



# International Journal of Research in Agronomy

E-ISSN: 2618-0618  
P-ISSN: 2618-060X  
© Agronomy  
NAAS Rating (2026): 5.20  
[www.agronomyjournals.com](http://www.agronomyjournals.com)  
2026; 9(8): 778-784  
Received: 24-05-2026  
Accepted: 28-06-2026

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## Genetic variability, correlation and path analysis for seed yield and its contributing traits in greengram (*Vigna radiata* L. Wilczek)

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i8j.6329>

### Abstract

The present study was carried out in the Field Experimentation Centre, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh during Zaid season of 2026 to evaluate genetic variability and the interrelationship of yield and its component traits in Greengram. Twenty genotypes of green gram were tested in Randomized Block Design with three replications. Fourteen quantitative traits such as days to 50% flowering, days to maturity, days to 50% pod setting, plant height, primary and secondary branches per plant, pods per plant, pods per cluster, pod length, seeds per pod, biological yield, seed yield per plant, seed index and harvest index were recorded. The analysis of variance showed that there were significant differences among the genotypes for all the characters studied, which indicated that there was considerable variability among the experimental material. The genotypic coefficient of variation ranged between 0.60% (days to 50% flowering) and 50% (secondary branches) and the phenotypic coefficient of variation between 1.07 and 15.96%. The broad sense heritability of traits ranged from 31.27% days to maturity to 63.99% seed index. Moderate genetic advancement as percentage of mean was observed for number of secondary branches, seed index, number of pods per plant and harvest index. The results of the correlation showed that the seed yield showed significant positive correlation with harvest index, number of pods per plant and seed index, whereas at the genotypic level, the biological yield showed significant positive correlation. Among the various traits evaluated the highest positive genotypic correlation with seed yield was recorded for harvest index (0.9044). The study concludes that, among the various traits, the harvest index, number of pods per plant, seed index and biological yield can be considered as important traits in selection programmes for improving seed yield in greengram.

**Keywords:** Greengram, *Vigna radiata*, genetic variability, GCV, PCV, heritability, genetic advance, correlation, path analysis, seed yield

### 1. Introduction

Greengram (*Vigna radiata* L. Wilczek) is an important short-duration pulse crop valued for its nutritional quality and suitability in diverse cropping systems. It is a good source of protein, essential amino acids, minerals and vitamins, while its nitrogen-fixing ability contributes to soil fertility (Mishra *et al.*, 2022; Pathak *et al.*, 2023) <sup>[4, 6]</sup>. Seed yield is a complex quantitative trait influenced by several genes and environmental factors. Therefore, understanding the magnitude of genetic variability and the relationships among yield and its component traits is essential for effective and crop improvement (Azam *et al.*, 2022) <sup>[2]</sup>. Genetic parameters such as GCV, PCV, heritability and genetic advance help in assessing the extent and nature of variability and the expected response to selection. Correlation analysis identifies traits associated with seed yield, while path coefficient analysis helps determine their direct and indirect contributions (Anita *et al.*, 2022; Supreetha *et al.*, 2023) <sup>[1, 11]</sup>. Hence, the present study was undertaken to assess genetic variability, determine the association among yield-related traits, and identify direct and indirect effects of component traits on seed yield in greengram.

### 2. Materials and Methods

#### 2.1 Experimental site

The present investigation was conducted during the Zaid season of 2026 at the Crop Research

Fields, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh. The experimental site was located at approximately 98 m above mean sea level, at 25.57° N latitude and 81.56° E longitude.

### 2.1 Experimental material and design

The experimental material comprised 20 greengram genotypes collected from the Department of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Prayagraj. The experiment was conducted in a Randomized Block Design (RBD) with three replications. The crop was sown at a spacing of 30 × 10 cm. The gross experimental area was 160.08 m<sup>2</sup>, while the net cultivated area was 63 m<sup>2</sup>. The genotypes evaluated were:

| S. No. | Genotype  | S. No. | Genotype   |
|--------|-----------|--------|------------|
| 1      | MGG-347   | 11     | LGG-450    |
| 2      | IC-43600  | 12     | SHALIMAR-2 |
| 3      | IPM-302-2 | 13     | IC-282079  |
| 4      | IC-119604 | 14     | MGG-295    |
| 5      | IC-333090 | 15     | ADT-3      |
| 6      | IC-76464  | 16     | IC-38995   |
| 7      | IC-76599  | 17     | PUS-9531   |
| 8      | IC-249656 | 18     | PANTM-5    |
| 9      | IC-211220 | 19     | IC-9887    |
| 10     | IC-76414  | 20     | SML-668    |

Fertilizer was applied at N:P: K @ 20:40:20 kg ha<sup>-1</sup>.

