Technical Report TR23-8 April 2023

Agricultural Experiment Station

Colorado State University

College of Agricultural Sciences | Department of Horticulture & Landscape Architecture | Arkansas Valley Research Center | Extension

Arkansas Valley Research Center 2022 Research Reports

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Acknowledgement

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We would like to express our gratitude to Seminis Vegetable Seeds for providing varietal trial seeds for broccoli, cantaloupe, seedless watermelon and sweet corn. We also want to thank Dr. Ainong Shi from the University of Arkansas for kindly providing cowpea seeds for field testing at AVRC.

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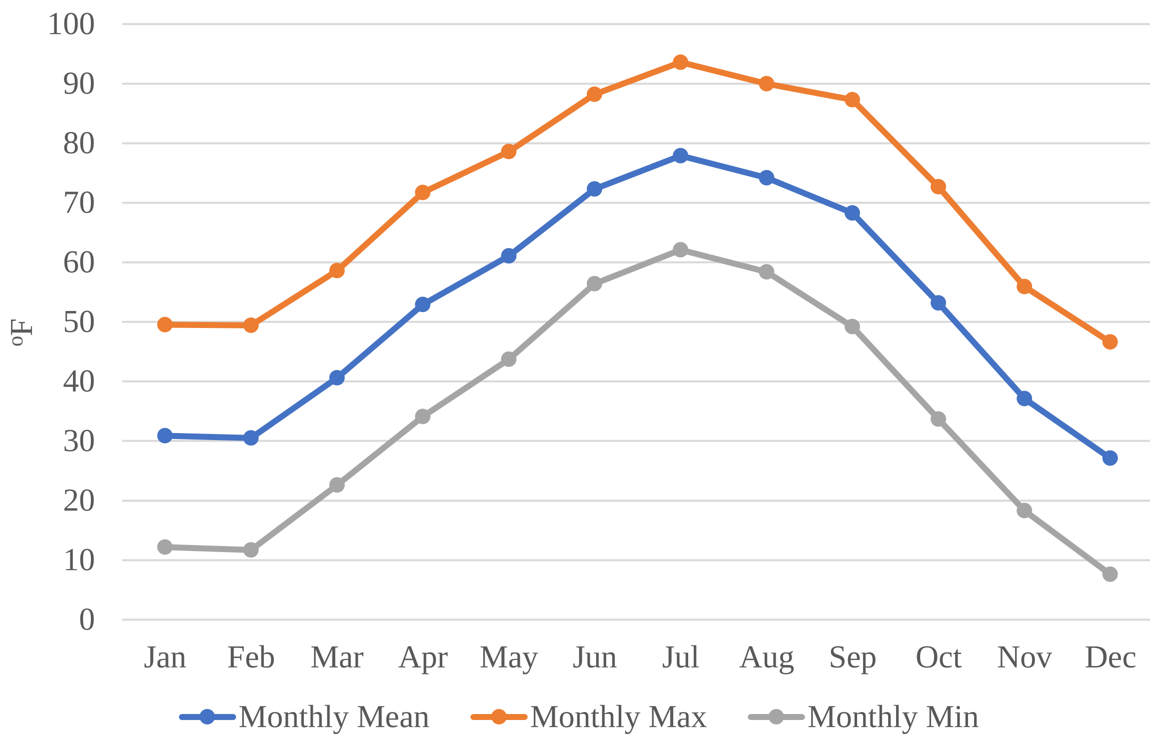
CoAgMet Monthly Data
Station: CSU Research Center Rocky Ford
Location: 2.5 mi SE Rocky Ford
Elevation: 4180
Longitude: 103.6950
Latitude: 38.0385

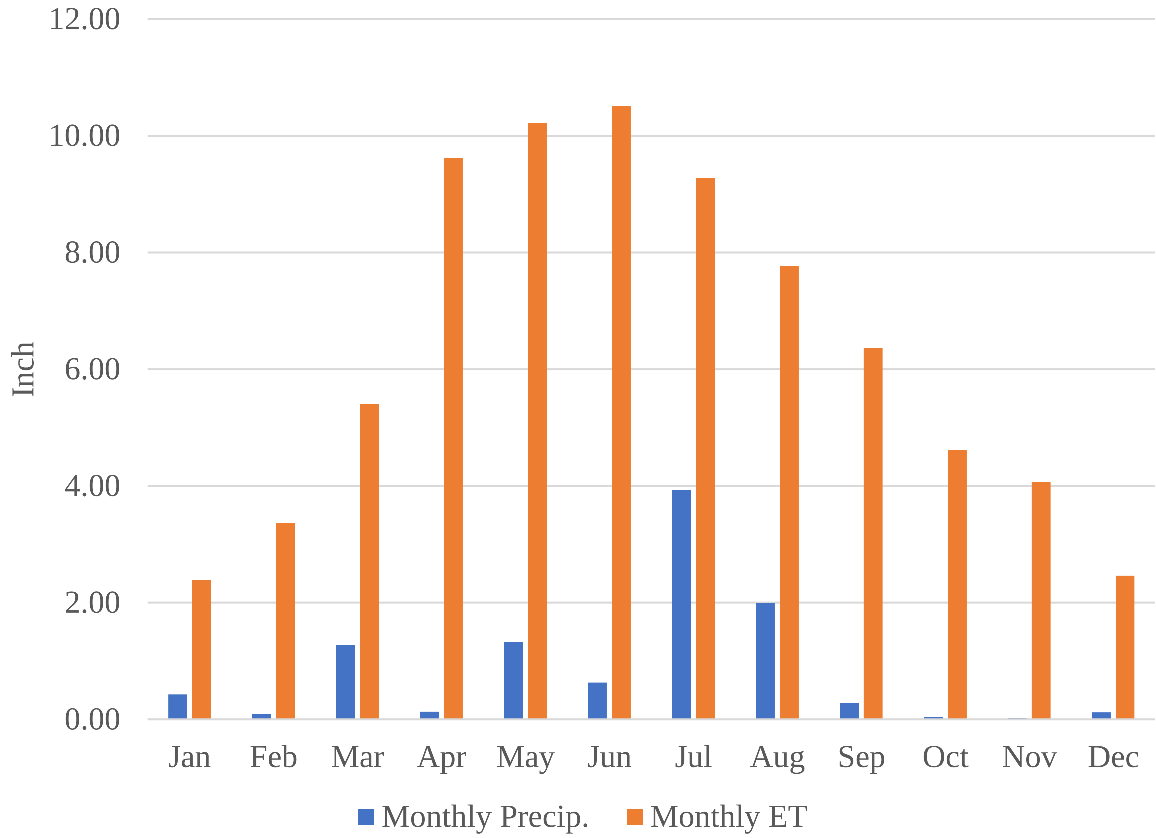
Monthly Climatic Data for Year 2022
- Monthly Maximum, Minimum and Mean Temperature



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Mean	30.9	30.5	40.6	52.9	61.1	72.3	77.9	74.2	68.3	53.2	37.1	27.1
Monthly Max.	49.5	49.4	58.6	71.7	78.6	88.2	93.6	90.0	87.3	72.7	55.9	46.6
Monthly Min.	12.2	11.7	22.6	34.1	43.7	56.4	62.1	58.4	49.2	33.7	18.3	7.6

Monthly Climatic Data for Year 2022

- Monthly Precipitation and Reference Evapotranspiration (ET)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly Precip.	0.43	0.09	1.28	0.13	1.32	0.63	3.93	1.99	0.28	0.04	0.02	0.12
Monthly ET	2.39	3.36	5.41	9.62	10.22	10.51	9.28	7.77	6.36	4.62	4.07	2.46

Can We Grow Cowpea in the Arkansas Valley?

Jianbing Ma, Kevin Tanabe, Lane Simmons

Introduction

Figure 1. Cowpea field plots at AVRC

Commonly known as black-eyed pea, cowpea (*Vigna unguiculata* L. Walp.) is an important annual herbaceous legume crop that is widely grown in Africa, South America, South and Southeast Asia, and the southern United States (Muchero, 2009; Tan, 2012). Cowpea is a versatile crop that can be used for human food as a fresh vegetable and a dry grain as well as for animal fodder and cover crop (Singh, 2014). Cowpea is rich in carbohydrates (~64%), protein (~25%), vitamins, and minerals, such as iron, calcium, thiamin, and folic acid (Boukar et al., 2019). Most importantly, cowpea has been planted widely in semi-arid regions because of its tolerance to drought, high temperatures, salinity, and infertile soil (Hall and Patel, 1985; Sanginga et al., 2000). Other benefits of growing cowpea include promoting healthy soil and soil fertility by nitrogen fixation and suppressing weeds and soilborne diseases.

Figure 2. Alfalfa field at AVRC

Alfalfa (*Medicago sativa* L.) is the most widely used forage crop in Colorado. In 2022, a total of 780,000 areas of alfalfa were grown in Colorado with a market value of nearly $500 million (Colorado Agricultural Statistics 2022). However, in the past twenty years, due to continuously drought and reduced water allotments, alfalfa growers have been forced to reduce irrigation water or curtail their acreages by converting the farmland into dryland or fallow ground, which significantly impacts alfalfa hay yield and quality as well as growers' profitability. Alfalfa hay growers are consistently looking for supplement crops for animal forage production with a lower water requirement. The objectives for this cowpea study were to (1) test the adaptability of cowpea varieties developed by University of Arkansas; (2) examine the regrowth ability of cowpea; (3) assess and compare the animal feed values of cowpea with alfalfa.

Materials and Methods

On May 31st, 2022, a total of 7 cowpea varieties, including the heirloom black-eyed pea variety CB5 and 6 highlighted varieties from University of Arkansas breeding group, were tested at AVRC (Table 1). The commercially grown pinto bean (*Phaseolus vulgaris*) was also planted in this trial and used as the reference for cowpea variety performance.

Figure 3. Cowpea field 7 weeks after planting at AVRC

Figure 4. Haulm and leaves & seed pods of cowpea

This trial was planted by direct seeding on 30-inch center-to-center beds. Each variety was planted as a single row in a 300-feet long bed with 2-inch in-row spacing. The crop management followed commercial standard practice in the Arkansas Valley.

Data Collection and Analysis

Field evaluations were conducted on cowpea phenology (days to flowering, 25%, 50% and 100% flowering, 80% pod color changed) and morphology [plant type (erect, semi-erect, prostrate)]. At 25% flowering stage and 80% pod color changed stage, three plants of each variety were cut at the soil line, and haulm (the stems collectively of cowpea vegetative growth without the seed pods) and leaf & seed pod were separated and weighed after being air dried in a greenhouse. The combined dry biomass of haulm and leaf & seed pod was considered as the animal fodder. On July 28 (58 days after planting), the regrowth ability of cowpea and pinto bean was assessed by cutting 3 plants at 2 or 6 inches above soil line, respectively, and the new growth of plants were observed 7, 21 and 33 days after cutting. Plant disease and insect pressure were monitored during the season. Soil water content (Kpa) and soil temperature (^{o}F) were also recorded by Irrometer 900M-O Watermark Monitor (Irrometer Company, Inc., Riverside, CA) at 12 and 24 inches deep in the soil, respectively.

The 100 grams compound dry sample containing half of haulm (50 grams) and half of leaf & seed pod for each variety taken at 25% flowering stage and 80% pod color changed stage, respectively, were sent to the Weld Laboratory, Inc (Greeley, CO) for animal feed value analysis. The same analysis was also performed on dry alfalfa sample that was taken from the alfalfa field adjacent to cowpea trial. Data analysis was implemented using JMP Pro 16 (SAS Institute Inc.) and the Tukey's honestly significant difference test (Tukey's HSD) was used to test differences among sample means for significance.

Results and Discussion

A total of 10 irrigation events occurred during the growth season which applied 20 inches water for cowpeas. The peak for water consumption was seen between the first week of July until early August (Figure 5 and 6) during flowering and seed filling stages of cowpea. More water fluctuation happened in top 12 inches soil indicating more distribution of cowpea root system. Less soil temperature difference was observed between the 12 and 24-inch soil depth after mid-July, possibly because of high day temperatures and more root growth in the summer.

Different plant morphology was seen in the trial in which the black-eyed pea, 3025, 18-86 and 3018 were vine (semi-erect) type, and Early Scarlet, 3021 and 09-529 were erect (bush) type (Table 2; Figure 7.). Flowering of cowpeas started 44 to 57 days after planting (DAP). The variety 09-529 indicated the fastest maturity and only took 14 days to reach full bloom after flowering initiated (Table 2; Figure 7 and 9). In general, cowpea varieties with an erect plant type were flowering earlier with faster maturity than vining varieties. Pinto Bean started to bloom 48 DAP but took longer time to reach 80% pod color changed stage. Example photos for different flowering stages and 80% pod color changed can be seen in Photo 1.

Significant differences were found for the dry weights of haulm, leaf & seed pod, and fodder at different growth stages (Table 3, 4; Figure 8). Regardless of growth stage, variety '3018' indicated the greatest weights for haulms, leaf & seed pod, and fodder. At 25% flowering, ranking the 2nd and 3rd variety with the highest haulms, leaf & seed pod, and total fodder were 18-86 and black-eyed pea, respectively. At 80% pod color changed stage, the 2nd and 3rd places were black-eyed pea and Early Scarlet for dry weights for leaf & seed pod, and total fodder. Both black-eyed pea and Early Scarlet presented higher variation for sample weights indicating less uniform plant growth (data not shown). In general, the vining cowpea varieties depicted the larger fodder weight and the top 3 varieties with the largest biomass were 3018, black-eyed pea and Early Scarlet.

Animal feed values were analyzed for cowpea samples taken at 25% flowering and 80% pod color changed stage, respectively (Table 5.). Although the highest protein % was found in alfalfa, cowpeas presented a better overall relative feed value (RFV) compared with alfalfa. It could be because RFV was determined by the formulation uses the acid detergent fiber (ADF) and neutral detergent fiber (NDF), and the high concentrations of ADF and NDF suggesting less digestibility of feed ingredients thus lower RFV values. The vining variety black-eyed pea and 3025 showed the highest RFV at 25% flowering and 80% pod color changed stage, respectively. More obvious varietal differences of cowpea were seen on RFV at 80% pod color changed stage. In addition, total digestible nutrients (TDN) related to feed energy values so the higher values of TDN, the larger net energy of feed for animals.

