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Morphological Characterization and Evaluation of Mungbean [*Vigna radiate* (L.) Wilczek] Germplasm for Various Yield Attributing Traits

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A B S T R A C T

The present investigation was carried out with 112 diverse genotypes along with 5 checks of mungbean [*Vigna radiata* (L.) Wilczek] during *Kharif* season. Data were recorded on various morphological and agronomic characters including hypocotyl pigmentation, days to 50 percent flowering, plant height, number of leaves, number of branches, number of clusters, number of pods per cluster, total number of pods per plant, pod length, pod diameter, pod wall thickness, seed length, seed diameter, 100-seed weight, seed density and seed yield. Analysis of variance revealed significant differences among all the genotypes for all the characters studied. Wide range of variation had been observed for all the characters except hypocotyl pigmentation. Eight genotype were at par with respect to seed yield per plot from the best performing check PM-6 (0.55 kg), these genotype were as PM 06-46 (0.71 kg), MH-318 (0.69 kg), VC 1997 A (0.68 kg), SML-668 (0.67 kg), COGG-912 (0.62 kg), Barimung-5 (0.61 kg), PM 03-4 (0.59 kg) and TM 96-2 (0.58 kg). The study also provides information about the performance of some of the promising genotypes in respect of morphological and agronomic characters and identifies some prominent genotypes. These genoypes may be further used for parental selection in breeding programmes for improvement of yield and various qualitative and quantitative characteristics in mungbean.

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] is one of the important grain legumes of global economic importance. In India, it is the third most important pulse crop after chickpea and pigeon pea. It belongs to family Fabaceae (syn. Leguminoseae) and sub family

Papilionaceae. It is believed to have been domesticated from *Vigna radiata* var. *sublobata*. Mungbean, also known as green gram, has originated in Indian sub-continent. Mungbeans are mainly cultivated in India, China, Thailand, Philippines, Indonesia, Burma, and Bangladesh and in hot and dry regions of South Europe and Southern USA (Singh *et al.*, 2005). It is priced among pulse crops as its seeds are high in essential dietary protein, easily digested and produce low flatulence when consumed as food (Lakhanpaul *et al.*, 2000). Mungbean is primarily used as *dhal*. Green pods are used as vegetables and is an excellent source of easily digestible protein (22-25%) (Rao *et al.*, 1964). Easy assimilability, short duration of cropping and the ease with which it could be grown as a mixture with other crops makes it superior than other legumes.

In any crop breeding programme, germplasm evaluation plays a vital role in identification of superior genotypes for different qualitative and quantitative characters which may be further used to create variability by hybridization. Plant genetic resources are the most valuable and essential basic raw materials to meet the current and future needs of crop improvement programmes (Paroda *et al.*, 1991). The genotypes which are suitable at present may not be suited in future due to change in environment and susceptibility to biotic and abiotic stresses. The evaluation of germplasm to identify genotypes capable of withstanding/ adapting to the newer stresses arising from the changing environment is, therefore, a continuous and indispensable process in crop improvement. The present investigation was, therefore, undertaken to morphological characterization and evaluation of mungbean germplasm for yield and attributing characters and identifies superior genotypes among them for various characters under studied.

Materials and Methods

The experiment on morphological characterization and evaluation of Mungbean (*Vigna radiata*) germplasm for various yield attributing traits were conducted at N. E. Borlaug Crop Research Center of G.B. Pant University of Agriculture and Technology, Pantnagar, India, during *Kharif* 2010-2011. The experimental material for the present study consisted of 112 germplasm lines of *Vigna radiata* along with 5 checks *viz.* Pant Mung-2 (PM-2), Pant Mung-3 (PM-3), Pant Mung-4 (PM-4), Pant Mung-5 (PM-5) and Pant Mung-6 (PM-6). The germplasm strains selected for the investigation were genetically diverse and exhibited wide range of variation for the qualitative and quantitative characters (Table 2). The field experiment was laid out in Augmented Block Design (Federer, 1961), which consisted 4 blocks with 5 checks repeated in each block. Two rows of each entry were planted with keeping row length 4 meter. Row to row distance was kept 30 cm and plant to plant distance was maintained at 10 cm.

