Research Article

Genetic variability and trait association for morphological and yield parameters of mungbean (*Vigna radiata* L.)

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Abstract

Genetic variability in existing germplasm is mandatory before commencement of a successful breeding program. To estimate genetic variability and correlations among mungbean genotypes, an experiment was conducted at The University of Agriculture, Peshawar during 2014. Fourteen mungbean genotypes were sown in RCB design with three replications. Data were recorded on days to maturity (days), plant height (cm), pod length (cm), pods plant⁻¹(no.), grains pod⁻¹(g), 1000 grain weight (g), biological yield (tons ha⁻¹) and grain yield (tons ha⁻¹). Analysis of variance showed highly significant differences ($P \leq 0.01$) among mungbean genotypes for all the studied traits. Mean value for the said traits ranged between 67-76.3, 48.7-105.7, 7.2-9.7, 15.2-22.5, 9.3-12.0, 42.6-55.6, 8.888-13.111 and 2.022-3.401 for days to maturity, plant height, pod length, pod plant⁻¹, grains pod⁻¹, 1000 grain weight, biological yield and grain yield, respectively. Genotype Mung NM11 performed better for yield and yield associated parameters under agro-climatic conditions of Peshawar. Significant negative phenotypic correlation for grain yield was observed with pods plant⁻¹ ($r = -0.51$) whereas, significant positive correlation was observed with 1000 grain weight ($r = 0.60$). Based on the results of current study, genotype "Mung NM11" could be disseminated directly among growers for the commercial production of mungbean or may be included in a cultivar development program to produce transgressive segregants.

Key words: Mungbean (*Vigna radiata* L.); genetic variability; correlations.

Introduction

Mungbean (*Vigna radiata* L.) is an important pulse crop due to its adaptation to short growth duration, low water requirement and soil fertility [1]. It is native to Indian subcontinent but it is also grown in Pakistan, China, Thailand, Philippines, Indonesia,

Burma, Bangladesh and in hot and dry regions of South Europe and Southern USA [2]. Thailand has been the world's largest mungbean exporter (approx. 30-50%) for the last 20 years or so. Mungbean is highly praised for its rich protein content, minerals and vitamins with outstanding digestibility

and low production of flatulence as compared to other beans [3]. In general, mungbeans contain 22-28% protein, 60-65% carbohydrates, 1-1.5 % fat and 3.5-4.5% fibers [2]. Mungbeans also contain certain essential amino acids like lysine [4]. Furthermore, it is a tropical and subtropical crop and requires a warm temperature of 30°C to 35°C. It has strong tap root system with nodules to fix atmospheric nitrogen. In Pakistan, it is one of the major pulse crop and ranks second to chickpea (*Cicer arietinum* L.) where it is cultivated on an area of 130.9 thousand hectares with an annual production of 92.9 thousand tons, yielding 710 kg ha⁻¹ [5]. In Khyber Pakhtunkhwa, mungbean has covered an area of 8.6 thousand hectares with the total production of 5.4 thousand tons having an average yield of 628 kg ha⁻¹ [5].

Knowledge of genetic variability in existing germplasm is imperative in crop improvement [6]. The greater genetic variability offers more liberty to the plant breeder to produce a cultivar with broadened genetic base, such cultivars are then remain viable for a longer period of time and have the capability to resist and tolerate the biotic and abiotic stresses [7]. Direct selection for seed yield is difficult and often deceptive because of the complex nature of the trait. Hence, it is an important practice to explore the relationship among morphological and yield parameters in mungbean germplasm and then make selections based on the knowledge obtained from these correlations. This experiment was therefore, designed to investigate genetic variability and ascertain relationship among various plant traits with seed.

Materials and methods

The study was carried out at the research farms of The University of Agriculture, Peshawar during 2014. Fourteen mungbean genotypes viz., KM-1, Chasma-98, Mung NM11, Mung Chakwal-06, Mung NM-06, Mung NCM-257-2, Mung AZRI-06, Mung

97, VC-6321, VC-6369, VC-6370, VC-6368, NM-19-19, and NM-92 were planted in randomized complete block design in three replications with 4 rows measuring 4m row length for each genotype. Row to row distance was maintained at 30cm while plants were 10cm apart in a row, respectively. Standard cultural practices including tillage, hoeing, irrigation, application of fertilizers etc. were performed during the whole crop season.

