

Morphological variation and characterization of local mungbean germplasm

H.A.P.A. Shyamalee^{1*}, J.K.J. Chandika² and P.A.P. Suranjika³

Abstract: Sixty one mungbean (green gram) accessions were evaluated for 12 agro morphological traits under field conditions during 2011 *Yala* seasons at the Grain Legumes and Oil Crops Research and Development Centre at Angunakolapelessa, Sri Lanka. Data were collected on quantitative agronomic characteristics, yield and yield parameters including days to first flowering, days to 50% flowering, days to first pod maturity, days to maturity, plant height, pod length, number of seeds per pod, pod length, number of seeds per plant, thousand seed weight, first yield, second yield, total yield and yield per plant. All the traits were analyzed using the SPSS version 20 software. The principal component analysis sorted the accessions into three principal components within cluster similarities and inter-cluster variations. Over 70% of the total variance was explained by the resulted principal components. At rescaled cluster distance of five, 61 mungbean accessions were made into seven clusters. The first and second clusters contained similar number of genotypes (nine) and three recommended varieties 'MI-05', 'MI-06' and 'Ari' were grouped into cluster II. The cluster VII was the largest and most diverse consisting 18 mungbean genotypes with the variety 'Harsha'. This clustering pattern can be used for the selection of parental materials with diverse characteristics for the effective utilization, conservation of the genetic recourses and also be useful in variety development in future mungbean breeding programmes.

Keywords: Morphological characterization, germplasm, mungbean, principle component analysis

Introduction

Mungbean [green gram; *Vigna radiata* (L) Wilczek] is one of the most important food legumes in south and south-east Asia. Presently about 11,095 ha in Sri Lanka are cultivated under mungbean and the annual production is about 14,130 mt (Ag Stat, 2014). However, Sri Lanka imports about 7,000 mt of mungbean, which accounts for 33% of domestic requirement, from Australia, Myanmar, Thailand and India. The productivity of mungbean was about 1.27 mt/ha in 2013. The grain is consumed as dhal, in soup, as bean sprout or processed into high value products. Mungbean is a cheap source of dietary protein with high levels of folate and iron compared to many other legumes (Nair et al., 2012). Farmers prefer to cultivate mungbean as it does not need much water and other inputs while it helps restoring soil fertility through symbiotic nitrogen fixation (Malik et al., 1997). Proteins of grain legumes contain

¹ Agriculture Research Station, Telijjawila, Sri Lanka

² Rice Research Station, Labuduwa, Sri Lanka

³ Seed Certification Service, Regional Office, Palmadulla, Sri Lanka

* Corresponding Author: shyamaleeanusha@gmail.com

relatively more essential amino acids such as Lysine and Tryptophan and thus, compliment the amino acids supplied by cereals. Moreover, they contain relatively small proportions of Sulphur-containing amino acids such as Methionine and Cysteine and, also a useful source of Thiamine, Niacin and Calcium. Therefore, mungbean has a tremendous market potential than any other grain legume crop. Improved accessions and old cultivars of mungbean are important and useful genes that can be used in breeding programmes. However, landraces and accessions are heterogeneous and include several genotypes within a population. The only way to ensure genetic variations of future generations is to exploit the present day genetic diversity of the crop and to identify the promising one for breeding programmes. Variation of mungbean accessions is important to maintain genetic diversity of gene pool. Estimation of genetic distance is one of the appropriate tools for parental selection in breeding programme. This is also important in identification of the diversity, crop evolution and the centre of origin (Mohammadi and Prasanna, 2003). The present study was conducted to evaluate the genetic diversity of mungbean accessions using quantitative agro-morphological traits in order to identify the superior parental genotypes to be used in future breeding programmes.