Observations recorded

Total 16 characters were recorded following DUS guideline of mungbean, these were as hypocotyl pigmentation (red or green), days to 50 percent flowering, plant height (cm), number of leaves, number of branches, number of clusters, number of pods per cluster, total number of pods per plant, pod length (cm), pod diameter (mm), pod wall thickness (mm), seed length (mm), seed diameter (mm), 100-seed weight (gm), seed density (gm/ml) and seed yield per plot (kg/plot). Observations were recorded on the whole plot basis for the characters hypocotyl pigmentation and days to 50 percent flowering, whereas the characters like plant height, number of branches, number of clusters, number of pods per cluster, total

number of pods per plant and number of leaves were taken on five randomly selected competitive plants from each line. The average values for these plants were calculated and used for the statistical analysis. Pod length, pod diameter and pod wall thickness were recorded on 10 randomly selected pods in each entry. Seed length and seed diameter were recorded on 10 randomly selected seeds in each entry, while 100-seed weight and seed density recorded on three sets (replications) of 100 randomly selected seeds in each entry.

Statistical analysis: The data were analyzed using IRRISTAT software.

Results and Discussion

The analysis of variance for the characters days to 50 percent flowering, plant height, number of leaves, number of branches, number of clusters, number of pods per cluster, total number of pods per plant, pod length, pod diameter, pod wall thickness, seed length, seed diameter, 100-seed weight, seed density and seed yield per plot was performed in augmented block design (ABD) and the results along with checks mean, Coefficient of variation and least significant differences for different characters are presented in table 1.

The statistical analysis revealed highly significant differences among the genotypes for all the characters studied which clearly indicated that there was sufficient variability for each character among the genotypes selected for the study. The adjusted mean value for all the characters of different genotypes, general mean and range of variation are presented in table 2. The list of top five superior genotypes for different characters is presented in table 3.

Out of 112 genotypes 100 had red pigmentation on the hypocotyl while 12 genotypes had green pigmentation. These 12 genotypes were Barimung-5, UPM 03-18, PM 08-16, PM 08-2, 45-8-1, NDM 5-3, VC 6040 A, ML 133, Pusa Ratna, PM 06-39, PM 06-43 and KM 09-174. The range of variation in days to 50 percent flowering varied from 31 days (CN 9-5) to 48 days (PM 06-34), plant height varied from 34.17 cm (IPM 02-19) to 84.49 cm (PM 06-57), number of branches lied between 2.35 (VC 7960-88) to 9.25 (PU 03-11). Number of clusters ranged from 3.83 (PM 06-43) to 38.03 (PM 06-32) and number of pods per cluster ranged between 3.17 (SML 668) to 5.67 (PM 06-46). Total number of pods per plant ranged from 18.10 (Harsha) to 88.14 (PM 06-46) and number of leaves ranged from 11.18 (NH-54) 61.36 (PM 06-32).

Average pod length varied from 4.10 cm (*Vigna radiata* var *sublobata*) to 10.32 cm (NH-54), average pod diameter was between 2 mm (*Vigna radiata* var *sublobata*) to 6.01 mm (VC 1997 A) and average pod wall thickness varied from 0.14 mm (RMG 991 and VC7960) to 0.28 mm (Barimung-5). Average seed length ranged from 2.63 mm (*Vigna radiata* var *sublobata*) to 5.55 mm (VC 6790A) and average seed diameter was between 1.73 mm (*Vigna radiata* var *sublobata*) to 4.02 mm (VC 1997 A).

Range of variation for 100-seed weight varied from 2.20 g (*Vigna radiata* var *sublobata*) to 5.85 g (VC 1997 A) and density of seed ranged from 1.12 g/ml (PM 08-1) to 1.72 g/ml (VC 1997 A). Seed yield per plot varied from 0.04 kg (*Vigna radiata* var *sublobata*) to 0.71 kg (PM 06-46). However, total eight genotype were at par with respect to seed yield per plot from the best performing check PM-6 (0.55 kg), these genotype were as PM 06-46 (0.71 kg), MH-318 (0.69 kg), VC 1997 A (0.68 kg), SML-668 (0.67 kg), COGG-912 (0.62 kg), Barimung-5 (0.61 kg), PM 03-4 (0.59 kg) and TM 96-2 (0.58 kg).

