



GENETIC VARIABILITY AND CORRELATION ANALYSIS FOR YIELD COMPONENTS IN MUNGBEAN (*Vigna radiata* L. Wilezek)

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ABSTRACT

20 Mungbean (*Vigna radiata* L. Wilezek) genotypes were tested for genetic variability and correlation among different yield contributing traits i.e., plant height, pods plant⁻¹, pod length, seed pod⁻¹, biological yield, and grain yield. Maximum plant height was observed for genotype NFM5-63-19 cm; maximum number of pods plant⁻¹ was recorded for genotype NFM5-63-19, while; genotype NFM-12-8 and NFM-6-5 found with a maximum pod length. Similarly the maximum number of seed pod⁻¹, biological yield and grain yield was observed in genotype NFM-6-5, NFM-12-6 and NM-98 respectively. The high heritability was recorded for pod length (99%) and plant height (70%), while pods plant⁻¹ (29%) and seed pod⁻¹ (17%) had low heritability. Based on genotypic correlation analysis characters like plant height, pods plant⁻¹, pod length and on phenotypic basis grain yield and seed pod⁻¹ could be the best criteria in any breeding program for increasing yield in mungbean genotypes under agro-climatic conditions of Peshawar.

Keywords: mungbean (*Vigna radiata* L. Wilezek), genetic variability, correlation analysis, genotype evaluation.

INTRODUCTION

Mungbean (*Vigna radiata* L.) Wilczek syn. Phaseolus radiatus L., P. aureus Roxb (Wilczek, 1954, Verdcourt, 1970) is one of the important pulse crops, which belongs to genus *Vigna*, specie radiata and family Leguminosae. India is considered its native country, but it is also cultivated in Pakistan, Philippines, China, Vietnam, Europe and USA. Mungbean is usually grown for its edible seed. It is a rich source of proteins, minerals and vitamins providing higher calories. Generally mungbean seeds contain 22-28% protein, 60-65% carbohydrates, 1-1.5 % fat and 3.5-4.5% fibers. Further it is a tropical and subtropical crop and requires a warm temperature of 30 to 35°C. Its self pollinated crop well grown in sandy and loam soils, having soil pH 6.2 to 7.2. Its growth rate is rapid and usually requires 70 to 90 days to mature and gains maximum three feet height. It has strong tap root system with nodulation to fix atmospheric nitrogen. It is cultivated both in summer and spring seasons, as a Kharif crop, it is sown in June-July while; as spring crop it is sown from mid march to April. In Pakistan mungbean is mainly grown as a Kharif crop. It is mostly cultivated in southern Sindh, Punjab, Khyber Pakhtunkhwa, and northern parts of the country. In Pakistan Punjab is an only account for 88% of the total area and 85% of production. In Pakistan it is planted on 2.6 million hectares with a total production of 1.8 million tons with an average yield of 723kg ha⁻¹ (Minfal 2008-2009). Out of the total cultivated area of mungbean in Pakistan, Khyber Pakhtunkhwa has covered an area of 10 thousand hectares with total production of 6.4 thousand tons and average yield of 634kg ha⁻¹ (Minfal, 2008-2009). Its yield per hectare in Pakistan is very low as compared to other mungbean producing countries of the world. The main constraints in increasing its yield are insect-pest that causes various diseases and crop damages (Bashir *et al.*,

1988). Significant variation does exist among different mungbean populations for yield contributing traits (Biaswas and Bhadra, 1997), which can be used for crop improvement. However, selection for similarly genotypic variability and selection of suitable varieties for different geographical areas is also the main factor affecting crop performance and final yield. Hence genetic variability, correlation and heritability estimated for quantitative characters are important in selecting suitable genotype and reliable yield components for efficient yield improvement. Islam *et al.* (1999), Khan *et al.* (2005). Ullah *et al.*, (2011a) also studied genetic variability and correlation between yield and yield components in mungbean and found significant differences among various genotypes. Thus the study was conducted to determine the broad - sense heritability for various traits and genotypic and phenotypic correlations among various yield components of selected genotypes.