### 2.2 Observations recorded

Observations were recorded on five randomly selected competitive plants from each plot in each replication. Fourteen quantitative characters were studied: Days to 50% flowering, Days to 50% pod setting, Days to maturity, Plant height (cm), Number of primary branches per plant, Number of secondary branches per plant, Number of pods per plant, Number of pods per cluster, Pod length (cm), Number of seeds per pod, Biological yield per plant (g), Seed yield per plant (g), Seed index (g), Harvest index (%).

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### 2.4 Statistical analysis

The data recorded for the 14 quantitative traits were subjected to analysis of variance following the procedure appropriate for the Randomized Block Design. Genetic variability was assessed through estimates of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), broad-sense heritability, genetic advance (GA), and genetic advance as percentage of mean (GAM). Genotypic and phenotypic correlation coefficients were estimated to determine the association between seed yield and its component traits. Path coefficient analysis was subsequently performed to partition the correlation coefficients into direct and indirect effects of component characters on seed yield. The thesis specifies that the path analysis procedure followed the method of Wright (1921) [13], as elaborated by Dewey and Lu (1959).

## 3. Results and Discussion

### 3.1 Analysis of Variance

Analysis of variance was carried out for the 14 quantitative traits to determine the extent of variation among the 20 greengram genotypes. The results revealed significant differences among genotypes for all the characters studied, indicating the presence of substantial genetic variability in the experimental material. Significant variation for yield and its component traits suggests considerable scope for selection and genetic improvement of greengram.

**Table 1:** Analysis of variance for quantitative characters in greengram genotypes

| S. No. | Source                       | Mean Sum of Squares |            |       |
|--------|------------------------------|---------------------|------------|-------|
|        |                              | Replications        | Treatments | Error |
|        | Degrees of Freedom           | 2                   | 19         | 38    |
| 1      | Days to 50% flowering        | 0.140               | 0.465*     | 0.196 |
| 2      | Days to maturity             | 1.161               | 2.816*     | 1.191 |
| 3      | Days to 50% pod setting      | 1.029               | 2.080*     | 0.878 |
| 4      | Plant height (cm)            | 6.954               | 14.351*    | 6.060 |
| 5      | Number of primary branches   | 0.052               | 0.157*     | 0.066 |
| 6      | Number of secondary branches | 0.228               | 1.515**    | 0.334 |
| 7      | Number of pods per plant     | 10.734              | 35.441**   | 9.969 |
| 8      | Number of pods per cluster   | 0.132               | 0.361**    | 0.138 |
| 9      | Pod length (cm)              | 0.046               | 0.126*     | 0.052 |
| 10     | Number of seeds per pod      | 0.559               | 1.848**    | 0.532 |
| 11     | Biological yield (g)         | 1.035               | 2.573*     | 1.085 |
| 12     | Seed yield per plant (g)     | 0.541               | 1.284**    | 0.492 |
| 13     | Seed index (g)               | 0.189               | 1.134**    | 0.179 |
| 14     | Harvesting index (%)         | 6.148               | 51.419**   | 8.080 |

### 3.2 Mean Performance of Genotypes

Considerable differences were observed among the 20 genotypes for the characters studied. The variation in mean performance

indicates the presence of useful variability that can be exploited for selecting superior genotypes. The detailed mean values of all 14 traits are presented in Table 2.