Table.1 Analysis of Variance in ABD for different characters of mungbean genotypes

S. No.	Characters	Mean value of Checks					Mean Sum of Squares			CV	CM	AVSB	AVDB	AVAC
		PM-2	PM-3	PM-4	PM-5	PM-6	*Blocks*	*Checks*	*Error*					
1.	Days to 50% flowering	39.50	39.00	39.50	36.75	42.25	5.60	15.33	6.06	5.15	3.79	7.58	8.31	6.57
2.	Plant height (cm)	53.55	68.50	58.30	55.40	75.30	2.71	347.57**	15.31	5.17	6.03	12.00	13.20	10.44
3.	No. of leaves	30.35	33.15	22.33	24.65	41.60	0.99	231.27**	4.90	6.92	3.41	6.82	7.47	5.91
4.	No. of branches	3.30	4.50	3.60	3.67	4.67	0.07	1.45**	0.04	4.96	0.30	0.61	0.67	0.53
5.	No. of clusters	14.75	15.51	20.00	17.20	23.50	2.43	51.45**	1.87	6.95	2.10	4.21	4.61	3.65
6.	No. of pods/cluster	3.95	4.15	4.20	3.90	4.33	0.09	0.13	0.05	5.51	0.36	0.72	0.79	0.63
7.	Total no. of pods/plant	55.15	53.27	39.20	29.20	66.65	6.53	855.24**	15.91	7.96	6.14	12.29	13.46	10.64
8.	Pod length (cm)	7.08	7.11	8.08	8.37	6.86	0.59	1.82**	0.17	4.43	0.64	1.29	1.41	1.12
9.	Pod diameter (mm)	4.28	4.44	4.60	4.96	4.53	0.03	0.25**	0.03	2.88	0.28	0.57	0.62	0.49
10.	Pod wall thickness (mm)	0.16	0.18	0.20	0.20	0.20	0.00003	0.001**	0.00001	1.26	0.01	.01	0.01	0.01
11.	Seed length (mm)	4.13	3.77	3.86	4.07	3.75	0.01	0.12**	0.01	2.24	0.16	0.31	0.34	0.27
12.	Seed diameter (mm)	3.13	3.12	3.10	3.62	3.05	0.00079	0.22**	0.0064	1.87	0.12	0.25	0.27	0.21
13.	100-seed weight (gm)	3.23	3.17	3.46	4.82	3.26	0.04	1.41**	0.16	4.79	0.14	0.28	0.31	0.24
14.	Seed density (gm/ml)	1.27	1.35	1.35	1.43	1.34	0.002	0.032	0.07	3.53	0.04	0.08	0.09	0.07
15.	Seed yield per plot (kg)	0.45	0.46	0.44	0.52	0.55	0.002	0.038**	0.022	8.85	0.07	0.02	0.03	0.02

* Significant at 5% of level of probability
** Significant at 1% of level of probability
CM= least significant difference between the means of two check varieties,
AVSB = least significant difference between adjusted values of two selections in the same block,
AVDB = least significant difference between adjusted value of two selection in different blocks,
AVAC = least significant difference between an adjusted selection value and a check mean