Materials and Methods

Seeds of 61 accessions of mungbean germplasm were collected from the Plant Genetic Resources Center (PGRC) at Gannoruwa, Sri Lanka and from various parts of the country during 2010. The plants were grown during the *Yala* season (March-August) 2011 at the Grain Legumes and Oil Crops Research and Development Centre at Angunakolapelessa, Sri Lanka in a complete randomized design. Two rows, each at 3 m length was planted to each accession with 50 cm and 10 cm inter- and intra-row spacing, respectively. Four varieties namely, 'MI-05', 'MI-05', 'Harsha' and 'Ari' were used as check varieties for visual comparison of lines. Recommended cultural practices were followed. The plants were evaluated for various morphological traits under field conditions.

Data collection and statistical analysis

The accessions were evaluated and data were collected at flowering and at harvest of each line for yield, yield component and other agronomic traits such as number days to first flowering, 50% flowering, first maturity and 50% maturity, plant height at maturity, pod length, seeds per plant, seeds per pod, yield per plant, thousand seed weight, first yield, second yield and total yield according to the mungbean descriptor. The crop was regularly monitored. The data were analyzed by using principal component analysis (PCA) and the cluster method using SPSS version 20. The Pearson's correlation (r) was used depict the strength of linear relationship between two considered variables and coefficient of correlation for pairs of morphological characters of the accessions.

Results and Discussion

The total yield was recorded with the highest deviation from the population mean (Table 1) while the other attribute traits such as first and second yield, thousand seed weight, and number of seeds per plant also deviated considerably from the mean.

Table 1. Mean and standard deviation for 13 agronomic characters, yield and yield parameters in 61 mungbean accessions

Character	Mean value	Standard deviation
Days to first flowering (FF)	31.98	3.61
Days to 50% flowering (FDF)	40.34	3.12
Days to first maturity (FMP)	47.54	2.13
Days to maturity (MAT)	57.91	1.75
Plant height (cm) (PH)	53.63	10.24
Pod length (cm) (PL)	9.14	1.52
Number of seeds per pod (SP)	12.50	0.91
Number of seeds per plants (SPP)	114.77	23.02
Thousand seed weight (g) (TSW)	41.10	18.65
First yield (g) (FYD)	207.82	84.58
Second yield (g) (SYD)	186.20	138.82
Total yield (g) (TYD)	394.03	179.32
Yield per plant (g) (YPP)	5.17	2.77

The Pearson's correlation coefficients among agronomic and yield attributing characters for 61 mungbean accessions, including the four varieties, are shown in Table 2. The extent of relationship between yield and its various components is important for the plant breeders to select plants which consist of desirable characteristics (Divyaramakrishnan and Savithramma, 2014).

The total yield was significantly correlated with first yield and second yield $r=0.661$ and $r=0.889$, respectively ($p<0.05$). Ganguly *et al.* (2012) reported that most of the variables were not dependent on each other but only few of them show a considerable relation. In the present study, the pod length and seeds per pods showed positive and significant ($p<0.05$) correlations with seeds per plant. The results are in agreement with those of Ganguly *et al.* (2012). Number of days to first flowering, 50% flowering and first pod maturity exhibited a significant positive relationship with the number of days taken to maturity. Most of the other variables were not dependent on each other. Our results also agree with Siddique *et al.* (1996) who reported an inverse correlation between seed yield and number of days to 50% flowering and maturity.

Principal component analysis

The progress in breeding programme for economic characters often depends on the availability of a large germplasm representing a diverse genetic variation. In order to

ensure an efficient and effective use of crop germplasm, its characterization is imperative and multivariate analysis provides a good evaluation of land races. After identifying variation of morphological traits that should be further evaluated at a genetic level (Rabhani *et al.*, 1998), PCA has extracted three principal components (PCs) in this study with an Eigen value more than 1.0, and expressed 70% of the among the traits studied (Table 3).

