Original Research Article

Studies on Genetic Variability, Association and Path Coefficient Analysis in Black Gram (Vigna mungo L. Hepper)

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ABSTRACT

One hundred and sixty two F$_2$ plants of the cross IC 436656 x KKB 14045 was phenotyped for nine quantitative characters. High PCV and GCV were observed for number of primary branches, number of clusters per plant, number of pods per plant and single plant yield. High heritability coupled with high genetic advance was registered for the traits viz., days to 50% flowering, number of clusters per plant, hundred seed weight, pod length and single plant yield suggesting the additive gene action. The trait single plant yield was significantly and positively associated with plant height, number of primary branches, number of cluster per plant, number of pods per plant, number of seeds per pod, pod length and hundred seed weight. Path analysis revealed that number of pods per plant was main component for improving the single plant yield. Hence selection of these traits would improve yield in black gram breeding programs.

Keywords

Genetic variability, Correlation coefficient, Path analysis, Black gram

Introduction

Black gram (Vigna mungo L. Hepper, 2n=22) is an important self-pollinated and short duration legume crop belonging to the family Leguminosae and sub-family Papilionaceae. India is the center of origin of black gram (Mehra et al., 2016) and black gram is cultivated as a sole crop or succeeding crop using residual moisture of preceding crop, normally cultivated after harvest of rice. India produces 1.5 to 1.9 million tons of black gram annually from about 3.5 million hectares of area, and an average productivity of 500 kg per hectare (Sakila et al., 2018). Black gram seeds are rich in protein (25-26 %), carbohydrate (60%), fat (1.5%), minerals, amino acids and vitamins (Parveen et al., 2011). Dried black gram seeds contain high protein and lysine content which is deficient in cereals.

Generally pulses are poor yielder due to the cultivation in marginally poor soils and rainfed conditions, narrow genetic diversity, photoperiod sensitivity, indeterminate growth habit, pod shattering and susceptible to pest and diseases (Fernandez and Shanmugasundaram, 1988; Sowmini and Jayamani, 2013). The achievement of high
yield mainly depends on the magnitude of yield contributing traits and nature of genetic variability (Johnson and Bernard, 1962). The magnitude of genetic variability is the base material for the development of new varieties (Venkatesan et al., 2005).

The correlation coefficient gives a measure of the mutual relationship between various plant characters and determines component characters on which selection is practiced for the improvement of economic important character (Hemalatha et al., 2017). The interrelationship between seed yield and plant characters are very important for making effective and viable breeding programmes for seed yield, for which direct selection is not much effective (Mathivathana et al., 2015). Path coefficient analysis is an efficient statistical technique to assess the interrelationship of different components and direct and indirect effects on seed yield (Reni et al., 2013). Hence, the present study focused on genetic variability, association and path coefficient analysis for efficient selection in black-gram breeding programs.

Materials and Methods

The experimental material consisted of 162 F₂ plants derived from the cross IC 436656 x KKB 14045. The field experiment was conducted at Department of Plant Breeding and Genetics at Agricultural college and Research Institute, Killikulam during 2018-2019. Biometrical traits viz., plant height (cm), days to fifty percent flowering, number of primary branches per plant, number of clusters per plant, number of pods per plant, number of seeds per pod, pod length (cm), hundred seed weight (g) and single plant yield (g) were recorded. The pedigree details of the parents are given below.

All the 162 F₂ plants were raised along with parents in 3 meter row with spacing of 30 x 10 cm and proper agronomic practices were followed. The statistical methods suggested by Johnson et al., (1955) for various genetic variability parameters viz., genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance as percentage of mean (GAM) were carried out. Genotypic correlation coefficient was worked out using the formulae given by Al-Jibouri et al., (1958) and path coefficient analysis was calculated using the formulae given by Dewey and Lu (1959). TNAUSTAT software was used for analysis of correlation and path coefficient analysis (Manivannan, 2014). The R software was used for preparing correlation chart (R Core Team, 2019). The direct and indirect effects were classified based on scale (Lenka and Mishra, 1973).

Results and Discussion

Studies on variability parameters

The genetic variability parameters for different plant characters were calculated and presented in Table 1. High PCV and GCV was observed for the traits viz., number of primary branches per plant (33.26% and 21.87% respectively), number of clusters per plant (53.54 and 42.19% respectively), number of pods per plant (40.09 and 30.73% respectively) and single plant yield (62.10 and 53.30% respectively). These suggested the presence of high genetic variability present in the population and selection is effective for these traits. Sohel et al., (2016) reported similar results of high PCV and GCV for number of primary branches per plant and Sushmitharaj et al., (2018) for the traits viz., number of clusters per plant, number of pods per plant and single plant yield.