MATERIALS AND METHODS

The experiment was conducted at the Experimental Farm of Plant Breeding and Genetics Department, Khyber Pakhtunkhwa Agricultural University Peshawar, during summer 2010. The genetic materials was consisted of 20 mungbean genotypes i.e., NFM5-63-4, NFM5-63-10, NFM5-63-13, NFM5-63-19, NFM5-63-34, NFM5-63-35, NFM-11-3, NFM-12-3, NFM-12-6, NFM-12-7, NFM-12-8, NFM-12-12, NFM-14-3, NFM-14-5, NFM-14-6, NFM-14-7, NFM-6-5, NFM-7-13, NM-92 and NM-98. A randomized complete block design (RCBD) with four replications was used. Each genotype was sown in four rows with a row length of 4m in each plot. Plant to plant and row to row distance was kept 30 cm. The experiment was plant on 15, June 2010 and harvested on 11, September 2010. The data were recorded on the



following parameters i.e., Plant height, Pods plant⁻¹, Pod length, Seed pod⁻¹, Biological yield and Grain yield.

Statistical analysis

The data for each trait was statistically analyzed using analysis of variance recommended for randomized complete block design (RCBD). F-test followed by least significant difference (LSD) test was applied for means analysis. The genetic and environmental variance for each trait was estimated by;

Genetic variance = $VG = \text{Genotype Ms} - \text{Error Ms}$

Environmental variance = $VE = \text{Error Ms}$

Phenotypic variance = $VP = VG + VE$

Broad - sense heritability for each trait was estimated as under.

Heritability ($h^2 BS$) = VG / VP .

While genetic and phenotypic correlations among the traits were determined by Singh and Chaudhery (2005) method.

RESULTS AND DISCUSSIONS

Plant height (cm)

The analysis of variance showed highly significant ($P = 0.01$) difference among mungbean genotypes for plant height (Table-1). Rehman and Hussain (2003) and Siddique (2006) are also in favor of our result. The coefficient of variation for plant height was found 15.4% and R^2 value was 0.79. Plant height of Mungbean genotypes ranged from 73.4 to 107.7 cm (Table-2 (a)). Genotype NFM-14-5 had shortest plants (73.4 cm) among 20 genotypes followed by NFM5-63-4 (75.5 cm). Similarly the genotype NFM5-63-19 was tallest (107.7 cm), followed by NFM5-63-34 (105.5 cm) and NFM-12-12 (103.4 cm). The genotypic, environmental and phenotypic variances and resultant heritability of plant height are given in (Table-3). The genetic and environmental variance for plant height was 435.6 and 184.9, respectively. Thus, the genetic variance was found 2.04 times greater than environmental variance. The resultant heritability of plant height was 70%, Yimran *et al.* (2009), Which showed that this trait is more under genetic control than the environment (Table-3) Plant height of mungbean genotypes showed a positive genetic correlation (Table-4) with seeds pod⁻¹ ($rG = 0.62^{**}$) and grain yield ($rG = 0.91^{**}$). However, plant height in mungbean expressed significantly negative genetic correlation with pod length ($rG = -0.90^{**}$) and biological yield ($rG = -0.57^{**}$). Phenotypic correlation of plant height was significant and positive with seed pod⁻¹ ($rP = 0.30^{**}$) and biological yield ($rP = 0.77^{**}$), Phenotypic relationship of plant height was non-significant with remaining traits (Table-4). By positive genetic correlation of plant height with seed pod-1 means it's purely under genetic control and less influence of environment, probably their genes association or the assimilation towards seed pod⁻¹ is more and hence increases in final grain yield as compare to vegetative growth. While positive phenotypic correlation with biological yield

represents the genetic capacity of the plant to cope with environment. It means that plant height favor the genotype trends toward production was more than to increase vegetative growth or life span. Thus the increase in grain yield could be due to increase in seed pod-1 in the prevailing environmental conditions. Thus this trait could be used as marker for improvement in yield for the tested areas. Our results are parallel with Dhuppe *et al.* (2005) and Pun Villeral (1989).