Table.2 Adjusted mean for various characters of mungbean genotypes

S. N.	Genotypes	Days to 50% flowering	Plant height (cm)	No. of leaves	No. of branches	No. of cluster	No. of pods/ cluster	Total no. of pods/ plant	Pod length (cm)	Pod dia. (mm)	Pod wall thickness (mm)	Seed length (mm)	Seed dia. (mm)	100-seed wt (g)	Seed density (g/ml)	Seed yield / plot (kg)
1	**PM-03-2**	39	41.25	24.30	9.05	9.55	4.59	31.38	9.03	5.19	0.22	4.68	3.47	4.45	1.37	0.35
2	**PM 03-4**	39	54.45	23.30	5.05	15.55	4.39	50.98	8.27	5.22	0.22	4.92	3.70	4.58	1.37	0.59
3	**PM 03-5**	37	56.85	28.70	8.05	14.55	3.59	40.98	8.18	4.97	0.19	4.19	3.17	4.02	1.34	0.35
4	**PM 03-7**	37	60.45	23.30	6.45	10.95	4.19	38.98	7.95	5.05	0.18	4.86	3.48	4.50	1.38	0.39
5	**PM 03-9**	36	67.85	30.90	9.05	9.95	4.19	46.58	7.50	4.77	0.18	3.99	3.51	3.89	1.36	0.34
6	**PM 03-11**	41	77.25	32.70	9.25	10.15	4.39	50.38	7.87	4.92	0.19	4.76	3.57	4.37	1.38	0.49
7	**PM 03-12**	43	61.25	36.30	6.85	7.75	4.19	42.38	7.00	4.53	0.16	4.38	3.36	3.63	1.40	0.24
8	**PM 03-13**	39	69.65	28.50	6.65	9.55	4.19	34.38	8.37	4.94	0.21	4.14	3.12	4.16	1.37	0.31
9	**PM 03-15**	36	74.45	32.50	9.05	14.95	4.39	38.78	7.67	4.89	0.19	4.52	3.47	4.43	1.39	0.35
10	**PM 03-16**	36	54.85	25.10	5.65	7.35	4.59	28.58	6.66	4.58	0.17	4.02	3.20	3.68	1.41	0.13
11	**PM 03-17**	35	52.25	22.10	4.25	8.75	4.39	32.98	7.99	5.20	0.22	4.77	3.53	4.17	1.40	0.30
12	**PM 03-18**	39	59.85	21.10	3.65	8.55	4.39	32.78	7.66	4.72	0.20	4.47	3.16	3.88	1.39	0.22
13	**PM 03-19**	35	64.05	23.50	5.25	12.95	4.19	45.18	7.87	5.16	0.20	4.05	3.12	4.09	1.28	0.38
14	**PM 03-20**	35	55.25	22.30	3.65	9.75	3.99	30.98	9.25	5.40	0.24	4.92	3.50	4.76	1.30	0.38
15	**PM 03-22**	37	62.25	31.30	4.45	15.75	4.19	44.98	8.37	4.97	0.23	4.68	3.43	4.29	1.38	0.46
16	**PM 03-23**	36	60.05	20.30	3.25	10.95	3.19	29.18	8.91	5.20	0.21	5.18	3.58	4.95	1.37	0.36
17	**PM 03-24**	41	55.45	28.10	3.85	12.35	3.59	36.78	7.76	4.79	0.19	4.18	3.29	4.04	1.36	0.28
18	**PM 03-25**	39	56.05	31.90	3.65	12.35	4.39	46.18	8.41	4.86	0.25	4.54	3.43	4.56	1.40	0.50
19	**PM-3(M)**	40	71.05	34.90	3.65	15.55	4.19	51.58	7.04	4.39	0.19	4.25	3.40	3.03	1.18	0.19
20	**PM 06-4**	39	59.25	32.30	4.45	15.15	3.59	37.58	6.93	4.46	0.20	4.29	3.17	3.33	1.38	0.17
21	**PM 06-16**	42	64.25	22.50	3.45	19.75	3.99	53.38	7.30	4.49	0.19	4.14	3.18	3.01	1.30	0.24
22	**PM 06-31**	47	72.45	32.10	4.05	21.75	3.99	55.98	6.72	4.63	0.23	4.13	3.23	3.22	1.36	0.28
23	**PM 06-41**	41	70.05	25.10	4.45	24.75	3.79	43.58	6.54	4.86	0.21	4.34	3.39	3.56	1.40	0.25
24	**PM 06-42**	42	82.65	31.90	3.45	17.15	3.59	47.58	6.71	4.58	0.23	4.16	3.23	3.23	1.38	0.23
25	**PM 06-45**	41	74.85	16.70	3.45	15.15	4.19	36.58	7.72	4.54	0.22	3.72	3.09	3.30	1.27	0.17
26	**PM 06-48**	39	69.45	21.10	3.65	12.75	4.59	24.38	7.67	4.81	0.19	4.61	3.57	3.56	1.30	0.11
27	**PM 06-49**	39	70.85	35.90	3.45	18.55	3.79	49.58	7.16	4.93	0.20	4.87	3.33	3.48	1.32	0.30

