | Specialty | IIb |
| UC Andino | University of California, Davis | Specialty | IIa |
| UC Southwest Gold | University of California, Davis | Specialty | IIa |
| UC Tiger's Eye | University of California, Davis | Specialty | IIb |
| UCD 1004 | University of California, Davis | Specialty | IIa |
| UCD 1005 | University of California, Davis | Specialty | I |
| UCD Holstein | University of California, Davis | Specialty | IIa |
| UCD Jacob's Cattle | University of California, Davis | Specialty | IIa |
| Zenith | Central Bean Co. | Black | IIb |
| Zorro | Treasure Valley Seeds | Black | IIa |

+Growth habit classification: I- determinate, bush; IIa- indeterminate; completely upright with no vine or weak vine; IIb- indeterminate; inclined upright with substantial vine; III- indeterminate, prostrate.

Table 2. Trial management information for the organic dry bean variety trial, Alburgh, VT, 2022.

| Location | Borderview Research Farm, Alburgh, VT |
|--|--|
| Soil type | Benson rocky silt loam, over shaly limestone, 8 to 15 % slopes |
| Previous crop | Spring wheat |
| Tillage operations | Pottinger TerraDisc |
| Plot size (ft) | 10 x 20 |
| Row spacing (inches) | 30 |
| Replicates | 4 |
| Planting date | 31-May |
| Seeding rate (pure live seeds ac ⁻¹) | Smaller seeded varieties: 110,000 Larger seeded varieties: 85,000 |
| Harvest dates | 9-Sep, 15-Sep, and 21-Sep |

The plots were planted on 31-May with a 4-row cone planter with John Deere row units fitted with Almaco seed distribution units (Nevada, IA). Seeding rate was adjusted for seed size and germination rate; smaller seeded varieties were planted at a target seeding rate of 110,000 pure live seeds ac⁻¹ and larger seeded varieties were planted at a target seeding rate of 85,000 pure live seeds ac⁻¹ (Table 3). Prior to planting, the seed was treated with dry bean inoculant (*Rhizobium leguminosarum biovar phaseoli*). The plot size was 10ft x 20ft, with 4 rows at 30-inch spacing. Plant emergence was measured by counting the number of plants in three 1-ft sections in each plot on 22-Jun. Plots were scouted on 20-Jul for overall pest damage and disease severity. In each plot, 5 leaves were selected and given a score from 0-4, with 0 indicating no leaf damage and 4 indicating that >75% of leaves had been damaged. Days to maturity was also recorded for each plot. Plots reached maturity when most of the plants reached growth stage R9 (mature, at least 80% of the pods showing yellow and mostly ripe; only 40% of the leaves still green).

Table 3. Target seeding rate, germination, and adjusted seeding rate by variety, Alburgh, VT, 2022.

| Variety | Target seeding rate | Germination | Adjusted seeding rate |
|------------------------|-------------------------|-------------|-------------------------|
| | plants ac ⁻¹ | % | plants ac ⁻¹ |
| Alpena | 110,000 | 93 | 118,000 |
| Black Tails | 110,000 | 93 | 118,000 |
| Blizzard | 110,000 | 95 | 116,000 |
| California Early | 85,000 | 90 | 94,000 |
| Calypso | 85,000 | 90 | 94,000 |
| Cayenne | 110,000 | 87 | 126,000 |
| Desert Song | 100,000 | 99 | 101,000 |
| Dr Wood | 85,000 | 98 | 87,000 |
| GTS 1701 | 85,000 | 93 | 91,000 |
| Gypsy Rose | 100,000 | 100 | 100,000 |
| Jacobs Cattle | 85,000 | 97 | 88,000 |
| Lariat | 85,000 | 87 | 98,000 |
| Merlin | 110,000 | 96 | 115,000 |
| Merlot | 110,000 | 90 | 122,000 |
| ND Palomino | 85,000 | 94 | 90,000 |
| Rojo Chiquito | 110,000 | 97 | 113,000 |
| Soldier | 85,000 | 97 | 88,000 |
| Tigers Eye | 85,000 | 98 | 87,000 |
| UC Andino ¹ | 85,000 | 90 | 87,120 |
| UC Southwest Gold | 85,000 | 99 | 86,000 |
| UC Tigers Eye | 85,000 | 99 | 86,000 |
| UCD 1004 | 85,000 | 90 | 94,000 |
| UCD 1005 ¹ | 85,000 | 90 | 83,635 |
| UCD Holstein | 85,000 | 90 | 94,000 |
| UCD Jacobs Cattle | 85,000 | 90 | 94,000 |
| Zenith | 110,000 | 74 | 149,000 |
| Zorro | 110,000 | 97 | 113,000 |

¹Insufficient quantity of seed to plant at target seeding rate based on germination; actual seeding rate listed in adjusted seeding rate column.

