Progress on the development of mung bean [*Vigna radiata* (L.) R. Wilczek] cultivars in Alberta

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Introduction

Mung bean [*Vigna radiata* (L.) R. Wilczek] is a grain legume crop cultivated across Asia. The seeds are cooked whole, included in dhal, and the flour may be used in noodles and cakes. This warm-season crop has a favorable demand in North America, particularly for sprouts. Due to conducive growing conditions southern Ontario, Canada is suitable for mung bean production. A locally developed mung bean cultivar 'AC Harosprout' was introduced into this area in 1995. This cultivar has good yield potential, a determinate growth habit, pods on the top of the plant canopy, resists lodging and ripens evenly. These traits are desired by the industry for direct combine harvesting. This variety has a mid to full-season maturation and is adapted to areas in Ontario with 3,000 or more corn heat units (CHU). Pulse traders and processors are interested in purchasing western Canadian-grown mung bean, therefore local pulse producers are attracted to growing this crop.

Objectives

1. To assess the locally available mung bean cultivar 'AC Harosprout' for adaptability, productivity and product quality.
2. To evaluate potential new lines and cultivars of mung bean for adaptability, productivity and product quality

Table 1. Agronomic performance of mung accessions at Brooks and Bow Island in 2011

Accession	Brooks		Bow Island	
	Days to flower	Yield (kg ha^{-1})	Days to flower	Yield (kg ha^{-1})
CHN-4	73	595	68	313
CSM-10-20	75	123	71	28
DZ09-02	75	538	72	191
F274	76	7	72	0
JILV No.2	68	68	67	316
M09-046	73	544	73	267
NM 94	63	14	62	103
PI 374130	65	21	66	329
B 414	80	5	72	6
VC 6370 (30-65)	61	32	63	110
VC 6372	63	105	65	323
VC 6372 (45-8-1)	64	91	60	165
VC 6368 (46-40-4)	62	22	62	100
VC 6370-92	63	23	64	50
VC 6371-94	65	14	61	114
ZHONG L08	67	604	72	287
LSD (p=0.05)	*5*	*98*	*4*	*128*

Table 2. Agronomic performance of twenty-two selected mung bean mutants at Brooks and Bow Island in 2011

Line	Brooks		Bow Island	
	Days to Maturity	Yield (kg ha^{-1})	Days to Maturity	Yield (kg ha^{-1})
M09-1001	107	1089	108	957
M09-1002	106	1118	108	680
M09-1003	109	**1526**	108	857
M09-1104	109	1237	108	798
M09-1202	109	1470	108	873
M09-1204	107	1236	110	940
M09-1301	105	633	107	658
M09-1302	107	1119	108	852
M09-1303	109	971	108	1035
M09-1503	108	1467	108	739
M09-1601	107	1085	108	765
M09-1602	110	1312	108	**1061**
M09-1603	107	1308	107	851
M09-1604	105	1514	107	856
M09-1605	109	1112	109	719
M09-1702	104	323	108	467
M09-1703	109	1002	108	856
M09-1801	107	1485	108	1028
M09-1802	108	1172	109	871
M09-1804	108	1485	109	892
M09-1902	109	1442	108	962
M09-1905	107	1224	107	817
LSD - line	*ns*	*232*	*ns*	*232*
LSD - loc x line	*ns*	*329*	*ns*	*329*

Materials and Methods

Field assessment of 'AC Harosprout'

Mung bean seed of cultivar 'AC Harosprout' were seeded in late May, 2003 and 2004 at the Crop Diversification Centre South (CDCS), in Brooks, Alberta, Canada. Two large plots (1.2-m wide and 10-m long each) were seeded at a density of 40 seeds m^{-2} with a 30-cm row spacing. The crop was assessed for plant height, maturity, 1000-seed weight and seed yield. Plots were harvested in mid-September in both years.