Statistical analysis

Data recorded on each trait were subjected to analysis of variance (ANOVA) and correlations coefficient using computer software SPSS v.16. Means separation for quality traits were carried out following LSD test at 5% level of probability.

Results and Discussion

Days to maturity (days)

Plant breeder's main aim is to develop early maturing genotypes, which yields more in short period of time. Short duration varieties of mungbean can efficaciously avoid yield reducing diseases like mungbean yellow mosaic virus (MYMV) and Cercospora leaf spot (CLS). Harvesting losses can also be alleviated by developing short duration cultivars in mungbean. Therefore, early maturity is desirable in mungbeans. Highly significant differences ($P \leq 0.01$) were displayed among the genotypes for days to maturity (Table 1). Similar results were also reported by Ali *et al.*, Begum *et al.* and Gul *et al.* [8, 9, 10]. Days to maturity among mungbean genotypes ranged from 67.0 to 76.3 (Fig. 1). Earliest maturity was exhibited by KM-1 (67.0) whereas; genotype VC-6369 took maximum days to maturity (76.3) with an average value of 72.6 days. Days to maturity had significant positive correlation with plant height ($r=0.62$) whereas, it showed non-significant association with other traits. These findings were confirmed by Derya *et al.* and Singh *et al.* [11, 12], who observed negative correlation between days to maturity

and seed yield among mungbean genotypes. They implied that high temperature was the

key factor responsible for longer reproductive phase resulting in more yield.

Table 1. Mean squares table for mungbean parameters evaluated during 2014

Parameters	Replications (df = 2)	Genotypes (df = 13)	Error (df = 26)	CV (%)
Days to maturity (days)	12.93	18.48*	6.70	3.57
Plant height (cm)	3.52	677.29**	4.63	2.43
Pod length (cm)	0.05	0.98**	0.19	4.95
Pods plant ⁻¹ (no.)	2	24**	1	5.74
Grains pod ⁻¹ (no.)	0.95	1.45**	0.14	3.30
1000 GW (g)	41.31	36.62**	6.09	5.35
Biological yield (tons ha ⁻¹)	4.507	51.790 **	6.894	4.88
Grain yield (tons ha ⁻¹)	0.030	4.828	1.592	9.31
Harvest index (tons ha ⁻¹)	7.00	59.00**	5.00	8.51

*, **=Significant at 5% and 1% probability level, respectively

Figure 1. Mean days to maturity (days) of 14 mungbean genotypes, during 2014

Plant height (cm)

Mean squares for plant height among mungbean genotypes were significantly different (Table 1) indicating the presence of sufficient genetic variability among the tested germplasm for the said traits. Similar results were also reported by [2, 9]. Mean values for plant height ranged from 48.7 to 105.7 cm (Figure 2). Genotype KM-1 produced the shortest plants while, genotype VC-6321 attained maximum plant height. Average

plants were noted as 88.4 cm. Plant height exhibited significant association with days to maturity ($r=0.62$), whereas, non-significant with pod length ($r=0.51$), pods plant⁻¹ ($r=0.45$), grains pod⁻¹ ($r=0.34$), 1000 grain weight ($r=-0.37$) and grain yield ($r=0.21$). Our findings are in conformity with the results of Dhupe *et al.* and Pun and Villarreal [13, 14], who observed non-significant associations of plant height with other yield associated traits among mungbean genotypes.

Figure 2. Mean plant height (cm) of 14 mungbean genotypes, during 2014

Pod length (cm)

Mean squares for pod length exhibited highly significant differences ($P \leq 0.01$) among mungbean genotypes suggesting the existence of reasonable genetic variability among tested germplasm (Table 1). Similar findings have been reported earlier by Tabasum *et al.* [6]. Longer pods provide more room for seeds and as a result the dream of high productivity is more likely to be realized. Mean values for pod length among mungbean genotypes ranged from 7.2 to 9.7 cm (Fig. 3). Genotype KM-1 produced shortest pods and longest pods were produced by genotype Mung NM-06 with a mean value of 8.8cm. Pod length had non-significant positive correlations with days to maturity ($r=0.46$), plant height ($r=0.51$), 1000grain weight ($r=0.33$) and grain yield ($r=0.39$) whereas, non-significant negative correlations with pods plant⁻¹ ($r=-0.04$) and grain pod⁻¹ ($r=-0.07$) were observed. Our results are in agreement with those of Singh *et al.* and Dhuppe *et al.* [12, 15], who reported positive correlation between plant height and grain yield in wheat. However, Naidu and Satyanarayana [16] reported contradictory results to those of present finding. This vague deviation might be due to the differences in climatic conditions and genetic material.