**Table 2:** Mean performance of 20 greengram genotypes for quantitative characters

| S. No.    | Genotype   | Days to 50% flowering | Days to maturity | Days to 50% pod setting | Plant height (cm) | Number of primary branches | Number of secondary branches | Number of pods per plant | Number of pods per cluster | Pod length (cm) | Number of seeds per pod | Biological yield (g) | Seed yield per plant (g) | Seed index (g) | Harvesting index (%) |
|-----------|------------|-----------------------|------------------|-------------------------|-------------------|----------------------------|------------------------------|--------------------------|----------------------------|-----------------|-------------------------|----------------------|--------------------------|----------------|----------------------|
| 1         | MGG-347    | 50.66                 | 63.33            | 51.00                   | 35.81             | 2.67                       | 6.13                         | 31.47                    | 4.13                       | 7.11            | 8.67                    | 60.94                | 15.21                    | 5.64           | 25.17                |
| 2         | IC-43600   | 49.67                 | 65.00            | 52.33                   | 34.89             | 2.53                       | 6.00                         | 25.00                    | 4.27                       | 7.15            | 9.00                    | 48.03                | 12.26                    | 5.68           | 25.43                |
| 3         | IPM-302-2  | 50.34                 | 64.67            | 52.33                   | 36.45             | 2.80                       | 5.67                         | 27.27                    | 4.73                       | 6.75            | 9.67                    | 62.16                | 17.25                    | 6.71           | 29.00                |
| 4         | IC-119604  | 49.33                 | 65.00            | 52.33                   | 35.80             | 2.80                       | 5.60                         | 23.40                    | 4.53                       | 7.00            | 10.27                   | 61.77                | 19.21                    | 5.52           | 31.67                |
| 5         | IC-333090  | 49.33                 | 65.67            | 51.67                   | 36.69             | 2.47                       | 5.40                         | 36.06                    | 4.20                       | 6.71            | 10.27                   | 59.11                | 18.48                    | 5.90           | 30.27                |
| 6         | IC-76464   | 49.66                 | 62.67            | 52.00                   | 30.00             | 2.53                       | 4.33                         | 33.26                    | 3.80                       | 6.76            | 10.07                   | 66.34                | 22.27                    | 7.46           | 34.57                |
| 7         | IC-76599   | 49.33                 | 63.33            | 51.67                   | 33.72             | 2.40                       | 5.20                         | 33.54                    | 4.47                       | 6.99            | 10.67                   | 58.92                | 16.84                    | 6.88           | 31.55                |
| 8         | IC-249656  | 49.67                 | 65.33            | 50.67                   | 36.97             | 2.06                       | 3.80                         | 31.67                    | 4.87                       | 6.91            | 10.47                   | 55.84                | 20.46                    | 5.91           | 37.23                |
| 9         | IC-211220  | 49.67                 | 65.33            | 50.67                   | 33.04             | 2.20                       | 5.00                         | 27.67                    | 4.27                       | 6.89            | 9.66                    | 41.97                | 13.53                    | 4.70           | 34.01                |
| 10        | IC-76414   | 50.33                 | 65.00            | 50.00                   | 37.41             | 2.20                       | 4.34                         | 28.94                    | 4.47                       | 7.01            | 10.20                   | 61.04                | 21.62                    | 6.24           | 35.73                |
| 11        | LGG-450    | 49.67                 | 65.67            | 50.67                   | 32.34             | 2.53                       | 5.20                         | 25.67                    | 4.40                       | 6.71            | 10.53                   | 77.10                | 28.89                    | 7.45           | 37.50                |
| 12        | SHALIMAR-2 | 49.67                 | 66.00            | 52.33                   | 38.44             | 2.46                       | 5.53                         | 26.67                    | 4.27                       | 6.45            | 9.93                    | 61.14                | 19.14                    | 6.57           | 32.13                |
| 13        | IC-282079  | 50.33                 | 65.33            | 51.66                   | 36.06             | 2.40                       | 4.27                         | 25.80                    | 4.14                       | 6.79            | 10.73                   | 82.84                | 25.12                    | 6.86           | 30.07                |
| 14        | MGG-295    | 50.00                 | 64.33            | 51.67                   | 37.49             | 2.53                       | 6.13                         | 27.40                    | 3.27                       | 6.83            | 9.73                    | 49.73                | 15.95                    | 5.41           | 32.40                |
| 15        | ADT-3      | 49.67                 | 65.33            | 50.00                   | 38.32             | 2.80                       | 5.20                         | 32.33                    | 4.00                       | 6.83            | 10.14                   | 44.51                | 14.97                    | 5.46           | 34.23                |
| 16        | IC-38995   | 49.67                 | 65.00            | 49.67                   | 36.18             | 2.40                       | 5.53                         | 28.80                    | 4.26                       | 7.09            | 10.40                   | 51.29                | 18.83                    | 5.44           | 36.87                |
| 17        | PUS-9531   | 49.34                 | 66.00            | 50.67                   | 38.86             | 2.47                       | 5.53                         | 31.07                    | 4.80                       | 7.05            | 10.13                   | 69.98                | 20.11                    | 6.68           | 29.63                |
| 18        | PANTM-5    | 50.00                 | 63.67            | 51.00                   | 35.71             | 3.00                       | 5.73                         | 24.60                    | 4.87                       | 6.93            | 9.60                    | 49.90                | 17.27                    | 6.45           | 34.06                |
| 19        | IC-9887    | 49.33                 | 63.67            | 51.00                   | 35.78             | 2.40                       | 6.60                         | 29.67                    | 5.07                       | 7.17            | 9.53                    | 51.36                | 14.14                    | 5.00           | 27.20                |
| 20        | SML-668    | 50.00                 | 64.00            | 51.00                   | 37.07             | 2.67                       | 5.73                         | 26.47                    | 4.10                       | 7.16            | 9.20                    | 41.47                | 9.60                     | 4.90           | 23.10                |
| Mean      |            | 49.78                 | 64.72            | 51.22                   | 35.85             | 2.52                       | 5.35                         | 28.84                    | 4.39                       | 6.78            | 9.61                    | 21.56                | 6.45                     | 6.18           | 30.10                |
| Range     | Min.       | 49.33                 | 62.67            | 49.67                   | 30.00             | 2.06                       | 3.80                         | 23.40                    | 3.20                       | 6.30            | 7.80                    | 20.11                | 5.41                     | 4.84           | 25.57                |
|           | Max.       | 50.66                 | 66.00            | 52.33                   | 38.86             | 3.00                       | 6.60                         | 36.06                    | 4.93                       | 7.07            | 10.60                   | 23.94                | 8.15                     | 7.17           | 36.92                |
| C.D. (5%) |            | 0.73                  | 1.80             | 1.55                    | 4.07              | 0.42                       | 0.96                         | 5.22                     | 0.61                       | 0.38            | 1.21                    | 1.72                 | 1.16                     | 0.70           | 4.68                 |
| SE(m)     |            | 0.26                  | 0.63             | 0.54                    | 1.42              | 0.15                       | 0.33                         | 1.82                     | 0.21                       | 0.13            | 0.42                    | 0.60                 | 0.40                     | 0.24           | 1.63                 |
| C.V.      |            | 0.89                  | 1.69             | 1.83                    | 6.87              | 10.20                      | 10.81                        | 10.95                    | 8.45                       | 3.38            | 7.58                    | 4.83                 | 10.88                    | 6.85           | 9.40                 |