The plant characters viz., days to 50 % flowering, number of seeds per pod, hundred seed weight and pod length expressed
moderate level of PCV and GCV values. Similar results were reported by Kumar et al., (2015) for days to 50 % flowering, Manjumder et al., (2011) for number of seeds per pod and Panigrahi et al., (2014) for hundred seed weight. The trait plant height showed high PCV but low GCV and similar finding was reported by Konda et al., (2008) and it indicated that the variability present in plant height was highly influenced by environmental factors.

High heritability was recorded for the traits viz., hundred seed weight (98.36%), days to 50% flowering (95.51%), pod length (89.60%), single plant yield (73.67%) and number of clusters per plant (62.11%). High GAM was recorded for traits single plant yield (94.24%), number of clusters per plant (68.50%), number of pods per plant (48.53%), hundred seed weight (37.55%), number of primary branches per plant (30.54%), pod length (23.35%) and days to 50% flowering (21.81%) on the basis of mean performance. Therefore for improving these traits simple selection would be more effective.

The pedigree details of the parents are given below

| SI. No | Parents       | Pedigree details | Source                                           |
|--------|---------------|------------------|--------------------------------------------------|
| 1.     | IC 436656     | Land race        | National Bureau of Plant Genetic Resources, New Delhi |
| 2.     | KKB 14045     | PU-0620 x ADT-3 | Agricultural College and Research Institute, Killikulam |

Table.1 Variability parameters in $F_2$ derivatives of the cross IC 436656 x KKB 14045

| Characters               | PCV (%) | GCV (%) | $(h^2)$ (%) | GAM (%) |
|--------------------------|---------|---------|-------------|---------|
| Days to 50% flowering    | 11.09   | 10.84   | 95.51       | 21.81   |
| Plant height             | 20.81   | 4.36    | 4.38        | 1.88    |
| Number of primary branches/plant | 32.26   | 21.87   | 45.95       | 30.54   |
| Number of clusters/plant | 53.54   | 42.19   | 62.11       | 68.50   |
| Number of pods/plant     | 40.09   | 30.73   | 58.76       | 48.53   |
| Number of seeds/pod      | 18.66   | 12.94   | 48.10       | 18.49   |
| Hundred seed weight      | 18.53   | 18.38   | 98.36       | 37.55   |
| Pod length               | 12.65   | 11.98   | 89.60       | 23.35   |
| Single plant yield       | 62.10   | 53.30   | 73.67       | 94.24   |
### Table 2: Correlation coefficients among yield components in F2 derivatives of the cross IC 436656 x KKB 14045

| Characters                              | Days to 50 % flowering | Plant height (cm) | Number of primary branches/plant | Number of clusters/plant | Number of pods/plant | Number of seeds/pod | Hundred seed weight (g) | Pod length (cm) | Single plant yield (g) |
|-----------------------------------------|-------------------------|-------------------|----------------------------------|--------------------------|----------------------|----------------------|--------------------------|-----------------|------------------------|
| Days to 50 % flowering                  | 1.000                   |                   |                                  |                          |                      |                      |                          |                 |                        |
| Plant height                            | 0.061                   | 1.000             |                                  |                          |                      |                      |                          |                 |                        |
| Number of primary branches/plant        | -0.131                  | 0.439**           |                                  |                          |                      |                      |                          |                 |                        |
| Number of clusters/plant                | -0.127                  | 0.612**           | 0.671**                          | 1.000                    |                      |                      |                          |                 |                        |
| Number of pods/plant                    | -0.135                  | 0.658**           | 0.523**                          | 0.868**                  | 1.000                |                      |                          |                 |                        |
| Number of seeds/pod                     | -0.283**                | 0.274**           | 0.222                            | 0.338**                  | 0.296**              | 1.000                |                          |                 |                        |
| Hundred seed weight                     | 0.001                   | 0.333**           | 0.215*                           | 0.181*                   | 0.148                | 0.282**              | 1.000                    |                 |                        |
| Pod length                              | -0.108                  | 0.298**           | 0.232**                          | 0.243**                  | 0.203*               | 0.671**              | 0.465**                  | 1.000           |                        |
| Single plant yield                      | -0.169*                 | 0.649**           | 0.441**                          | 0.779**                  | 0.852**              | 0.524**              | 0.387**                  | 0.410**         | 1.000                  |

