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Bridger Plant Materials Center, Bridger, MT

Evaluation of Cowpea and Mung bean Varieties

Study Number MT-16-001
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ABSTRACT

There is a need for well adapted warm season legumes for use in cover crop mixes in Montana to provide needed plant diversity in dryland cropping systems. Field observations of cowpea (*Vigna unguiculata* L.) and mung bean (*Vigna radiata* L.) in mixes have shown limited or poor performance in terms of number of plants and vigor. To identify suitable varieties, a variety trial consisting of two mung bean and four cowpea varieties was conducted at the Bridger Plant Materials Center (BPMC) in Bridger, Montana using a randomized complete block design. There was no significant difference in biomass yields, but there were significant differences in height and days to 50% flowering. 'Iron & Clay' cowpea was the tallest of all six varieties, whereas 'Berken' mung bean was the shortest. 'Iron & Clay' and 'Black Stallion' cowpeas never flowered, while the other varieties flowered and produced seed. All varieties exhibited excellent vigor and health, despite poor soil structure and soil compaction, and a lack of nodulation, demonstrating the potential for these species to do well in degraded systems. There is potential for seed production in Montana of 'Chinese Red' cowpea and mung bean varieties 'OK2000' and 'Berken,' which could meet a market demand for cover crop seed and provide an alternative crop in dryland farming systems. Future research should focus on 1) seed production potential of mung bean and cowpea in Montana dryland systems, 2) using higher seed rates of cowpea and mung bean in cover crop mixes, and 3) testing whether plant habit (prostrate versus upright) has an effect on legume performance in cover crop mixes.

INTRODUCTION

The goal of this study was to evaluate varieties of cowpea (*Vigna unguiculata* L.) and mung bean (*Vigna radiata* L.) for use in cover crop mixes in dryland conditions. Cover crop mixes in Montana are increasingly becoming a tool for producers to improve soil health. Producers plant mixes for a variety of reasons, e.g. supplemental grazing, additional soil nitrogen, adding plant type diversity, and breaking compaction layers. Cover crop mixes, at least in eastern Montana, typically have five or more species, and are dominated by warm season species, as warm season crop types are often missing in crop rotations. While there are excellent choices in warm season grasses (millet, sorghum, corn, sudangrass, etc.), there are limited warm season legume options. Soybeans, cowpeas, and mung beans are used in mixes, but performance has been variable. Soybeans are not very drought tolerant, limiting their potential in dryland cropping systems. Cowpeas and mung beans are drought tolerant, and prefer higher temperatures. Cowpeas have been utilized in mixes with variable success, possibly due to inferior variety adaptation. Mung bean, a shorter season legume than cowpea and only recently included in cover crop mixes, may be better adapted to dryland Montana conditions. Unfortunately, current mung

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bean varieties often produce seed (personal observation, author), something farmers prefer to avoid. Later maturing varieties would alleviate this problem, making mung beans a more viable option in cover crop mixes.

MATERIALS AND METHODS

Four cowpea and two mung bean varieties (see Table 1 for varieties and sources) were planted in 4 replications using a randomized complete block design. Seeding was on May 20 in plots 4.7 feet wide by 25 feet long. A double disk plot drill was used that planted 4 rows per plot. The soil, a Heldt silty clay loam, was moist at planting. No fertilizer was applied. There was no residue cover and the site has a long history of conventional tillage. The Bridger, MT area is in a 10 to 11 inch precipitation zone with frost free dates of May 19 through September 20.

Seed was inoculated just prior to planting with the appropriate rhizobia strain. The mung bean varieties were 7300 seeds per pound while the cowpea varieties ranged from 4100 to 7000 seeds per pound. The plot was irrigated twice to ensure stand establishment. Total precipitation for January through September was 5.33 inches (see Table 2).

Table 1. Cowpea and mung bean varieties, seeding rates, seeds per pound, and seed sources; planted at the BPMC, Bridger, MT, 2016.

Variety	**Seeding Rate**	**Seeds per Pound**	**Source**
	PLS lbs. per Acre		
Berken (mung bean)	15	7300	Oklahoma Foundation Seed, Stillwater, OK
OK2000 (mung bean)	15	7300	Green Cover Seed, Bladen, NE
Black Stallion (cowpea)	15	7000	Green Cover Seed, Bladen, NE
Iron & Clay (cowpea)	30	4400	Green Cover Seed, Bladen, NE
Red Rippers (cowpea)	30	4100	Green Cover Seed, Bladen, NE
Chinese Red (cowpea)	30	4900	Green Cover Seed, Bladen, NE

Table 2. Monthly precipitation, January through September, BPMC, Bridger, MT, 2016.