### 3.3 Genetic Variability, Heritability and Genetic Advance

The estimates of GCV, PCV, heritability, genetic advance and genetic advance as percentage of mean are presented in Table 3. GCV ranged from 0.60% for days to 50% flowering to 11.73% for number of secondary branches, while PCV ranged from 1.07 to 15.96%. In all traits, PCV was higher than GCV, indicating the

influence of environmental factors on trait expression.

The highest heritability was recorded for seed index (63.99%), followed by number of secondary branches (54.06%) and number of pods per plant (46.00%). Seed index also recorded relatively high genetic advance as percentage of mean (15.04%), indicating good scope for selection.

**Table 3:** Estimates of genetic variability parameters for seed yield and its contributing characters in greengram

| S. No. | Characters                   | Genotypic coefficient of variation (%) | Phenotypic coefficient of variation (%) | Heritability Broad Sense (%) | Genetic advance | Genetic Advance as percent of mean |
|--------|------------------------------|----------------------------------------|-----------------------------------------|------------------------------|-----------------|------------------------------------|
| 1      | Days to 50% flowering        | 0.60                                   | 1.07                                    | 31.34                        | 0.35            | 0.69                               |
| 2      | Days to maturity             | 1.14                                   | 2.03                                    | 31.27                        | 0.85            | 1.31                               |
| 3      | Days to 50% pod setting      | 1.24                                   | 2.21                                    | 31.31                        | 0.73            | 1.42                               |
| 4      | Plant height (cm)            | 4.64                                   | 8.29                                    | 31.32                        | 1.92            | 5.35                               |
| 5      | Number of primary branches   | 6.92                                   | 12.32                                   | 31.52                        | 0.20            | 8.00                               |
| 6      | Number of secondary branches | 11.73                                  | 15.96                                   | 54.06                        | 0.95            | 17.77                              |
| 7      | Number of pods per plant     | 10.10                                  | 14.90                                   | 46.00                        | 4.07            | 14.12                              |
| 8      | Number of pods per cluster   | 6.20                                   | 10.48                                   | 35.03                        | 0.33            | 7.56                               |
| 9      | Pod length (cm)              | 2.30                                   | 4.09                                    | 31.79                        | 0.18            | 2.68                               |
| 10     | Number of seeds per pod      | 6.89                                   | 10.25                                   | 45.23                        | 0.92            | 9.55                               |
| 11     | Biological yield (g)         | 3.27                                   | 5.83                                    | 31.38                        | 0.81            | 3.77                               |
| 12     | Seed yield per plant (g)     | 7.97                                   | 13.48                                   | 34.92                        | 0.63            | 9.70                               |
| 13     | Seed index (g)               | 9.13                                   | 11.41                                   | 63.99                        | 0.93            | 15.04                              |
| 14     | Harvesting index (%)         | 7.75                                   | 12.18                                   | 40.46                        | 3.06            | 10.15                              |

### 3.4 Correlation Analysis

Genotypic and phenotypic correlation coefficients were estimated to determine the association between seed yield and its contributing traits. In general, genotypic correlations were higher than the corresponding phenotypic correlations for most traits, indicating stronger inherent genetic associations and some masking effect of the environment.