All plots were hand harvested as they reached maturity, about 5 days after 95% of pods were brown, on 9-, 15-, and 21-Sep. At harvest, lodging was measured by visual assessment for the whole plot on a scale of 1 to 5, where 1 meant all plants were erect and 5 meant all plants were horizontal. Pod height was measured by selecting 5 plants at random from two 1-m row lengths within the center two rows of each plot and measuring the distance from the soil surface to the bottom of the lowest pod. These assessments are used to determine which varieties may be better suited for direct harvest with a combine. Stand counts were measured by counting the total number of plants from the two 1-m sections at harvest. All plants within the two 1-m row lengths were hand-pulled and then hung to dry in a well-ventilated space. Once dry, the beans were threshed using a portable Swanson B-1 thresher with a rasp bar rotor. Beans were then weighed to

calculate yields and a DICKEY-John MINI GAC meter used to determine bean moisture content. Seed yield was adjusted to 14% moisture.

Data were analyzed using the mixed model procedure in SAS (SAS Institute, 1999) with the Tukey-Kramer adjustment, which means that each main effect was analyzed with a pairwise comparison. Replications were treated as a random effect and varieties were treated as fixed. Treatments were considered different at the 0.10 level of significance. Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among treatments is real or whether it might have occurred due to other variations in the field.

RESULTS

Weather data were recorded with a Davis Instruments Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT (Table 4). The 2022 growing season was cooler than normal with above average rainfall. There was a total of 20.5 inches of precipitation from June to September, 5 inches above average. The cooler temperatures resulted in a total of 2106 accumulated Growing Degree Days (GDDs), 139 less than normal. The wet field conditions were challenging for timely weed management and mechanical cultivation, resulting in increased weed pressure especially later in the season.

Table 4. Weather data for Alburgh, VT, 2022.

| | 2022 | | | |
|-------------------------------|-------|-------|-------|-------|
| Alburgh, VT | June | July | Aug | Sep |
| Average temperature (°F) | 65.3 | 71.9 | 70.5 | 60.7 |
| Departure from normal | -2.18 | -0.54 | -0.20 | -1.99 |
| Precipitation (inches) | 8.19 | 3.00 | 4.94 | 4.40 |
| Departure from normal | 3.93 | -1.06 | 1.40 | 0.73 |
| Growing Degree Days (50-86°F) | 459 | 674 | 630 | 343 |
| Departure from normal | -64 | -20 | -11 | -44 |

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.

Historical averages are for 30 years of NOAA data (1991-2020) from Burlington, VT.

Adjusted seeding rate, plant emergence, and final harvest population for each variety are shown in Table 5. Because of differences in seeding rate by seed size, percent germination was calculated. Statistical analysis was only done on percent emergence. The average emergence population for the trial was 89,298 plants ac^{-1} . There was a statistical difference in germination rate. UC Southwest Gold had the highest percent emergence but was not statistically different from all but four varieties, Blizzard, Calypso, Jacobs Cattle, and Zenith. The trial average percent emergence was 88.3%. Percent emergence greater than 100% was likely due to overseeding. Germination rates used to calculate adjusted seeding rates were lower than what was observed after planting for some varieties. Harvest populations ranged from 17,260 plants ac^{-1} (Calypso) to 86,301 plants ac^{-1} (UCD Holstein), and the trial average was 56,198 plants ac^{-1} .