Pods plant⁻¹

The analysis of variance expressed highly significant ($P = 0.023$) the genetic variation among genotype for pods plant⁻¹, The coefficient of variance for Pods plant⁻¹ was 17.6% and R^2 value was 0.48. (Table-1). The range of pods plant⁻¹ was estimated from 43.8 to 71.3 among 20 mungbean genotypes. Mungbean genotype NM-92 gave a minimum number of pods plant⁻¹ (43.8) followed by NFM-12-7 (45.6) and NFM-14-6 (49) genotypes. While maximum number of pods plant⁻¹ was produced by NFM 5-63-19 (71.3) followed by NFM-12-12 (63.3) (Table-2 (b)). The genotypic, environmental and phenotypic variance and heritability of pods plant⁻¹ are given in Table-3. The genetic variance for pods plant⁻¹ was 43.4 and environmental variance was 104.3, which showed that the environmental variance was 2.4 times greater than genetic variance. The resultant heritability was 29%, which show that the trait is in environmental control (Table-3). These findings are supported by Anwar and Soehendi (1999) and Rehman and Hussain (2003) who observed low heritability for Pods plant⁻¹ in 20 mungbean genotypes. Pods plant⁻¹ significantly positive genetic correlation with pods length ($rG = 0.52^*$) and biological yield ($rG = 0.57^{**}$) (Table-4). However pods plant⁻¹ in mungbean expressed negative and non-significant genetic correlation with seed pod⁻¹ ($rG = -0.6$ NS) and grain yield ($rG = -0.36$ NS). The phenotypic correlation of pods plant⁻¹ was a significant positive correlation with pod length ($rP = 0.34^{**}$) while show negative with remaining traits while non-significant. The negative genotypic correlation with seed pod⁻¹ and grain yield and positive correlation with pod length and biological yield is evident that plant pods⁻¹ is more under environmental influence thus its linkage with other environmentally controlling trait is stronger than genetic thus its contribution in vegetative growth is more than reproductive. It is also concluded from that the contribution of pod plant⁻¹ in final grain yield minor under existing environmental conditions. Thus this trait might not be used as a tool for improvement in yield for the tested geographical area although; it could be a better marker for an increase in geological yield. Similar results have been reported in studies conducted by Zubair *et al.* (2007) and Ghafoor *et al.* (1992).

Pod length (cm)

The analysis of variance showed highly significant ($P = 0.01$) differences among mungbean genotypes for pod length Ullah *et al.* (2011). The



coefficient of variation for pod length were 10.8% and R^2 value was 0.9 (Table-3). Pod length of 20 mungbean genotypes used in the experiment ranged from 6.2 to 7.4 cm. Genotype NFM-12-8 and NFM-6-5 gain maximum pod length (7.4 cm) followed by NFM-12-3 genotype (7.2 cm) while NFM-5-63-4 mungbean genotype had minimum pod length (6.2 cm) followed by NFM-14-6 (6.3cm) (Table-2 (c)). The genotypic and environmental variance for pod length are 92.6 and 0.99, respectively, the heritability for pod length was 99 % (Table-3), Kumar and Chaudhary (2007) and Chaudhary *et al.*, (1971). This showed that the traits pod length in mungbean genotypes was more under genetic control. Correlations of the trait (pod length), with other traits are given in (Table-4) pod length of mungbean genotype had significantly positive correlation with biological yield ($rG = 0.70^{**}$) but negative with grain yield ($rG = -0.9^{**}$) and seeds pod^{-1} ($rG = -0.60^{**}$). The phenotypic correlations showed that pod length had negatively correlated with seed pod^{-1} ($rP = -0.37$) and non-significant with remaining traits (Table-4). As from positive genetic correlation with biological yield means that its contribution in biological yield is more than grain yield evident from negative correlation with grain yield and seed pod^{-1} . Thus it can be used as a better plant marker in breeding for biological yield in the tested environment. While its negative phenotypic correlation with seed pod^{-1} and non-significant phenotypic correlation shows that as this trait is purely genetic control (99% heritable) thus its phenotypic influence is minor on other observed trait except seed pod^{-1} .

