Introduction

Greengram (Vigna radiata (L.) Wilczek) popularly known as mungbean is the third important legume after chickpea and pigeon pea. It is a self-pollinating, short duration legume that belongs to family Fabaceae with a chromosome number of 2n=22. It is mainly grown for its seeds which are used as whole or splits (dhal). The major constraints of greengram production are cultivation under low rainfall condition, low fertile lands, frequent dry spells, poor availability of quality seeds, lack of improved varieties and narrow genetic base. There is an urgent need to enhance the genetic potential of green gram for yield. It is third most important pulse crop of India. It is grown mainly in Madhya...
Pradesh, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka and Rajasthan. Recently domestic consumption of greengram has increased because of the rising popularity in Indian ethnic foods and perceived health benefits (Datta et al., 2012).

The protein is comparatively rich in lysine, an amino acid that is deficient in cereal grains. Greengram seeds are rich in minerals like calcium, iron, magnesium, phosphorus and potassium and vitamins like ascorbic acid, thiamine, riboflavin, niacin, pantothenic acid and vitamin A (Tang et al., 2014).

40 grams of pulses is the recommended daily intake for a balanced diet of an average sedentary man. On the production front, although India ranks first globally in terms of area and production of pulses, it is not yet self-sufficient and remains a net importer of pulses. Among all pulses greengram have high proportion of protein (24gm/100gm). So research is necessary to release the high yielding variety of greengram to meet the requirement.

Materials and Methods

The present investigation was carried out at the Field Experimentation Centre, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. during kharif, 2018. All types of facilities necessary for cultivation of successful crop including field preparation, inputs and irrigation facilities were provided In the present investigation, 31 (30+1 check) greengram (Vigna radiata (L.) Wilczek) genotypes were grown. The experiment was conducted in Randomized Block Design with three replications. The gross area of experiment was 179.55m² and cash plot size was 1×1m spacing of 30cm between rows and 10cm between plants. The recommended dose of fertilizer N: P: K @ 20:40:40 kg/ha was applied in the form of Urea, Di-Ammonium Phosphate and Muriate of potash as basal dose at the time of sowing.

Results and Discussion

Mean data for 12 characters viz., days to 50% flowering, days to 50% pod setting, plant height, number of branches per plant, days to maturity, number of clusters per plant, number of pod per plant, pod length, number of seed per pod, biological yield, harvest index, 100 seed weight and seed yield per plant were subjected to analysis of variance for experimental design. The mean sum of squares due to 31 genotypes were highly significant for all the characters studied, suggesting that the experimental materials were genetically divergent from each other. This indicates that there is ample scope for selection of promising lines for the present gene pool for yield and its components. The presence of large amount of variability might be due to diverse source of materials taken as well as environmental influence affecting the phenotypes.

On the basis of mean performance, days to 50% flowering showed early in Kanpur Mung-13-11 X Kanpur Mung-13-18 (39.00), RMG-1014 X GANGA genotype had showed early maturity (60.67), number of pods per plant KM-1-02 X KM-13-30 (20.00), number of seeds per pod RMG-1037 X GANGA-1 (11.51), seed yield per plantRMG-1010 X RMG-1071 (6.52 g).

In the present investigation, it estimates of phenotypic coefficient of variation was found higher than their corresponding genotypic coefficient of variation, indicating that the influence of environment on the expression of these characters. However, maximum phenotypic and genotypic coefficient of variation was observed for all the traits in the following genotype (i.e.,) number of primary branches per plant (31.83) and number of
primary branches per plant was observed high for GCV (31.49), followed by seed index for PCV and GCV (31.08, 30.83), clusters per plant for GCV and PCV (21.22, 21.00). High heritability was observed for all the traits ranged from pod length (98.4) followed by seed index (98.4) number of primary branches per plant (97.9), and number of clusters per plant (97.9). Genetic advance revealed that it was high for harvest index (9.5), followed by plant height (5.8). Genetic advances as percent of mean was exhibited high for number of primary branches per plant (64.168), followed by seed index (63.004). Seed yield per plant exhibited positive significant correlation with number of clusters per plant (0.498**), number of pods per plant (0.465**), and plant height (0.382*).