Table 5. Percent emergence and final population of organic dry bean varieties, Alburgh, VT, 2022.

| Variety | Adjusted seeding rate | Emergence | | Harvest population |
|------------------------|-----------------------|-------------------------|--------------|--------------------|
| | | plants ac ⁻¹ | % | |
| Alpena | 118000 | 100188 | 84.9* | 58419 |
| Black Tails | 118000 | 103092 | 87.4* | 73024 |
| Blizzard | 116000 | 85668 | 73.9 | 62402 |
| California Early | 94000 | 91476 | 97.3* | 57091 |
| Calypso | 94000 | 39204 | 41.7 | 17260 |
| Cayenne | 126000 | 100188 | 79.5* | 47134 |
| Desert Song | 101000 | 79860 | 79.1* | 48461 |
| Dr Wood | 87000 | 69696 | 80.1* | 53108 |
| GTS 1701 | 91000 | 92928 | 102.1* | 61075 |
| Gypsy Rose | 100000 | 91476 | 91.5* | 65058 |
| Jacobs Cattle | 88000 | 63888 | 72.6 | 36512 |
| Lariat | 98000 | 92928 | 94.8* | 55100 |
| Merlin | 115000 | 104544 | 90.9* | 73024 |
| Merlot | 122000 | 105996 | 86.9* | 63730 |
| ND Palomino | 90000 | 72600 | 80.7* | 40495 |
| Rojo Chiquito | 113000 | 107448 | 95.1* | 71032 |
| Soldier | 88000 | 79860 | 90.8* | 59747 |
| Tigers Eye | 87000 | 85668 | 98.5* | 43151 |
| UC Andino ¹ | 87120 | 70670 | 81.1* | 37575 |
| UC Southwest Gold | 86000 | 98736 | 114.8 | 45142 |
| UC Tigers Eye | 86000 | 94380 | 109.7* | 53108 |
| UCD 1004 | 94000 | 89020 | 93.7* | 54234 |
| UCD 1005 ¹ | 83635 | 63852 | 76.3* | 39186 |
| UCD Holstein | 94000 | 98736 | 105.0* | 86301 |
| UCD Jacobs Cattle | 94000 | 103092 | 109.7* | 75016 |
| Zenith | 149000 | 97284 | 65.3 | 57755 |
| Zorro | 113000 | 113256 | 100.0* | 68377 |
| Level of significance | N/A [§] | N/A | <.0001 | N/A |
| Trial Mean | 101213 | 89298 | 88.3 | 56198 |

†Values in **bold** indicate the top performer for the production metric and varieties with an asterisk * performed statistically similarly to the top performer.

§N/A- statistical analysis not conducted.

¹Insufficient quantity of seed to plant at target seeding rate based on germination; actual seeding rate listed in adjusted seeding rate column.

The earliest maturing variety was UC Southwest Gold, reaching R9 stage 85 days after planting (Table 6). This was not statistically different from five other varieties, Cayenne, Desert Song, GTS 1701, California Early, and Merlot. The varieties Dr Wood, Soldier, UC Andino, UCD Holstein, and UCD Jacobs Cattle took the longest to mature, reaching R9 stage 113 days after planting, almost a month after the earliest maturing variety. Due to these differences, varieties were not harvested at the same time, but harvested as

they reached maturity. Dry bean yield at 14% moisture ranged from 569 lbs ac⁻¹ (Calypso) to 3451 lbs ac⁻¹ (Blizzard). The top performer was not statistically different from nineteen dry bean varieties. Blizzard had the lowest harvest moisture (17.9%), but was not statistically different from twenty-three other varieties. The trial average was 27.9% and all dry beans required additional drying to reach a safe storage moisture, approximately 12-16%. The trial average score for lodging at harvest was 2.28, and UCD Holstein and Zenith had the lowest lodging score (1.00). This was not statistically different from all but four varieties. There was an average pod height of 3.30 cm. Zenith had the greatest pod height (7.80cm) and was not statistically different from eleven varieties.

Table 6. Harvest characteristics of organic dry bean varieties, Alburgh, VT, 2022.