Seed pod^{-1}

The analysis of variance for seed pod^{-1} showed significant ($P = 0.04$) Mensah and Oludoya (2007). The coefficient of variation was 10%, and estimated R^2 value was 0.39 (Table-1). Seed pod^{-1} of 20-mungbean genotypes were ranged between 6.9 and 8.3. Minimum seeds pod^{-1} was recorded for genotype NFM-12-6 (6.9) and maximum were calculated in NFM-6-5 (8.3) (Table-2 (d)). The genotypic and environmental variance for seed pod^{-1} of mungbean genotypes were 0.12 and 0.58 (Table-3) respectively. Heritability calculated for seed pod^{-1} was 17%. Varma and Grag (2001), Menash, and Oludyo (2007) and Chaudhary *et al.* (1971) are in favor of our result who observed low heritability. The heritability value shows that this trait is more under environmental influence. Seed pod^{-1} of mungbean genotypes exhibited a significantly positive correlation with grain yield ($rG = 0.63^{**}$) and plant height ($rG = 0.63^{**}$) while negative and non-significant with pod length ($rG = -0.06$ NS). Phenotypic correlation of seed pod^{-1} was significantly positive with biological yield and grain yield ($rP = 0.39$), ($rP = 0.37$). From significant positive correlation of seed pod^{-1} with grain yield and plant height supports its contribution in final yield. Thus character could be used in a breeding program under the existing environmental condition for improvement in yield. The positive phenotypic correlation with biological and grain yield evident that the contribution and genetic effect could be

different in different environmental conditions, thus the variation in yield. While non-significant genotypic and phenotypic correlation with remaining traits shows its minor influence on these traits in the existing environment.

Biological yield

The statistical analysis revealed highly significant differences ($P = 0.0001$) among genotypes for biological yield (Table-1). The coefficient of variation for biological yield was 30%, and R^2 was 0.87 (Table-1). Biological yield among 20 genotypes ranged from 11111.1 kg ha^{-1} to 16111.1 kg ha^{-1} . Genotype NFM-12-6 gave a maximum biological yield (16111.1 kg ha^{-1}) followed by genotype NFM-5-63-19 (15277.8 kg ha^{-1}), while genotype NFM-14-5 gave minimum biological yield (11111.1 kg ha^{-1}) followed by genotype NFM-5-63-10 (11666.7 kg ha^{-1}), (Table-2 (e)). The genotypic and environmental variance for biological yield was 8052365, and 2020486.5 respectively. The resultant heritability was observed 22% which show that the trait is greatly influenced by environment. (Table-3) Biological yield showed highly significant positive genetic correlation (Table-4) with pod length ($rG = 0.7^{**}$) and pods plant^{-1} ($rG = 0.5^{**}$) while significant negative genetic correlation with plant height ($rG = -0.5^{**}$). Phenotypic correlation of biological yield was a significant positive with plant height ($rP = 0.77^{**}$) but non significant with pods plant^{-1} ($rP = -0.23$) and pod length ($rP = -0.85$). Such correlations were also observed by Zubair *et al.* (2007). Mostly the biological yield of crops is highly influenced by variation in the environment. The heritability value shows the part of the environment as compare to the genotypic performance. Thus in this case the purpose of a genotype selection could be based on adaptability and final economic output either biological or grain yield. Similarly the positive genetic correlation shows that biological yield could be increased with the increase in pod length and pod plant^{-1} and they might be good phenotypic markers. While, plant height has a secondary role in biological yield as comparing to grains yield. Thus plant height as secondary phenotypic trait in selection for biological yield.