Regarding regrowth ability, slight varietal variation was observed in the field (Figure 10). However, all the cowpea varieties can regrow new branches and set new seed pods after new flowering. It was noted that plants regrow faster when cut at 6 inches above the soil line. Pinto beans failed to grow back after cutting the plants. The ability to regrow and reproduce after cutting cowpea suggests the high potential of hay production since the fodder yield could be doubled if 2-3 cuts can be implemented in cowpea fields.

Conclusions

The overall trial quality was excellent and cowpea varieties adapted well in Arkansas Valley climate. Moderate root nodules were seen on plant roots. The vining varieties '3018' and Black-eyed pea showed the highest potential for forage hay production due to high fodder yields. And vine type cowpea suggested higher animal feed values than alfalfa. The regrowth ability was proven in the field, and 25% blooming stage should be used as the cutting time indicator for cowpea forage hay, which aligns with current alfalfa hay production practices. Cowpea varieties tested in this trial showed fast maturity which only took ~80 days from planting to harvest and demonstrated the potential for planting in a double crop system. This cowpea variety performance study provides the fundamental knowledge for cowpea field growth and development which will benefit future cowpea studies in the southeastern region of Colorado.

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Table 1. Information about the cowpea varieties and pinto beans tested at AVRC in 2022.

ID	Variety	Origin	Type	Trait
C1	Black-eyed pea (CB5)	California	Blackeye	Vine type
C2	Pinto bean	-	-	-
C3	22-B72 HB 2021 3025 (3025)	Arkansas	Black	Good yield
C4	Early Scarlet	Arkansas	Pinkeye	High Protein
C5	3021	Arkansas	Cream	High Protein
C6	18-86	Arkansas	Red	Vine type; Drought Tolerant
C7	09-529	Arkansas	Blackeye	High Sugar
C8	3018	Arkansas	Red	Vine type; Salt Tolerant

Table 2. Phenology (day) and morphology characteristics of cowpea and pinto bean tested at AVRC in 2022.

ID	Variety	Type	Flowering	25% Flowering	50% Flowering	75% Flowering	100% Flowering	80% Pod Color Changed
C1	Black-eyed pea (CB5)	Vine	52	56	59	64	71	79
C2	Pinto bean	-	48	52	55	65	84	91
C3	22-B72 HB 2021 3025	Vine	52	57	60	65	74	76
C4	Early Scarlet	Erect	50	52	55	65	76	74
C5	3021	Erect	51	55	58	69	74	78
C6	18-86	Vine	55	59	65	69	76	77
C7	09-529	Erect	44	48	52	55	59	70
C8	3018	Vine	57	61	65	67	74	81

Table 3. Dry weights at 20% flowering for cowpea and pinto bean tested at AVRC in 2022.

Variety	**Haulm (g)**		**Leaf & Seed Pod (g)**		**Fodder (g)**	
3018	26.17	A	28.33	A	54.50	A
18-86	20.73	AB	21.07	AB	41.80	AB
Black-eyed pea	15.33	B	22.30	AB	37.63	AB
Early Scarlet	13.67	B	18.03	AB	31.70	AB
Pinto bean	10.27	B	17.73	AB	28.00	B
3021	13.60	B	13.00	B	26.60	B
3025	13.87	B	12.30	B	26.17	B
P Value	*P*=0.0032		*P*=0.0143		*P*=0.0079	
	HSD=10.792		HSD=13.313		HSD=22.985	

Table 4. Dry weights at 80% pod color changed for cowpea and pinto bean tested at AVRC in 2022.

Variety	**Haulm (g)**		**Leaf & Seed Pod (g)**		**Fodder (g)**	
3018	57.60	A	94.27	A	151.87	A
Early Scarlet	26.20	AB	55.33	AB	81.53	AB
Black-eyed Pea	35.73	AB	54.03	AB	89.77	AB
18-86	26.73	AB	46.87	AB	73.60	AB
3021	28.90	AB	41.70	AB	70.60	AB
3025	19.07	B	34.90	B	53.97	B
09-529	15.10	B	30.40	B	45.50	B
P Value	*P*=0.0367		*P*=0.0385		*P*=0.0292	
	HSD=37.973		HSD=58.145		HSD=91.739	

Table 5. Animal feed value analysis results at different growth stages for cowpea tested at AVRC in 2022.

Crop/Variety	Growth Stage	Dry Matter (%)	Moisture (%)	Protein (%)	ADF (%)	NDF (%)	TDN (%)	RFV
Black-eyed Pea	25% Flowering	91.67	8.33	18.31	28.35	32.22	70.76	193
Pinto Bean		91.71	8.29	15.46	32.62	39.45	66.01	150
3025		91.37	8.63	14.73	30.80	39.38	68.03	153
Early Scarlet		91.87	8.13	21.11	28.57	32.86	70.51	189
3021		91.44	8.56	19.15	29.22	33.03	69.79	186
18-86		91.82	8.18	13.98	30.04	37.95	68.88	161
09-529		91.46	8.54	16.58	27.47	32.66	71.74	192
3018		91.87	8.13	16.63	34.10	40.76	64.36	142
Black-eyed Pea	80% Pod Color Changed	91.73	8.27	15.74	23.93	28.99	75.68	225
3025		91.55	8.45	14.97	23.11	25.65	76.59	257
Early Scarlet		91.42	8.58	16.67	26.59	29.95	72.72	212
3021		91.41	8.59	16.37	22.90	29.97	76.83	221
18-86		91.34	8.66	13.17	29.18	33.07	69.84	186
09-529		91.91	8.09	11.31	34.67	38.89	63.72	148
3018		91.48	8.52	14.39	30.25	37.60	68.64	162
Alfalfa		91.73	8.27	21.36	30.51	44.59	68.35	136

Figure 5. In Season Soil Water Metric Potential of Cowpeas Tested at AVRC in 2022.

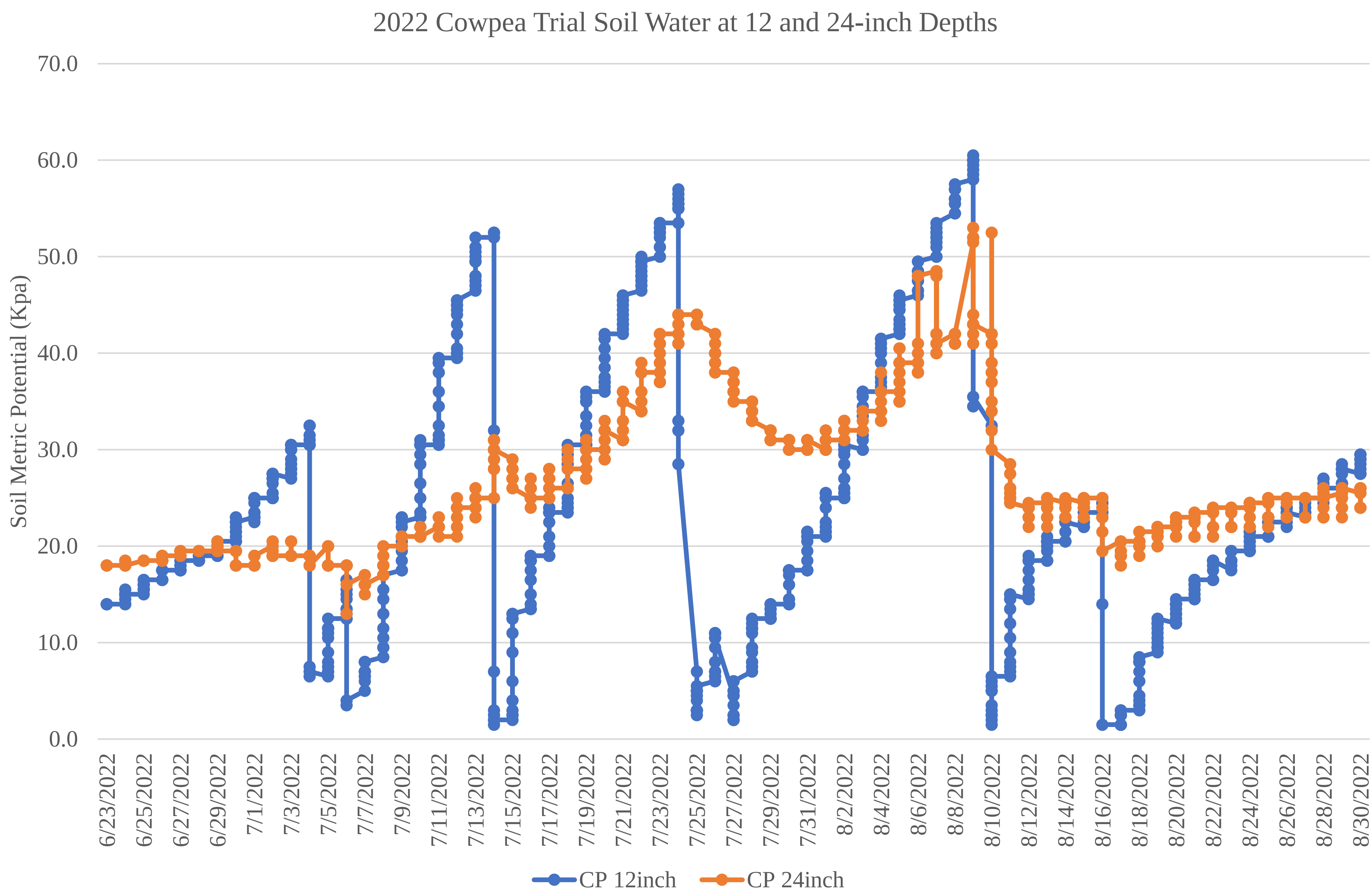


Figure 6. In Season Soil Temperature of Cowpeas Tested at AVRC in 2022.

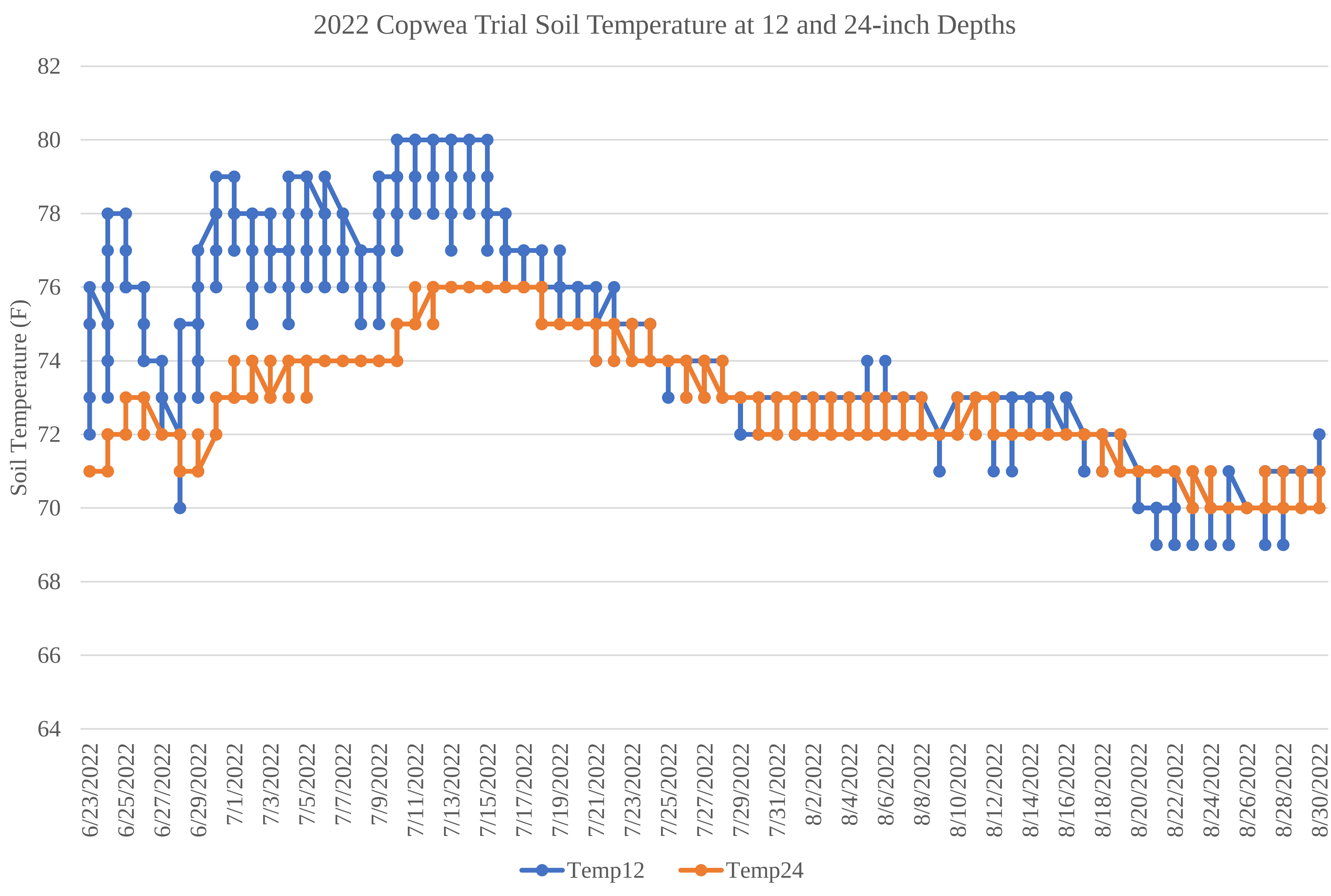


Figure 7. Phenology Traits of Cowpeas and Pinto Bean Planted at AVRC in 2022.