Table 2. Pearson's correlation coefficients among agronomic characteristics and yield parameters of evaluated mungbean accessions

	FF	FPF	FPM	MAT	PH	PL	SP	SPP	TSW	FYD	SYD	TYD	YPP
FF	-	0.80*	0.59*	0.62*	0.31	-0.25	0.18	-0.15	-0.43	-0.56	-0.32	-0.51	-0.50
FDF		-	0.54*	0.57*	0.09	-0.23	0.22	-0.12	-0.33	-0.47	-0.35	-0.49	-0.45
FPM			-	0.92*	0.07	-0.29	0.12	-0.19	-0.35	-0.46	-0.37	-0.49	-0.51
MAT				-	0.097	-0.31	0.06	-0.23	-0.32	-0.39	-0.39	-0.49	-0.47
PH					-	0.13	0.09	0.12	0.04	-0.06	0.25	0.16	-0.04
PL						-	0.29	0.94*	0.57*	0.24	0.41	0.43	0.44
SP							-	0.61*	-0.06	-0.14	-0.06	-0.12	0.04
SPP								-	0.452	0.15	0.32	0.32	0.39
TSW									-	0.37	0.33	0.43	0.38
FYD										-	0.24	0.66*	0.44*
SYD											-	0.89*	0.64*
TYD												-	0.71*
YPP													-

*significant correlates at the 0.05 level; FF - Days to first flowering, FDF - Days to 50% flowering, FPM - Days to first pod maturity, MAT - Days to maturity, PH - Plant height, PL - Pod length, SP - Number of seeds per pod, SPP - Number of seeds per plant, TSW - Thousand seed weight, FYD - First yield, SYD - Second yield, TYD - Total yield, YPP - Yield per plant.

Table 3. Eigen values of 13 growth and yield parameters in 61 mungbean germplasm

Principal component (PC)	Eigen values	Percentage of variance	Cumulative percentage
1	5.481	42.16	42
2	2.289	17.60	60
3	1.356	10.43	70
4	0.924	7.10	77

1 = Days to first flowering; 2 = Days to 50% flowering; 3 = Days to first pod maturity, 4 = Days to maturity.

The first PC always describes variation of the population (Guei *et al.*, 2005). The first components were extracted with the relatively large amounts of variance, while the later components accounted for relatively smaller amounts. Among the first three PCs, PC1 accounted for high proportions of the total variance (42%) and remaining

two principal components PC₂ and PC₃ recorded 17% and 10% of variance from the total variance, respectively.

The first PC was more related to total yield, yield per plant, second yield, first yield and thousand seeds weight (Table 4). This implies that the yield related characteristics are close together when the second principal component seeds per plant, seeds per pod and pod length were more related traits. The third principle component exhibited negative effects on seeds per plant, seeds per pod and pod length.

Table 4. Values of principle component traits of mungbean

Traits	Component		
	1	2	3
Days to first flowering (FF)	-0.759	0.392	0.278
Days to 50% flowering (FPF)	-0.711	0.370	0.110
Days to first pod maturity (FPM)	-0.758	0.269	0.169
Day to maturity (MAT)	-0.759	0.237	0.208
Plant height (PH)	-0.006	0.390	0.665
Pod length (PL)	0.618	0.658	-0.167
Number of seeds per pod (SP)	-0.042	0.715	-0.360
Number of seeds per plant (SPP)	0.499	0.804	-0.277
Thousand seed weight (TSW)	0.621	0.207	-0.081
First yield (FYD)	0.654	-0.225	0.018
Second yield (SYD)	0.693	0.162	0.553
Total yield (TYD)	0.845	0.019	0.437
Yield per plant (YPP)	0.779	0.076	0.117

Three PCs extracted from the 13 characteristics by PCA were used for clustering the accessions. Similar genotypes were classified into the same cluster based on their various agronomic and yield parameters. The single Dendrogram represented four clusters at 10 re-scaled distances. Basnet *et al.* (2014) reported that the multivariate analysis involving the qualitative traits clearly show the alignment of the different genotypes into different clusters according to the similarity indices. Cluster analysis grouped genotypes together with greater genetics similarity; the clusters did not necessarily include all genotypes from the same origin (Figure 1).