28	**PM 06-51**	41	79.65	42.50	4.65	17.15	5.39	50.38	7.75	4.91	0.21	3.95	3.49	3.56	1.35	0.36
29	**PM 06-57**	42	84.49	43.58	3.55	16.59	4.39	53.80	7.50	4.47	0.22	4.20	3.35	3.40	1.38	0.33
30	**MH-429**	37	64.49	26.18	3.55	9.59	3.99	37.60	7.79	4.40	0.20	4.01	3.03	3.44	1.31	0.19
31	**NH-54**	34	59.49	11.18	3.35	12.79	3.59	29.80	10.32	5.24	0.20	5.03	3.49	3.28	1.30	0.25
32	**NM-94**	39	60.49	18.58	3.15	14.39	3.59	37.40	7.83	4.43	0.19	4.40	3.38	3.61	1.35	0.22
33	**NM-1 (Mutant)**	39	47.69	27.18	2.55	9.79	3.39	24.40	7.20	4.39	0.19	3.84	3.43	3.69	1.42	0.10
34	**ICM-1**	37	55.49	27.58	3.15	9.39	4.39	34.00	7.20	4.40	0.19	3.84	3.43	3.07	1.31	0.12
35	**VC 6790 A**	33	68.89	31.18	2.95	12.59	3.99	28.60	8.86	5.71	0.26	5.55	3.81	5.31	1.35	0.42
36	**VC 6769 (57-99)**	32	57.69	21.78	3.55	13.99	3.99	42.20	7.86	4.87	0.20	3.83	3.30	3.75	1.29	0.29
37	**VC 7960-88**	33	52.29	20.18	2.35	10.79	3.59	27.20	8.25	5.32	0.22	4.73	3.53	4.38	1.49	0.29
38	**BDYR-1**	37	79.49	46.38	4.75	26.19	4.19	61.40	7.80	4.59	0.22	4.35	3.36	3.88	1.32	0.47
39	**BDYR-2**	37	64.69	31.98	4.15	18.99	3.79	45.20	8.08	4.83	0.24	4.04	3.18	3.91	1.39	0.38
40	**Barimung-4**	44	70.49	45.58	6.15	28.59	3.79	57.00	7.75	4.42	0.22	4.20	3.15	3.41	1.31	0.44
41	**Barimung-5**	37	53.69	29.78	3.55	12.59	4.39	34.00	8.36	5.90	0.28	4.28	3.81	5.52	1.53	0.61
42	**Barimung-7**	37	60.29	17.78	3.35	11.79	3.99	37.60	7.07	4.22	0.23	3.84	3.45	3.30	1.37	0.36
43	**Barisal Local**	37	62.29	18.38	3.55	12.59	3.79	37.40	9.21	4.79	0.21	4.21	3.28	3.90	1.54	0.40
44	**Mauritius Local**	32	67.09	40.78	5.35	25.19	4.39	62.00	7.65	4.43	0.18	3.81	3.35	3.84	1.48	0.50
45	**Pusa Vishal**	32	57.69	31.58	3.55	16.19	3.79	41.40	7.95	4.88	0.21	4.42	3.53	4.00	1.15	0.27
46	**UPM 02-16**	39	56.09	22.98	2.75	12.59	3.39	36.20	9.42	4.80	0.23	4.48	3.27	3.77	1.34	0.32
47	**UPM 98-1**	31	56.49	31.38	3.95	18.39	3.59	38.80	8.02	4.66	0.20	4.17	3.46	3.71	1.39	0.28
48	**UPM-98**	39	50.09	30.38	2.75	10.79	3.59	32.40	9.08	5.09	0.23	5.00	3.82	4.53	1.42	0.38
49	**UPM 03-18**	39	60.09	28.78	3.15	10.19	3.59	38.40	7.56	4.53	0.21	4.35	3.49	4.27	1.39	0.29
50	**UPM 98-10**	42	71.69	38.58	4.15	19.79	4.19	49.40	8.00	4.49	0.26	3.92	3.16	3.32	1.26	0.27
51	**UPM 93-3**	42	70.69	34.58	4.75	25.19	3.99	56.80	8.06	4.76	0.22	4.09	3.29	3.66	1.31	0.42
52	**UPM 99-3**	39	50.69	28.98	3.55	15.39	3.79	44.20	7.40	4.58	0.17	4.11	3.37	3.75	1.32	0.27
53	**PM 08-16**	42	55.89	29.98	3.55	18.19	4.19	51.80	7.98	4.41	0.18	3.94	2.94	3.31	1.24	0.28
54	**PM 08-2**	37	48.69	22.58	2.54	13.19	4.39	45.00	7.69	4.41	0.17	3.96	3.20	2.86	1.21	0.17
55	**PM 08-1**	33	58.89	32.38	4.15	20.79	4.19	51.20	8.54	4.83	0.16	4.57	3.56	4.25	1.12	0.41
56	**MH-318**	37	48.69	34.78	4.15	17.79	3.99	57.40	9.46	4.91	0.24	4.46	3.73	5.24	1.56	0.69
57	**Mauritius Mung-1**	32	50.09	29.18	2.81	8.22	3.97	31.50	7.21	4.48	0.19	4.07	3.32	3.73	1.36	0.16
58	***V. radiata* var *sublobata***	38	36.29	24.98	3.41	11.62	3.17	30.30	4.10	2.00	0.16	2.63	1.73	2.20	1.23	0.04

