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# Heritability Estimates and Correlations among Flowering and Yield Related Traits in Mungbean Genotypes

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors SB, MN and HR designed the study, and wrote the first draft of the manuscript. Authors GH, D and A performed the statistical analysis, constructed field layout and managed the analyses of the study. Author HU managed the literature searches. All authors read and approved the final manuscript.*

***Research Article***

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## ABSTRACT

Heritability and correlation are the key components while, conducting an experiment for some specific traits on plant breeding. Keeping in view that importance this study was carried out utilizing 10 mungbean genotypes. Field Experimental was conducted in Randomized Complete Block Design (RCBD) with four replications. The parameters studied include, days to flowers initiation (DF), days to pods initiation (DPI), plant height (PH), days to maturity (DM), grain yield plant$^{-}$1(GY) and 100-grain weight (100-GW). Significant differences ($P \leqq 0.01$) were observed for DF, PH, DM and 100-GW, while days to pods initiation and grain yield plant$^{-1}$ showed considerable difference at $P \leq 0.05$. Genotype NM-93 took minimum number of days to 50% flowering (42.0 days), days to pods initiation (66.50 days) and days to maturity (78.25). Maximum grain yield was recorded for genotype Ramzan (45.35) while maximum 100-grain weight was recorded for NM-93 (5.85). High heritability was recorded for days to 50% flowering (88.75%), days to

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maturity (86.29%), 100-grain weight (77.17%) and plant height (67.32%). Low heritability was recorded for days to 50% pods formation (31.72%) and grain yield plant$^{-1}$ (33.50%). The results revealed that grain yield plant$^{-1}$ had highly significant phenotypic correlation with days to 50% pod formation (0.60) and with 100-grain weight. Grain yield plant$^{-1}$ had significant genotypic correlation with days to pods formation (0.70). Therefore, days to flowering, days to maturity and100-grain weight can be recommended as selection indices for high yield and genotypes Ramzan, NM-93 and NM19-19 can be used in further mungbean breeding programmes.

*Keywords: Mungbean; genetic correlation; heritability; grain yield.*

## 1. INTRODUCTION

Mungbean (*Vigna radiata* L.) is a tropical or sub-tropical warm season legume crop which adapted to different types of soil conditions, belongs to family leguminoseae. Mungbean can be successfully grown on sandy and loamy soils. Mungbean varieties based on their seed size can be classified into two groups. The first one is bold-seeded varieties (50-70 g/1000 seed), usually called Philippino types, and is predominantly grown in Southeast Asian countries. The Philippino types possess relatively higher yield potential (1-2 t/ha), large foliage and usually need 2-3 hand pickings to harvest the ripe pods due to pod shattering and lack of uniformity in maturity. These varieties usually fail in south Asian countries mainly due to their susceptibility to Mungbean Yellow Mosaic Virus (MYMV). The second one is small-seeded varieties (20-35 g/1,000 seed) mainly cultivated in south Asian countries. This type have relatively low yield potential (0.5-1.0 t/ha) but are fairly adapted to the local environmental conditions of several countries including Pakistan. It was planted on an area of 2.5 million hectares with a total annual production of 1.8 million tonnes with an average yield of 723 kg ha$^{-1}$ [19]. Out of the total area of Pakistan, Khyber Pakhtunkhwa covered an area of 10.1 thousand hectares with the production of 6.4 thousand tonnes producing an average yield of 634 kg ha$^{-1}$.

Mungbean has the potential to make up the gap of protein shortage, but its production is low in developing countries. For any yield improvement programme selection of superior parents is essential i.e., possessing high heritability and genetic advance for various traits [13]. Correlation analysis provides the information of interrelationship of important plant characters and hence, leads to a directional model for direct and/or indirect improvement in grain yield [12]. [1] reported that phenotypic and genotypic coefficients of variation were high for pods per plant and yield per plant. [12] indicated highly significant genetic differences among genotypes for days to 50% flowering, yield and yield related traits. Similarly, [7] pointed out positive and statistically significant relationships between seed yield per plant and days to flowering, pods per plant, seeds per plant, harvest index and 1000-seed weight. [11] stated that the estimated variance due to environment exceeded than that due to genotypes for all characters.