At the genotypic level, seed yield per plant showed highly significant and positive correlations with harvest index (0.904), number of pods per plant (0.328\*\*), biological yield per plant (0.279\*\*) and seed index (0.249\*\*). Significant negative associations were observed with number of secondary branches (-0.434), days to maturity (-0.295\*\*), plant height (-0.244\*\*), primary branches (-0.182\*\*), days to 50% pod setting (-0.170\*\*)

and pods per cluster (-0.167\*\*).

At the phenotypic level, seed yield exhibited highly significant positive correlations with harvest index (0.493), number of pods per plant (0.249\*\*) and seed index (0.161\*\*). Days to 50% flowering and number of seeds per pod also showed significant positive associations, whereas days to maturity, secondary branches and primary branches showed significant negative associations with seed yield.

### 3.5 Path Coefficient Analysis

Path coefficient analysis was performed to partition the correlation of yield-contributing traits with seed yield into their direct and indirect effects at both genotypic and phenotypic levels. The analysis helps identify traits having an important direct contribution to seed yield.

#### 3.5.1 Genotypic Path Analysis

At the genotypic level, harvest index recorded the highest positive direct effect (0.4512) on seed yield per plant. It also showed

positive indirect effects through seed index, days to maturity, number of pods per plant, days to 50% flowering and primary branches. The strong positive association of harvest index with seed yield (0.9044\*\*) together with its high direct effect indicates that harvest index is an important criterion for selection for higher seed yield. Number of pods per plant, biological yield and seed index also showed significant positive associations with seed yield.

#### 3.5.2 Phenotypic Path Analysis

At the phenotypic level, the path analysis further partitioned the observed correlations into direct and indirect effects. The results indicated that harvest index was an important contributor to seed yield, consistent with its significant positive phenotypic correlation with seed yield (0.4933\*\*). Overall, the path analysis indicates that harvest index, number of pods per plant, biological yield and seed index are important traits associated with seed yield and may be useful as selection criteria in greengram breeding programmes.

**Table 4:** Genotypic correlation coefficients among yield and yield-contributing traits in greengram

| Genotypic Correlation Matrix |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         |                      |                |                      |                          |
|------------------------------|-----------------------|------------------|-------------------------|-------------------|----------------------------|------------------------------|--------------------------|----------------------------|-----------------|-------------------------|----------------------|----------------|----------------------|--------------------------|
| Trait                        | Days to 50% flowering | Days to maturity | Days to 50% pod setting | Plant height (cm) | Number of primary branches | Number of secondary branches | Number of pods per plant | Number of pods per cluster | Pod length (cm) | Number of seeds per pod | Biological yield (g) | Seed index (g) | Harvesting index (%) | Seed yield per plant (g) |
| Days to 50% flowering        | 1.000                 | -0.215**         | -0.063                  | 0.117*            | 0.166**                    | -0.077                       | -0.243**                 | -0.362**                   | -0.018          | -0.009                  | -0.076               | 0.016          | -0.018               | -0.033                   |
| Days to maturity             |                       | 1.000            | -0.145**                | 0.476**           | -0.277**                   | -0.201**                     | -0.169**                 | -0.044                     | 0.424**         | -0.445**                | 0.128*               | 0.228**        | -0.383**             | -0.295**                 |
| Days to 50% pod setting      |                       |                  | 1.000                   | 0.182**           | 0.279**                    | 0.190**                      | -0.216**                 | 0.070                      | 0.198**         | 0.382**                 | 0.348**              | 0.254**        | -0.314**             | 0.170**                  |
| Plant height (cm)            |                       |                  |                         | 1.000             | 0.061                      | 0.207**                      | -0.033                   | 0.343**                    | -0.076          | -0.412**                | -0.156**             | 0.437**        | -0.196**             | 0.244**                  |
| Number of primary branches   |                       |                  |                         |                   | 1.000                      | 0.510**                      | -0.313**                 | -0.013                     | 0.390**         | -0.171**                | 0.004                | 0.358**        | -0.179**             | 0.182**                  |
| Number of secondary branches |                       |                  |                         |                   |                            | 1.000                        | -0.228**                 | 0.139**                    | 0.048           | -0.090                  | -0.018               | 0.172**        | -0.422**             | 0.434**                  |
| Number of pods per plant     |                       |                  |                         |                   |                            |                              | 1.000                    | 0.297**                    | 0.364**         | 0.249**                 | 0.262**              | 0.014          | 0.254**              | 0.328**                  |
| Number of pods per cluster   |                       |                  |                         |                   |                            |                              |                          | 1.000                      | -0.102          | 0.114*                  | -0.140**             | 0.222**        | -0.100               | 0.167**                  |
| Pod length (cm)              |                       |                  |                         |                   |                            |                              |                          |                            | 1.000           | 0.381**                 | -0.088               | 0.171**        | 0.169**              | 0.095                    |
| Number of seeds per pod      |                       |                  |                         |                   |                            |                              |                          |                            |                 | 1.000                   | 0.083                | 0.126*         | 0.071                | 0.082                    |
| Biological yield (g)         |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         | 1.000                | 0.209**        | -0.148**             | 0.279**                  |
| Seed index (g)               |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         |                      | 1.000          | 0.326**              | 0.249**                  |
| Harvesting index (%)         |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         |                      |                | 1.000                | 0.904**                  |
| Seed yield per plant (g)     |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         |                      |                |                      | 1.000                    |

\*, \*\* = Significant at 5% and 1% levels, respectively.