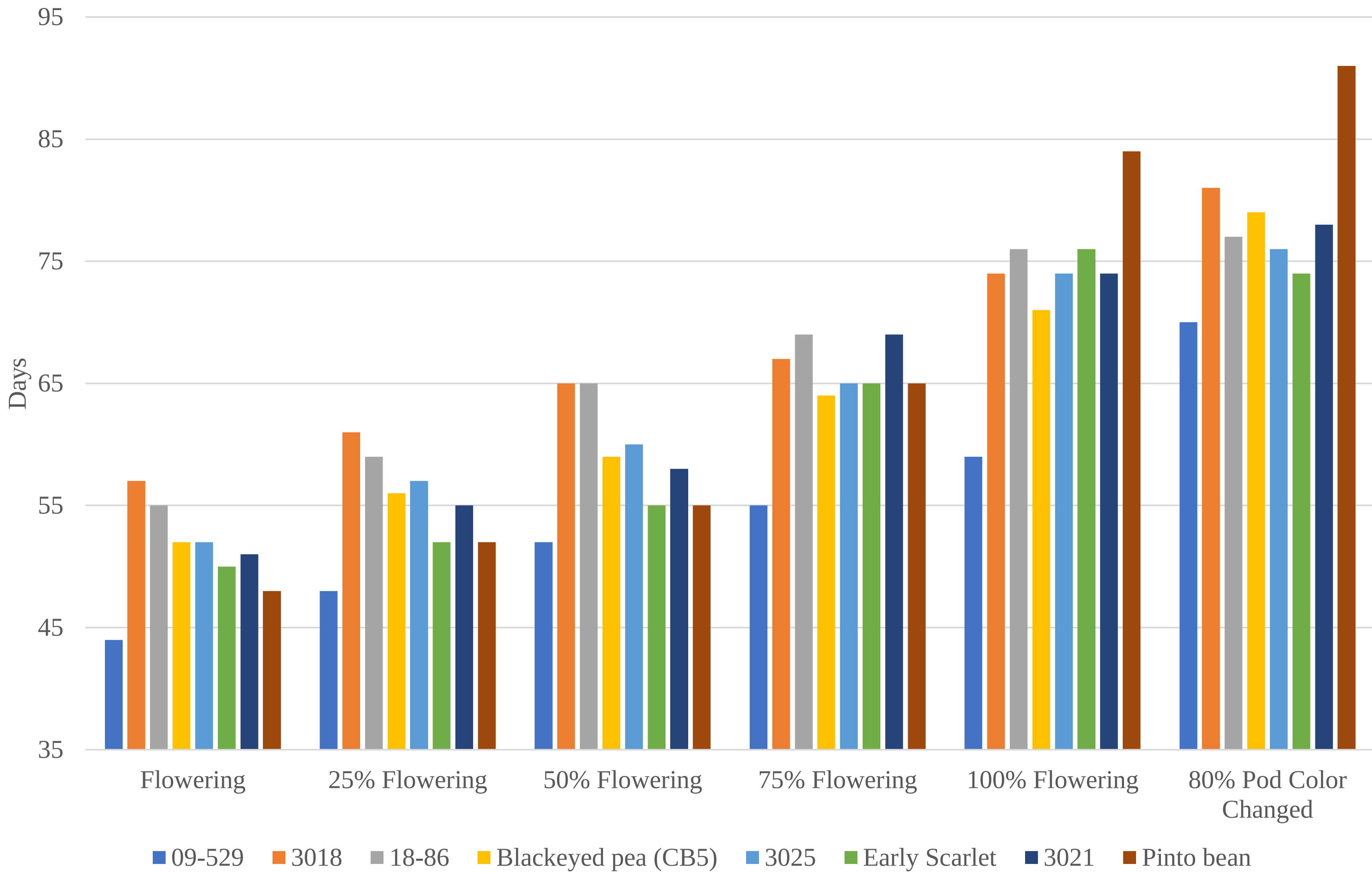
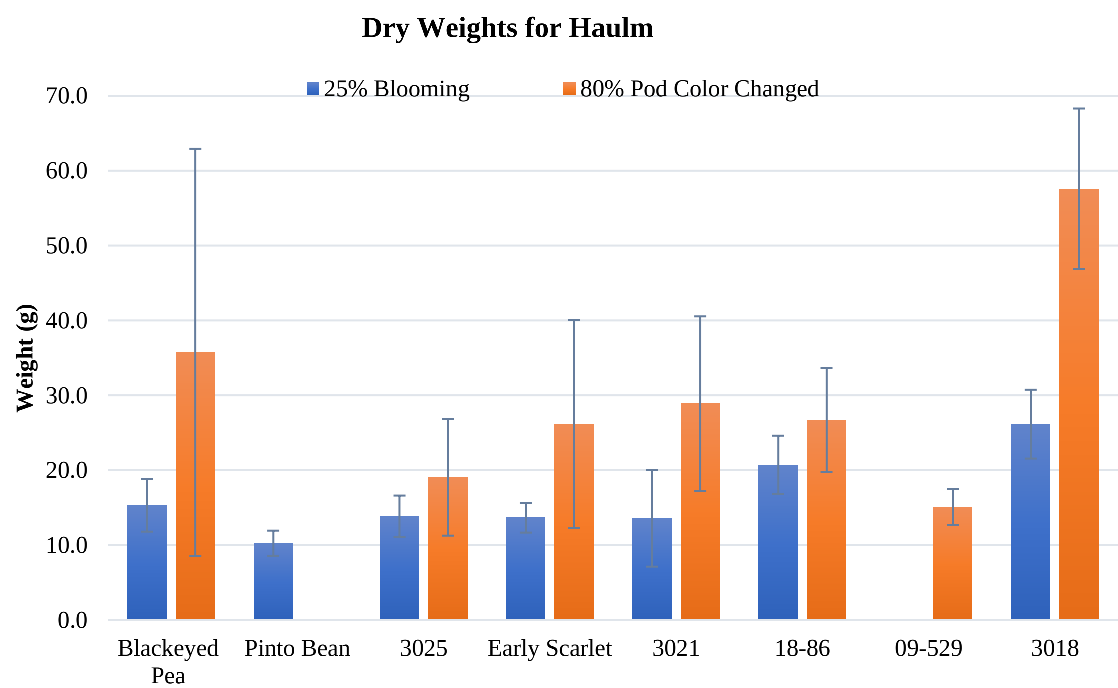
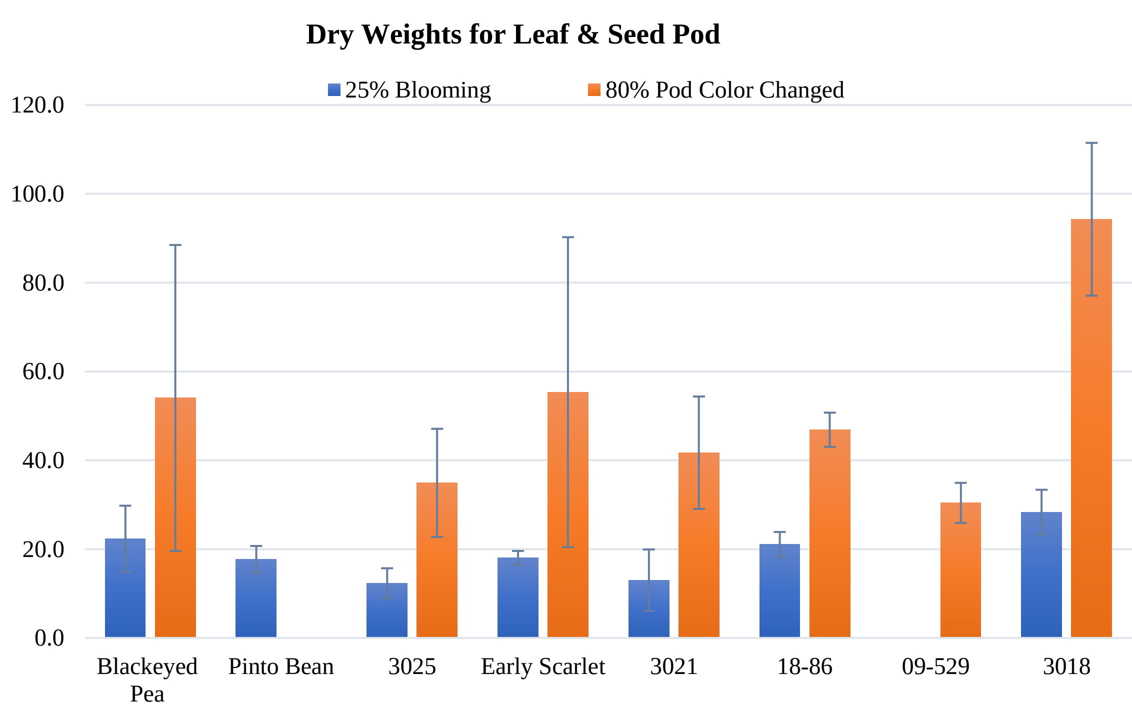


Figure 8. Dry Weights for Haulm, Leaf & Seed Pod and Fodder of Cowpea Test at AVRC in 2022.





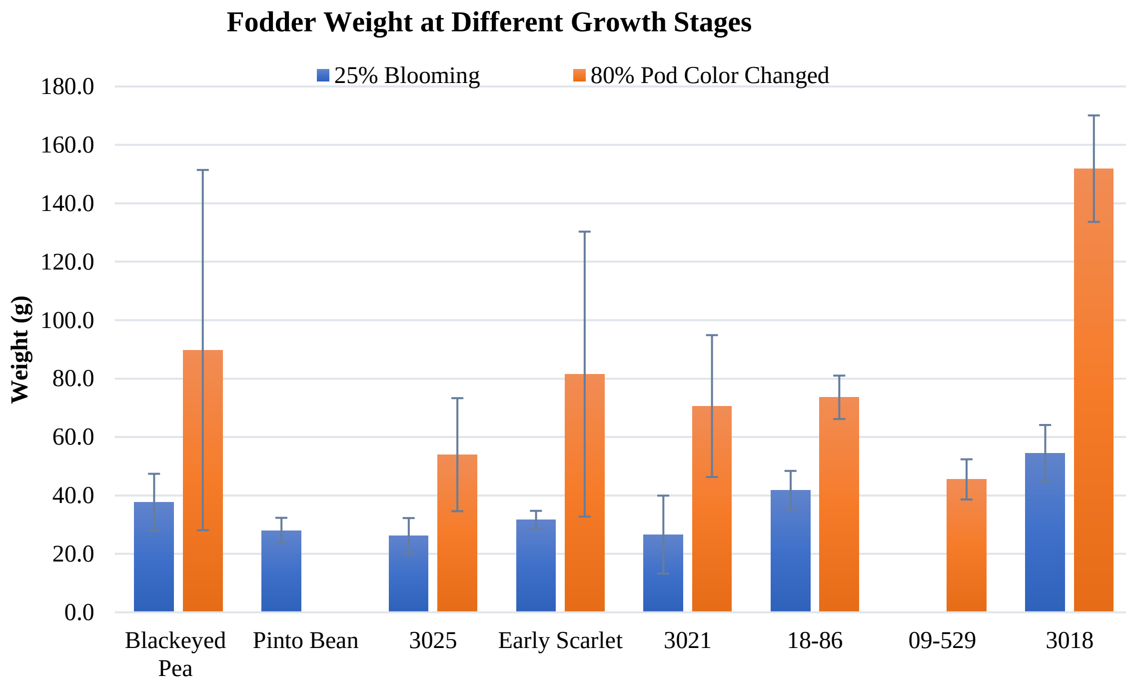
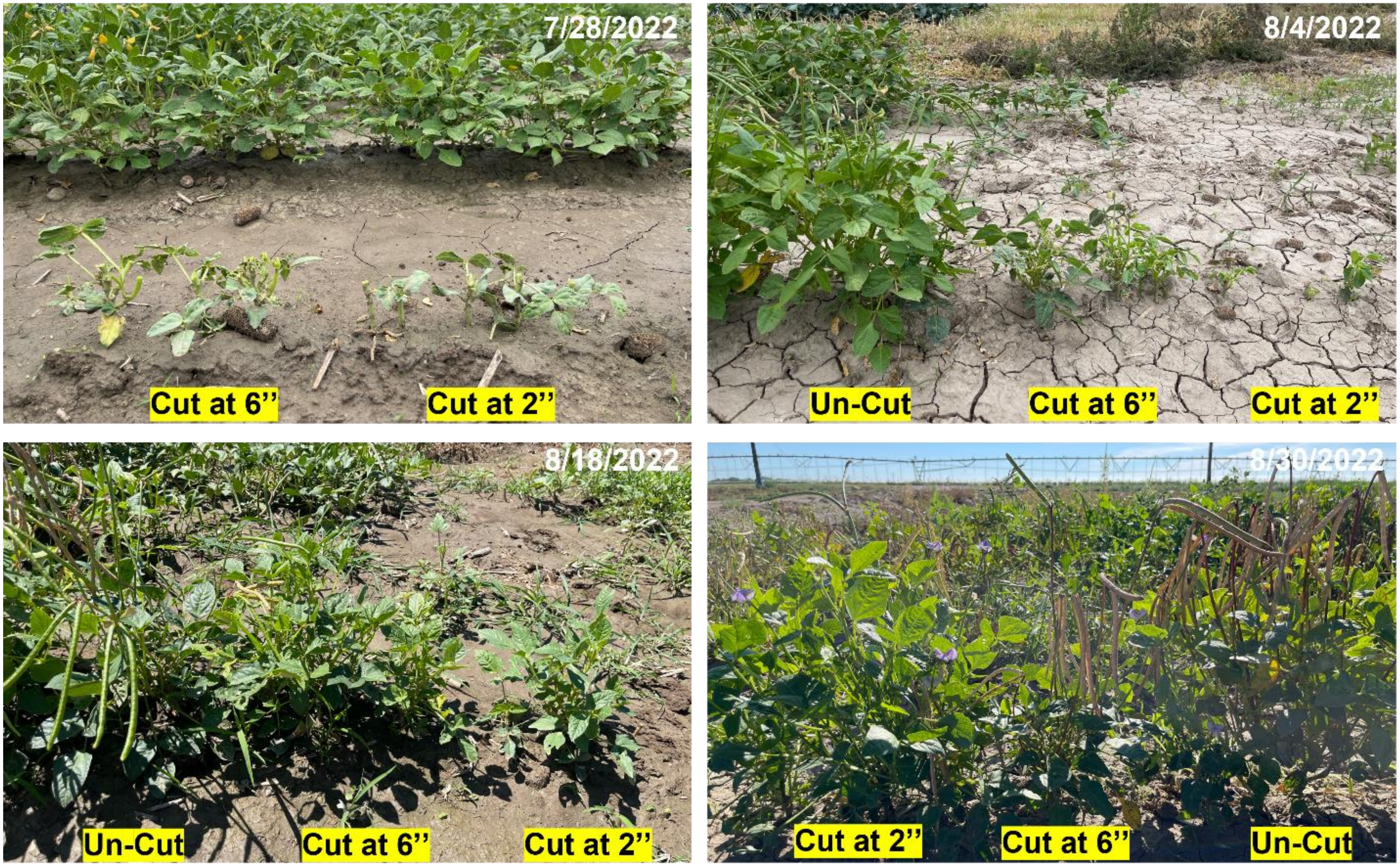

Fodder Weight at Different Growth Stages
25% Blooming
80% Pod Color Changed
Weight (g)
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Blackeyed Pea
Pinto Bean
3025
Early Scarlet
3021
18-86
09-529
3018

Figure 9. Phenology Examples of Cowpeas Tested at AVRC in 2022.