The correlation (Table-2) showed positive non significant association with days to maturity (0.248), number of primary branches per plant (0.135), days to 50% flowering (0.129). The correlation showed negative non significant association with number of seeds per plant (-0.185) and plant length (-0.132). Character association analysis revealed that seed yield per plant exhibited positive significant association at phenotypic level with plant height (0.382*), number of clusters per plant (0.498**), number of pods per plant (0.465**) and harvest index (0.361*) direct selection for these traits could be helpful in the improvement of Greengram breeding.

### Table 1 GCV, PCV, Heritability, Genetic Advance, GA % of Mean for 12 biometrical characters of greengram

| S.No | Characters                                      | Genotypic coefficient of variation | Phenotypic coefficient of variation | Heritability (%) (broad sense) | Genetic advance | Genetic advance as % of mean |
|------|------------------------------------------------|-----------------------------------|------------------------------------|-------------------------------|----------------|-----------------------------|
| 1    | Days to 50% flowering                          | 4.51                              | 5.01                               | 81.0                          | 3.5            | 8.356                       |
| 2    | Days to maturity                               | 2.31                              | 2.78                               | 69.4                          | 2.5            | 3.971                       |
| 3    | Plant height                                   | 6.99                              | 7.58                               | 85.0                          | 5.8            | 13.265                      |
| 4    | Number of Primary Branches per Plant           | 31.49                             | 31.83                              | 97.9                          | 2.1            | 64.168                      |
| 5    | Number of Cluster per Plant                    | 21.00                             | 21.22                              | 97.9                          | 2.3            | 42.808                      |
| 6    | Number of Pods per Plant                       | 7.95                              | 8.62                               | 85.1                          | 2.7            | 15.108                      |
| 7    | Number of Seeds per Plant                      | 9.90                              | 10.22                              | 93.7                          | 2.1            | 19.734                      |
| 8    | Pod Length                                     | 15.27                             | 15.39                              | 98.4                          | 2.1            | 31.188                      |
| 9    | Seed Index                                     | 30.83                             | 31.08                              | 98.4                          | 2.1            | 63.004                      |
| 10   | Biological Yield per Plant                     | 16.52                             | 17.08                              | 93.6                          | 4.3            | 32.913                      |
| 11   | Seed Yield per Plant                           | 19.22                             | 19.46                              | 97.6                          | 2.2            | 39.103                      |
| 12   | Harvest Index                                  | 12.66                             | 13.68                              | 85.6                          | 9.5            | 24.133                      |
**Table 2** Phenotypic correlation coefficient of seed yield with its component characters in greengram

| Character                      | Days to maturity | Plant height | Number of primary branches per plant | Number of clusters per plant | Number of pods per plant | Number of seeds per Pod | Pod length | Seed index | Biological yield | Harvest index | Seed yield per plant |
|-------------------------------|-----------------|--------------|--------------------------------------|-----------------------------|-------------------------|------------------------|------------|------------|-------------------|---------------|----------------------|
| Days to 50% flowering         | 0.679**         | 0.373*       | -0.210                               | 0.547**                     | 0.095                   | 0.488**                | 0.064      | 0.257      | -0.426            | 0.129         |                      |
| Days to maturity              | 1               | 0.341        | -0.171                               | 0.438*                      | 0.059                   | 0.458*                 | -0.063     | 0.340      | -0.623**          | 0.248         |                      |
| Plant height                  | 1               | -0.455*      | 0.702**                              | -0.024                      | 0.465*                  | 0.322                  | -0.225     | 0.430*     | -0.403*           | 0.382*        |                      |
| Number of primary branches per plant | 1              | -0.588*      | -0.028                               | -0.428*                     | -0.251                  | 0.167                  | -0.381*    | 0.472**    | 0.135             |               |                      |
| Number of clusters per plant  | 1               | 0.115        | 0.359                                | 0.433*                      | 0.033                   | 0.698**                | -0.453*    | 0.498**    |                   |               |                      |
| Number of pods per plant      | 1               | -0.198       | 0.000                                | 0.131                       | -0.122                  | -0.165                 | 0.465**    |            |                   |               |                      |
| Number of seeds per pod       | 1               | 0.598**      | -0.175                               | 0.364                       | -0.505**                | -0.185                 |            |            |                   |               |                      |
| Pod length                    | 1               | 0.248        | 0.242                                | -0.411*                     | 0.146                   | -0.068                 |            |            |                   |               |                      |
| Seed index                    | 1               | -0.057       | 0.146                                | -0.498**                    | -0.106                  |                       |            |            |                   |               |                      |
| Biological yield              | 1               | -0.498**     | -0.106                               |                             |                         |                       |            |            |                   |               |                      |
| Harvest index                 | 1               | 0.361*       |                                      |                             |                         |                       |            |            |                   |               |                      |
Table 3 Estimation of direct (Diagonal) and indirect effect of yield and its component characters in greengram