**Table 5:** Phenotypic correlation coefficients among yield and yield-contributing traits in greengram

| Phenotypic Correlation Matrix |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         |                      |                |                      |                          |
|-------------------------------|-----------------------|------------------|-------------------------|-------------------|----------------------------|------------------------------|--------------------------|----------------------------|-----------------|-------------------------|----------------------|----------------|----------------------|--------------------------|
| Trait                         | Days to 50% flowering | Days to maturity | Days to 50% pod setting | Plant height (cm) | Number of primary branches | Number of secondary branches | Number of pods per plant | Number of pods per cluster | Pod length (cm) | Number of seeds per pod | Biological yield (g) | Seed index (g) | Harvesting index (%) | Seed yield per plant (g) |
| Days to 50% flowering         | 1.000                 | -0.050           | 0.115*                  | 0.077             | -0.022                     | -0.049                       | -0.203**                 | -0.177**                   | -0.053          | 0.095                   | 0.109*               | 0.087          | 0.012                | 0.119*                   |
| Days to maturity              |                       | 1.000            | -0.036                  | 0.278**           | -0.114*                    | -0.188**                     | -0.025                   | 0.131*                     | -0.235**        | -0.116*                 | 0.086                | 0.147**        | -0.226**             | -0.184**                 |
| Days to 50% pod setting       |                       |                  | 1.000                   | -0.063            | 0.239**                    | 0.068                        | -0.141**                 | -0.057                     | 0.135*          | 0.341**                 | 0.311**              | -0.080         | -0.228**             | 0.007                    |
| Plant height (cm)             |                       |                  |                         | 1.000             | 0.106*                     | 0.143**                      | -0.126*                  | 0.115*                     | -0.116*         | -0.286**                | -0.096               | 0.250**        | -0.086               | -0.079                   |
| Number of primary branches    |                       |                  |                         |                   | 1.000                      | 0.188**                      | -0.151**                 | 0.010                      | 0.236**         | -0.034                  | 0.094                | -0.279**       | -0.156**             | -0.119*                  |
| Number of secondary branches  |                       |                  |                         |                   |                            | 1.000                        | -0.075                   | -0.008                     | 0.011           | -0.010                  | -0.066               | -0.127*        | -0.230**             | -0.121*                  |
| Number of pods per plant      |                       |                  |                         |                   |                            |                              | 1.000                    | 0.233**                    | 0.205**         | 0.288**                 | 0.045                | -0.052         | 0.137**              | 0.249**                  |
| Number of pods per cluster    |                       |                  |                         |                   |                            |                              |                          | 1.000                      | -0.100          | 0.092                   | -0.076               | 0.209**        | -0.017               | -0.079                   |
| Pod length (cm)               |                       |                  |                         |                   |                            |                              |                          |                            | 1.000           | 0.270**                 | -0.053               | -0.070         | 0.112*               | 0.042                    |
| Number of seeds per pod       |                       |                  |                         |                   |                            |                              |                          |                            |                 | 1.000                   | 0.193**              | 0.123*         | 0.040                | 0.117*                   |
| Biological yield (g)          |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         | 1.000                | -0.083         | -0.061               | 0.094                    |
| Seed index (g)                |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         |                      | 1.000          | 0.285**              | 0.161**                  |
| Harvesting index (%)          |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         |                      |                | 1.000                | 0.493**                  |
| Seed yield per plant (g)      |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         |                      |                |                      | 1.000                    |