| Variety | Days to maturity | Yield at 14% moisture | Harvest moisture | Lodging | Pod height |
|-----------------------|------------------------|-----------------------|------------------|-------------------------|------------|
| | days after planting | lbs ac ⁻¹ | % | 1-5 rating [£] | cm |
| Alpena | 97 | 3081* | 19.0* | 1.75* | 3.33* |
| Black Tails | 97 | 3205* | 17.9 | 2.75* | 6.83* |
| Blizzard | 99 | 3451 | 18.5* | 2.00* | 6.43* |
| California Early | 94* | 2471* | 21.9* | 1.50* | 3.20* |
| Calypso | 105 | 569 | 55.5 | 1.75* | 0.25 |
| Cayenne | 90* | 2462* | 19.9* | 1.50* | 4.98* |
| Desert Song | 95* | 2171* | 19.2* | 4.5 | 0.7 |
| Dr Wood | 113 | 2601* | 28.4* | 3.25* | 3.23* |
| GTS 1701 | 89* | 1987 | 24.0* | 3.5 | 1.8 |
| Gypsy Rose | 99 | 1964 | 22.9* | 4.25 | 1.4 |
| Jacobs Cattle | 100 | 1068 | 23.1* | 3.75 | 0.93 |
| Lariat | 96 | 2897* | 26.8* | 2.50* | 7.08* |
| Merlin | 102 | 3016* | 25.1* | 2.00* | 4.75* |
| Merlot | 93* | 2322* | 21.4* | 3.00* | 5.50* |
| ND Palomino | 97 | 2699* | 24.0* | 2.00* | 2.48 |
| Rojo Chiquito | 109 | 2686* | 27.8* | 2.75* | 5.23* |
| Soldier | 113 | 2308* | 28.7* | 3.00* | 1.15 |
| Tigers Eye | 109 | 626 | 57.8 | 2.00* | 1.3 |
| UC Andino | 113 | 2527* | 30.8* | 1.64* | 1.45 |
| UC Southwest Gold | 85 [†] | 1978 | 31.4* | 1.75* | 1.18 |
| UC Tigers Eye | 105 | 1842 | 31.5* | 1.50* | 1.35 |
| UCD 1004 | 107 | 3057* | 29.0* | 1.13* | 0.99 |
| UCD 1005 | 106 | 2245* | 41.8 | 1.47* | 1.12 |
| UCD Holstein | 113 | 2390* | 30.6* | 1 | 2.4 |
| UCD Jacobs Cattle | 113 | 2903* | 29.4* | 1.75* | 2.95 |
| Zenith | 100 | 2809* | 19.9* | 1 | 7.8 |
| Zorro | 109 | 2632* | 28.3* | 2.00* | 6.75* |
| Level of significance | p <.0001 | | | | |
| Trial Mean | 101 | 2371 | 27.9 | 2.28 | 3.3 |

[†]Values in **bold** indicate the top performer for the production metric and varieties with an asterisk * performed statistically similarly to the top performer.

[£]Lodging scale: 1=all plants erect; 5=all plants horizontal

Overall pest and disease pressure were low for this growing season, but some common foliar diseases and arthropod damage were observed (Table 7). Plots were scouted for the following common dry bean arthropod pests: potato leafhopper (*Empoasca fabae*) and Japanese beetle (*Popillia japonica*), and the following foliar diseases: bacterial brown spot (*Pseudomonas syringae* pv. *syringae*), common bacterial blight (*Xanthomonas campestris* pv. *phaseoli*), and halo blight (*Pseudomonas syringae* pv. *phaseolicola*). In each plot, 5 leaves were selected and given a score from 0-4, with 0 indicating no leaf damage and 4 indicating that >75% of leaves had been damaged. There was no statistical difference in the severity of bacterial brown spot. The trial average was 0.23 and severity scores ranged from 0.05 to 0.45. Common bacterial blight severity was also not statistically different. The trial average was only 0.01 and ranged from 0 to 0.05. Soldier had the most severe halo blight, with a score of 0.45, but was not statistically different from eighteen varieties. Cayenne, Desert Song, California Early, Merlot, ND Palomino, Tigers Eye, UC Tigers Eye, and UCD Jacobs Cattle all had scores of 0, and the trial average was only 0.10. Potato leafhopper damage was quite low for most of the dry bean varieties, and the average score was 0.20. Jacobs Cattle had the greatest potato leafhopper damage with a score of 1.15, and this was not significantly different from just one other variety, Gypsy Rose (0.95). Foliar damage from Japanese beetle was the greatest overall, with a trial average score of 0.28. UCD Holstein had the most Japanese beetle damage (0.70) but was not statistically different from twenty-two other varieties.