25% Flowering | 50% Flowering | 75% Flowering | 100% Flowering | 80% Pod Color Changed

Figure 10. Field Regrowth Capability of Cowpeas Tested at AVRC in 2022.



Evaluation of Field Adaptation of Arizona Melons in the Arkansas Valley

Jianbing Ma, Kevin Tanabe, Lane Simmons

Introduction

Figure 1. Cantaloupe Melon

Melon (*Cucumis melo* L.) is an important cash crop for the southeast region of Colorado, especially for Arkansas Valley because of the ideal climate for production in which days are hot and dry and nights are cool which helps increase sucrose contents in the melons. In 2022, four farms including Hirakata Farm, Hanagan Farm, Knapp Farm and Matt Proctor Farm members of the Rocky Ford Growers Association planted approximately 450 acres of melon including cantaloupe and honeydew in the Arkansas Valley.

Extended shelf-life (ESL) melon can provide growers with prolonged storage time and improved fruit qualities. In 2021, a project to define Rocky Ford melon quality attributes was conducted at the Arkansas Valley Research Center (AVRC) and 15 cantaloupe cultivars were tested. Three extended shelf-life varieties, Cayucos Beach, Sunpac and Hermosa Beach were highlighted from the study with higher fruit weights, better outer texture (firmness) and sweeter taste (Brix%).

In 2022, four Arizona ESL melon varieties including two commercial varieties Don David, Ultra Jelly and two experimental cultivars SVMF1124 and SVMF8362 were tested at AVRC. Three promising ESL varieties from 2021 testing, Cayucos Beach, Sunpac, Hermosa Beach, the industrial standard variety, Athena, the heirloom variety, PMR45, as well as the commercial variety Accolade were also included in the plot trial. The objectives of this study were to (1) evaluate the field adaptation of the Arizona ESL melon varieties; and (2) compare the performance of Arizona ESL melon varieties with other ESL and standard melon varieties grown in Colorado.

Materials and Methods

Figure 2. Melon field direct seeding using a Jab-planter

On May 10th, 2022, a total of 10 yellow flesh cantaloupe varieties including ESL and regular types were planted at AVRC (Table 1)

This trial was planted by direct seeding on 30-inch center-to-center beds. Each plot was 27 feet in length with 18-inch in-row spacing and two side-by-side plots per variety in each replication. The experimental design was a Randomized

Figure 3. Melon seeding on a 30-inch bed with 18-inch in-row spacing

Complete Block Design (RCBD) with 3 replications. The crop management was following commercial standard practices in the Arkansas Valley.

Data Collection and Analysis

Field evaluations were conducted on August 16th and August 19th, 2022, respectively, when the fruits began to change color and detached easily from their peduncles. Three fruits per variety per replication, therefore a total of 9 fruits per variety, were assessed for the maturity (days), fruit diameter (cm) and fruit weight (kg). A small internal flesh sample was taken by a flesh sampler and the Brix concentration (%) was measured by the Atago 3810 PAL-1 Digital Hand-held Pocket Refractometer (Atago, Atago Co., Ltd.). Flesh sample (3″ × 2″) for each fruit was cut from the center of fruit. After placing the flesh sample on the top of the fixture table, the flesh texture (firmness) was measured by the Brookfield CT3 Texture Analyzer (Brookfield Engineering Laboratories, Middleboro, MA, USA). The instrument was set for the 100 mm sphere probe to descend at 2 mm/s with a trigger load of 75 grams at which point the instrument recorded the highest force applied, the "peak load" in grams was used as the indication of the firmness. The surface of each flesh sample was then scanned by Hunter Lab Mini Scan XE (HunterLab Associates Laboratory Inc., Hong Kong, PRC) for L, A, and B color. Fruit quality parameters including Brix (%) and the texture (firmness) as well as the internal flesh colors (L, A and B color) were only determined for "Athena", "SVMF1124", "SVMF8362", "Ultra Jelly" and "Don David" due to the late arrival of the equipment. Data analysis was implemented using JMP Pro 16 (SAS Institute Inc.) and the Tukey's honestly significant difference test (Tukey's HSD) was used to test differences among sample means for significance.

(1) (2) (3)

Figure 4. (1) Atago 3810 PAL-1 Digital Hand-held Pocket Refractometer; (2) Hunter Lab Mini Scan XE; (3) Brookfield CT3 Texture Analyzer

Results and Discussion

Fruit shapes, exterior patterns and internal flesh colors of tested cantaloupes were shown in Figure 5. In general, "Athena" had the fastest maturity and the Arizona varieties matured slower than the commercial varieties grown in Colorado (Table 2). Less obvious statistical differences were seen on the fruit diameters and fruit weights, but with the numerically larger and heavier fruits borne by "Ultra Jelly". Regarding Brix %, Arizona varieties showed higher sugar contents in which Don David presented the highest Brix % (Table 2).

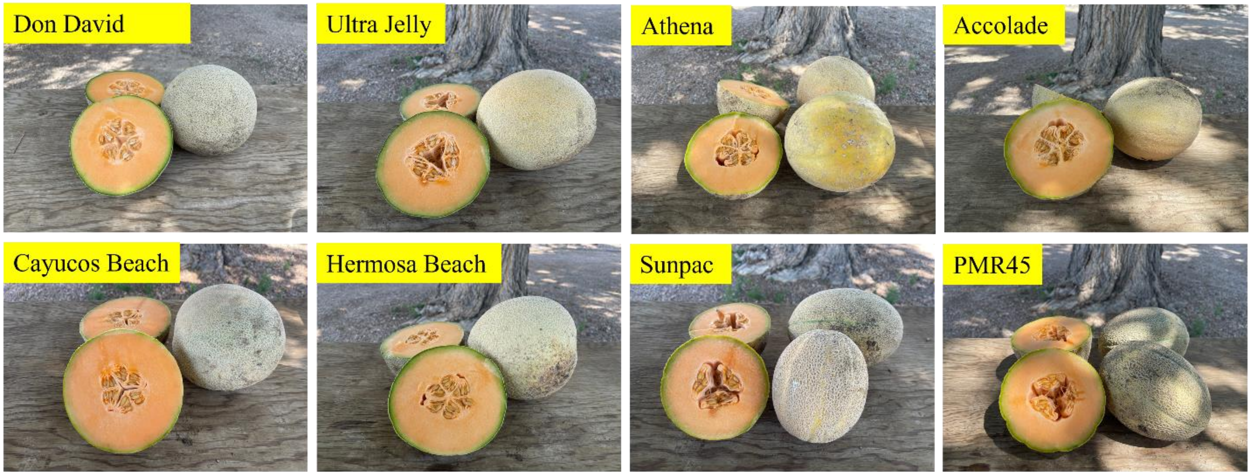


Figure 5. Fruit shapes, exterior patterns and interior flesh colors of 10 cantaloupe varieties tested at AVRC in 2022

Except “SVMF8362”, the measured peak load required for flesh deformation suggested Arizona varieties presenting a firmer texture than “Athena” (Table 3). In terms of fruit colors, Arizona varieties presented an overall better yellow flesh color than “Athena”.

This study deemed that the melon varieties tested and grown in Arizona adapted well in the Colorado climate and thus “Don David” and “Ultra Jelly” provided growers with the new variety options for melon production in the Arkansas Valley of Colorado.

Table 1. Information of the melon varieties tested at AVRC in 2022.

Company	ID	Variety	Type	Origin
Seminis	M1	Don David	ESL	AZ
Seminis	M2	Ultra Jelly	ESL	AZ
Syngenta	M3	Athena		CO
Syngenta	M4	Accolade		CO
Rijk Zwaan	M5	Cayucos Beach	ESL	CO
Rijk Zwaan	M6	Hermosa Beach	ESL	CO
Harris Moran	M7	Sunpac	ESL	CO
	M8	PMR45		CO
Seminis	M9	SVMF1124	ESL	AZ
Seminis	M10	SVMF8362	ESL	AZ

Table 2. Characteristics comparison for 10 melon varieties planted at AVRC in 2022.

Variety	**Maturity**		**Diameter (cm)**		**Weight (kg)**		**Brix %**	
Accolade	95.0	EF	17.30	A	2.36	AB	12.12	B
Athena	94.3	F	15.48	CDE	2.20	ABC	11.58	B
Cayucos Beach	97.0	D	16.33	ABC	2.09	ABC	12.83	B
Don David	103.0	B	16.09	BC	2.02	BC	16.63	A
Hermosa Beach	96.3	DE	15.97	C	2.12	ABC	11.41	B
PMR45	96.7	D	14.03	F	1.47	D	10.93	B
Sunpac	98.7	C	14.63	EF	1.73	CD	11.81	B
SVMF1124	105.0	A	16.10	ABCD	2.25	ABCD	12.80	AB
SVMF8362	105.0	A	14.60	DEF	1.60	BCD	13.27	AB
Ultra Jelly	98.3	C	16.88	AB	2.55	A	13.00	B
P value	*P*<0.0001 HSD=1.2254		*P*<0.0001 HSD=0.9591		*P*<0.0001 HSD=0.5545		*P*<0.0001 HSD=3.4333	

Table 3. Internal flesh color and flesh firmness for 5 melon varieties planted at AVRC in 2022.

Variety	**Firmness (g/cm)**		**L color**		**A color**		**B color**	
Athena	2218.95	B	11.85	B	11.48	B	6.10	B
Don David	3626.83	A	21.28	A	19.62	AB	15.68	A
SVMF1124	3682.89	A	22.89	AB	21.35	AB	11.01	AB
SVMF8362	2010.11	B	26.08	A	24.83	A	14.55	AB
Ultra Jelly	3304.00	A	17.27	AB	12.56	B	6.99	B
P value	*P*<0.0001		*P*=0.0076		*P*=0.0095		*P*=0.0105	
	HSD=714.60		HSD=11.19		HSD=12.95		HSD=9.51	

Seedless Watermelon Variety Trial in the Arkansas Valley

Jianbing Ma, Kevin Tanabe, Lane Simmons

Introduction

Figure 1. Crimson sweet

Watermelon [*Citrullus lanatus* (Thunb). Matsum. et Nakai] is an important cash crop for the southeast region of Colorado, especially for Arkansas Valley which stretches across the Eastern Plains outside of Pueblo. In 2022, four farms including Harikata Farm, Hanagan Farm, Knapp Farm and Matt Proctor Farm that are part of the Rocky Ford Growers Association planted approximately 350 acres of watermelon in the Arkansas Valley with the average yield of 27.5 tons/acre which generated about 8.9 million dollars in revenue.

The seeded watermelon, Crimson Sweet is the standard variety grown in the Arkansas Valley. However, seedless watermelon has gained popularity due to its sweet taste and ease of consumption. One large fresh producer from Pueblo County grows Joyride which is the seedless watermelon variety from Seminis Vegetable Seeds. In 2022, five seedless watermelon varieties from Seminis Vegetable Seeds including 4 commercial varieties, Joyride, Tailgate, Bottle Rocket, Paddleboat, and pre-commercial variety SVMA6179 were tested at AVRC. Crimson Sweet was also included in this study for comparison. The objectives for this study were to (1) test the field adaptability of 5 seedless watermelon from Seminis Vegetable Seeds; (2) compare the fruit quality of seedless watermelon with standard seeded watermelon that are commonly grown in the Arkansas Valley.

Materials and Methods

On May 20th and May 23rd, 2022, Crimson Sweet and 5 seedless watermelons were transplanted, respectively. For the seedless watermelons, the female plant, and the pollinator (Wingman, Seminis Vegetable Seeds) were planted in a 3:1 ratio. To avoid cross pollination, seeded watermelon field was planted at the corner of the research farm. Both seeded and seedless watermelons were planted on 30-inch center-to-center beds and one empty bed was set as buffer zone between watermelons. For the seedless variety, each plot was 84 feet in length with 36-inch in-row spacing. The seedless

(1) (2)

Figure 2. (1) Watermelon transplanting at AVRC in 2022; (2) Watermelon seedings on a 30-inch bed with 36-inch in-row spacing

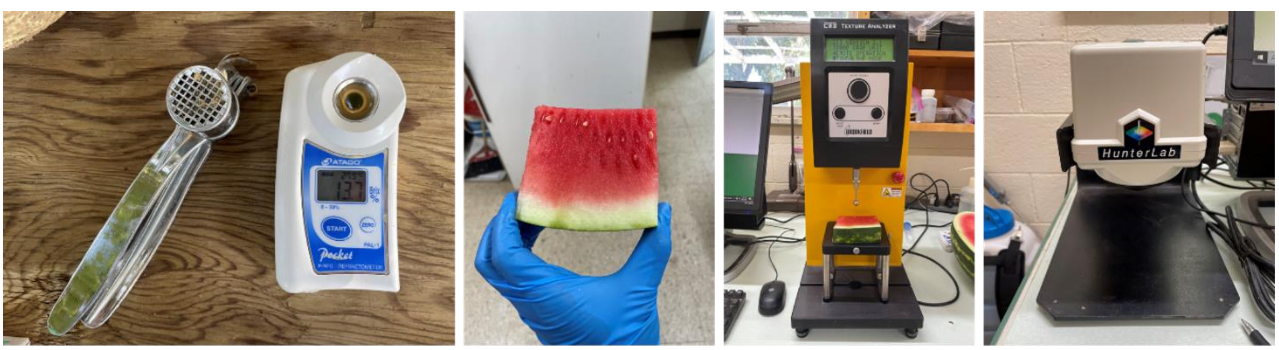
watermelon plots were only replicated twice due to limited seedlings. The seeded watermelon block was 75 feet × 2 beds with the same plant spacing.

