USDA United States Department of Agriculture

FINAL STUDY REPORT
Bridger Plant Materials Center, Bridger, MT

Evaluation of Cowpea and Mung Bean Varieties

Mark Henning, Area Agronomist, Miles City, MT
Robert Kilian, (Retired) Rangeland Management Specialist, Bridger PMC, MT

ABSTRACT

There is a need for well adapted warm season legumes for use in cover crop mixes in Montana and Wyoming 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 the six tested 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 soil. There is potential for seed production in Montana of 'Chinese Red' cowpea, as well 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) evaluation of 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

Cover crop mixes in Montana are increasingly becoming a tool for producers to improve soil health. Soil health is the continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans.[1] 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 (Davis et al., 2017 and Oplinger et al., 2017). Cowpeas have been utilized in mixes with variable success, possibly due to inferior

[1] Further information on soil health can be found at:
https://www.nrcs.usda.gov/wps/portal/nrcs/main/mt/soils/health/

Mark Henning, Area Agronomist, 3120 Valley Drive East, Miles City, MT, mark.henning@mt.usda.gov;
Robert Kilian, berto.rk84@gmail.com

variety adaptation (personal observation, author). 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 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. 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.

MATERIALS AND METHODS

Four cowpea and two mung bean varieties (Table 1) were planted in 4 replications using a randomized complete block design. Plots were seeded on May 20 at 14-inch row spacing using a four-row cone planter (Kincaid Equipment Manufacturing®, Haven, KS) equipped with double disk furrow openers, depth bands, and double packer wheels. Each plot measured 4.7 feet wide by 25 feet long and consisted of four rows. The soil, a Heldt silty clay loam (Soil Survey of Carbon County Area, Montana), 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 annual frost-free dates of May 19 through September 20.

Seed was inoculated just prior to planting with the appropriate rhizobia strain (*Bradyrhizobium spp*.). 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 (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 lb/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 five plants per plot in the inner two rows on August 5. Plants were evaluated for 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 the analysis of variance procedure in Statistix 10 (Analytical Software, Tallahassee, FL). Significant means were separated with Tukey's HSD all-pairwise comparisons tests at $P<0.05$.

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) (Table 3). '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
Red Rippers (cowpea)	77[1/]	a	green pods, some seed	prostrate
Chinese Red (cowpea)	72	b	seed	upright
OK2000 (mung bean)	68	b	seed	upright
Berken (mung bean)	68	b	seed	upright
Black Stallion cowpea)	DNF[*]		none	upright
Iron & Clay (cowpea)	DNF[*]		none	upright

[1/] Means in columns followed by different letters are significantly different according to Tukey's HSD at $P<0.05$.
[*]DNF - did not flower.

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. A virus was observed on leaves of some plants 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.[2]

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

[2] All photos from authors.


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 the lack nodulation, 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' (21.7 inches) was the tallest of the six varieties, whereas 'Berken' (12.5 inches) was the shortest (Table 4). For biomass, there was no statistical difference between varieties (Table 5).

Table 4. Mean height of cowpea and mung bean varieties, Bridger PMC, Bridger, MT.

Variety	Mean Height[1/]	
	--inches--	
Iron & Clay	21.7	a[2/]
Chinese Red	19.0	b
Red Rippers	16.9	bc
Black Stallion	16.7	bc
OK2000	15.6	c
Berken	12.5	d

[1/] Plant height measured on August 5, 2016.
[2/] Means in columns followed by different letters are significantly different according to Tukey's HSD at $P<0.05$.

Table 5. Mean biomass of varieties, Bridger PMC, Bridger, MT.

Variety	Mean Biomass[1/]	
	--lb/acre--	
Chinese Red	3837	a
Iron & Clay	3783	a
Red Rippers	2863	a
Berken	2594	a
OK2000	2421	a
Black Stallion	1629	a

[1/] Harvested on August 24-25, 2016.
[2/] Means in columns followed by different letters are significantly different according to Tukey's HSD at $P<0.05$.