Table 7. Severity of disease and arthropod damage by dry bean variety, Alburgh, VT, 2022.

| Variety | Bacterial brown spot | Common bacterial blight | Halo blight | Potato leafhopper | Japanese beetle |
|------------------|------------------------|-------------------------|-------------|-------------------|-----------------|
| | 0-4 scale ^s | | | | |
| Alpena | 0.20 | 0.00 | 0.10* | 0.05 | 0.25* |
| Black Tails | 0.45 | 0.00 | 0.20* | 0.00 | 0.15* |
| Blizzard | 0.15 | 0.00 | 0.20* | 0.15 | 0.25* |
| California Early | 0.25 | 0.00 | 0.00 | 0.00 | 0.45* |
| Calypso | 0.20 | 0.05 | 0.20* | 0.60 | 0.05 |
| Cayenne | 0.25 | 0.00 | 0.00 | 0.25 | 0.65* |
| Desert Song | 0.10 | 0.00 | 0.00 | 0.05 | 0.20* |
| Dr Wood | 0.20 | 0.05 | 0.15* | 0.10 | 0.60* |
| GTS 1701 | 0.15 | 0.00 | 0.35* | 0.15 | 0.25* |
| Gypsy Rose | 0.05 | 0.00 | 0.20* | 0.95* | 0.15* |
| Jacobs Cattle | 0.20 | 0.00 | 0.15* | 1.15 | 0.20* |
| Lariat | 0.15 | 0.00 | 0.10* | 0.05 | 0.20* |
| Merlin | 0.35 | 0.00 | 0.20* | 0.00 | 0.40* |
| Merlot | 0.35 | 0.00 | 0.00 | 0.20 | 0.20* |
| ND Palomino | 0.30 | 0.00 | 0.00 | 0.00 | 0.25* |
| Rojo Chiquito | 0.35 | 0.00 | 0.15* | 0.00 | 0.45* |
| Soldier | 0.20 | 0.00 | 0.45 | 0.40 | 0.30* |
| Tigers Eye | 0.20 | 0.00 | 0.00 | 0.25 | 0.30* |
| UC Andino | 0.45 | 0.00 | 0.01* | 0.10 | 0.36* |

| | | | | | |
|-----------------------|-----------------|------|-------|--------|-------------|
| UC Southwest Gold | 0.20 | 0.00 | 0.05* | 0.20 | 0.15* |
| UC Tigers Eye | 0.30 | 0.00 | 0.00 | 0.05 | 0.05 |
| UCD 1004 | 0.35 | 0.00 | 0.07* | 0.27 | 0.05 |
| UCD 1005 | 0.42 | 0.00 | 0.01* | 0.07 | 0.02 |
| UCD Holstein | 0.15 | 0.05 | 0.05* | 0.05 | 0.70 |
| UCD Jacobs Cattle | 0.15 | 0.00 | 0.00 | 0.10 | 0.20* |
| Zenith | 0.30 | 0.00 | 0.05* | 0.20 | 0.15* |
| Zorro | 0.05 | 0.00 | 0.05* | 0.00 | 0.35* |
| Level of significance | NS [‡] | NS | 0.03 | <.0001 | 0.001 |
| Trial Mean | 0.23 | 0.01 | 0.10 | 0.20 | 0.28 |

§Average portion of leaf damaged by pest or disease; 0= 0%, 1= 1-25%, 2= 26-50%, 3= 51-75%, 4= 76-100% of leaf damaged

†Values in **bold** indicate the top performer for the production metric and varieties with an asterisk * performed statistically similarly to the top performer.

‡NS- not statistically significant (p=0.10)

DISCUSSION

In the 2022 growing season, the UVM Extension Northwest Crops and Soils Program conducted an organic dry bean variety trial at Borderview Farm in Alburgh, VT to evaluate different alternative market classes for direct harvestability, yield, and pest and disease resistance. The weather conditions this year were cool and wet, resulting in a total of 2106 Growing Degree Days (139 less than normal) and 20.5 inches of rain (5 inches above average). There was good emergence across market classes, with the exception of Calypso, an heirloom variety. Days to maturity ranged from 85 to 113 day after planting. The cool, wet conditions made timely weed management challenging especially as the dry beans approached harvest maturity. Weed pressure was not measured in this trial but did result in some yield loss for varieties that had poor emergence. For example, Calypso (specialty/heirloom), a late maturing variety, had significant weed pressure resulting in low yields. Dry bean varieties with a range of maturities were able to achieve good seed yields, as illustrated in Figure 1. Top yielding varieties ranged from early to late maturing varieties. The lowest yielding varieties were all specialty/heirloom varieties. The top yielding varieties were navy and black bean varieties, but specialty varieties like UCD 1004 and UCD Jacobs Cattle had comparable yields. These data represent only one year of research at one location, and the NWCS program plans to repeat this trial in 2023 to better understand which alternative market classes of organic dry beans are best suited for the Northeast.