Data Collection and Analysis

(1) (2)

Figure 3. (1) Watermelon harvested at AVRC; (2) Watermelon weighed on scale

On August 29th, 2022, when the fruits detached easily from its peduncles, field evaluations were conducted for both seeded and seedless watermelons. Three fruits per variety were assessed for fruit length (cm), fruit diameter (cm) and fruit weight (kg). Fruit quality parameters including brix (%) and the texture (firmness) as well as the internal flesh colors (L, A and B color) were also determined. A small internal flesh sample was taken by a flesh sampler and the Brix concentration (%) was measured by the Atago 3810 PAL-1 Digital Hand-held Pocket Refractometer (Atago, Atago Co., Ltd.). Flesh sample sized 4″ × 3″ for each fruit was cut from the center of fruit and the flesh texture (firmness) was measured by the Brookfield CT3 Texture Analyzer (Brookfield Engineering Laboratories, Middleboro, MA, USA). The instrument was set for the 100 mm sphere probe to descend at 2 mm/s with a trigger load of 75 grams at which point the instrument recorded the highest force applied, the "peak load" in grams was read as the firmness. The surface of each flesh sample was then scanned by Hunter Lab Mini Scan XE (HunterLab Associates Laboratory Inc., Hong Kong, PRC) to determine the L, A, and B color. Data analysis was implemented using JMP Pro 16 (SAS Institute Inc.) and the Tukey's honestly significant difference test (Tukey's HSD) was used to test differences among sample means for significance.



(1) (2) (3) (4)

Figure 4. (1) Atago 3810 PAL-1 Digital Hand-held Pocket Refractometer; (2) Fruit sample; (3) Brookfield CT3 Texture Analyzer; (4) Hunter Lab Mini Scan XE

Results and Discussion

Figure 5. The water-soaked lesion of Phytophthora fruit rot

During the season, the plant disease Phytophthora fruit rot which is caused by *Phytophthora capsici* was observed in the field, especially for the variety Tailgate. The water-soaked lesion was seen where fruit attached soil due to extra moisture (Figure 5). This disease can be alleviated if plastic mulch was used.

Figure 6. Hollowheart of watermelon

Hollowheart of watermelon fruit was also seen for the variety Paddleboat and Crimson Sweet (Figure 6). The possible causes for this physiological fruit disorder were poor pollination, cold weather and excessive fertilizers. Typically, hollowheart occurs more often in seedless watermelons. Since both seedless and seeded watermelons showed hollowheart, the poor pollination could be the possible cause of this defect.

Both the exterior and interior characteristics were shown in Table 1. Bottle Rocket had thick rind. Generally, the seedless watermelon indicated a darker exterior green color, deeper red flesh color and smoother fruit shape than seeded variety. Crimson Sweet fruits tended to crack easily probably due to thin rind.

In terms of horticulture traits, no statistical differences were found between seeded and seedless watermelons (Table 2.). Although the *P* value for the width was less than 0.05 in ANOVA, no HSD among varieties was detected. Numerically, Crimson Sweet depicted the large fruit size with the highest Brix %. Among the seedless varieties, Tailgate showed the heavier fruit with high Brix %. The informal "taste test" was held at the 2022 AVRC Field Day (9/8/2022) and the stakeholders liked the sweet taste as well as the texture of seedless watermelons.

Figure 7. "Taste Test" of watermelon at the Field Day at AVRC in 2022

No statistical difference was seen for fruit colors (Table 3). However, numerically seedless watermelons showed darker red fruit colors. The significances for fruit firmness were found and seedless varieties inclined to have firmer flesh than Crimson Sweet (Table 3). Based on field observation and fruit quality measurement, the overall rank for seedless watermelon was Tailgate > Joyride > SVWA6179 > Bottle Rocket > Paddleboat (Table 1).

In summary, seedless watermelons performed well in 2022. Regardless of the smaller fruit size, the overall fruit quality of seedless watermelons was slightly better than Crimson Sweet. The risk of Phytophthora fruit rot can be reduced if plastic mulch was implemented. And better pollination can be achieved if beehive is placed close to watermelon fields. Seedless watermelon will provide growers with another option for watermelon production in the Arkansas Valley.

Table 1. Fruit exterior and interior characteristics of seedless and seeded watermelons planted at AVRC in 2022.

Variety	Type	Fruit Exterior Color	Fruit Interior Color	Note	Rank
Tailgate	Seedless			uniform size; more button rot, faster, sand texture, sweet, good favor	1
Joyride	Seedless			great size and good favor	2
Bottle Rocket	Seedless			thick rind, less sweet	4
Paddleboat	Seedless			internal cracking, pink, late mature	5

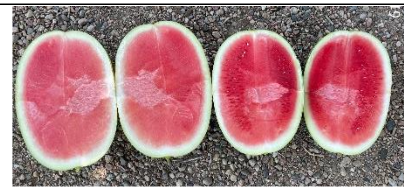
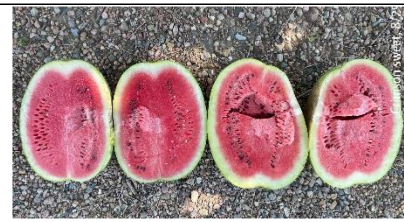
SVMA6169	Seedless			big size, less mature, less sweet, less favor	3
Crimson Sweet	Seeded			big size, ribby, flat, easy crack skin texture	-

Table 2. Characteristics comparison for seedless and seeded watermelons planted at AVRC in 2022.

Variety	**Length (cm)**		**Width (cm)**		**Weight (kg)**		**Brix %**	
Bottle Rocket	32.17	A	22.50	A	8.06	A	10.77	A
Crimson Sweet	32.93	A	25.80	A	11.75	A	12.97	A
JOYRIDE	32.80	A	25.17	A	14.60	A	11.77	A
SVWA5203	30.67	A	22.23	A	8.65	A	11.77	A
SVWA6179	34.57	A	24.90	A	11.89	A	10.47	A
TAILGATE	30.50	A	23.83	A	12.30	A	12.13	A
P value	*P*=0.6616 HSD=8.9593		*P*=0.0300 HSD=3.6366		*P*=0.1056 HSD=7.5966		*P*=0.2161 HSD=3.3589	

Table 3. Internal flesh color and flesh texture firmness for seedless and seeded watermelons planted at AVRC in 2022.

Variety	**Firmness (g/cm)**		**L color**		**A color**		**B color**	
Bottle Rocket	824.33	BC	27.27	A	18.59	A	9.92	A
Crimson Sweet	573.44	C	37.00	A	14.99	A	8.58	A
JOYRIDE	1203.00	AB	31.41	A	17.23	A	10.04	A
SVWA5203	1318.00	A	29.00	A	18.68	A	11.80	A
SVWA6179	1353.33	A	30.32	A	15.35	A	7.99	A
Tailgate	1008.44	AB	34.86	A	19.00	A	11.81	A
P value	*P*<0.0001 HSD=403.41		*P*=0.1961 HSD=13.11		*P*=0.7568 HSD=11.65		*P*=0.5270 HSD=7.80	

Testing Western Broccoli Varieties in the Arkansas Valley

Jianbing Ma, Kevin Tanabe, Lane Simmons

Introduction

Figure 1. Broccoli crowns

Broccoli (*Brassica oleracea* var. italics) is a cruciferous vegetable that is related to cauliflower, cabbage, kale, bok choy and Brussels sprouts. Broccoli is high in fiber, vitamin C, vitamin K, iron, and potassium (Martiniakova et al., 2022). Other health benefits of broccoli include preventing cancer, lowering cholesterol levels, improving eye health, and reducing risk of heart diseases (Blekkenhorst et al., 2018; Royston and Tollefsbol, 2015; Mrowicka et al., 2022). The production of broccoli is centered in California and Arizona. In 2022, a total of 1.2 billion pounds of broccoli was produced on 96,400 acreage fields which generated about $815 million revenue.

In Colorado, broccoli is mainly grown in the Northern regions, and the small-scale production is aggregated near bigger cities where farmers sell fresh broccoli on farm stands and local grocery stores. The objectives of this study were to (1) test the adaptability of broccoli varieties that have been tested and commercially grown in Arizona and California; (2) determine the optimum planting windows (slots) for Western broccoli varieties.

Materials and Methods

(1) (2) (3) (4)

Figure 2. (1) Broccoli seedlings in greenhouse; (2) Broccoli field transplanting; (3) Broccoli testing plots at early growing season; (4) Broccoli testing plots at late growing season

A total of 49 broccoli varieties that have been grown and tested in Arizona and California were evaluated at AVRC in 2022. The broccoli types included conventional, improved nutrition broccoli (INB), high rise and natural floret varieties (Table 1). Most of the broccoli varieties were from the Desert Southwest (Yuma Valley of Arizona) and a few varieties were more popular in coastal California regions (Table 1). This trial was transplanted in a single row on 30-inch center-to-center beds. Each plot was 7.5 feet long with 10-inch in-row spacing. Each variety was replicated 3 times and two transplanting were conducted on June 2nd and June 8th, 2022, respectively.

Data Collection and Analysis

A total of 14 horticultural traits well used for broccoli breeding for seed companies were chosen for this broccoli variety study (Table 2). Daily scouting was carried out for each planting and the date when the crown was 0.25 inch in diameter for each variety was recorded and considered as the beginning of maturity stage. The date when the crown was 6-7 inches in diameter for each variety was documented as the harvest date. Insect pressure, common plant diseases such as bacteria soft rot, systemic downy mildew, head pin rot as well as the percentage of heads with hollow stem were monitored during the season. Soil water content (Kpa) and soil temperature (°F) were also recorded by Irrometer 900M-O Watermark Monitor (Irrometer Company, Inc., Riverside, CA) at 12 and 24 inch deep in the soil, respectively.

Data analysis was implemented using JMP Pro 16 (SAS Institute Inc.) and the Tukey's honestly significant difference test (Tukey's HSD) was used to test differences among sample means for significance.

Results and Discussion

Broccoli varieties started to form crowns 39 and 47 days after 1st and 2nd planting, respectively. Both trials were completed 98 days after transplanting. A total of 12 irrigation events occurred during the growth season which applied 24 inches water for broccoli. The peak for water consumption was seen between late July until mid-August (Figure 3). More water fluctuation happened in top 12 inches soil indicating more distribution of broccoli root system. Less soil temperature difference was observed between 12 and 24-inch soil depth after mid-July possibly because of high day temperatures and more root growth in summer (Figure 4 and 5).

However, many crown quality defects including lime green color, bracting, lumpiness, softness, excessive cat eyes, flat and mis-shaped crown and poor field holding were seen in the field for both plantings (Figure 6). The crowns for most varieties were not harvestable based on commercial market standards. A possible cause for non-harvestable crowns was because of the high temperature during the growth season since broccoli is a cool season vegetable with the optimum growing temperature of 60-68 °F. During the growth season, the daily max temperatures were above 80 °F and the average daily temperatures were higher than 70 °F starting from July which indicated the less idea growth conditions for broccoli (Figure 5). The only variety for both plantings showing promising harvestable quality was the stem broccoli, BC1611 (Figure 7), and it took about 64 days from planting to harvesting for BC1611.

Conclusion

The broccoli trials for two plantings were considered to have failed due to less than ideal planting time windows. The broccoli varieties will be re-trialed in 2023 season with earlier planting dates.

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Vegetables 2022 Summary (February 2023) USDA, National Agricultural Statistics Service.

Table 1. Information of the broccoli varieties tested at AVRC in 2022.

Variety ID	Company	Type	Origin	Variety
1	Seminis	Conventional	DSW	Castle Dome
2	Seminis	Conventional	DSW	BC1764
3	Seminis	Conventional	Eastern	Abrams
4	Seminis	Conventional	DSW	Spectre
5	Seminis	Conventional	DSW	Warthog
6	Sakata	Conventional	DSW	Emerald crown
7	Seminis	Conventional	DSW	Lieutenant
8	Seminis	Conventional	DSW	BC1691
9	Seminis	Conventional	DSW	Osprey
10	Sakata	Conventional	DSW	Green gold
11	Seminis	Conventional	DSW	SVBL2159
12	Syngenta	Conventional	DSW	Green pak 28
13	Rijk Zwaan	Conventional	DSW	Kariba
14	Rijk Zwaan	Conventional	DSW	Tahoe
15	Seminis	Conventional	DSW	SVBL2124
16	Seminis	Conventional	DSW	SVBL2125
17	Seminis	Conventional	DSW	SVBL2189
18	Sakata	Conventional	DSW	Millennium
19	Sakata	Conventional	DSW	Emerald jewel
20	Seminis	Conventional	Coastal	Heritage
21	Sakata	Conventional	DSW	Emerald star
22	Sakata	Conventional	DSW	Sarasota
23	Seminis	Conventional	Mexico	Zafiro
24	Seminis	Conventional/INB	European	B1199
25	Seminis	Conventional/INB	European	SVB187
26	Seminis	Conventional	European	SVR224
27	Seminis	Conventional	European	SVR248
28	Seminis	Conventional	Coastal	Ironman
29	Seminis	Conventional	Coastal	SVBL1822
30	Sakata	Conventional	Coastal	Endurance
31	Sakata	Conventional	Coastal	Expo
32	Sakata	Conventional	Coastal	Marathon
33	Sakata	Conventional	Coastal	AVENGER
34	Sakata	Conventional	Coastal	IMPERIAL
35	Seminis	High Rise	European	Titanium
36	Seminis	High Rise	Coastal	Eiffel
37	Seminis	High Rise	Coastal	Hancock
38	Seminis	High Rise	DSW/Coastal	SVR273
39	Seminis	High Rise	DSW/Coastal	SVBL300
40	Seminis	High Rise	DSW/Coastal	SVBL306

41	Seminis	High Rise	DSW/Coastal	SVBL310
42	Seminis	High Rise	DSW/Coastal	SVBL311
43	Seminis	High Rise	DSW/Coastal	SVBL313
44	Seminis	High Rise	DSW/Coastal	SVBL314
45	Seminis	High Rise	Coastal	Eiffel
46	Sakata	Conventional	DSW/Coastal	Diamante
47	Seminis	Stem	European	BC1611
48	Seminis	Stem	European	SVR68 (Stem)
49	Seminis	Natural Floret	European	SVR509

Table 2. Horticultural traits for broccoli evaluation at AVRC in 2022.