The Asian Vegetable Research and Development Center (AVRDC) have made tremendous contribution in improving the world mungbean production through its research and development efforts and a network of active research collaborators in the national programs. The genetic variability, correlation and heritability estimates for quantitative characters are important in selecting suitable genotypes and reliable yield components for efficient yield improvement. Thus, this study was conducted to evaluate mungbean genotypes and estimate heritability for different important parameters and estimate genotypic correlations among various parameters of the mungbean.

## 2. MATERIALS AND METHODS

This research was conducted at the experimental Farm of Plant Breeding and Genetics Department of KPK Agricultural University, Peshawar, during the year of 2009. The objectives of this research were to estimate heritibilities and genotypic correlations among traits of 10 mungbean genotypes, viz., Chakwal, NM19-19, NM-28, NM-51, NM-98, 6601, Ramzan, Pak-22, AEM-96 and NM-93. These genotypes were procured from Nuclear Institute for Food and Agriculture (NIFA). A randomized complete block design was used with four replications and ach entry consisted of four row plot with a row length of 5m and a plant to plant distance of 0.3m. The recommended cultural practices were carried out throughout the experiment. Data were recorded on days to 50% flowering, days to 50% pods formation, plant height (cm), days to maturity, numbers of pods plant$^{-1}$, numbers of grains pod$^{-1}$, number of grains plant$^{-1}$, 100-grain weight (g), grain yield plant$^{-1}$ (g). Grain yield plant$^{-1}$ was recorded by threshing all pods from the selected plants and weighing them on single plant basis by electronic balance.

Heritability in broad sense was estimated for the parameters according to [23].

$$h^2 = \frac{S^2 v}{S^2 e + S^2 v}$$

Where $h^2$ = Broad sense heritability

$$S^2v = \frac{\text{Varietal variance - error variance}}{\text{Number of replications}}$$

$$\text{Broad sense heritability} = \frac{\text{Genotypic variance}}{\text{Phenotypic variance}}$$

Phenotypic and Genotypic correlation coefficients were computed by the following formula suggested by [6].

Phenotypic correlation

$$\frac{(\delta\,\text{gxy} + \delta\,\text{exy})}{[(\delta^2\text{gx} + \delta^2\text{ex})\,(\delta^2\text{gy} + \delta^2\text{ey})]^{1/2}}$$

Genotypic correlation

$$\frac{(\delta\,\text{gxy})}{[(\delta^2\text{gx})\,(\delta^2\text{gy})]^{1/2}}$$

Where $\sigma^2$ gx = Variety component of variance for trait x.
$\sigma^2$ gy = Variety component of variance for trait y.

$\sigma^2$ ex = Error component of variance associated with trait x.
$\sigma^2$ ey = Error component of variance associated with trait y.
$\sigma$ xy = Variety component of variance for trait x and y.
$\sigma$ exy = Error component of covariance associated with trait x and y.

## 3. RESULTS AND DISCUSSION

This research was conducted on ten mungbean genotypes to find out genotypic correlations and heritability estimates for various characters. Mean squares and heritability estimates are presented in Table 1, whereas mean values, genotypic and phenotypic correlations are presented in Table 2 and 3, respectively. Significant variations were observed among the genotypes for all the studied traits (Fig. 1). The results are discussed as under:

### 3.1 Days to 50% Flowering

Analysis of variance indicated highly significant differences ($P < 0.01$) among the genotypes for days to flowering (Table 1). The differences among the genotypes for days to 50% flowering were highly significant. These results are confirmed by the study of [22] who reported significant differences among genotypes for this character. Days to flowering ranged from 42.0 to 67.25 days. Genotype NM-93 took minimum number of days (42.0 days) to flowering followed by NM19-19 (43.0). The maximum number of days (67.25) to flowering were taken by genotype 6601. Broad sense heritability recorded for days to flowering was 88.75% (Table 1), which shows greater proportion of genetic variance to phenotypic variance and is expected to remain stable under varied environmental conditions, as environment is less influential on highly heritable traits and could easily be improved by applying selection pressure. High heritability value (88.75%) was recorded for days to 50% flowering. Similarly, high heritability for days to flowering has also been reported by [3] and [25].