59	**Pant Mung-5**	38	45.29	15.38	2.61	9.82	3.97	23.70	7.53	5.00	0.21	4.52	3.51	4.84	1.40	0.20
60	**Harsha**	40	48.69	26.18	3.01	5.42	3.77	18.10	6.50	3.95	0.20	3.93	2.77	5.00	1.60	0.09
61	**KM-2241**	44	54.89	28.38	2.61	12.02	4.16	40.10	6.64	4.19	0.19	4.02	2.98	3.35	1.32	0.15
62	**OBGG-52**	38	48.49	20.58	2.41	10.62	4.16	39.70	5.72	4.00	0.18	3.69	2.87	2.90	1.35	0.08
63	**12/333**	38	58.29	26.38	4.01	22.42	4.16	59.30	7.39	4.52	0.21	4.12	3.15	3.29	1.37	0.35
64	**SML-668**	34	61.09	26.78	3.81	18.62	3.17	45.10	9.52	5.44	0.18	5.07	3.33	4.86	1.52	0.67
65	**45-8-1**	40	51.09	39.98	3.61	17.62	3.97	49.30	7.56	4.61	0.21	4.49	3.58	3.32	1.39	0.30
66	**AKM-9904**	38	57.49	34.18	3.81	16.62	3.57	45.30	7.16	4.27	0.18	4.22	3.28	3.35	1.31	0.21
67	**Pre Dred**	38	49.09	21.18	3.81	12.42	3.97	56.50	7.48	4.60	0.18	4.55	3.14	3.29	1.44	0.36
68	**Samrat**	47	50.09	29.18	2.81	8.22	3.97	31.50	6.67	4.29	0.18	3.98	3.29	4.24	1.51	0.19
69	**NDM 5-3**	42	64.89	41.78	4.61	24.42	3.77	62.90	7.72	4.09	0.18	4.22	3.17	3.59	1.40	0.40
70	**MH-429**	34	62.29	40.58	4.81	16.82	3.77	55.10	7.66	4.44	0.15	4.30	3.17	4.46	1.49	0.53
71	**NIABM**	33	53.09	19.98	2.61	9.22	3.57	24.90	7.76	4.63	0.20	4.24	3.52	3.77	1.41	0.14
72	**VC 1997 A**	38	60.69	33.98	3.61	17.02	3.77	49.10	9.31	6.01	0.22	5.54	4.02	5.85	1.72	0.68
73	**VC 6040 A**	40	47.29	14.18	2.81	9.42	3.77	30.50	7.28	4.18	0.16	4.62	3.35	5.09	1.53	0.26
74	**VC-7960**	38	40.29	12.98	2.81	9.42	3.77	28.10	6.96	4.87	0.14	4.41	3.16	5.16	1.60	0.30
75	**HUM-16**	34	39.89	17.98	2.61	8.02	3.77	27.30	7.79	4.61	0.16	4.90	3.12	5.15	1.66	0.32
76	**NDM-1**	40	69.49	45.38	4.81	25.82	3.97	63.50	7.03	4.99	0.23	3.81	3.49	3.49	1.25	0.47
77	**NDM 5-31**	38	59.29	32.78	4.01	17.22	4.16	43.10	7.60	4.55	0.21	4.13	3.37	4.17	1.44	0.35
78	**MH-418**	42	56.09	32.98	4.01	18.62	3.97	61.30	6.56	4.54	0.21	3.79	3.15	3.00	1.17	0.22
79	**ML-133**	40	56.09	43.38	3.81	14.42	4.37	58.70	7.47	5.13	0.18	4.05	3.19	3.52	1.20	0.38
80	**CN 9-5**	31	58.09	33.98	3.01	18.22	4.37	61.10	8.31	4.95	0.17	4.48	3.57	5.11	1.34	0.51
81	**Mung Local**	34	48.09	26.78	3.01	18.82	3.57	55.10	6.35	4.75	0.20	4.32	3.13	3.07	1.15	0.20
82	**Pusa Ratna**	34	37.49	18.98	2.40	7.22	3.97	26.90	6.76	4.34	0.17	4.11	2.98	3.94	1.39	0.12
83	**Pusa-9531**	42	51.49	23.78	2.61	11.82	3.97	38.70	6.09	4.36	0.18	3.96	3.36	3.79	1.35	0.17
84	**Pusa-672**	38	52.29	41.58	3.61	13.42	3.37	35.90	7.51	4.65	0.20	4.47	3.22	2.89	1.19	0.12
85	**IPM 02-19**	36	50.37	29.96	3.79	17.23	4.07	57.54	7.34	4.47	0.17	4.09	3.15	3.44	1.31	0.33
86	**IPM 02-17**	39	55.17	30.16	3.59	20.83	3.87	59.34	7.28	4.65	0.17	4.10	2.98	3.70	1.35	0.40
87	**MH-521**	39	53.37	20.96	3.79	12.23	3.87	39.94	7.12	4.62	0.19	3.82	3.31	3.84	1.37	0.25
88	**MH-318**	41	53.97	25.76	3.99	14.43	4.07	49.14	7.16	4.17	0.17	3.74	3.06	3.50	1.36	0.25
89	**TM 96-2**	35	61.37	44.96	4.99	25.63	4.47	69.34	9.15	4.94	0.21	4.45	3.40	4.11	1.37	0.58
90	**COGG-912**	41	65.77	32.96	4.39	19.43	3.87	50.34	7.80	5.26	0.24	4.95	3.16	5.09	1.56	0.62