Some clusters consisted only of the local or exotic genotypes while in others, genotypes of both were found together. This was primarily due to the similarity in the different genotypes for the qualitative traits observed. Our results also showed the same pattern with some-sub clusters consisted only of the recommended varieties while in others, both accessions and variety were found together. By incision, the dendrogram at 5 rescaled distance, the genotypes were categorized into 7 clusters (Figure 1). The number of accessions per cluster varied from three accessions in the sixth cluster to 18 in the last cluster. The first cluster contained 9 genotypes and those were separated into two sub groups.

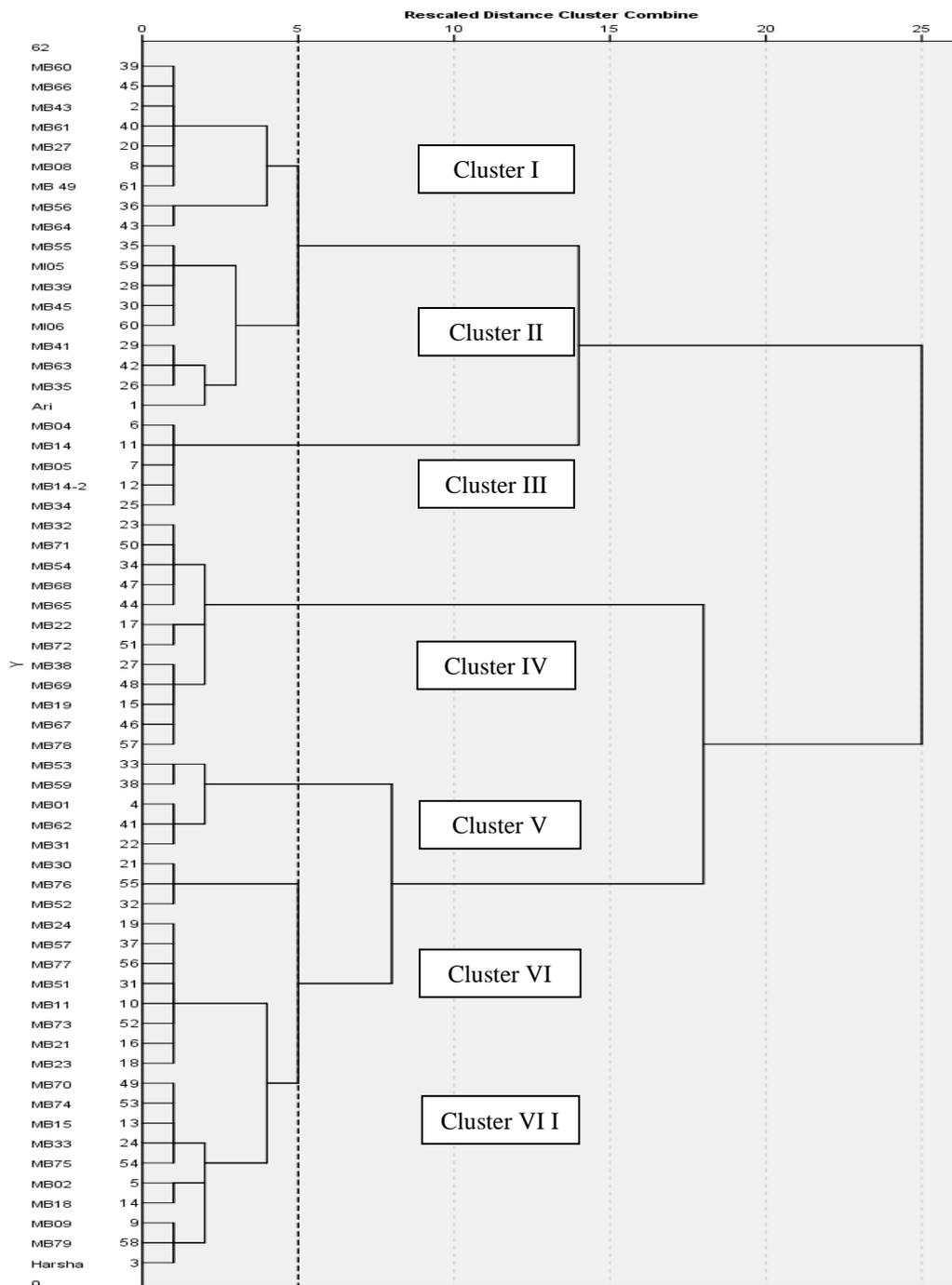


Figure 1. Dendrogram of mungbean accessions obtained through Ward Linkage cluster analysis based on 13 characteristics.

Most of the genotypes in the first cluster were large-seeded, high yielding and had a high thousand seed weight. Long-seeded variety “Ari”, which was grouped into one

of the sub groups, was distinct from the other genotypes in the cluster II. The three recommended varieties were separated into cluster II with two sub groups. The most popular mungbean varieties ‘MI-05’ and ‘MI-06’ were clearly separated to the same sub group under cluster II with three other accessions. Those lines were high yield with similar maturity periods.