The coefficient of genotypic correlation (Table 3) revealed that days to flowering was highly significant and positively correlated with plant height (0.80) and days to maturity (0.97). The association with grains per pod and grains per plant was positive and non-significant. While with the rest of the traits days to flowering had negative and non-significant correlations. At phenotypic level (Table 3) the correlation of days to flowering was highly significant with plant height and days to maturity. It had highly significant and negative correlation with 100-grain weight (-0.46). Highly significant genotypic correlation of days to flowering with plant height and days to maturity was found. Our results are also in agreement with the findings of [4], [3] who reported highly significant genotypic correlation of days to flowering with plant height and days to maturity. However, association of days to 50% flowering with pod plant$^{-1}$ and grain yield plant$^{-1}$ was negative and non-significant which is supported by [26] who found that days to flowering have negative and non-significant correlation with pod plant$^{-1}$ and grain yield plant$^{-1}$.

### 3.2 Days To 50% Pods Formation

Genotypes showed significant differences ($P<0.05$) for days to pods formation (Table 1). Days to pods formation ranged from 44.00 to 67.25 days (Table 2). NM-93 took minimum number of days (44.00) to pods formation followed by genotype AEM-96 (45.00 days) and Pak-22 (52.00 days). The maximum number of days to pods formation were recorded for genotype hakwal (105.50 days) (Table 2). High broad sense heritability (87.79%) was found for days to pods formation (Table 1). [10] also recorded significant differences with low heritability for days to flowering.

The coefficient of genotypic correlations (Table 3) for days to pods formation was positively and highly significant with plant height and days to maturity. While it had non-significant and negative correlation with grain yield per plant and 100-grain weight. Phenotypic correlations (Table 3) of days to pods formation were positive and highly significant with plant height and days to maturity. Negative and non-significant correlation was observed days to pod formation and grain yield per plant. Our study is in adversary with the findings of [17] who stated that number of days to pods formation have positive significant correlation with grain yield.

### 3.3 Plant Height

Analysis of variance showed highly significant differences ($P<0.01$) among the mungbean genotype for plant height (Table 1). Plant height ranged from 55.50 to 73.50 (Table 2). Minimum plant height was observed for genotypes Pak-22 and Ramzan (55.5 cm). The results of [21] and [22] are also in favor of our results who reported highly significant differences among genotypes for plant height. Moderate heritability (67.32%) was recorded for plant height (Table 1). High heritability value (67.32%) was observed for plant height. Our findings are in agreement with [25], [27], [2] and [9] who also recorded high heritability for plant height.

Plant height showed significantly high genotypic correlation with days to flowering (0.80) and days to maturity (0.79), while with the rest of the traits its correlation was non-significant (Table 3). Phenotypic correlations of plant height were positive and significant with branches plant$^{-1}$, days to flowering and days to maturity and non-significant with rest of the traits (Table 3). These results are confirmed by the study of [4], [16] and [3] who observed positive significant correlation of plant height with days to flowering and days to maturity. Non-significant and negative association of plant height with grain yield plant$^{-1}$, 100-grain weight and grains plant$^{-1}$ was observed. Our results are supported by the study of [26] and [20].

### 3.4 Days to Maturity

The differences among the genotypes were highly significant for days to maturity. These results were similar with the findings of [18] and [22]. Days to maturity ranged from 78.25 to 105.50 days (Table 2). Minimum days to maturity were recorded for genotype NM-93 (78.25) followed by AEM-96 (78.50), while genotype Chakwal took maximum days to maturity (105.50 days; Table 2). High broad sense heritability (88.77%) was observed for days to maturity (Table 1). Similarly, [27], [24] and [10] have also reported high heritability for days to maturity.

The genotypic correlation coefficient revealed that days to maturity had highly significant and positive correlation with days to flowering (0.97) and with plant height (0.79) while, non-significant correlations with grain yield per plant and 100-grain weight. Phenotypic correlation of days to maturity was positive and highly significant with days to flowering (0.92) and plant height (0.57), while highly significant but negative correlation with 100-grain weight (Table 3). Correlation of days to maturity with days to flowering and plant height was found significant and positive. These results are in agreement with the study of [26] and [4] who recorded positive and significant correlation of days to maturity with days to flowering and plant height.

Significant negative association of days to maturity with 100-grain weight, which is supported by the study of [21].