\*, \*\* = Significant at 5% and 1% levels, respectively

**Table 6:** Direct and indirect effects of yield-contributing traits on seed yield at genotypic level

| Genotypic Correlation Matrix |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         |                      |                |                      |                          |
|------------------------------|-----------------------|------------------|-------------------------|-------------------|----------------------------|------------------------------|--------------------------|----------------------------|-----------------|-------------------------|----------------------|----------------|----------------------|--------------------------|
|                              | Days to 50% flowering | Days to maturity | Days to 50% pod setting | Plant height (cm) | Number of primary branches | Number of secondary branches | Number of pods per plant | Number of pods per cluster | Pod length (cm) | Number of seeds per pod | Biological yield (g) | Seed index (g) | Harvesting index (%) | Seed yield per plant (g) |
| Days to 50% flowering        | 0.0019                | 0.0064           | 0.0013                  | -0.0007           | -0.0028                    | 0.0026                       | 0.0126                   | -0.0042                    | -0.0003         | 0.0003                  | -0.0345              | 0.0006         | -0.0165              | -0.0332                  |
| Days to maturity             | -0.0004               | -0.0297          | 0.0029                  | -0.0030           | 0.0046                     | 0.0069                       | 0.0088                   | -0.0005                    | -0.0069         | 0.0160                  | 0.0579               | 0.0083         | -0.3595              | -0.2946**                |
| Days to 50% pod setting      | -0.0001               | 0.0043           | -0.0200                 | 0.0012            | -0.0046                    | -0.0066                      | 0.0112                   | 0.0008                     | 0.0032          | -0.0137                 | 0.1581               | -0.0093        | -0.2948              | -0.1702**                |
| Plant height (cm)            | 0.0002                | -0.0141          | 0.0036                  | -0.0064           | -0.0010                    | -0.0071                      | 0.0017                   | 0.0039                     | -0.0012         | 0.0148                  | -0.0711              | 0.0159         | -0.1833              | -0.2441**                |
| Number of primary branches   | 0.0003                | 0.0082           | -0.0056                 | -0.0004           | -0.0166                    | -0.0176                      | 0.0163                   | -0.0002                    | 0.0064          | 0.0062                  | 0.0016               | -0.0130        | -0.1677              | -0.1820**                |
| Number of secondary branches | -0.0001               | 0.0060           | -0.0038                 | -0.0013           | -0.0084                    | -0.0344                      | 0.0119                   | 0.0016                     | 0.0008          | 0.0033                  | -0.0081              | -0.0063        | -0.3953              | -0.4344**                |
| Number of pods per plant     | -0.0005               | 0.0050           | 0.0043                  | 0.0002            | 0.0052                     | 0.0079                       | -0.0520                  | 0.0034                     | 0.0059          | -0.0090                 | 0.1189               | 0.0005         | 0.2385               | 0.3284**                 |

|                            |         |         |         |         |         |         |         |         |         |         |         |         |         |           |
|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----------|
| Pods per plant             |         |         |         |         |         |         |         |         |         |         |         |         |         |           |
| Number of pods per cluster | -0.0007 | 0.0013  | -0.0014 | -0.0022 | 0.0002  | -0.0048 | -0.0154 | 0.0115  | -0.0017 | -0.0041 | -0.0636 | 0.0081  | -0.0941 | -0.1669** |
| Pod length (cm)            | -0.0000 | 0.0126  | -0.0040 | 0.0005  | -0.0065 | -0.0017 | -0.0189 | -0.0012 | 0.0163  | -0.0137 | -0.0401 | -0.0062 | 0.1583  | 0.0953    |
| Number of seeds per pod    | -0.0000 | 0.0132  | -0.0076 | 0.0026  | 0.0028  | 0.0031  | -0.0130 | 0.0013  | 0.0062  | -0.0360 | 0.0379  | 0.0046  | 0.0663  | 0.0816    |
| Biological yield (g)       | -0.0001 | -0.0038 | -0.0069 | 0.0010  | -0.0001 | 0.0006  | -0.0136 | -0.0016 | -0.0014 | -0.0030 | 0.4544  | -0.0076 | -0.1385 | 0.2794**  |
| Seed index (g)             | 0.0000  | -0.0068 | 0.0051  | -0.0028 | 0.0059  | 0.0059  | -0.0007 | 0.0025  | -0.0028 | -0.0045 | -0.0947 | 0.0364  | 0.3052  | 0.2488**  |
| Harvesting index (%)       | -0.0000 | 0.0114  | 0.0063  | 0.0012  | 0.0030  | 0.0145  | -0.0132 | -0.0012 | 0.0027  | -0.0025 | -0.0671 | 0.0118  | 0.9375  | 0.9044**  |