Month	**Precipitation**
	inches
January	0.05
February	0.00
March	0.61
April	0.99
May	1.67
June	0.09
July	0.51
August	0.38
September	1.03
Total	**5.33**

Plant counts for 40 feet of row per plot (inner two rows) were taken on July 19. Plant height to top of canopy was taken for 5 plants per plot in the inner two rows on August 5. Notes were taken on plant habit, nodule presence, time of 50% flowering, seed pod formation, and seed maturity. Plant biomass was harvested to ground level on August 24 and 25 in a 14.4 square foot area (middle two rows), and then dried for 48 hours at 50°C.

Data was analyzed using Statistix 10 (Analytical Software, Tallahassee, FL). ANOVA and Tukey's tests were done on biomass, days to flowering, and plant height.

RESULTS AND DISCUSSION

Considering the poor soil conditions at the site— compaction, low organic matter, and no residue cover, all varieties did well, growing vigorously and showing a healthy, green color, despite little or no root nodulation. 'Berken,' 'OK2000,' and 'Chinese Red' produced seed. 'Red Rippers' produced pods, and some plants produced seed. 'Black Stallion' and 'Iron and Clay' did not produce pods or seed. Of the varieties that did flower, 'Red Rippers' were the latest (77 days from planting), with Tukey's test showing this variety was significantly later than 'Berken,' 'OK2000,' and 'Chinese Red' (see Appendix A). 'Black Stallion' and 'Iron & Clay' never flowered.

Table 3. Mean days to flowering, seed production, and plant habit data of cowpea and mung bean varieties at BPMC Bridger, MT, 2016.

Variety/Species	**Mean Days to 50% Flowering**	**Seed or Pods produced by harvest (Aug. 24/25)**	**Plant Habit**
Berken (mung bean)	68	seed	upright
OK2000 (mung bean)	68	seed	upright
Black Stallion cowpea)	DNF*	none	upright
Iron & Clay (cowpea)	DNF	none	upright
Red Rippers (cowpea)	77†	green pods, some seed	prostrate
Chinese Red (cowpea)	72	seed	upright

* Did not flower. † Statistically later than other flowering varieties (see Appendix A).

All varieties had an upright habit (Figure 1) with the exception of 'Red Rippers,' which had a prostrate growth habit (Figure 2). It was not unusual for this variety to have stems in the neighboring plot. There was some virus present, which was observed on September 16, in 'Black Stallion' across all four replications, and in 'Iron & Clay' in three out of four replications. Figure 3 shows the virus symptoms on the newest growth, which is typical of a viral infection. Virus could have originated from local dry bean production. Symptoms developed late enough that it could not have been seed-borne, making it likely insect transmitted.

Figure 1. ‘Iron & Clay’ cowpea variety with upright growth habit.

Figure 2. ‘Red Ripper’ cowpea variety with prostrate growth habit.


Figure 3. Virus symptoms on cowpea, September 16, 2016.

Interestingly, there was little to no nodulation in any variety, despite having been inoculated directly before seeding. Inoculant was stored in a refrigerator before planting, and ample amounts were applied to the seeds. Despite this, plants were very healthy, vigorous, and green (Figure 4). With no evident signs of nitrogen deficiency, it is likely the plants scavenged nitrogen from the soil. Roots went down at least 12 to 18 inches, which was surprising given the lack of soil structure and compaction layers present. Excavating plant roots proved to be challenging due to poor soil quality.

Figure 4. Test plot looking west and showing greenness of plants, despite little or no nodulation, or fertilizer application; August 5, 2016, BPMC, Bridger, MT.

'Iron & Clay' (55.20 centimeters) was the tallest of the six varieties, whereas 'Berken' (31.65) was the shortest (Table 4). For yield, there was no statistical difference between varieties (Table 5).

Table 4. Tukey HSD all-pairwise comparisons test of height for variety (0.05), BPMC, Bridger, MT data.

Variety	**Mean Height**	**Homogeneous Groups**
	centimeters	
Iron & Clay	55.200	A
Chinese Red	48.250	B
Red Rippers	43.000	BC
Black Stallion	42.500	BC
OK2000	39.700	C
Berken	31.650	D

Table 5. Tukey HSD all-pairwise comparisons test of yield for variety (0.05), BPMC, Bridger, MT data.

Variety	**Mean Biomass**	**Homogeneous Groups**
	Lbs./A	
Chinese Red	3836.6	A
Iron & Clay	3783.4	A
Red Rippers	2863.3	A
Berken	2593.8	A
OK2000	2420.8	A
Black Stallion	1628.8	A

CONCLUSIONS

The main goal of this experiment was to identify warm season legume varieties that will perform well in cover crop mixes in Montana. Varieties that do not produce seed yet produce high biomass are most desirable. However, only two varieties— 'Black Stallion' and 'Iron & Clay' cowpeas, did not produce seed, making these two varieties good choices if avoiding seed production is important to a producer. There has been limited germplasm development of mung bean in the U.S., probably owing to little demand, so finding germplasm that is late and adapted to Montana is challenging.