** Significant at 1% level; * Significant at 5% level

### Table 3: Direct and indirect effects of different traits on yield in F2 derivatives of the cross IC 436656 x KKB 14045

| Characters                              | Days to 50 % flowering | Plant height (cm) | Number of primary branches/plant | Number of clusters/plant | Number of pods/plant | Number of seeds/pod | Hundred seed weight (g) | Pod length (cm) | Single plant yield (g) |
|-----------------------------------------|-------------------------|-------------------|----------------------------------|--------------------------|----------------------|----------------------|--------------------------|-----------------|------------------------|
| Days to 50 % flowering                  | -0.0147                 | 0.0031            | 0.0149                           | -0.0164                  | -0.0904              | -0.0658              | 0.0003                   | -0.0001         | -0.1690                |
| Plant height                            | -0.0009                 | ** 0.0507**       | -0.0498                          | 0.0784                   | 0.4379               | 0.0637               | 0.0689                   | 0.0002          | 0.6491                 |
| Number of primary branches/plant        | 0.0019                  | 0.0223            | ** -0.1133**                     | 0.0859                   | 0.3484               | 0.0517               | 0.0445                   | 0.0002          | 0.4416                 |
| Number of clusters/plant                | 0.0019                  | 0.0311            | -0.0761                          | **0.1279**               | 0.5780               | 0.0786               | 0.0375                   | 0.0002          | 0.7791                 |
| Number of pods/plant                    | 0.0020                  | 0.0334            | -0.0593                          | ** 0.1111**             | **0.6654**           | 0.0689               | 0.0308                   | 0.0001          | 0.8523                 |
| Number of seeds/pod                    | 0.0042                  | 0.0139            | -0.0252                          | 0.0433                   | 0.1971               | **0.2325**           | 0.0583                   | 0.0005          | 0.5245                 |
| Hundred seed weight (g)                 | -0.0000                 | 0.0169            | -0.0244                          | 0.0232                   | 0.0990               | 0.0656               | **0.2068**               | 0.0003          | 0.3874                 |
| Pod length (cm)                         | 0.0016                  | 0.0151            | -0.0263                          | 0.0311                   | 0.1353               | 0.1561               | 0.0963                   | **0.0007**      | 0.4100                 |

Residual effect: 0.38
High heritability coupled with high GAM was registered for days to 50% flowering, number of clusters per plant, hundred seed weight, pod length and single plant yield suggesting additive gene action for the genetic control of these traits. Konda et al., (2008) reported similar finding for days to 50% flowering; Sushmitharaj et al., (2018) for number of clusters per plant and single plant yield; Usharani and Kumar (2015) for hundred seed weight and Veeramani et al., (2005) for pod length.

**Studies on association between traits**

The correlation between the traits is presented in Table 2 and Figure 1. The trait single plant yield had significant and positive association with plant height (0.649), number of primary branches per plant (0.441), number of clusters per plant (0.779), number of pods per plant (0.852), number of seeds per pod (0.524), pod length (0.387) and hundred seed weight (0.410) and also significant and negative association with days to 50 % flowering. These traits could be targeted for improvement of single plant yield. Similar significant and positive association was reported by Sushmitharaj et al., (2018) for plant height, number of clusters per plant and number of pods per plant; Keerthiga et al., (2018) for number of primary branches per plant, number of seeds per pod and hundred seed weight and Rami Reddy et al., (2011) for pod length.

From inter correlation studies, days to 50 % flowering was significant and negative association with number of seeds per pod and single plant yield. Plant height had significant and positive association with number of primary branches per plant, number of clusters per plant, number of pods per plant, number of seeds per pod, hundred seed weight, pod length and single plant yield. Number of primary branches showed positive and significant association with number of clusters per plant, number of pods per plant, number of seeds per pod and flowers per plant.
number of seeds per pod, hundred seed weight, pod length and single plant yield. Number of clusters per plant showed positive and significant association with number of pods per plant, number of seeds per pod, hundred seed weight, pod length and single plant yield. Number of pods per plant exhibited positive and significant association with number of seeds per pod, pod length and single plant yield. Number of seeds per pod showed positive and significant association with hundred seed weight, pod length and single plant yield. Hundred seed weight expressed positive and significant association with pod length and single plant yield. Pod length exhibited positive and significant association with and single plant yield. Hence selection of these traits would improve the plant yield in black gram.

Studies on path coefficient analysis

The results on path coefficient analysis are presented in Table 3. The trait number of pods per plant showed high, positive and direct effect on single plant yield. Sathya et al., (2018) reported a similar result. Number of seeds per pod showed moderate, positive and direct effect on single plant yield. Plant height and pod length showed very low, positive and direct effect on single plant yield. Number of primary branches showed low, negative and direct effect on single plant yield. Days to 50% flowering showed very low, negative and direct effect on single plant yield.

Similar results were carried out by Parveen et al., (2011). Number of clusters per plant, plant height and number of primary branches showed high, positive and indirect effect on single plant yield through number of pods per plant. Number of seeds per pod and pod length showed low, positive and indirect effect on single plant yield through number of pods per plant.

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