| Characters                              | Days to 50% flowering | Days to maturity | Plant height | Number of primary branches per plant | Number of clusters per plant | Number of pods per plant | Number of seeds per pod | Pod length | Seed index | Biological yield | Harvest index | Seed yield per plant |
|-----------------------------------------|-----------------------|------------------|--------------|--------------------------------------|-----------------------------|--------------------------|----------------------------|------------|-------------|---------------------|------------------|-----------------------|
| Days to 50% flowering                   | 0.203                 | 0.268            | -0.177       | -0.018                               | 0.045                       | 0.025                    | 0.003                       | -0.198     | -0.004      | -0.027              | 0.011            | 0.129                 |
| Days to maturity                        | 0.138                 | 0.394            | -0.163       | -0.014                               | 0.036                       | 0.015                    | 0.047                       | -0.186     | 0.004       | -0.035              | 0.015            | 0.248                 |
| Plant height                            | 0.075                 | 0.134            | 0.478        | -0.039                               | 0.057                       | -0.005                   | 0.126                       | -0.130     | 0.014       | -0.045              | 0.010            | 0.382                 |
| Number of primary branches per plant   | -0.043                | -0.067           | 0.220        | 0.085                                | -0.048                      | -0.007                   | -0.118                      | 0.101      | -0.011      | 0.040               | -0.012           | 0.135                 |
| Number of clusters per plant            | 0.112                 | 0.173            | -0.335       | -0.050                               | 0.082                       | 0.027                    | 0.099                       | -0.174     | -0.002      | -0.073              | 0.011            | 0.498                 |
| Number of pods per plant                | 0.020                 | 0.024            | 0.010        | -0.003                               | 0.009                       | 0.247                    | -0.055                      | 0.000      | -0.008      | 0.013               | 0.004            | 0.465                 |
| Number of seeds per pod                 | 0.002                 | 0.067            | -0.220       | -0.037                               | 0.030                       | -0.049                   | 0.274                       | -0.243     | 0.012       | -0.038              | 0.012            | -0.185                |
| Pod length                              | 0.100                 | 0.181            | -0.153       | -0.021                               | 0.035                       | 0.000                    | 0.164                       | -0.405     | -0.016      | -0.025              | 0.010            | -0.132                |
| Seed index                              | 0.012                 | -0.024           | 0.105        | 0.014                                | 0.002                       | 0.032                    | -0.049                      | -0.101     | -0.065      | 0.006               | -0.004           | -0.068                |
| Biological yield                        | 0.053                 | 0.134            | -0.206       | -0.032                               | 0.057                       | -0.030                   | 0.099                       | -0.097     | 0.004       | -0.104              | 0.012            | -0.106                |
| Harvest index                           | -0.087                | -0.244           | 0.191        | 0.040                                | -0.037                      | -0.039                   | -0.137                      | 0.166      | -0.010      | 0.052               | 0.425            | 0.361                 |
Path analysis (Table-3) at phenotypic level indicates the days to 50% flowering (0.203), days to maturity (0.394), plant height (0.478), number of primary branches per plant (0.085), number of clusters per plant (0.082), number of pods per plant (0.247), number of seeds per pod (0.274), harvest index (0.425) had maximum positive direct effect on seed yield per plant. On the basis of results of the experiment it can be conducted that the genotypes have observed 50% flowering which showed early in KM-13-11 X KM-13-18 (39.00), RMG-1014 X GANGA-2 genotype had showed early maturity (60.67), number of pods per plant KM-13-02 X KM-13-30 (20.00), number of seeds per pod RMG-1037 X GANGA-1 (11.51), seed yield per plant RMG-1010 X RMG-1071 (6.52 g).

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