Pods plant⁻¹ (pods)

Pods plant⁻¹ is an important yield contributing trait that has direct influence on the seed yield in mungbean. Analysis of variance displayed highly significant differences ($P \leq 0.01$) among the mungbean genotypes for pods plant⁻¹ (Table 1) suggesting the presence of sufficient variability among this set of genotypes. Similar results have been reported by Zaid *et al.* [2] in wheat. Mean value for Pods plant⁻¹ among mungbean genotypes ranged from 15.2 to 22.5 (Fig. 4) where minimum pods plant⁻¹ were produced by VC-6368 and maximum pods plant⁻¹ were recorded for genotype Mung NM-11 with an average value of 18.7. Current results are in line with the findings of Jalilian *et al.* [17], who observed significant difference among mungbean genotypes for pod plant⁻¹. Pods plant⁻¹ showed significant positive correlation with grain yield, whereas, non-significant correlation was observed with days to maturity ($r=0.19$), plant height ($r=0.45$), pod length ($r=-0.04$), grains pod⁻¹ ($r=0.27$) and 1000 grain weight ($r=-0.52$). Ali *et al.* [8] also reported significant correlation of pods plant⁻¹ with yield and yield components.

Figure 3: Mean pod length (cm) of 14 mungbean genotypes, during 2014

Figure 4. Mean Pods plant⁻¹ (no.s) of 14 mungbean genotypes, during 2014

Grains pod⁻¹ (grains)

Mean squares values exhibited highly significant differences ($P \leq 0.01$) among the mungbean genotypes for grains pod⁻¹ (Table 1). Similar results were also reported by Abna *et al.* [18]. Mean value for grains pod⁻¹ among mungbean genotypes ranged from 9.3 to 12.0 (Fig. 5). Minimum grains pod⁻¹ was recorded for NM-92 while, maximum mean value for grains pod⁻¹ NM-19-19 with an average mean value of 11.2 grain pod⁻¹. Grain pod⁻¹ had non-significant correlation with days to maturity ($r = -0.47$), plant height ($r = 0.34$), pod length ($r = -0.07$), pods plant⁻¹ ($r = 0.27$), 1000 grain weight ($r = -0.12$), grain

yield ($r = 0.25$) and harvest index ($r = -0.60$). Current findings are contradictory with the results of Abna *et al.* [18], who observed significant association with the yield and yield related traits.

1000 grain weight (g)

Mean square values displayed highly significant differences ($P \leq 0.01$) among the genotypes for 1000 grain weight (Table 1) indicating acceptable amount of variation. Similar results were also reported earlier by Begum *et al.* [9]. Mean value for 1000 grain weight among mungbean genotypes ranged from 42.6 to 55.6 (Fig.6) whereas, minimum 1000 grain weight was recorded for genotype

Mung Chakwal-06 while maximum 1000 grain weight was displayed by genotype Mung NM-11 with a mean value of 46.2 g. 1000 grain weight had significant association with grain yield ($r=0.60$) whereas, it showed

non-significant correlation with rest of the traits (Table 2). Significant correlation between 100-grain weight and seed yield was also reported by Patil and Deshmukh [19].

Figure 5. Mean grains pod⁻¹ (no.s) of 14 mungbean genotypes, during 2014

Figure 6. Mean thousand grains weight (g) of 14 mungbean genotypes, during 2014

Biological yield (tons ha⁻¹)

Mean squares for biological yield exhibited highly significant variance ($P \leq 0.01$) among the genotypes (Table 1) indicating the presence of acceptable amount of variation. Similar results were also reported by Tiwari *et al.* [20]. Mean value for Biological yield among mungbean genotypes ranged from 8.888 to 13.111 (Fig.7). Minimum Biological yield was recorded for genotype KM-1

(8.888 tons ha⁻¹) while maximum Biological yield (13.111 tons ha⁻¹) was recorded for NM-92. Biological yield had significant positive correlation with days to maturity ($r=0.56$) while, non-significant association was observed by biological yield with rest of the traits. Our results are in conformity with Talebi *et al.* [21], who suggested that biological yield and harvest index could be

used as base for selecting genotypes with high grain yield.