#	Trait	Code	Description
1	Plant Vigor	PLTVG	1. Very Vigorous; 5. Medium Vigor; 9. Very low Vigor
2	Visibility	VISBL	0-100%
3	Head smoothness	HDSMO	1=Very Smooth, 3=Smooth, 5=Average, 7=Irregular, 9=Very Irregular
4	Head color	HDGRC	1=Dark Green, 3=Green, 5=Medium Green, 7=Light Green, 9=Purple Green
5	Head shape	HDCSH	1=High Dome, 3=Dome, 5=Medium Dome, 7=Semi-Flat, 9=Flat
6	Bead size	BEAD	1=Very Fine, 3=Fine, 5=Medium, 7=Med-Large, 9=Large
7	Bead uniformity	HDBDU	1= Very uniform; 5= Acceptable uniformity; 9= Not uniform, unacceptable
8	Cateye	CATEY	1=Absent; 5=Present, acceptable;9=Severe, Unacceptable
9	Head firmness	HDFRM	1=Very Firm, 3=Firm, 5=Medium Firm, 7=Medium, 9=Soft
10	Head weight (gram for 1:1 ratio)	AVGHW	in gram for 1:1 ratio
11	Percent Harvest Uniformity (% for 1st cut)	HVUNI	0-100%; Percentage of estimation product harvestable in 1 cut at marketable quality in the situation of market at time of harvest
12	Days to Harvest	DAYHV	Total number of days from planting to harvest
13	Holding ability	FHOLD	1= Excellent; 5= Average; 9= Very weak
14	Final	FINAL	1= Advance; 3= Retrial-Advance; 5= Retiral; 7= Drop-Retrial; 9= Drop

Figure 3. In Season Soil Water Metric Potential of Broccoli Tested at AVRC in 2022.

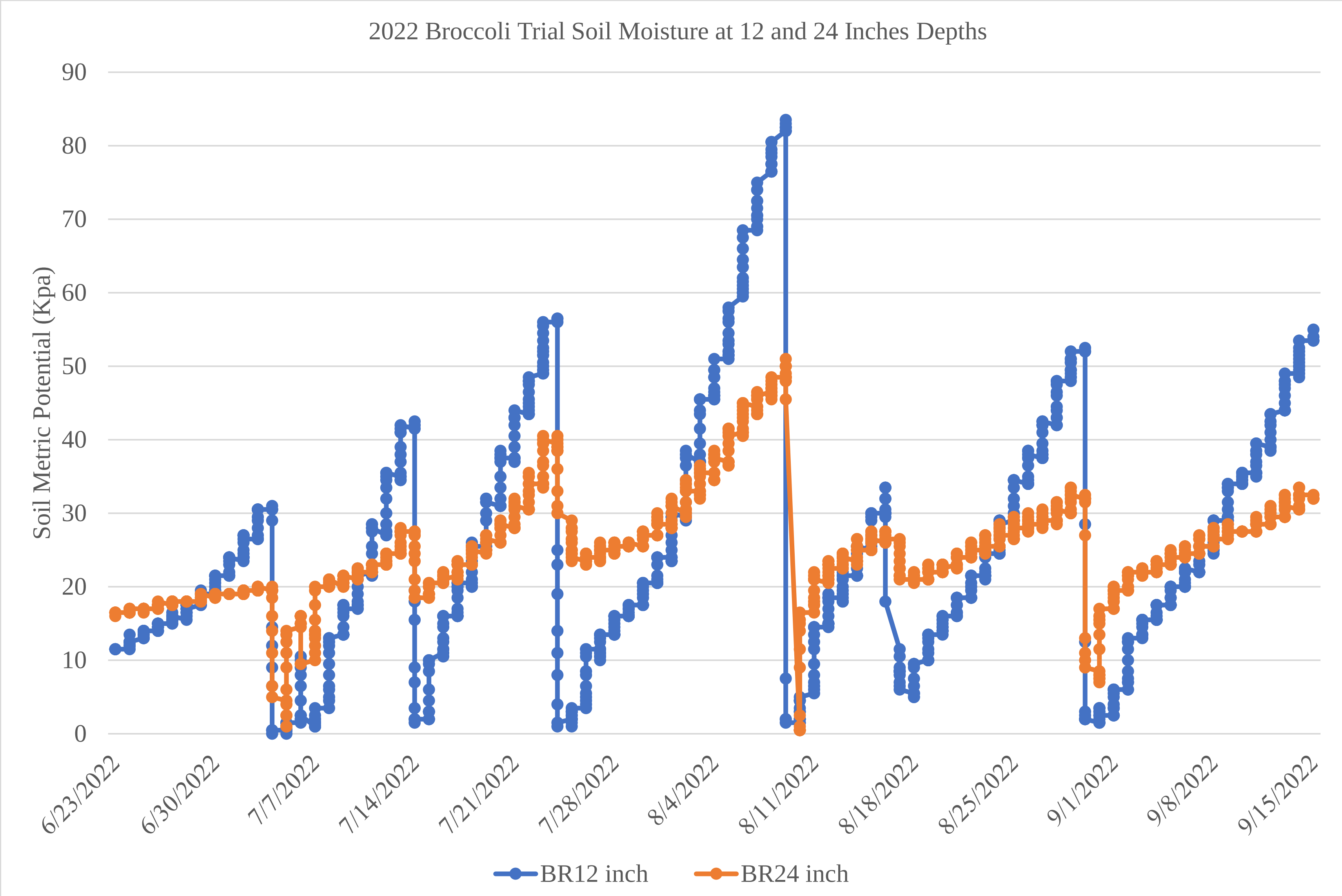


Figure 4. In Season Soil Temperature of Broccoli Tested at AVRC in 2022.

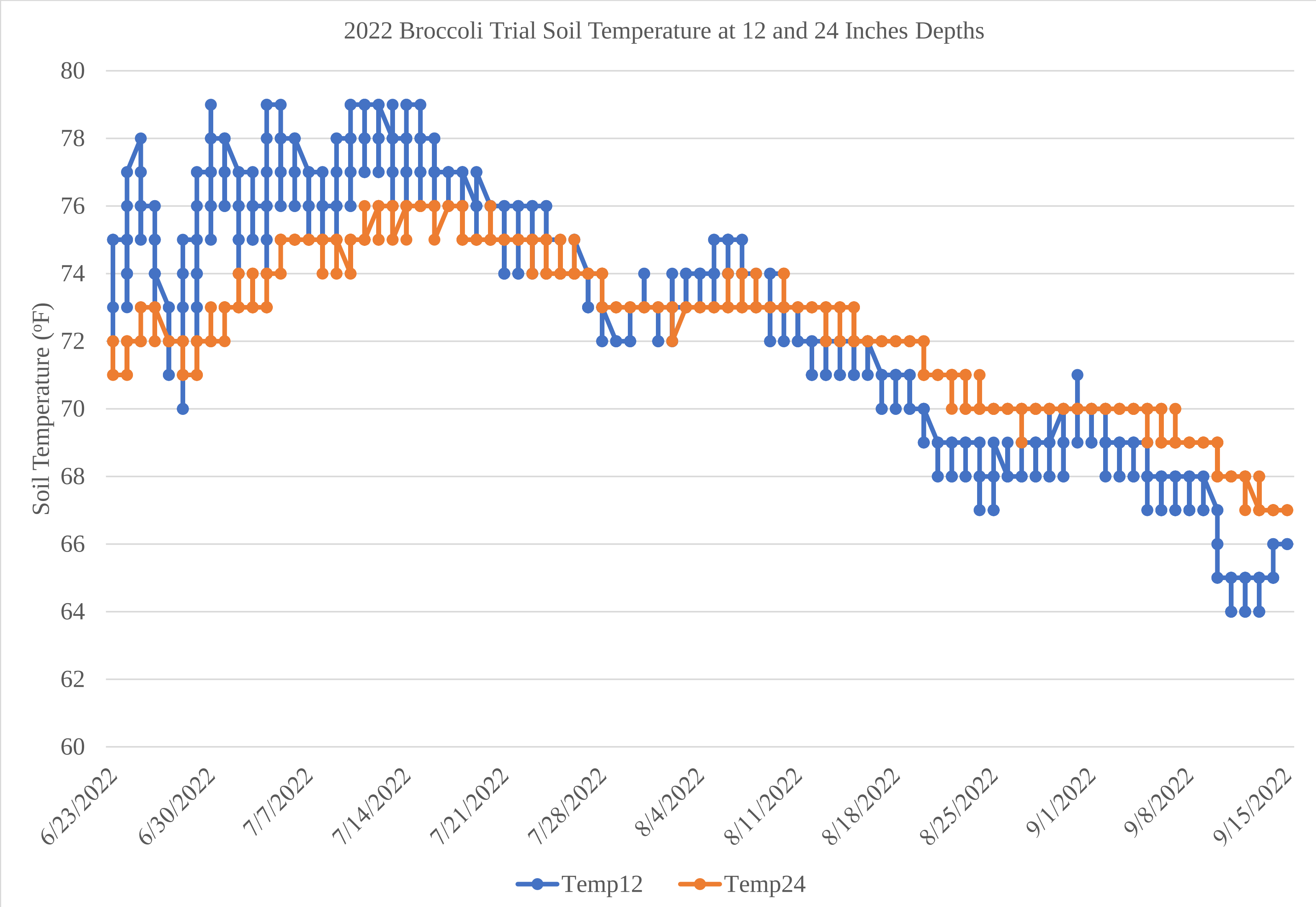
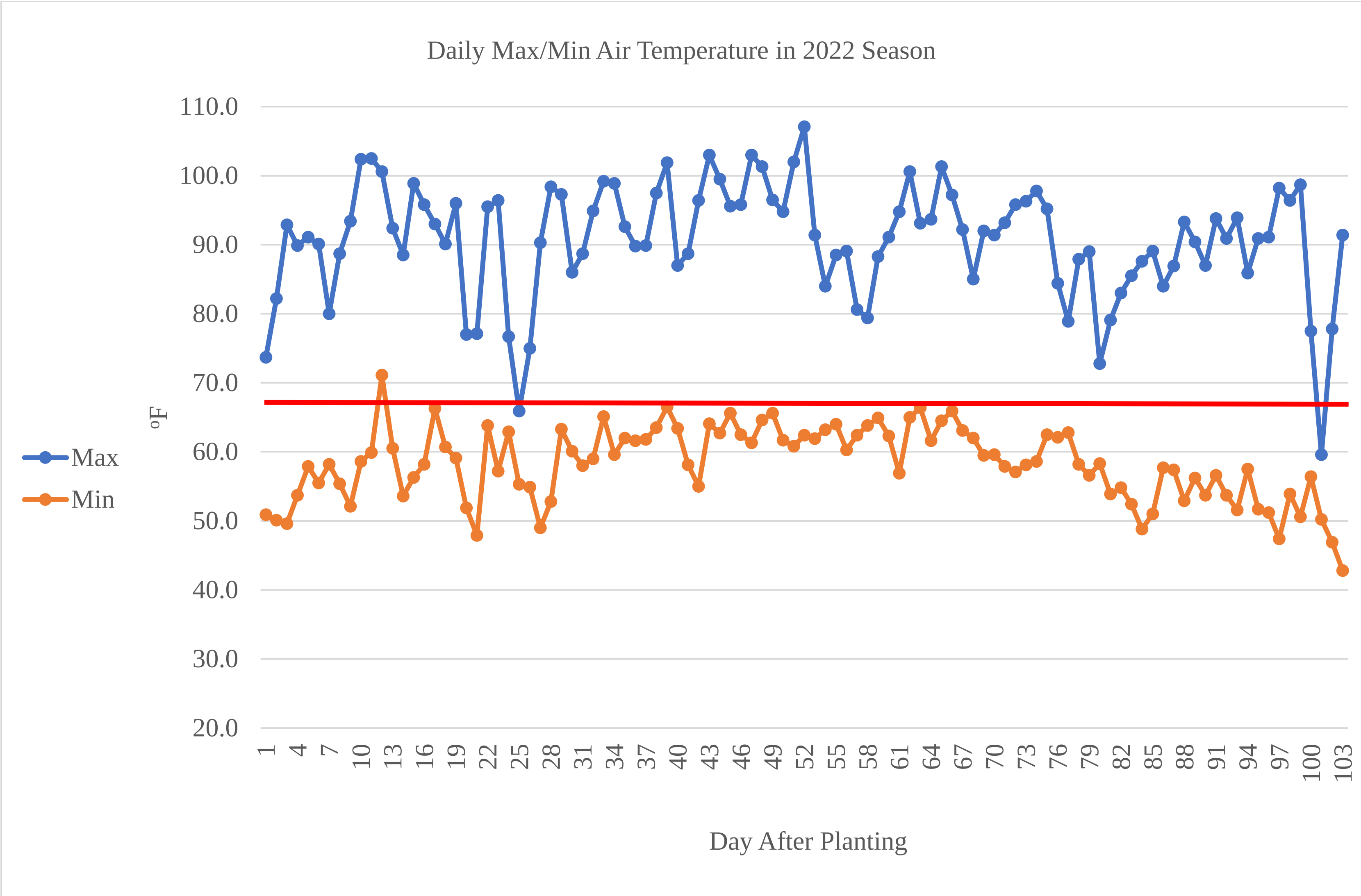


Figure 5. Daily Maximum and Minimum Air Temperature for Broccoli Tested at AVRC in 2022.