Grain yield

The analysis of variance indicated highly significant differences ($P = 0.0001$) among 20 mungbean genotypes for grain yield (Table-1) Siddique (2006). The coefficient of variation recorded was 30% while R^2 value was 0.64. Grain yield among 20 mungbean genotypes have range 189.2 kg ha^{-1} to 805.6 kg ha^{-1} . Genotype NM-98 was found with a maximum grain yield (805.6 kg ha^{-1}) followed by NFM-6-5 (710.1 kg ha^{-1}) and NFM-12-3 (662.2 kg ha^{-1}) while genotype NFM-12-12 gave a minimum grain yield among 20 genotypes (189.2 kg ha^{-1}) followed by NFM-14-6 (309.2 kg ha^{-1}) and NFM-12-6 (338.3 kg ha^{-1}), (Table-2 (f)). The genotypic and environmental variances for grain yield were 20736 and 20516 respectively and the heritability for grain yield was 50% (Table-3) which shows that the trait mutually influence by both genetic and phenotypic effects. Grain



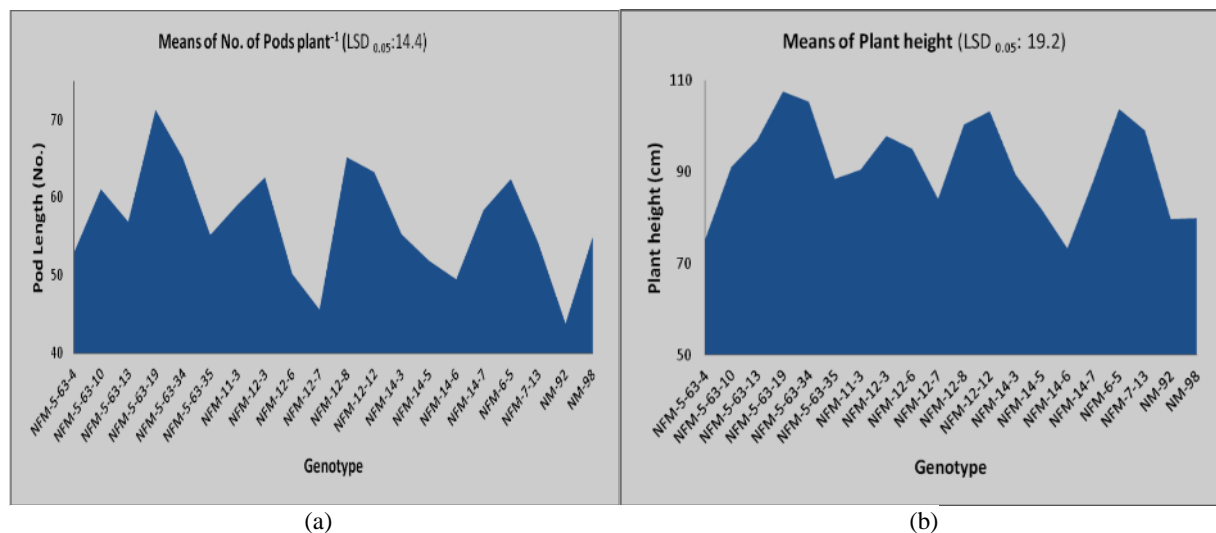
yield of mungbean genotypes showed highly significant positive genetic correlation with plant height and seeds pod⁻¹ ($rG = 0.92^{**}$) and ($rG = 0.63^{**}$) while the highly significant negative correlation with pod length ($rG = -0.92^*$) and negative with biological yield ($rG = -0.47$). Phenotypic correlation of grain yield was positive with seed pod⁻¹ and biological yield ($rP = 0.15$) and ($rP = 0.37$). The positive genetic correlation of grain yield with plant height and seed pod⁻¹ means that they have a strong genetic association among under the tested environmental conditions and they could be used as good biological