91	**RMG-991**	39	51.57	29.96	3.59	15.63	3.67	44.74	5.97	3.88	0.14	3.95	2.81	3.05	1.20	0.09
92	**Pusa-871**	39	47.37	17.56	3.19	12.03	3.47	34.34	6.54	4.18	0.16	3.79	3.17	3.51	1.40	0.13
93	**PM 06-32**	39	81.37	61.36	4.39	38.03	3.87	65.94	6.33	4.36	0.19	3.66	3.13	2.87	1.15	0.49
94	**PM 06-33**	41	62.77	35.96	3.79	20.03	4.07	49.74	7.39	4.63	0.21	3.98	3.30	4.13	1.44	0.41
95	**PM 06-34**	48	69.37	41.36	4.39	24.63	3.67	62.94	7.72	4.18	0.17	4.10	3.29	3.67	1.34	0.40
96	**PM 06-35**	44	59.97	25.16	3.19	14.43	3.67	42.54	7.21	4.20	0.19	3.69	3.17	3.59	1.35	0.21
97	**PM 06-36**	39	67.17	46.36	3.79	17.23	4.87	58.34	7.59	4.53	0.21	3.77	3.25	3.60	1.39	0.40
98	**PM 06-37**	41	72.77	47.36	5.79	29.83	3.67	63.34	6.75	4.78	0.22	3.70	3.35	3.40	1.34	0.47
99	**PM 06-39**	39	53.77	37.16	4.19	19.83	3.47	39.94	6.64	4.33	0.20	4.06	3.34	3.30	1.34	0.16
100	**PM 06-43**	41	64.77	34.16	5.39	3.83	5.07	57.14	6.85	4.26	0.19	3.68	3.09	3.23	1.35	0.27
101	**PM 06-46**	41	81.17	43.76	5.39	30.23	5.67	88.14	6.83	4.66	0.19	4.02	3.19	3.71	1.36	0.71
102	**KM 09-174**	41	54.57	34.36	4.39	18.63	3.27	47.14	8.81	4.80	0.18	4.47	3.47	4.36	1.34	0.48
103	**KM 09-182**	42	55.17	28.76	3.79	18.63	3.87	41.34	7.43	4.54	0.18	4.29	3.25	3.16	1.22	0.17
104	**SM 10-505**	39	48.97	21.96	3.39	13.03	3.67	33.94	7.15	4.46	0.16	3.89	3.22	3.23	1.28	0.13
105	**SM 10-503**	41	49.97	21.56	3.99	15.03	4.47	34.14	7.23	4.38	0.18	3.76	3.04	3.40	1.29	0.14
106	**SM 10-533**	41	49.57	18.96	3.59	23.63	3.27	34.34	9.15	4.80	0.20	4.56	3.49	4.34	1.48	0.39
107	**SM 10-529**	39	57.17	41.76	4.59	24.43	3.47	53.74	9.26	4.77	0.22	4.21	3.32	4.98	1.42	0.54
108	***V. trilobata* X**	41	62.77	37.76	5.19	25.83	4.27	57.54	7.35	4.73	0.19	3.98	3.24	3.49	1.30	0.36
109	***V. sublobata*X**	42	56.37	29.36	5.59	20.83	3.87	51.34	7.36	4.73	0.19	3.97	3.26	2.56	1.32	0.20
110	***V. silvestris* X**	42	57.77	42.16	4.79	20.83	3.47	49.34	5.10	4.44	0.23	4.19	2.76	3.81	1.50	0.22
111	**IPM 02-19**	47	34.17	25.16	3.59	19.83	3.27	40.54	6.50	4.39	0.18	4.17	3.26	3.17	1.29	0.14
112	**PM 06-50**	36	36.97	27.76	3.19	11.43	3.27	29.94	7.39	4.29	0.18	4.11	3.11	4.07	1.53	0.20
Mean		**38.38**	**58.71**	**29.86**	**4.10**	**15.76**	**3.96**	**44.15**	**7.59**	**4.66**	**0.20**	**4.24**	**3.29**	**3.85**	**1.36**	**0.31**
Range	**Min.**	**31**	**34.17**	**11.18**	**2.35**	**3.83**	**3.17**	**18.10**	**4.10**	**2.00**	**0.14**	**2.63**	**1.73**	**2.20**	**1.12**	**0.04**
	Max.	**48**	**84.49**	**61.36**	**9.25**	**38.03**	**5.67**	**88.14**	**10.32**	**6.01**	**0.28**	**5.55**	**4.02**	**5.85**	**1.72**	**0.71**