Evaluation of mung bean accessions

A seed assessment was conducted in a greenhouse at the Crop Diversification Centre North, in Edmonton, Alberta, Canada during the winter of 2004-2005 using 209 accessions obtained from various gene banks and collaborating institutes. All accessions were tested for performance in the field at the Crop Diversification Centre South (CDCS), in Brooks, Alberta, Canada in 2005. Based on cultivar response under field conditions, 33 accessions were selected for further evaluation in 2007 and 2008.

In 2007 and 2008, field experiments were conducted to examine 33 lines of mung bean for plant phenology, seed size and yield at three locations; Brooks and Bow Island, Alberta and Morden, Manitoba. Plot size ranged from 1.2 m wide by 4.5 m long, 4 rows with a 30-cm spacing at Brooks and Bow Island to 1.2 m wide by 5.0 m, 2 rows with a 60-cm spacing at Morden. The crop was seeded on May 26, May 27 and June 5 at Brooks, Bow Island and Morden, respectively at a density of 44 plants m^{-2}.

In 2011, 2012 and 2013, field evaluations were conducted using 16, 14 and 4 accessions, respectively, either in combination with selected mung bean mutants or separately, at Brooks and Bow Island. (Tables 1, 3 and 4). In 2011, each accession was seeded at a 30 cm row spacing, 6-m long in four rows, whereas in 2012 and 2013, they were seeded at a 72 cm row spacing, 6-m long in two rows at a seeding density of 50 seeds m^{-2}. Seeds were treated with 5% Ag. streptomycin slurry+ Apron Maxx® (fludioxonil + metalaxyl-M) mixture to suppress bacterial blight and root disease incidence.

All trials were set up as a Randomized Complete Block (RCBD) with two or three replicates at each location.

Evaluation of mung bean mutants

In 2006, one kilogram of cultivar 'AC Harosprout' was presoaked in deionized water for 9 hours and treated with a 0.2% solution of 'Ethylmethene sulphonate' (EMS) for 6 hours with intermittent shaking at 20 ^{0}C. Treated seeds (M1) were thoroughly rinsed and seeded in mid-May in the field at the Crop Diversification Centre South (CDCS). Using plant growth, early maturity and pod number as selection criteria, over 200 individual plants were selected and further evaluations were conducted in the 2007, 2008, 2009 and 2010 growing seasons. In 2011 22 lines were evaluated at Brooks and Bow Island in a replicated trial (Table 2). Data collected included; days to 50% flower, days to maturity, plant height, 1000-seed weight, halo bacterial blight assessment and seed yield.

Fig. 1. Mung bean test sites in Alberta and Manitoba in Canada

Results and discussion

Field assessment of 'AC Harosprout'

Mung bean is a tropical-origin plant species that thrives under warm growing conditions. Thus, evaluation of accessions were in warmer regions in western Canada, with higher corn heat units (>2,200) and longer (> 110 frost days) growing seasons. Studies conducted at 2003 and 2004 indicated that the crop matured 110-115 days after seeding with a yield of 520 kg ha^{-1} and 590 kg ha^{-1} in 2003 and 2004, respectively (Data not shown).

Evaluation of mung bean accessions

Of the 33 lines selected for further evaluation in Brooks, Bow Island and Morden, 11 genotypes had a maturation range of 1947 - 1996 corn heat units and yielded from 200 -750 kg ha^{-1} (Table 4). All lines, however, were susceptible to halo blight caused by *Pseudomonas syringae* pv. *Phaseolicola*.

A field study conducted using 16 mung bean accessions in 2011 indicated that at Brooks, days to flowering varied from 61 days to 80 days, and seed yield varied from 5 kg ha^{-1} for B414 to 604 kg ha^{-1} for Zhong L08. At Bow Island, days to flowering varied from 60 to 72 days and seed yield varied from 0 kg ha^{-1} for F 274 to 329 kg ha^{-1} for PI 374130 (Table 1) Bacterial blight incidence varied significantly among accessions (data not shown) , but none of the mung bean accessions exceeded seed yield of 604 kg ha^{-1}.