**Table 7:** Direct and indirect effects of yield-contributing traits on seed yield at phenotypic level

| Phenotypic Correlation Matrix |                       |                  |                         |                   |                            |                              |                          |                            |                 |                         |                      |                |                      |                          |
|-------------------------------|-----------------------|------------------|-------------------------|-------------------|----------------------------|------------------------------|--------------------------|----------------------------|-----------------|-------------------------|----------------------|----------------|----------------------|--------------------------|
|                               | Days to 50% flowering | Days to maturity | Days to 50% pod setting | Plant height (cm) | Number of primary branches | Number of secondary branches | Number of pods per plant | Number of pods per cluster | Pod length (cm) | Number of seeds per pod | Biological yield (g) | Seed index (g) | Harvesting index (%) | Seed yield per plant (g) |
| Days to 50% flowering         | 0.1152                | 0.0047           | 0.0166                  | -0.0002           | 0.0002                     | 0.0000                       | -0.0582                  | 0.0205                     | 0.0049          | -0.0040                 | 0.0067               | 0.0077         | 0.0054               | 0.1194*                  |
| Days to maturity              | -0.0058               | -0.0931          | -0.0052                 | -0.0008           | 0.0008                     | 0.0001                       | -0.0071                  | -0.0152                    | 0.0215          | 0.0049                  | 0.0052               | 0.0130         | -0.1022              | -0.1838**                |
| Days to 50% pod setting       | 0.0133                | 0.0034           | 0.1436                  | 0.0002            | -0.0016                    | -0.0000                      | -0.0406                  | 0.0066                     | -0.0123         | -0.0144                 | 0.0190               | -0.0071        | -0.1027              | 0.0071                   |
| Plant height (cm)             | 0.0088                | -0.0259          | -0.0090                 | -0.0027           | -0.0007                    | -0.0001                      | -0.0362                  | -0.0134                    | 0.0106          | 0.0121                  | -0.0059              | 0.0222         | -0.0386              | -0.0789                  |
| Number of primary branches    | -0.0025               | 0.0106           | 0.0344                  | -0.0003           | -0.0069                    | -0.0001                      | -0.0432                  | -0.0011                    | -0.0216         | 0.0014                  | 0.0057               | -0.0248        | -0.0702              | -0.1186*                 |
| Number of secondary branches  | -0.0056               | 0.0175           | 0.0098                  | -0.0004           | -0.0013                    | -0.0007                      | -0.0217                  | 0.0009                     | -0.0011         | 0.0004                  | -0.0040              | -0.0113        | -0.1037              | -0.1212*                 |
| Number of pods per plant      | -0.0233               | 0.0023           | -0.0203                 | 0.0003            | 0.0010                     | 0.0001                       | 0.2871                   | -0.0270                    | -0.0188         | -0.0122                 | 0.0028               | -0.0046        | 0.0616               | 0.2490**                 |
| Number of pods per cluster    | -0.0203               | -0.0122          | -0.0081                 | -0.0003           | -0.0001                    | 0.0000                       | 0.0668                   | -0.1162                    | 0.0091          | -0.0039                 | -0.0046              | 0.0185         | -0.0076              | -0.0790                  |
| Pod length (cm)               | -0.0061               | 0.0218           | 0.0193                  | 0.0003            | -0.0016                    | -0.0000                      | 0.0588                   | 0.0116                     | -0.0917         | -0.0114                 | -0.0033              | -0.0062        | 0.0506               | 0.0422                   |
| Number of seeds per pod       | 0.0110                | 0.0108           | 0.0490                  | 0.0008            | 0.0002                     | 0.0000                       | 0.0827                   | -0.0107                    | -0.0248         | -0.0422                 | 0.0118               | 0.0109         | 0.0179               | 0.1174*                  |
| Biological yield (g)          | 0.0126                | -0.0080          | 0.0446                  | 0.0003            | -0.0006                    | 0.0000                       | 0.0130                   | 0.0088                     | 0.0049          | -0.0082                 | 0.0610               | -0.0074        | -0.0274              | 0.0937                   |
| Seed index (g)                | 0.0100                | -0.0137          | -0.0115                 | -0.0007           | 0.0019                     | 0.0001                       | -0.0149                  | -0.0242                    | 0.0064          | -0.0052                 | -0.0051              | 0.0888         | 0.1288               | 0.1609**                 |
| Harvesting index (%)          | 0.0014                | 0.0211           | -0.0327                 | 0.0002            | 0.0011                     | 0.0002                       | 0.0392                   | 0.0020                     | -0.0103         | -0.0017                 | -0.0037              | 0.0254         | 0.4512               | 0.4933**                 |

#### 4. Conclusion

The present investigation revealed significant genetic variability among the 20 greengram genotypes for all 14 quantitative traits, indicating considerable scope for genetic improvement through selection. Moderate genetic advance as percentage of mean was observed for secondary branches, seed index, pods per plant and harvest index. Correlation analysis identified harvest index, number of pods per plant, seed index and biological yield as important traits associated with seed yield. Harvest index showed the strongest positive association with seed yield at both

genotypic (0.9044\*\*) and phenotypic (0.4933\*\*) levels. Path analysis further supported the importance of these traits for yield improvement. Among the evaluated material, IC-76599, IC-76414 and IC-76464 were identified as promising genotypes and may be utilized in future selection and hybridization programmes for developing high-yielding greengram genotypes. In conclusion, greater emphasis on harvest index, number of pods per plant, seed index and biological yield during selection could be effective for improving seed yield in greengram.

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