### 3.5 Grain Yield Plant $^{-1}$

Significant differences ($P<0.05$) were observed among the genotypes for grain yield plant$^{-1}$ (Table 1). Similarly, [22], [5] and [21] have also reported significant differences for grain yield plant$^{-1}$. Grain yield plant$^{-1}$ ranged from 21.87 to 45.35 (Table 2). Genotype Ramzan showed maximum grain yield plant$^{-1}$ (45.35) followed by genotype NM-51 (35.40), while genotype NM19-19 had minimum grain yield plant$^{-1}$ (Table 2). Low heritability (33.52%) was recorded for grain yield plant$^{-1}$ (Table 1). Low heritability (33.52) was recorded for grain yield palnt$^{-1}$. These results are in line with the study of [10] and [3] who also reported low heritability for grain yield palnt$^{-1}$. Grain yield plant$^{-1}$ had positive and significant genotypic correlation with pods plant$^{-1}$ and days to pod formation while non-significant correlations with all other traits (Table 3).

Grain yield plant$^{-1}$ showed highly significant phenotypic correlation with significant correlation with 100- grain weight (Table 3). Our results are supported by [9], [16] and [17] who also reported positive and significant correlation of grains yield plant$^{-1}$ with pods plant$^{-1}$ and days to pods formation. Grain yield had significantly positive correlation with 100-grain weight. Our results are in agreement with [21] and [15] who also reported significant positive correlation of grain yield with 100-grain weight.

### 3.6 100-Grain Weight (g)

Highly significant differences were observed for 100-grain weight among the genotypes. These results are supported by the findings of [18], [8] and [15] who observed highly significant differences for 100-grain weight. The range of 100-grain weight was 3.22 g to 5.85 g (Table 2). The maximum 100-grain weight (5.85g) was observed for NM-93 followed by Ramzan (5.07), while minimum 100-grain weight was observed for NM-28 (3.22g) (Table 2). High heritability (77.17%.) was recorded for 100-grain weight. Heritability estimates for 100-grain weight is high. Higher heritability was also reported by [10], [24] and [27] for 100-grain weight. Phenotypic correlation of 100-grain weight was highly significant but negative correlated with days to flowering, plant height and days to maturity (Table 3). Significant positive association of 100-grain weight with grain yield plant$^{-1}$. Our results are in line with the findings of [14] and [20] who reported significant positive correlation of 100-grain weight with grain yield plant$^{-1}$. Highly significant and negative correlation of 100-grain weight with days to flowering and days to maturity were observed. [21] also reported significant negative correlation of 100-grain weight with days to flowering and days to maturity.

**Table 1. Replication mean squares (RMS), Genotypic mean squares (GMS), coefficient of variation and heritability values for days to flowering, days to pod formation, plant height, days to maturity, grain yield plant$^{-1}$ and 100-grain weight of 10 mungbean genotypes**

| Trait | RMS | GMS | CV | % $h^2$ |
|---|---|---|---|---|
| Days to flowering | 25.36 | 304.28** | 5.49 | 88.75 |
| Days to pod formation | 24.33 | 257.29** | 5.22 | 87.79 |
| Plant height | 162.50 | 208.93** | 7.31 | 67.32 |
| Days to maturity | 28.23 | 368.23** | 3.66 | 88.77 |
| Grain yield plant$^{-1}$ | 172.18 | 188.71* | 26.89 | 33.52 |
| 100 grain weight | 0.35 | 3.05** | 11.22 | 77.17 |

