NORTHWEST CROPS & SOILS PROGRAM

2022 Organic Dry Bean Variety Trial

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THE UNIVERSITY OF VERMONT EXTENSION

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 expend 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, prostate.

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

[1]Insufficient 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}	plants ac^{-1}	%	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.

[1]Insufficient 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[§]				
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.

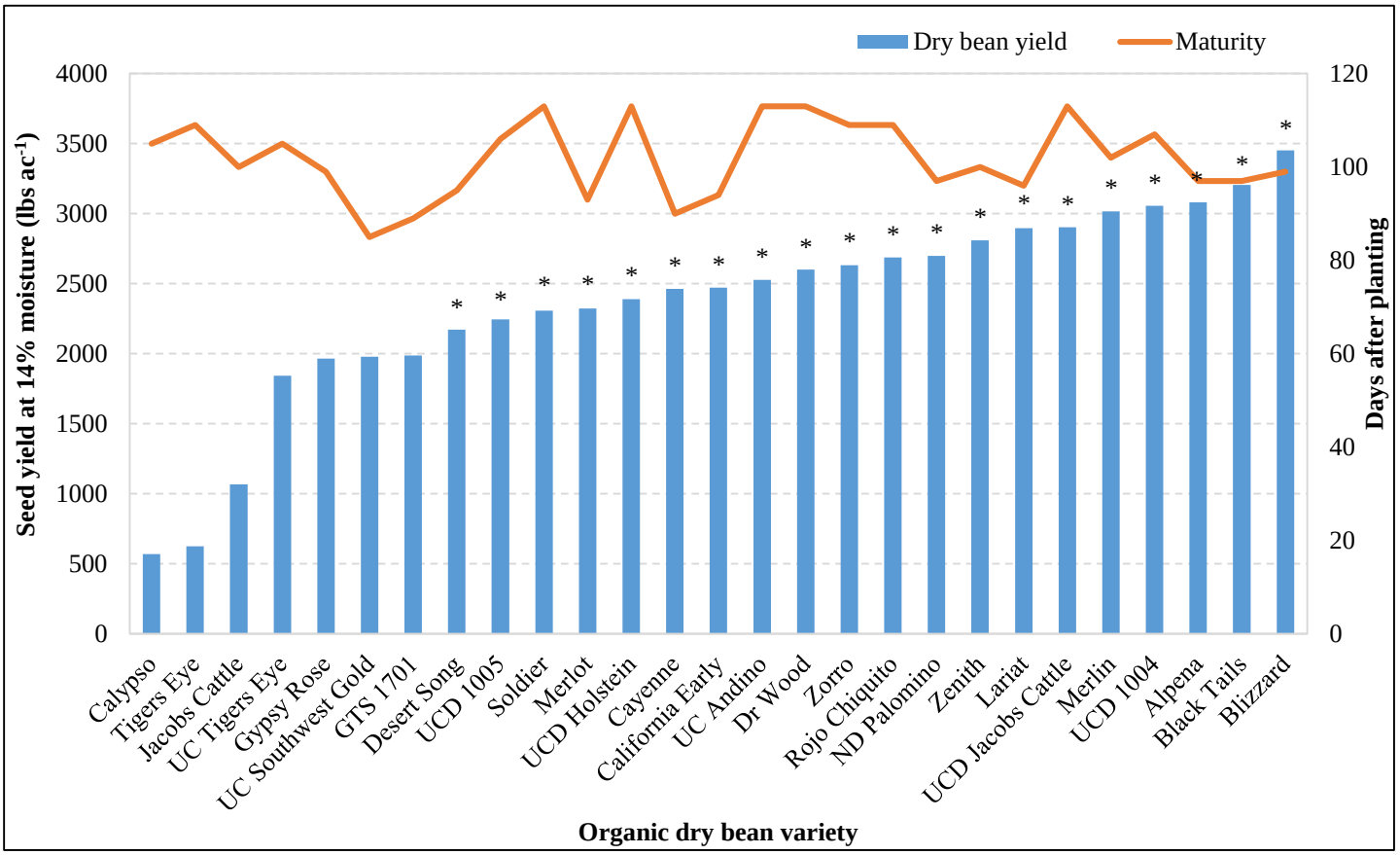

Figure 1. Dry bean seed yield and maturity by variety, Alburgh, VT, 2022.
An asterisk (*) indicates that variety was not statistically different from the top yielding variety (p=0.10).

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