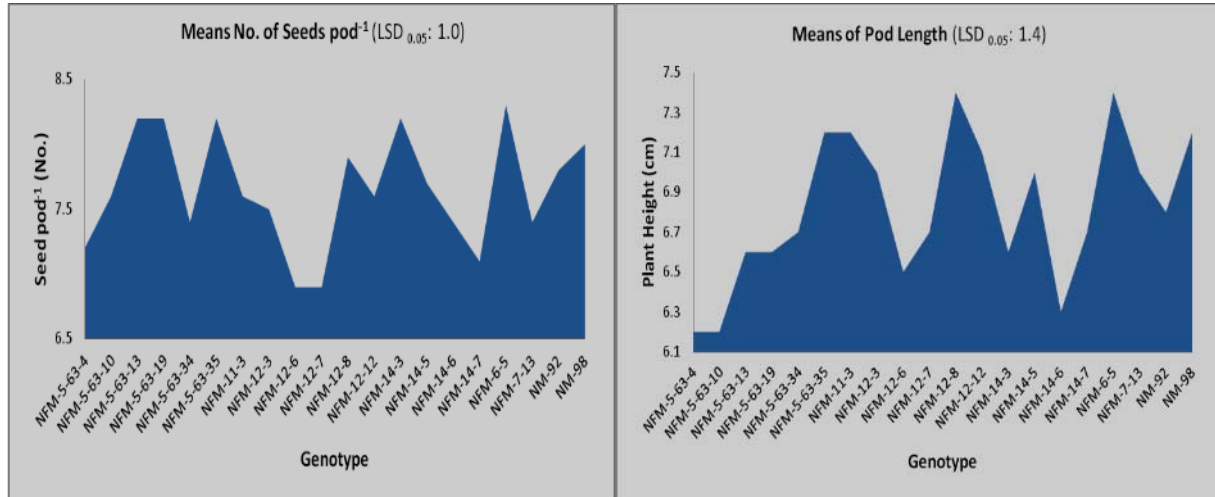
indicator for variety selection or in any breeding program. While it's negative correlation values with pod length and biological yield means a minor association and more influence on phenotype. As the trait (grain yield) is mutually influence by genetic and environmental effects thus variation in final economic yield is considered with shuffling of trait performance. Thus recommended variety selection is suggested because with little fluctuation in environmental condition might cause variation in final yield. Similar results have been reported by Dhuppe *et al.* (2005) and Pun and Villarreal (1989).

Table-1. Analysis of variance for plant height, pods plant⁻¹, pod length, seed pod⁻¹, biological yield, grain yield of 20 mungbean genotypes evaluated at Khyber Pakhtunkhwa Agricultural University, Peshawar during 2010.

Source	DF	Plant height (cm)	Pods plant ⁻¹ (No.)	Pod length (cm)	Seed pod ⁻¹ (No.)	Biological yield (kg ha ⁻¹)	Grain yield (kg ha ⁻¹)
Replication	3	874.5	80.8	318.6	0.428	45259261.7	60634.2
Genotype	19	1927.3 ^{**}	277.6 ^{**}	371.6 ^{**}	1.06 [*]	34229945.7 ^{**}	103460.2 ^{**}
Error	57	184.9	104.3	0.99	0.58	2020486.5	20516.9
C. V. (%)	—	15.4	17.6	10.8	10	11.3	30
R ² value	—	0.79	0.48	0.99	0.39	0.87	0.64