Evaluation of mung bean mutants

A separate study using 22 selected EMS-induced mutants in 2011 indicated that at Brooks, crop maturity ranged from 105 to110 days and seed yield ranged from 323 kg ha^{-1} for M09-1702 to 1526 kg ha^{-1} for M09-1003. At Bow Island, days to maturity ranged from 107 to 110 and seed yield ranged from 467 kg –ha^{-1} for M09-1702 to 1061 kg ha^{-1} for M09-1602 (Table 2).

Most promising mung bean accessions and mutants

In 2013, seven selected mutants and four accessions were evaluated for further selection at Brooks and Bow Island. The crop at Bow Island was totally destroyed by the heavy rain storm and windy conditions. Table 3 summarizes data only from Brooks. Results indicates that days to flowering of tested mutants and accessions varied from 57 to 65 days, blight incidence was very low with 1 to 3 scale, plant height at harvest ranged from 34 to 46 cm, maturity ranged from 99 to 107 days and seed yield ranged from 264 kg ha^{-1} for AVMU8501 to 1294 kg ha^{-1} for M09-1804.

Summary

- All introduced accessions are highly susceptible to halo bacterial blight cause by *Pseudomonas syringae* pv. *phaseolicola.*, as compared to mutants.
- Seed treatment with 5% Ag. streptomycin slurry+ Apron Maxx® (fludioxonil + metalaxyl-M followed by repeated application of copper oxide based fungicide/bactericide can be used to control halo blight incidence.
- The majority of the tested accessions and mutants are somewhat photo-period period sensitive to flowering, consequently flower initiation occurs in early to mid-July.
- Several promising mung bean mutants are available for seed production in Alberta, but, depending upon the growing season, seed yield can vary from 100 to 1660 kg ha^{-1} with maturity range of 96 to 100 days.

Fig 2. Mung bean test plots at Bow Island, Alberta

Table 3. Agronomic performance of selected mutants and accessions at Brooks in 2013

Line / Accession	Days to Flower	Bact blight (1-9)	Plant height (cm)	Days to Maturity	Yield (kg ha^{-1})
M09-1003	57	1	34	99	1071
M09-1202	57	1	34	102	826
M09-1602	57	1	36	101	1083
M09-1603	59	2	33	99	1062
M09-1605	58	1	27	102	766
M09-1703	57	1	31	102	889
M09-1804	59	1	41	100	1296
CH 616	63	1	46	102	814
AVMU8501	62	3	44	107	264
AVDRCV-1411	65	2	44	107	488
V218HLVI	65	3	39	107	500

Table 4. Crop heat units, seed yield and CBB rating of eleven mung bean accessions at Brooks, Bow Island and Morden in 2007 and 2008.

Accession	CHU to maturity	Yield (kg ha-1)	Bacterial Blight (1-9)[u]
	Mean	Mean	
VC 6372 (45-8-1)	1974	750	0.8
CHN-4	1966	690	0.5
CN 33520	1981	580	1.0
NM 94	1973	540	2.5
Morden Mung	1988	500	0.5
CHN-18	1973	480	1.3
Morden 39	1993	430	0.8
JILIN	1996	430	0.3
PI 374130	1967	420	1.3
Chinese 2000	1996	340	0.5
AC Harosprout	1982	200	1.3
Mean	1981	490	1.2
'Pintium' dry bean[z]	1947	2600	-
Probability	<0.01	<0.01	0.01
Tukey-Kramer test[y]	28	270	1.8
Standard error	6	64	0.4

[u]Disease rating for common bacterial blight (CBB) (%): 0 = <10%; 1 = 10 to 40%, 2 = 40-70% and 3 = >70% of leaves with CBB.

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Conclusions

1. Several genotypes of mung bean selected from exotic accession and mutants are available for seed production in southern Alberta.
2. Among tested accessions, CH 616, ZHONG L08, CN 35520 as well as mung bean mutants M09-1003, M09-1204, M09-1602, M09-1603, and M09-1804 are the most promising genotypes. These can be used for further evaluation, selection and seed production, as well as parental material for crop improvement.
3. Further improvement on seed yield, resistant to halo blight, standability and crop maturity are imperative for cost-effective seed production.

References

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