Figure 7. Mean Biological yield (tons ha⁻¹) of 14 mungbean genotypes, during 2014

Grain yield (tons ha⁻¹)

Mean square data revealed highly significant ($P \leq 0.01$) differences among mungbean genotypes for grain yield (Table 1). Our findings are in line with the results reported by Zaid *et al.* and Begum *et al.* [2, 9]. Mean value for grain yield among mungbean genotypes ranged from 2.022 to 3.401 tons ha⁻¹ (Fig. 8) where genotype KM-1 displayed minimum grain yield and NM-92 produced maximum grain yield. Average mean value across genotypes was 2.656 tons ha⁻¹. Current

results were similar to the earlier findings of Soltani and Hammer [22], who reported significant differences for grain yield in mungbean genotypes. Grain yield exhibited significant negative correlation with pod plant⁻¹ ($r = -0.51$) whereas, it showed significant positive association with 1000 grain weight ($r = 0.60$) (Table 2). Similar results have been reported earlier by Dhuppe *et al.* and Pun and Villarreal [13, 14], who observed significant correlation among mungbean genotypes for yield and its contributing traits.

Figure 8. Mean grain yield (tons ha⁻¹) of 14 mungbean genotypes, during 2014

Harvest index (%)

Analysis of variance expressed highly significant variation ($P \leq 0.01$) among mungbean genotypes for harvest index (Table 1). Our findings are in line with the earlier reported results of Tabasum *et al.* [6]. Mean value for harvest index among mungbean genotypes ranged from 17.7 to 36.5 % (Fig.9). Minimum harvest index was recorded by genotype NM-92 whereas;

maximum harvest index was recorded for genotype Mung NM11 with an average mean value of 25.5%. Harvest index had significant positive correlation with 1000-grain weight ($r=0.75$) and grain yield ($r=0.84$) whereas, non-significant association was observed with rest of the traits. Our results are in conformity to the earlier findings of Tabasum *et al.* [6].

Figure 9. Mean grain yield (tons ha⁻¹) of 14 mungbean genotypes, during 2014

Table 2. Correlation among yield and yield associated traits in Mungbean

Traits	Plant height	Pod length	Pods plant ⁻¹	Grains pod ⁻¹	1000-grain weight	Biological yield	Grain yield	Harvest index
Days to maturity	0.62*	0.46	0.19	-0.47	-0.28	0.56*	-0.06	-0.33
Plant height		0.51	0.45	0.34	-0.37	0.41	0.21	-0.12
Pod length			-0.04	-0.07	0.33	0.15	0.39	0.23
Pods plant ⁻¹				0.27	-0.52	0.01	0.56*	0.45
Grains pod ⁻¹					-0.12	-0.19	0.25	0.23
1000-grain weight						-0.45	0.60*	0.75**
Biological yield							0.08	-0.60
Grain yield								0.84**

Conclusion and recommendations

On the basis of current investigation following results can be concluded: Sufficient amount of variability was recorded among genotypes for all the studied traits thus providing adequate scope for the breeder

to start a cultivar development program. Genotype Mung NM11 displayed maximum mean value for 1000grain weight, harvest index and grain yield, therefore could be selected as a parent in a breeding plan to achieve transgressive segregants. It can also

be recommended for general cultivation under Peshawar conditions. Seed yield had significant positive correlation with 1000 grain weight and significant negative association was observed with pods plant⁻¹, therefore special attention should be given to the mentioned traits in selection process to attain high productivity.

Authors' contribution

Conceived and designed the experiments: R Gul, Performed the experiments: A Sohail, Analyzed the data: F Uddin, Contributed reagents/ materials/ analysis tools: Q Uddin, Wrote the paper: Fakharuddin & S Ahmed.

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