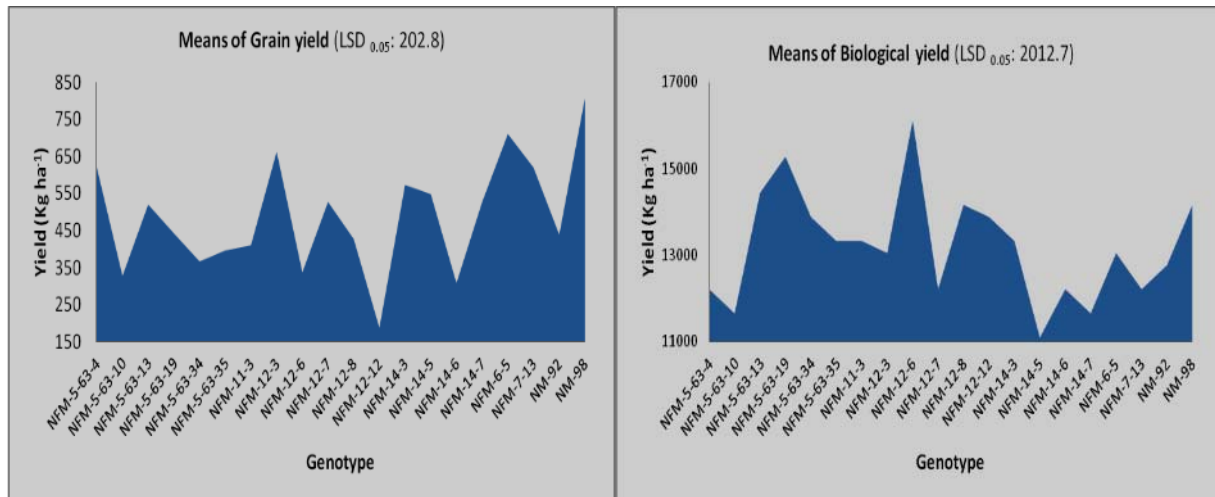
Table-2. Means for plant height, pods plant⁻¹, pod length, seeds pod⁻¹, biological yield and grain yield of 20 mungbean genotypes evaluated at the Khyber Pakhtunkhwa Agricultural University, Peshawar during 2010.





(c)

(d)



(e)

(f)

Table-3. Genetic (VG), Environmental (VE) Variances and phenotypic (VP) along with heritability for plant height, pod plant⁻¹, pod length, seeds pod⁻¹, biological yield and grain yield of 20 mungbean genotypes evaluated at the Khyber Pakhtunkhwa Agricultural University, Peshawar during 2010.

Traits	VG	VE	VP	h ² (%)
Plant height	435.6	184.9	620.5	70
Pods plant ⁻¹	43.4	104.3	147.7	29
Pod length	92.6	0.99	93.59	99
Seed pod ⁻¹	0.12	0.58	0.7	17
Biological yield	8052365	2020486.5	36250432	22
Grain yield	20736	20516	41252	50



Table-4. Genetic (Rg) and phenotypic (RP) correlations among various traits of 20 mungbean genotypes evaluated at Khyber Pakhtunkhwa Agricultural University, Peshawar during 2010.

Traits	Plant height	Pods plant ⁻¹	Pod length	Seed pod ⁻¹	Bio. yield	Grain yield
Plant height	—	-0.17NS	-0.90**	0.62**	-0.57**	0.92**
Pods plant ⁻¹	0.06 ^{NS}	—	0.52*	-0.6 ^{NS}	0.57**	-0.36 ^{NS}
Pod length	-0.79**	0.34**	—	-0.60**	0.77**	-0.92**
Seed pod ⁻¹	0.30**	-0.05 ^{NS}	-0.37**	—	-0.37 ^{NS}	0.63**
Bio. yield	0.77**	-0.23	-0.85	0.39	—	-0.47*
Grain yield	0.15	-0.19	-0.27	0.37	0.17	—

*, ** = Significant at 5 and 1 % probability level, respectively. NS = Non-significant

CONCLUSIONS AND RECOMMENDATIONS

On the basis of obtained results from this experiment it can be concluded that:

- Genotype NFM 5-63-19 had maximum plant height, NFM 5-63-19 had more number of pods per plant, NFM-12-8 and NFM-6-5 gain maximum pod length, NFM-6-5 had maximum number of seeds per pod, Genotype NFM-12-6 produced highest biological yield and genotype NM-98 produced maximum grain. Therefore, it is suggested that these genotypes should be utilized in the future mungbean breeding program.
- On the basis of high heritability, plant height, pod length and seed pod⁻¹ could be used as selection criteria in future breeding program.
- On the basis of genotypic correlation characters like plant height, pods plant⁻¹, pod length, and basis of phenotypic correlation grain yield and seed pod⁻¹ will be a better index for increasing yield in mungbeans.

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