Biomass was statistically the same across all varieties. Tukey's test at 0.1 did show some yield differences, with all varieties yielding higher than 'Black Stallion' cowpea. A study with larger plots, perhaps 0.25 to 0.50 acre, may show yield differences between varieties.

On a positive note, the high percentage of seed producing varieties suggests it may be possible to grow these species and varieties as seed crops in Montana under dryland conditions. There is increasing demand for cover crop seed, and seed companies will need to expand their production to meet this demand. 'Chinese Red' cowpea and mung bean varieties'OK2000' and 'Berken' all have potential as new cash crops.

The reason(s) for the lack of nodulation remains unclear. Unfortunately there are no recent soil tests to determine if there was residual nitrate from previous crops and/or fertilizer applications. In future experiments soil tests should be conducted to 2 feet, and perhaps even 4 feet. Poor soil structure could have played a role in the lack of nodulation, although plants still managed to grow 12 to 18 inch taproots, which was impressive. The photos of plants with roots (see Appendix B) do not show the entire root system as it could not be fully excavated due to the tightness of the soil.

It was interesting to compare the overall performance of these warm season legumes as monocultures as compared to cover crop mixes. As a monoculture each variety performed well, but in mixes across eastern Montana they generally have not been as vigorous or "present," in terms of number of plants. Three reasons are suggested: 1) the seeding rate being used in mixes is not high enough, 2) other cover crop species, particularly warm season grasses, are more competitive in mixes than cowpea or mung bean, and/or 3) varieties are simply not adapted to growing in mixes. To help answer these questions future experiments and demonstrations could include:

1) Seeding rate experiment— use different legume seeding rates in a cover crop mix to determine if higher seeding rates show better legume presence and performance in warm season cover crop mixes.
2) Test a prostrate cowpea ('Red Rippers') versus upright cowpea ('Iron & Clay') in a cover crop mix to determine if plant growth habit plays a role in its performance in mixes.

In addition, mung bean and/or cowpea seed production demonstrations could be established on 1 to 2 acres to test the feasibility of growing these species for seed production in Montana.

Appendix A– Statistical Analysis

Statistix 10.0 PMC 2016 Yield Analysis

Tukey HSD All-Pairwise Comparisons Test of Yield for Variety

Variety	**Mean**	**Homogeneous Groups**
Chinese Red	3836.6	A
Iron & Clay	3783.4	A
Red Rippers	2863.3	A
Berken	2593.8	A
OK2000	2420.8	A
Black Stallion	1628.8	A

Alpha **0.05** Standard Error for Comparison 712.28
Critical Q Value 4.595 Critical Value for Comparison 2314.2
There are no significant pairwise differences among the means.

Statistix 10.0 PMC 2016 Yield Analysis

Tukey HSD All-Pairwise Comparisons Test of Yield for Variety

Variety	**Mean**	**Homogeneous Groups**
Chinese Red	3836.6	A
Iron & Clay	3783.4	A
Red Rippers	2863.3	AB
Berken	2593.8	AB
OK2000	2420.8	AB
Black Stallion	1628.8	B

Alpha **0.1** Standard Error for Comparison 712.28
Critical Q Value 4.051 Critical Value for Comparison 2040.5
There are 2 groups (A and B) in which the means are not significantly different from one another.

Statistix 10.0 PMC 2016 Days to Flower

Tukey HSD All-Pairwise Comparisons Test of Days to 50% Flowering for Variety

Variety	**Mean**	**Homogeneous Groups**
Red Rippers	77.000	A
Chinese Red	71.750	B
OK2000	68.250	B
Berken	67.500	B

Alpha **0.05** Standard Error for Comparison 1.4860
Critical Q Value 4.418 Critical Value for Comparison 4.6425
There are 2 groups (A and B) in which the means are not significantly different from one another.

Tukey HSD All-Pairwise Comparisons Test of Height for Variety

Variety	**Mean**	**Homogeneous Groups**
Iron & Clay	55.200	A
Chinese Red	48.250	B
Red Rippers	43.000	BC
Black Stallion	42.500	BC
OK2000	39.700	C
Berken	31.650	D

Alpha	**0.05**	Standard Error for Comparison	2.1829
Critical Q Value	4.101	Critical Value for Comparison	6.3307

There are 4 groups (A, B, etc.) in which the means are not significantly different from one another.

Appendix B – Photos, August 5, 2016

‘Berken’ mung bean

‘OK2000’ mung bean

‘Black Stallion’ cowpea

‘Iron & Clay’ cowpea

‘Red Rippers’ cowpea

‘Chinese Red’ cowpea


Mung bean flower, August 8, 2016.

Mung bean flowers and pod development, August 8, 2016.


Mung bean seed pods.

Cowpea flower and pod development, August 8, 2016.

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