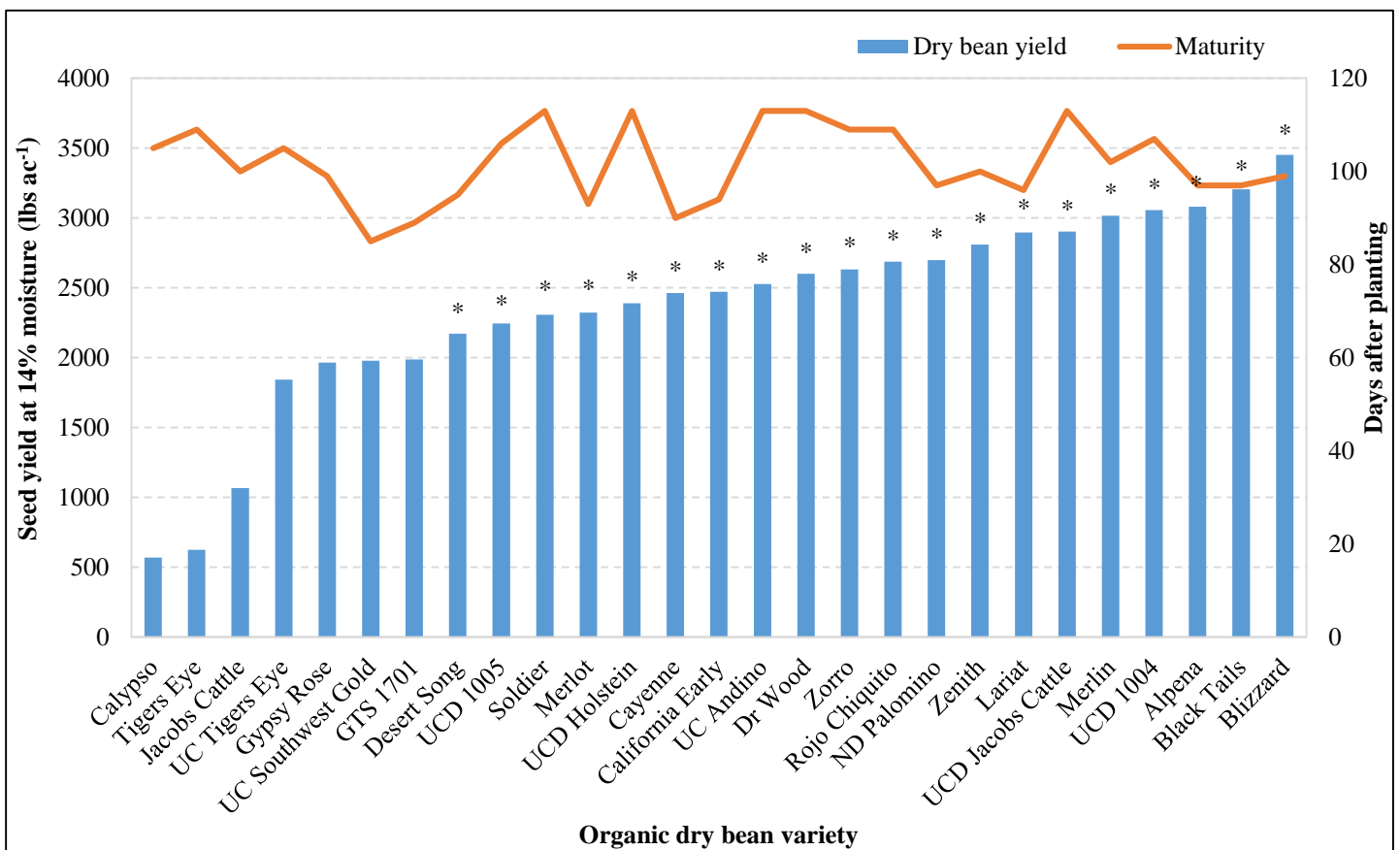


Figure 1. Dry bean seed yield and maturity by variety, Alburgh, VT, 2022.
 An asterisk (*) indicates that variety was not statistically different from the top yielding variety (p=0.10).

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