* Red line indicated the optimum growth temperature for broccoli

Figure 6. The Defects Shown on Crowns for Broccoli Planted at AVRC in 2022.

Figure 7. Stem Broccoli BC1611 Showed Promising Marketable Quality at 1st and 2nd Broccoli Planting at AVRC in 2022.

P1, 65 DAP

P2, 64 DAP

In 2022 season, four agronomic trials for forage crops were conducted at AVRC in which forage sorghum hybrid performance trials were led by CSU, AES, Department of Soil and Crop Sciences, and the hybrid performance trials for sunflower and corn were deployed by CSU. These trials were multi-regional crop studies in Colorado and the trials conducted at AVRC were managed by the farm manager, Kevin Tanabe.

The irrigated trial for sunflower at Rocky Ford was lost due to severe bird damage prior to harvest. Only the data originated from the trials at AVRC were included in the 2022 AVRC Trial Report. More details regarding hybrid performance of sunflower, forage and grain sorghum as well as silage corn can be found at CSU Crop Testing website https://csucrops.com/
The contact information for CSU Crop Testing Program can be found below:

Crops Testing Program
Colorado State University Extension
181 Birch Ave, Akron, CO 80720
Phone: 970-214-4611
https://csucrops.com/

You can also find the trial summaries in PDF files using these links:

Summary of the 2022 Colorado Sunflower Hybrid Performance Trials
Making Better Decisions: Colorado Sunflower Performance Trials – February 2023
2022 Sorghum Hybrid Performance Trials in Eastern Colorado
Making Better Decisions: Colorado Sorghum Performance Trials – January 2023
2022 Colorado Corn Hybrid Performance Trials
Making Better Decisions: Colorado Corn Hybrid Trials – December 2022

Trial 1. 2022 Irrigated Forage Sorghum Hybrid Performance Trial at Rocky Ford

		Yield										
Brand	Hybrid	Forage[a]	Dry Matter	Yield	2-Year Avg.	Moisture	Brix	Plant Height	Forage Type[b]	Relative Maturity[c]	Traits[d]	RFQ[e]
		tons/ac		% of test average	tons/ac	% at harvest	percent	in				
Dyna-Gro Seed	Fullgraze II	34.7	12.1	136%	34.3	67	12	153	SS	ML		72
Dyna-Gro Seed	Super Sile 20	34.2	12.0	134%	31.9	73	17	124	FS	ML		90
Warner Seeds, Inc	2-Way AT	30.8	10.8	120%		70	9	102	FS	ML	SCA	106
Dyna-Gro Seed	Danny Boy II BMR	30.5	10.7	119%	31.0	80	9	142	SS	ME	BMR	80
Dyna-Gro Seed	5FS Star	30.1	10.5	118%	30.4	68	12	112	FS	E		112
Alta Seeds	ADV F8322	29.6	10.4	116%	25.8	68	17	92	FS	M	SCA	98
Dyna-Gro Seed	F72FS05	29.3	10.3	115%	25.9	69	6	91	FS	ME		113
Dyna-Gro Seed	Super Sile 30	28.0	9.8	110%	29.5	71	15	136	FS	ME		90
Dyna-Gro Seed	F75FS13	27.1	9.5	106%		69	15	112	FS	M		126
Alta Seeds	ADVF8484IG	26.3	9.2	103%		73	15	87	FS	ML	IG, BD	90
Dyna-Gro Seed	Dynagraze II BMR	26.1	9.1	102%	25.4	69	11	113	SS	ME	BMR	108
Dyna-Gro Seed	Fullgraze II BMR	25.8	9.0	IOI%	27.6	72	16	143	SS	ML	BMR	92
Dyna-Gro Seed	SweetTon MS	25.6	9.0	100%	25.4	70	21	117	GS	ML	SCA	120
Dyna-Gro Seed	F74FS23 BMR	25.3	8.9	99%	19.1	71	16	99	FS	M	BMR, BD	131
Dyna-Gro Seed	Dynagraze II	24.3	8.5	95%	23.7	67	7	107	SS	ME		100
Mojo Seed	PEARL	23.2	8.1	91%	23.8	69	3	90	FS	M	SCA	107
Warner Seeds, Inc	W7706-W	21.6	7.6	85%		68	3	80	GS	ME	SCA	124
Alta Seeds	AF7102	21.2	7.4	83%		69	7	82	FS	ME	BMR	131
Dyna-Gro Seed	F72FS25 BMR	20.5	7.2	80%	20.0	74	14	74	FS	M	BMR	141
Dyna-Gro Seed	F71FS72 BMR	20.4	7.1	80%	19.1	71	4	84	FS	E	BMR	163
Dyna-Gro Seed	Super Sweet 10	20.2	7.1	79%		72	14	103	ss	M		112
Dyna-Gro Seed	F74FS72 BMR	19.6	6.9	77%	18.1	74	13	74	FS	M	BMR	120
Mojo Seed	OPAL	19.6	6.9	77%	19.8	71	JO	86	FS	M		86
Alta Seeds	ADVF7232	19.5	6.8	76%		73	17	71	FS	M	SCA	123
	Average	**25.6**	**8.9**		**25**	**71**	**12**	**103**				**110**
[f]LSD (0.30)		2.1										
[f]LSD (0.05)		4.1										

[a]Forage yield adjusted to 65% moisture content based on dried samples. Yields in bold are in the top LSD (.30) group and are not significantly different from one another.

[b]Forage Type: GS=grain sorghum; FS=forage sorghum; SS=sorghum sudangrass.

[c]Relative maturities provided companies. E=early; ME=medium-early; M=rnedium; ML=medium-late; L=late; PPS=photoperiod sensitive.

[d]Traits are provided by the companies. Dashes mean conventional (no traits) or information isn't available. BD=brachytic dwarf; BMR=brown mid-rib; DS=dry stalk; IG=iGrowth herbicide technology; MS=rnale sterile; SCA=sugar cane aphid.

[e]Forage quality analyses based on oven-dried weight. RFQ=relative forage quality.

[f]If the difference between two hybrids equals or exceeds the LSD value, the difference is significant. Farmers selecting a hybrid based on yield should use the LSD (0.30) to protect from false negative conclusions (concluding hybrids are the same when they are actually different). Companies or researchers may be interested in the LSD (0.05) to avoid false positive conclusions (concluding hybrids are different when they are actually the same). Yield differences less than the LSD value are considered the same.

Site Information

Collaborator: CSU Arkansas Valley Research Center (Kevin Tanabe and Lane Simmons)
Planting Date: May 16, 2022
Harvest Date: September 22, 2022
Herbicide: Huskie at 16 oz/ac and Starane at 6.4 oz/ac applied on June 20th
Fertilizer: Pre-plant: N at 111, P at 14, and K at 1.5 lb/ac
Irrigation: Furrow irrigated
Soil Type: Rocky Ford silty clay loam
GPS Coordinates: 38.0389, -103.6933

Trial 1. 2022 Irrigated Forage Sorghum Hybrid Performance Trial Feed Quality at Rocky Ford

			Forage Quality[a]													
Brand	Hybrid	Forage Yield[b]	RFQ	CP	aNDFom	Lignin	WSC Sugar	Starch	Ash	Fat	NDFD 30hr	NDFD 240hr	TDN	NEL	Milk/Ton	Beef/Ton
		tons/ac						percent						Meal/cwt	lb/ton	lb/ton
Dyna-Gro Seed	Fullgraze II	**34.7**	72	5.7	65	6.3	7.5	4	6	2	46	63	63	64	2346	31
Dyna-Gro Seed	Super Sile 20	**34.2**	90	7.0	52	5.1	5.3	18	10	2	42	60	65	67	2482	50
Warner Seeds, Inc	2-Way AT	30.8	106	7.0	45	4.9	2.6	28	8	2	37	57	67	69	2839	72
Dyna-Gro Seed	Danny Boy II BMR	30.5	80	7.7	64	4.2	8.4	0	14	2	54	68	63	64	1899	26
Dyna-Gro Seed	5FS Star	30.1	112	5.8	44	4.6	8.1	23	7	2	38	56	67	69	2978	98
Alta Seeds	ADV F8322	29.6	98	6.4	49	4.6	4.5	24	11	2	42	60	66	68	2579	56
Dyna-Gro Seed	F72FS05	29.3	113	6.2	46	5.1	3.2	27	7	2	42	61	66	68	2955	106
Dyna-Gro Seed	Super Sile 30	28.0	90	7.1	59	4.7	10.0	5	9	2	51	66	64	66	2450	67
Dyna-Gro Seed	F75FS13	27.1	126	6.5	43	4.5	8.4	24	6	3	40	58	67	69	3123	128
Alta Seeds	ADV F8484IG	26.3	90	7.7	53	4.9	4.6	17	II	2	45	63	65	67	2454	54
Dyna-Gro Seed	Dynagraze II BMR	26.1	108	6.8	50	5.5	5.9	21	6	2	45	62	66	68	2939	115
Dyna-Gro Seed	Fullgraze II BMR	25.8	92	6.8	65	5.3	11.9	2	9	2	56	69	64	65	2415	78
Dyna-Gro Seed	SweetTon MS	25.6	120	6.9	43	3.5	9.1	22	9	3	42	58	68	70	2916	98
Dyna-Gro Seed	F74FS23 BMR	25.3	131	6.1	44	2.7	5.7	26	13	2	51	63	68	70	2760	94
Dyna-Gro Seed	Dynagraze II	24.3	100	7.4	47	4.5	7.3	23	12	2	42	58	66	68	2529	45
Mojo Seed	PEARL	23.2	107	6.3	47	3.6	6.0	25	13	2	44	60	67	69	2528	54
Warner Seeds, Inc	W7706-W	21.6	124	6.5	40	4.0	3.2	31	II	2	40	57	67	69	2854	75
Alta Seeds	AF7102	21.2	131	6.3	43	3.1	8.9	23	13	3	51	64	67	70	2785	102
Dyna-Gro Seed	F72FS25 BMR	20.5	141	6.3	38	3.5	2.5	29	10	2	44	60	68	71	3122	120
Dyna-Gro Seed	F71FS72 BMR	20.4	163	6.7	36	3.8	5.7	34	7	3	42	58	69	71	3378	155
Dyna-Gro Seed	Super Sweet 10	20.2	112	8.5	46	5.5	6.2	19	7	2	41	59	65	67	2925	102
Dyna-Gro Seed	F74FS72 BMR	19.6	120	8.1	46	3.3	3.7	24	13	2	49	63	67	69	2689	88
Mojo Seed	OPAL	19.6	86	6.7	50	4.0	7.3	19	13	2	41	58	66	68	2272	14
Alta Seeds	ADV F7232	19.5	123	8.8	45	3.1	4.4	18	14	2	53	67	66	68	2650	98
	Average	**25.6**	**110**	**6.9**	**48**	**4.3**	**6.3**	**20**	**10**	**2**	**45**	**61**	**66**	**68**	**2703**	**80**
	[c]LSD (0.30)	2.1														
	[c]LSD (0.05)	4.1														

[a]All forage quality analyses results are dry basis values. CP=crude protein; aNDFom=ash free neutral detergent fiber; NDFD=neutral detergent fiber digestibility; TDN=total digestible nutrients; NEL=net energy for lactation; Milk/ton= predicted amount of milk produced per ton of silage dry matter calculated using.

[b]Yields are adjusted to 65% moisture content based on oven-dried samples. Yields in bold are in the top LSD (.30) group and are not significantly different from one another.

[c]If the difference between two hybrids equals or exceeds the LSD value, the difference is significant. Farmers selecting a hybrid based on yield should use the LSD (0.30) to protect from false negative conclusions (concluding hybrids are the same when they are actually different). Companies or researchers may be interested in the LSD (0.05) to avoid false positive conclusions (concluding hybrids are different when they are actually the same). Yield differences less than the LSD value are considered the same.

Trial 2. 2022 Irrigated Grain Sorghum Hybrid Performance Trial at Rocky Ford

Brand	Hybrid	Grain Yield[a]	Yield	Test Weight	Moisture	Maturity Group[b]	Grain Color
		bu/ac	% of test avg.	lb/bu	percent		
Dekalb	DKS38-16	**134.4**	117%	60	19	ME	Bronze
Dyna-Gro Seed	M63GB78	**130.2**	114%	58	26	ME	Bronze
Dekalb	DKS36-07	**127.8**	112%	57	25	ME	Bronze
Dyna-Gro Seed	M60GB31	125.4	110%	59	25	ME	Bronze
Alta Seed	AG1201	125.1	109%	58	18	E	Red
Dekalb	DKS29-95	123.6	108%	59	17	E	Dark Red
Dekalb	DKS28-07	123.0	107%	58	19	E	Bronze
Dekalb	DKS28-05	122.7	107%	60	15	E	Bronze
Dyna-Gro Seed	M59GB94	118.5	104%	56	26	E	Bronze
Dekalb	DKS29-28	117.6	103%	59	18	E	Bronze
Dyna-Gro Seed	M60GB88	115.5	101%	59	18	ME	Bronze
Dyna-Gro Seed	GX22923	115.2	101%	55	26	E	Cream
Alta Seed	ADV G1329	106.2	93%	58	19	E	Cream
Alta Seed	ADV XG272	104.7	91%	56	30	ME	Bronze
Dyna-Gro Seed	M59GB57	103.5	90%	58	18	E	Bronze
Dyna-Gro Seed	M54GR24	102.3	89%	59	18	E	Red
Dyna-Gro Seed	M57GC29	101.4	89%	58	20	E	Cream
Dyna-Gro Seed	GX21991	98.4	86%	57	22	ME	Bronze
Alta Seed	ADV GI 120IG	97.2	85%	57	27	ME	Red
Dyna-Gro Seed	GX22916	96.9	85%	57	24	ME	Bronze
	Average	**114.5**	**100%**	**58**	**21**		
	[c]LSD (30)	9					
	[c]LSD (.05)	17					

[a]Yields adjusted to 14% moisture and hybrids ranked by yield. Yields in bold are in the top LSD group (.30) and are not significantly different from one another.