Five large-seeded accessions with the same days to maturity grouped into the cluster III, while the cluster IV consisted of 12 accessions with three subgroups. These genotypes had medium seed size and the same maturity period. The subgroup MB 53 and MB 59 were grouped separately from other germplasm, where these genotypes had same thousand seed weight, yield per plant, number of seeds per plant and similar pod length. Three genotypes were grouped into the second sub group of cluster V with similar number of days to 50% flowering and maturity, and number of seeds per pod. The smallest cluster (Cluster VI) categorized the accessions with little number of seeds per plants, green purple hypocotyls, and days to first flowering, days to 50% flowering and days to maturity. The cluster VII was the largest and most diverse consisting 18 mungbean genotypes. This cluster was made into four sub groups. Most of the genotypes grouped into this cluster had small seed size, similar number of flowering days and maturity days. The variety ‘Harsha’ was grouped with two other accessions under cluster VII with same characteristics of 50% flowering, number of days taken to maturity, plant height pod length, number of seeds per pod and yield per plant.

The scatter plot (Figure. 2) consisting of four quadrants illustrated the distribution of mungbean genotypes according to the diversity of their morphological characteristics.

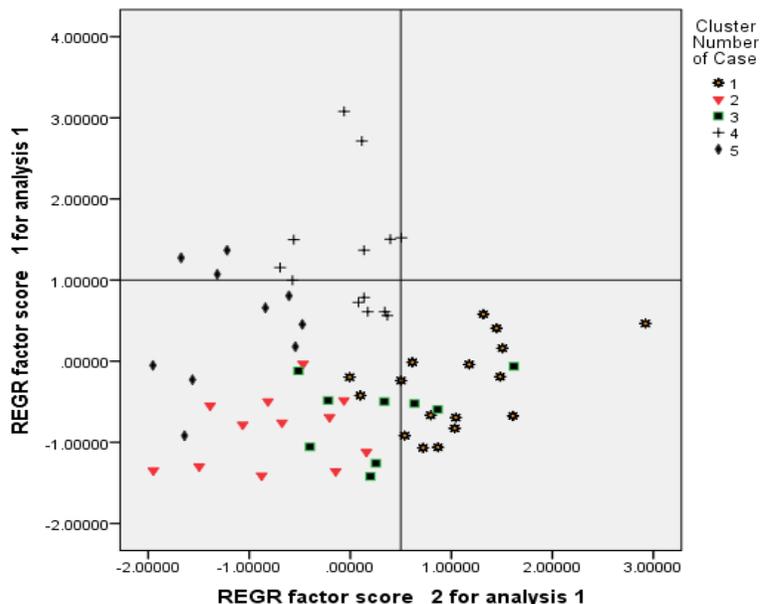


Figure 2. Simple scatter plots of principal component scores of the *mungbean* accessions based on 13 morphological characteristics.