CONCLUSIONS

The main goal of this experiment was to identify cowpea and mung bean varieties with potential to 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. 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 do not show

the entire root system as it could not be fully excavated due to the tightness of the soil (Appendix A).

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.

LITERATURE CITED

Davis, D.W., E.A. Oelke, E.S. Oplinger, J.D. Doll, C.V. Hanson, and D.H Putnam. Alternative Field Crops Manual- Cowpea. Available at: https://hort.purdue.edu/newcrop/afcm/cowpea.html (accessed December 20, 2017).

Oplinger, E.S., L.L. Hardman, A.R.Kaminski, S.M. Combs, and J.D. Doll. Alternative Field Crops Manual- Mungbean. Available at: https://hort.purdue.edu/newcrop/afcm/mungbean.html (accessed December 20, 2017).

Appendix A – Photos, August 5, 2016

‘Berken’ mung bean

‘Iron & Clay’ cowpea

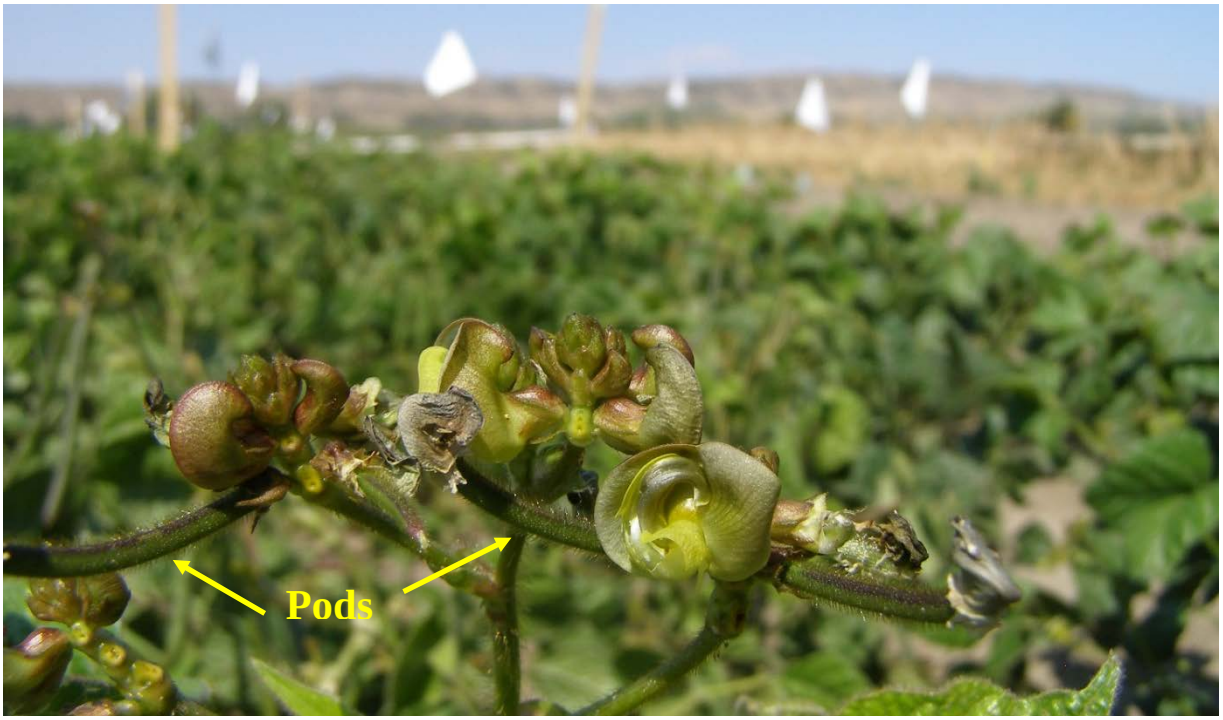
‘OK2000’ mung bean

‘Black Stallion’ 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.