

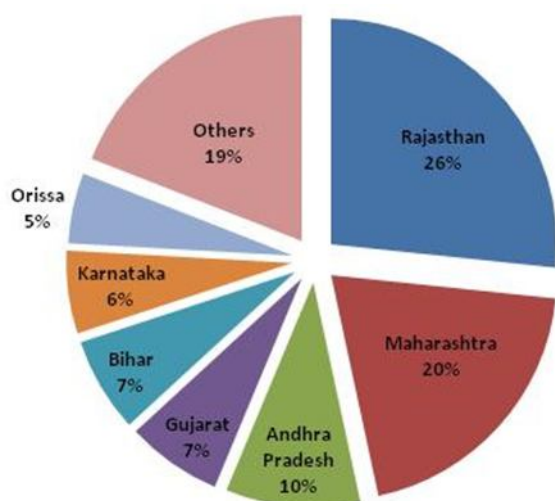
ASSESSMENT OF GENETIC DIVERSITY IN GREEN GRAM [*Vigna radiata* (L.) Wilczek] FOR QUANTITATIVE AND QUALITATIVE TRAITS

**ABSTRACT:** The current study, "Assessment of genetic diversity in green gram [*Vigna radiata* (L.) Wilczek] for quantitative and qualitative traits" was carried out during the *kharif* of 2022 at the College of Agriculture, Dhule. The experimental materials consisted local collection of 42 mungbean genotypes which were evaluated in a randomized block design (RBD) with two replications, representing various eco-geographic regions for twelve different characters and studies of genetic divergence were carried out. The genetic diversity among landraces is determined by the range of  $D^2$  values which varied from 44.68 (MG-2022-15 and MG-2022-30) to 1678.53 (MG-2022-18 and MG-2022-31) for each genotype, showing adequate variance. Based on  $D^2$  levels, the 42 genotypes were split up into 16 groups with notable genetic differences. Cluster I and III were the largest, with 11 and 10 genotypes each. It was adjacent to Clusters II, which had eight genotypes. Based on inter-cluster means and per se performance, breeding programs may employ the following effective genotypes *viz.*, MG-2022-31, MG-2022-42, MG-2022-21, MG-2022-40, MG-2022-39, MG-2022-14, MG-2022-11, MG-2022-18, MG-2022-02, MG-2022-25, and MG-2022-24 to further enhance grain yield and its contributing characters in mungbean.

**KEYWORDS:** Genetic diversity, mungbean, cluster, genotypes,

**INTRODUCTION:** The current study was carried out because it offers a quantitative evaluation of the relationship between genetic diversity and geographic location based on generalised distance and is helpful in determining the level of genetic divergence. India leads the world in pulse production, imports, and consumption. Around the world, mungbean has been a staple traditional cuisine (Berihunet *et al.*, 2017). It is a good source of protein, folate as well as iron in comparison to other legumes (Keatinge *et al.*, 2011). On a dry weight basis, mungbean seeds contain 24–28% protein, 1.0–1.5% oil, 4.5–5.5% ash, 3.5–4.5% fibre, and 62–65% carbs. In 2019–2020, green gramme was cultivated on more than 31.15 lakh acres in India.

Madhya Pradesh (1.57 lakh ha), Rajasthan (20.89 lakh ha), Karnataka (4.40 lakh ha), Maharashtra (3.94 lakh ha), and Orissa (1.48 lakh ha) were the states with the highest mungbean production (figure 1). 2.85 Mt mungbean's were produced in India in total, 1.48 Mt in *kharif* and 1.37 Mt in rabi season. This amounts to 10% of the country's total pulse production. (Directorate of Economics and Statistics, 2022). Ten main Indian states account for more than 80% of the country's mungbean production (Sehrawat, *et al.*, 2021).



**Figure 1: State-wise share of mungbean production in India (Anonymous, 2019)**

In India, the total area covered by green gram in 2020–21 was around 35.79 lakh hectares, as opposed to 30.75 lakh hectares in 2019–20 (Anonymous, 2020). The study of diversity within a species is genetic diversity. More diversity increases the likelihood of choosing suitable genotypes for hybridization. The ability to estimate parental diversity may be aided by direct chemical examination of genetic material or gene products (Thorat *et al.*, 2023). Genetic diversity provides the foundation for trait improvement and adaptation to changing environmental conditions. Evaluation of germplasm resources has enabled breeders to identify valuable traits and select suitable parents for hybridization (Aswiniet *al.*, 2023).