Table.3 List of superior genotypes for different characters

S. No.	Character	Rank	Genotypes	Values
1.	Days to 50% flowering	1.	UPM 98-1	31.00
		2.	CN 9-5	31.00
		3.	VC 6769 (57-99)	32.00
		4.	Mauritius Local	32.00
		5.	Pusa Vishal, Mauritius Mung-1	32.00
2.	Plant height (cm)	1.	IPM 02-19	34.17
		2.	*Vigna radiata* var *sublobata*	36.29
		3.	PM 06-50	36.97
		4.	Pusa ratna	37.49
		5.	HUM-16	39.89
3.	Number of leaves	1.	NH 54	11.18
		2.	VC 7960	12.98
		3.	VC 6040 A	14.18
		4.	Pant mung-5	15.38
		5.	PM 06-45	16.70
4.	Number of branches	1.	VC 7960-88	2.35
		2.	Pusa ratna	2.40
		3.	OBGG-52	2.41
		4.	PM 08-2	2.54
		5.	NM 1 (Mutant)	2.55
5.	Number of clusters	1.	PM 06-32	38.03
		2.	PM 06-46	30.23
		3.	PM 06-37	29.83
		4.	Barimung-4	28.59
		5.	BDYR-1	26.19
6.	Number of pods per cluster	1.	PM 06-46	5.67
		2.	PM 06-51	5.39
		3.	PM 06-43	5.07
		4.	PM 06-36	4.87
		5.	PM-03-2, PM 03-16, PM 06-48	4.59
7.	Total number of pods per plant	1.	PM 06-46	88.14
		2.	TM 96-2	69.34
		3.	PM 06-32	65.94
		4.	NDM-1	63.50
		5.	PM 06-37	63.34
8.	Pod length (cm)	1.	NH-54	10.32

		2.	SML-668	9.52
		3.	MH-318	9.46
		4.	UPM 02-16	9.42
		5.	VC 1997 A	9.31
9.	Pod diameter (mm)	1.	VC 1997 A	6.01
		2.	Barimung-5	5.90
		3.	VC 6790 A	5.71
		4.	SML-668	5.44
		5.	PM 03-20	5.40
10.	Pod wall thickness (mm)	1.	RMG 991	0.14
		2.	VC 7960	0.14
		3.	MH 429	0.15
		4.	PM 08-1	0.16
		5.	*Vigna radiata* var *sublobata*	0.16
11.	Seed length (mm)	1.	VC 6790 A	5.55
		2.	VC 1997 A	5.54
		3.	PM 03-23	5.18
		4.	SML-668	5.07
		5.	NH-54	5.03
12.	Seed diameter (mm)	1.	VC 1997 A	4.02
		2.	UPM-98	3.82
		3.	VC 6790 A	3.81
		4.	Barimung-5	3.81
		5.	MH-318	3.73
13.	100-seed weight (g)	1.	VC 1997 A	5.85
		2.	Barimung-5	5.52
		3.	VC 6790 A	5.31
		4.	MH-318	5.24
		5.	VC-7960	5.16
14.	Seed density (g/ml)	1.	VC 1997 A	1.72
		2.	HUM-16	1.66
		3.	VC-7960, Harsha	1.60
		4.	COGG-912, MH-318	1.56
		5.	Barisal local	1.54
15.	Seed yield per plot (kg)	1.	PM 06-46	0.71
		2.	MH-318	0.69
		3.	VC 1997 A	0.68
		4.	SML-668	0.67
		5.	COGG-912	0.62

The efficiency of a breeding programme for the improvement of quantitative traits depends to a large extent on magnitude of variability present in the available germplasm (Hanna *et al.*, 1999). Goodman (1999) emphasized the importance of breeding stock and germplasm accessions by suggesting that although lines may be unpromising phenotypically but may contain untapped alleles or allelic combinations that could be utilized for plant breeding with adequate investment in conventional and marker assisted selection. The list of promising genotypes in respect of various characters has been presented in table 3, which may be used for parental selection in breeding programmes for improvement of yield and to improve various qualitative and quantitative characteristics in mungbean.

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