Most of the genotypes fell into the third and fourth quadrants and few were in the first quadrant. The variety 'Ari' of cluster II was clearly seen to be diverged greatly from the other clusters. Most of the genotypes were concentrated in fourth quadrant none of them in the second quadrant.

Conclusion

Results of the study revealed that the agronomic characteristics and yield parameters can be effectively used to group mungbean accessions. The principal component analysis grouped these accessions into three principal components that were within cluster similarities and inter-cluster variations. Sixty one mungbean genotypes were grouped into VII divergent groups at the rescaled cluster distance of 5. This clustering pattern can be used for the selection of parental materials with diverse characteristics for the effective utilization, conservation of the genetic resources and useful in development of varieties in the future mungbean breeding programmes.

Acknowledgement

The authors gratefully acknowledge the financial assistance provided by the Sri Lanka Council for Agricultural Research Policy (SLCARP) under the National Agricultural Research Plan (NARP), the Plant Genetic Resources Centre (PGRC), Gannoruwa for providing the seed materials, and Former Additional Directors Drs. P. Weerasinghe and (Mrs.) A.P. Bentota of the Grain Legume and Oil Crops Research and Development Centre at Angunakolapelessa, Sri Lanka for providing all the support to make this research successful.

References

- Ag Stat. (2014): Pocket book of Agricultural Statistics. Socio-Economic and Planning Centre, Department of Agriculture, Peradeniya, Sri Lanka.
- Basnet, K.M., Adhikari, N.R. and Pandey, M.P. (2014): Multivariate analysis among the Nepalese and Exotic mungbean (*Vigna radiata* L.) genotypes based on the qualitative parameters, Department of Plant Breeding and Genetics, Institute of Agriculture and Animal Science, Nepal.
- Divyaramakrishnan, C.K. and Savithramma, D.L. (2014): Tailoring genetic diversity of mungbean (*Vigna radiata* L. Wilczek) germplasm through principal component and cluster analysis for yield and yield related traits, International journal of Agronomy and Agricultural Research, India.
- Guei, R.G., Sanni, K.A., Abamu, F.J. and Fawole, I. (2005): Genetic diversity of rice (*Oryza sativa* L.) Agronomic Africans. 5: 17-28
- Mohammadi, S.A. and. Prasanna, B.M. (2003): Analysis of genetic diversity of crop plants salient statistical tool and considerations. Division of Genetics, Indian Agricultural Research Institute, New Delhi.

- Malik, I.A., Ali, M., Sabir, H.M., and Ahmad, B. 1997. The Mungbean Green Revolution in Pakistan. Technical Bulletin No. 24. AVRDC. Shanhua, Taiwan, ROC. 66 p,
- Nair, R.M., Schafleitner, R., Kenyon, L., Srinivasan, R., Easdown, W., Ebert, R.W. and Hanson, P. (2012) Genetic improvement of mungbean. SABRAO J. Breed. Genet. 44: 177-190.
- Ganguly, R.P. and Bhat K.V. (2012): Analysis of Economically important morphological traits diversity in *Vigna radiata*. National Research Centre on DNA Fingerprinting, Agricultural Research Institute, New Delhi.
- Rabhani, M.A.A., Iwabuchi, Y., Murakami, T., Susuki, S. and Takayangi, K. (1998): Phenotypic variation and the relationship among mustard (*Brassica juncea* L.) germplasm from Pakistan, Euphytica, International Journal of Plant Breeding Wageningen University, The Neatherlands.
- Siddique, K.H.M., Loss, P.S. and Enneking, D. (1996): Narbon bean (*Vicia norbonensis* L.) A promising grain legume for low rainfall areas of South -Western Australia, Australian Journal of Experimental Agriculture, Australia.