**MATERIAL AND METHODS:** The experimental materials for the present investigation included 42 genotypes of mungbean representing different eco-geographic regions, source of material was Assistant Pulse Breeder, Oilseed Research Station, Nimkhedi- Jalgoan and local collection from Dhagdaon. The 42 genotypes were evaluated in a Randomized Block Design (RBD) with two replications during *kharif* – 2022 at a spacing of 30 cm x 10 cm. Plants were evaluated for diverse characters like days for 50 % maturity, days to maturity, plant height (cm), number of pods per plant, pod length (cm), pod thickness (mm), number of clusters per plant, number of pods per cluster, number of seeds per pod, 100 seed weight (g), protein content (%), and seed yield per plant (g).

By calculating the organic nitrogen using the Kjeldahl technique described by Hawk *et al.* (1954), the protein content of dry seed was ascertained. Five plants were chosen for each genotype, and their seeds were bulked and ground in a grinder. At the Department of Soil Science, College of Agriculture, Dhule, 0.2 g of ground samples were subjected to a wet digestion procedure for nitrogen content analysis. Using the mean data from various sources, the analysis of variance for various characteristics was conducted using the Panse and Sukhatme (1995) approach. Diversity analysis will be done as per procedure given by Mahalanobis (1936) and clustering will be done by following the procedure of Rao (1952).

**RESULTS AND DISCUSSION:** Gayacharanet *al.* (2020) concluded that the crop species has evolved in a diverse range of agro climatic conditions and therefore the local germplasm has rich

**genetic diversity.** Genetic diversity provides the foundation for trait improvement and adaptation to changing environmental conditions. Evaluation of germplasm resources has enabled breeders to identify valuable traits and select suitable parents for hybridization (Aswini *et al.*, 2023). The genetic diversity among the landraces is decided on the basis of the range of  $D^2$  values among genotypes and high significant differences among the genotypes. Analysis of variance revealed extremely significant genotype differences for all characteristics in the current investigation, as shown in table 1.

Estimates of the population mean, range, and coefficient of variation were applied to the observations. There were notable differences across the genotypes, as evidenced by the large mean sum of squares for all attributes resulting from treatments. However, the replication-related differences were not statistically significant, suggesting that the experiment's land was uniform. High variation was present in all twelve characters that were examined. For seed yield per plant,  $D^2$  values for all feasible pairs of 42 genotypes varied from 44.68 (MG-2022-15 and MG-2022-30) to 1678.53 (MG-2022-18 and MG-2022-31).

The Tocher's method for cluster formation was given by Rao (1952). The formation of clusters (figure 3) and finding out intra and inter-cluster divergence is aimed at making available basis for selection of parents for further hybridization programs. In table 2 averages inter and intra-cluster  $D^2$  values are given. The cluster XIII and XIV (16.57) shown maximum inter-cluster distance, followed by cluster XV and XVI (15.75), cluster XII and XV (15.47), cluster XIII and XV (15.01) while minimum inter-cluster distance was found between cluster IV and V (3.52). In case of intra-cluster distance, cluster III had maximum intra-cluster distance (6.1) followed by cluster II (5.4), and cluster I (4.8). Whereas intra-cluster distance was not shown by clusters IV, V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, XVI were solitary clusters (Fig. 3). Most diverse groups are selected as they give better performance in heterosis breeding (Goyalet *al.* 2021).

Mean performance of sixteen clusters for twelve characters are presented in table 3. Mean performance for character seed yields is the highest in cluster XVI (8.5 g) and cluster XV (3.64 g) was inferior among all the clusters. Cluster XI early flowered early matured, good in height but less in clusters per plant and 100 seeds weight resulted inferior in yield. The cluster mean for days to 50 per cent flowering was maximum of 38.75 days (cluster X), while for days to maturity, highest mean value was 77.50 days (cluster VII, VIII, XIII). The 56.83 cm (cluster VII) having maximum height among all clusters. A mean value for number of pods per plant was maximum for cluster XII (16.9), whereas mean value for pod length was maximum for cluster IV (9.18 cm). The highest mean performance for number of clusters per plant was observed in 4.97 (cluster X) and for number of pods per cluster is 5.95 (cluster XV). In case of seeds per pod, the highest mean value given by cluster XVI (11.31), 8.5 g is mean performance for 100 seeds weight and shown by cluster XVI. The highest mean value for protein content was found in cluster IX (24.53 per cent).