[b]Maturity group: E=early; ME=medium-early. Maturity groups are provided by the company and may not align with the observed flowering dates in the trial due to the latitude and relatively high elevation of the trial site.

[c]Farmers selecting a hybrid based on yield should use the LSD (.30) to protect themselves from false negative conclusions (concluding hybrids are the same when they are actually different). Companies or researchers may be interested in the LSD (.05) to avoid false positive conclusions (concluding hybrids are different when they are actually the same). Yield differences less than the LSD value are considered the same.

Site Information

Collaborator: Arkansas Valley Research Station (Kevin Tanabe and Lane Simmons)
Planting Date: May 31, 2022
Harvest Date: October 11, 2022
Herbicide: Huskie at 16 oz/ac and Starane at 6.4 oz/ac applied on June 20th
Fertilizer: Pre-plant: N at 111, P at 14, and K at l.5 lb/ac
Irrigation: Furrow irrigated
Previous Crop: Forage sorghum
Soil Type: Rocky Ford silty clay loam
GPS Coordinates: 38.0382, -103.69406
Trial Comments: Trial had excellent emergence and stands. Trial cultivated one time for weed control. Light pressure from volunteer forage sorghum in the field. Weather station estimates showed the trial received about 7 inches of rain from planting to harvest (in addition to full irrigation) and 11.7 inches since January 1st, which is 102% of the ten-year average (year-to-date).

Trial 3. 2022 Irrigated Silage Corn Hybrid Performance Trial at Rocky Ford

COLORADO STATE UNIVERSITY
EXTENSION

2022 Irrigated Silage Corn Hybrid Performance Trial at Rocky Ford

Crops Testing
www.csucrops.com

Hybrid	Brand	Insect and Herbicide Technology Traits[b]	Yield: Silage[c]	Yield: Dry Matter	Yield	Moisture	Relative Maturity[d]	Plant Population	Plant Height	Forage Quality[a]: CP	aNDFom	Lignin	Starch	Ash	Fat	NDFD 30hr	NDFD 240hr	TDN	NEL	Milk/Ton	Beef/Ton
			tons/ac	tons/ac	% of test avg.	% at harvest		plants/ac	in	percent	percent	percent	percent	percent	percent	percent	percent	percent	Mcal/cwt	lb/ton	lb/ton
D55VC80	Dyna-Gro Seed	VT2P, RR2	**42.0**	15.3	111%	56.6	115	37,200	107	7.8	40.9	3.0	34.1	4.9	1.6	52.7	66.6	69.5	72.0	2966	211
D53SS13	Dyna-Gro Seed	STX, LL, RR2	40.2	14.7	106%	53.3	113	33,700	103	8.3	28.2	2.0	48.1	3.6	2.6	47.4	62.8	76.0	79.2	3360	267
D57TC29	Dyna-Gro Seed	TRE, RR2	39.6	14.4	104%	60.4	117	35,600	111	8.2	27.9	3.3	50.0	3.7	2.5	59.6	66.1	72.0	-	3340	-
D53TC23	Dyna-Gro Seed	TRE, RR2	39.3	14.1	104%	54.2	113	34,800	104	7.9	32.0	2.6	44.6	4.2	2.2	48.8	64.8	73.4	76.3	3198	244
8560 Q	Hoegemeyer Hybrids	Q, LL, RR2	39.3	13.8	104%	59.6	115	35,900	110	8.3	32.9	2.3	41.6	4.8	2.0	53.3	67.5	73.3	76.3	3197	253
D54SS34	Dyna-Gro Seed	STX, LL, RR2	39.0	14.4	103%	58.3	114	36,300	107	8.0	31.1	2.3	45.9	3.9	2.6	48.4	63.9	74.0	77.1	3270	255
D50VC09	Dyna-Gro Seed	VT2P, RR2	36.9	13.5	97%	54.7	110	34,600	104	7.6	31.9	2.0	46.2	4.0	2.2	50.1	66.8	73.9	76.9	3232	255
8370 AM	Hoegemeyer Hybrids	AM, LL, RR2	36.9	13.2	97%	55.6	113	34,100	109	7.9	34.5	2.3	41.5	4.6	1.9	52.5	68.2	72.6	75.4	3158	244
7843 AM	Hoegemeyer Hybrids	AM, LL, RR2	36.6	13.5	96%	54.3	108	36,300	107	8.2	31.8	2.6	42.8	4.6	2.1	48.6	64.3	73.9	76.9	3172	240
8052 Q	Hoegemeyer Hybrids	Q, LL, RR2	35.7	12.6	94%	59.0	110	35,000	105	8.1	39.0	2.7	33.8	5.2	1.9	54.4	66.9	70.6	73.2	3061	225
D52SS82	Dyna-Gro Seed	STX, LL, RR2	35.7	12.9	94%	58.2	112	33,100	110	8.4	32.5	2.1	41.7	5.0	2.1	51.7	66.1	73.1	76.0	3169	246
D54SS74	Dyna-Gro Seed	STX, LL, RR2	34.2	12.6	90%	56.8	114	34,900	100	8.2	34.1	2.8	41.6	4.3	2.2	50.2	65.0	72.7	75.6	3177	240
		Average	**38.0**	**13.8**	**100%**	**56.7**	**113**	**35,125**	**106**	**8.1**	**33.1**	**2.5**	**42.7**	**4.4**	**2.1**	**51.5**	**65.7**	**72.9**	**75.9**	**3192**	**244**
		[e]LSD (0.30)	1.5																		
		[e]LSD (0.05)	3.0																		

[a]All forage quality analyses results are dry basis values. CP=crude protein; aNDFom=ash free neutral detergent fiber; NDFD=neutral detergent fiber digestibility; TDN=total digestable nutrients; NEL=net energy for lactation; Milk/ton= predicted amount of milk produced per ton of silage dry matter calculated using MILK2006; Beef/ton=predicted amount of beef produced per ton of silage dry matter calculated using ISU Beef.

[b]Technology trait designations: AM=AcreMax; LL=LibertyLink; Q=QROME; RR2=Roundup Ready 2; STX=SmartStax; TRE=Trecepta; VT2P=VecTran Double Protection.
For a list of specific pests controlled by each trait, please click here.

[c]Silage yield adjusted to 65% moisture content based on dried samples. Hybrids are grouped by relative maturity and then ranked by yield (highest to lowest). Hybrid yields in bold are in the top LSD group for the trial (0.30).

[d]Relative maturity is provided by the respective companies and is the approximate time from planting to harvest maturity. The method of calculation of the relative maturity ratings may vary among companies.

[e]Farmers selecting a hybrid based on yield should use the LSD (.30) to protect themselves from false negative conclusions (concluding hybrids are the same when they are actually different). Companies or researchers may be interested in the LSD (.05) to avoid false positive conclusions (concluding hybrids are different when they are actually the same).

Site Information

Collaborator: CSU Arkansas Valley Research Center (Kevin Tanabe and Lane Simmons)
Planting Date: April 28, 2022
Harvest Date: September 14, 2022
Fertilizer: N at 230, P at 28, and K at 3.5 lb/ac
Herbicide: Mad Dog Plus at 1 qt/ac and Starane at 3.75 pt/ac
Soil Type: Rocky Ford silty clay loam
GPS Coordinates: 38.0389, -103.6933

2022 Lysimeter Report

Lane Simmons

Part I. 2022 Small Lysimeter
Crop: Grass
Please refer to the 2022 SL logbook (s) for specifics on crop and lysimeter management.

Water Budget Start Date: 3/15/2022 (74) - Approximate green-up date; matches previous years.
Water Budget End Date: 11/20/2022 (324) - Arbitrary end date; matches previous years.

Mixture/Variety as Planted on 9/7/2017.

Cache Meadow Brome	39.93%
Crown Royal Orchardgrass	37.88%
Lincoln Smooth Brome	19.70%

Days in the budget season: (includes start and end dates): 251
Number of non-standard days: 57 (23% of the days in the budget season)
Number of non-standard events: 65

Non-Standard Events (NSE's)*
Irrigations: 8 (over 7 days)
Precipitation: 47 (over 43 days)
Drains: 6
Harvests: 2

*It is important to distinguish between a single Non-Standard Event (NSE) vs. multiple NSE's contributing to a single line item in the water budget. For example, a Non-Standard Day (NSD) rain line item in the water budget may consist of multiple NSE's separated by time.

2022 SL Grass	Inches
Irrigation	29.26
Precipitation	9.28
I+P	38.54
Drainage	5.13
Measured ET	30.70
Average Daily ET	0.12
Peak ETc (adjusted)	0.40
Peak ETc Date	6/13/2022

Date	Cutting	Location	Tons/Acre*
5/31/22	1st	Bulk	
6/3/22	1st	SL Surface	0.65
9/10/22	2nd	Bulk	
9/12/22	2nd	SL Surface	1.04

*The surface yield indicated here is the greenhouse dried yield, not DM basis.
*The bulk field yield is based on crop sales, per Kevin Tanabe.

ETr calculation comparison – METS and RFD01

METS ETr was used for the SL water budget Kc curve, with some missing data substituted with RFD01 values.

2022 - Inches	METS ETr	RFD01 ETr
Season Total	62.040	60.331
Season Daily Max	0.725	0.682
Season Daily Max Date	4/22/22	4/22/22
Season Average	0.247	0.240

Crop Discussion:

There are several things to note about the 2022 grass crop. I would consider the 2022 crop not as good as usual:

- The surface yield was less than what would be considered normal. This was particularly true for the 1st cutting. It is safe to assume that this was driven by fertility issues. Dr. Mike Bartolo recommended a fertilizer application, which was done three times. This noticeably helped the grass.

- Irrigation mistake on 6/9/22. A SL irrigation was started at 9:50 AM MST but was interrupted for a time by other farm business. To attend to this business, the electrical generator and irrigation pump were shut off. The mistake made was that the water connection was not broken, and water syphoned through the pump and hose resulting in an unattended over irrigation. The load cell load increased to 4.0852 m/V/V which is still within the safe zone of the load cells, however a total of 10" was applied to the surface.

- Drainage problems. Excerpt from the Lysimeter Narrative Log 2022: *"One item of note. This year I've had a very difficult time getting the bottom of the SL monolith to drain. I've kept the vacuum pump running full time, but water accumulation in the drainage tank has been very slow, which is surprising when one looks at how wet the NMM readings are at depth…". "…on 9/20, an obstruction was found. The obstruction was in a short section of tubbing between the drainage tank and the first T-fitting. The section of tubing was replaced, and the vacuum pump turned back on. The system now appears to be drawing water out of the monolith".*

  It should be noted that the system is still not drawing water though the drainage plumbing as well as it should.

Part II. 2022 Large Lysimeter
Crop: Milo (Grain Sorghum, *Sorghum bicolor*)
Variety: Alta Seeds AG1203, Vertix Premier

Please refer to the 2022 LL logbook(s) for specifics on crop and lysimeter management.

Water Budget Start Date: 6/1/2022-The day after surface planting.
Water Budget End Date: 10/20/2022-The day before bulk harvest.

Surface Planting Date: 5/31/2022
LL Surface (monolith) Emergence: 6/7/2022
Bulk Harvest: 10/21/2022 and 10/24/2022
LL Surface Harvest: 10/25/2022

Days in the budget season: 142 (includes start and end dates)
Number of non-standard days: 52
Number of non-standard events: 62

Non-Standard Events (NSE's)*
Irrigations: 13
Precipitation: 38 events over 31 separate days
Drainage: 10
Fertilizer: 0
Counterweight Changes: 0
Other: 1

*It is important to distinguish between a single Non-Standard Event (NSE) vs. multiple NSE's contributing to a single line item in the water budget. For example, a Non-Standard Day (NSD) rain line item in the water budget may consist of multiple NSE's separated by time.

Irrigation: 20.5"
Precipitation: 8.62"
I+P: 29.12"
Drainage: 2.88"
Measured ET: 26.43"
Average Daily ETc: 0.19"
Max ETc: 0.35"
Max ETc Date: 7/10/2022 (standard day)

ETr calculation comparison – METS and RFD01
METS ETr was used for the water budget Kc curve. This ETr was calculated by code in the Campbell Scientific CR1000 datalogger program.

- METS ETr Daily Average: 6.52 mm
- RFD01 ETr Daily Average: 6.32 mm
- METS ETr Season Total: 922.43 mm
- RFD01 ETr Season Total: 893.32 mm

Crop Discussion:

The 2022 crop was notable on a couple of fronts:

1. This was the first season using a new CR1000X datalogging system, replacing the original CR7 unit. Additionally, this season followed a fall 2021 monolith load cell(s) replacement and scale calibration. These changes triggered new programing and data management considerations.
2. The original 2022 crop planted was seeded onions – planted on 3/15/2022. However due to multiple days with strong winds and blowing dust from a neighbor's field, notably on 4/12/22, we had a crop failure. The wind and dust severed off most of the recently emerged small onion plants right at the surface. Milo was planted on 5/31/22.

The LL surface (Milo) looked great for the entire season. Most of the bulk field looked good as well, however there were several bare spots in the bulk field where milo failed to emerge. As the season progressed these spots became camouflaged by the surrounding plants. Late in the season there were many areas in the bulk field experiencing weed pressure.

In summary, it feels like the LL ETc data was very solid, with a great stand on the LL surface. The plants in our problem area, a 10'x10' area (approximate) immediately east of the LL surface, were slightly stunted (as per usual) but they were not bad, perhaps 85% the quality of the rest of the field.