**,**Significantly different from zero at 5% and 1% levels of probability, respectively.*

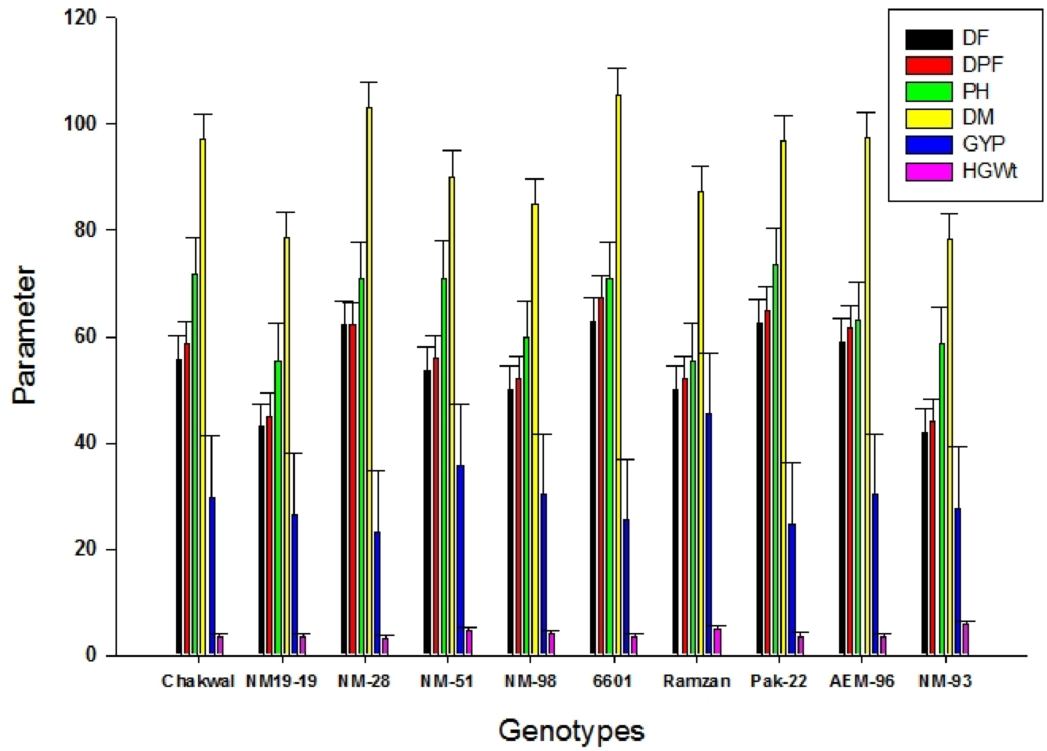


**Fig. 1. Mean values for days to flowering, days to pod formation, plant height (cm), days to maturity, grain yield per plant (g) and 100-grain weight (g)**

**Table 2. Means for days to 50% flowering, days to 50% pods formation, plant height, days to maturity, grain yield plant$^{-1}$ and 100-grain weight**

| Entries No. | Days to 50% flowering | Days to 50% pods formation | Plant height | Days to maturity | Grain yield plant$^{-1}$ | 100-grain wt. |
|---|---|---|---|---|---|---|
| Chakwal | 55.70bc | 67.25a | 71.75a | 105.50a | 29.35bc | 3.40e |
| NM19-19 | 43.00d | 65.00ab | 55.50c | 103.00a | 21.87c | 3.47de |
| NM-28 | 65.00a | 62.25bc | 70.75a | 97.25b | 23.32c | 3.22e |
| NM-51 | 56.00bc | 61.50bc | 71.00a | 97.00b | 35.40ab | 4.10cd |
| NM-98 | 52.00c | 58.50cd | 59.75bc | 96.75b | 30.42bc | 3.60de |
| 6601 | 67.30a | 56.00de | 70.75a | 90.00c | 25.37bc | 3.60de |
| Ramzan | 52.00c | 52.00e | 55.50c | 87.25cd | 45.35a | 5.07b |
| Pak-22 | 64.50a | 52.00e | 73.50a | 84.75d | 24.95bc | 3.60de |
| AEM-96 | 59.00b | 45.00f | 63.25b | 78.50e | 30.30bc | 3.40e |
| NM-93 | 42.00d | 44.00f | 58.75bc | 78.25e | 27.72bc | 5.85a |
| LSD | 4.43 | 4.27 | 6.90 | 4.88 | 11.47 | 0.65 |

*Means followed by the same letters are not significantly different according to least significant difference test at 5% probability level.*

**Table 3. Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients among days to flowering (DF), plant height (PH), days to maturity (DM), grain yield plant$^{-1}$ (GYP), 100- grains weight (HGW), days to pods formation (DPF) of 10 mungbean genotypes**

| | DF | PH | DM | GYP | HGW | DPF |
|---|---|---|---|---|---|---|
| DF | - | 0.80** | 0.97** | -0.15 | -0.58 | 0.99** |
| PH | 0.57** | - | 0.79** | -0.30 | -0.63 | 0.81** |
| DM | 0.93** | 0.57** | - | -0.19 | -0.61 | 0.96** |
| GYP | -0.02 | -0.08 | -0.02 | - | 0.55 | -0.29 |
| HGW | -0.46** | -0.49** | -0.46** | 0.45** | - | -0.61 |
| DPF | 0.98** | 0.57** | 0.93** | -0.07 | -0.48 | - |

****Significantly different at 5% and 1% probability levels, respectively.*

## 4. CONCLUSION

Highly and significant variations were observed among the mungbean genotypes used in current experiment, showing that the germplasm can be utilized in further breeding programs. Positive and highly significant correlation among grain yield, hundred grain weight and days to pod formation was observed, presenting linear relationship among these parameters.


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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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