Using data collected, genetic divergence was determined for twelve characters of all the forty two genotypes in mungbean. From these 12 characters, the number of seeds per pod (46.57%) contributed maximum for divergence, followed by 100 seeds weight (24.27%) and

number of clusters per plant (8.71%). However, the contribution of plant height (5.92%), number of pods per cluster (5.69%), Seed yield per plant (4.99%), pod thickness (2.67%) were moderate. The contribution of pod length (0.47%), protein content (0.35%), days to 50% flowering (0.12%), days to maturity (0.12%), and number of pods per plant (0.12%) were negligible

Srivastava *et al.* (2024) found that plant height, number of branches/plant, number of pods/cluster, pod length, biological yield, harvest index, and seed yield/plant were recognized as significant contributors to genetic diversity, which may be utilized as a guide when choosing parents from a variety of backgrounds for hybridization in breeding programmes to increase yield substantially.

The clustering pattern indicates that, genotypes from different sources were clubbed into one group and also genotypes of same source forming different clusters indicating no relationship between geographical diversity and genetic divergence (Barate *et al.* 2020). The range of  $D^2$  values across genotypes and the high significant difference between genotypes are used to determine the genetic diversity among landraces. The  $D^2$  values demonstrated sufficient variation across the genotypes and varied from 44.68 (MG-2022-15 and MG-2022-30) to 1678.53 (MG-2022-18 and MG-2022-31). Solitary clusters included IV, V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, and XVI. On the basis of diversity analysis, the best possible genotypes were taken which were desirable for specific character and are mentioned in table 5.

The findings suggests that there is substantial genetic diversity available among the genotypes. The parents with more genetic distance produce higher variation that increases genetic gain by selection (Feteme *et al.* 2012). The genetic diversity was not to be necessarily associated with geographical origin. It was associated with genetic architecture of the genotypes. Also, the genotypes with more protein content, early flowering and maturing, maximum plant height with long and thick pod size, having more number of seeds per pod and better seed weight can give maximum yield in mungbean. On the basis of best suitable local genotypes for each trait, possible cross combinations are given in table 4 which can be further exploited to get desirable progenies.

**SUMMARY AND CONCLUSIONS:** The study's findings indicate that 42 genotypes were divided into 16 clusters, with cluster I having the most genotypes- 11 in all. All 42 genotypes were categorised into 16 clusters with significant genetic difference based on  $D^2$  values. With 11 and 10 genotypes apiece, cluster I and III were the biggest, followed by cluster II, which had 8 genotypes each. With a  $D^2$  value of (6.1), cluster III was the most divergent, followed by clusters II and I (5.4 and 4.8, respectively). This implies that the hybridisation algorithm has enough room to choose a variety of parents from these clusters in order to produce mungbean recombinants with a number of desired traits. It can be concluded that, MG-2022-31, MG-2022-42, MG-2022-21, MG-2022-40, MG-2022-39, MG-2022-14, MG-2022-11, MG-2022-18, MG-2022-02, MG-2022-25, and MG-2022-24 are effective genotypes that can be used in breeding programs to further improve grain yield and its contributing characters in mungbean based on inter-cluster means and per se performance.

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**Table1: Analysis of variance for twelve characters in mungbean**

| Sr. No. | Characters           | Mean sum of squares |                |            |
|---------|----------------------|---------------------|----------------|------------|
|         |                      | Replication (1)     | Genotypes (41) | Error (41) |
| 1       | Daysto 50% flowering | 3.24                | 1.81**         | 1.10       |

|    |                           |      |         |       |
|----|---------------------------|------|---------|-------|
| 2  | Daysto maturity           | 4.30 | 2.07**  | 1.07  |
| 3  | Plantheight(cm)           | 3.52 | 67.88** | 13.80 |
| 4  | Numberofclustersper plant | 0.15 | 1.28**  | 0.17  |
| 5  | Numberofpods per cluster  | 0.01 | 2.92**  | 0.20  |
| 6  | Numberofpods per plant    | 0.17 | 7.18**  | 3.42  |
| 7  | Numberofseedsper pod      | 0.52 | 3.95**  | 0.09  |
| 8  | Podlength                 | 0.00 | 1.10**  | 0.50  |
| 9  | Podthickness              | 0.22 | 0.21**  | 0.06  |
| 10 | 100 seedsweight           | 0.00 | 1.34**  | 0.06  |
| 11 | Proteincontent            | 2.29 | 2.29**  | 1.02  |
| 12 | Seedyieldperplant         | 0.10 | 2.53**  | 0.36  |

\* ,\*\*significant at 5 and 1 per cent level, respectively.

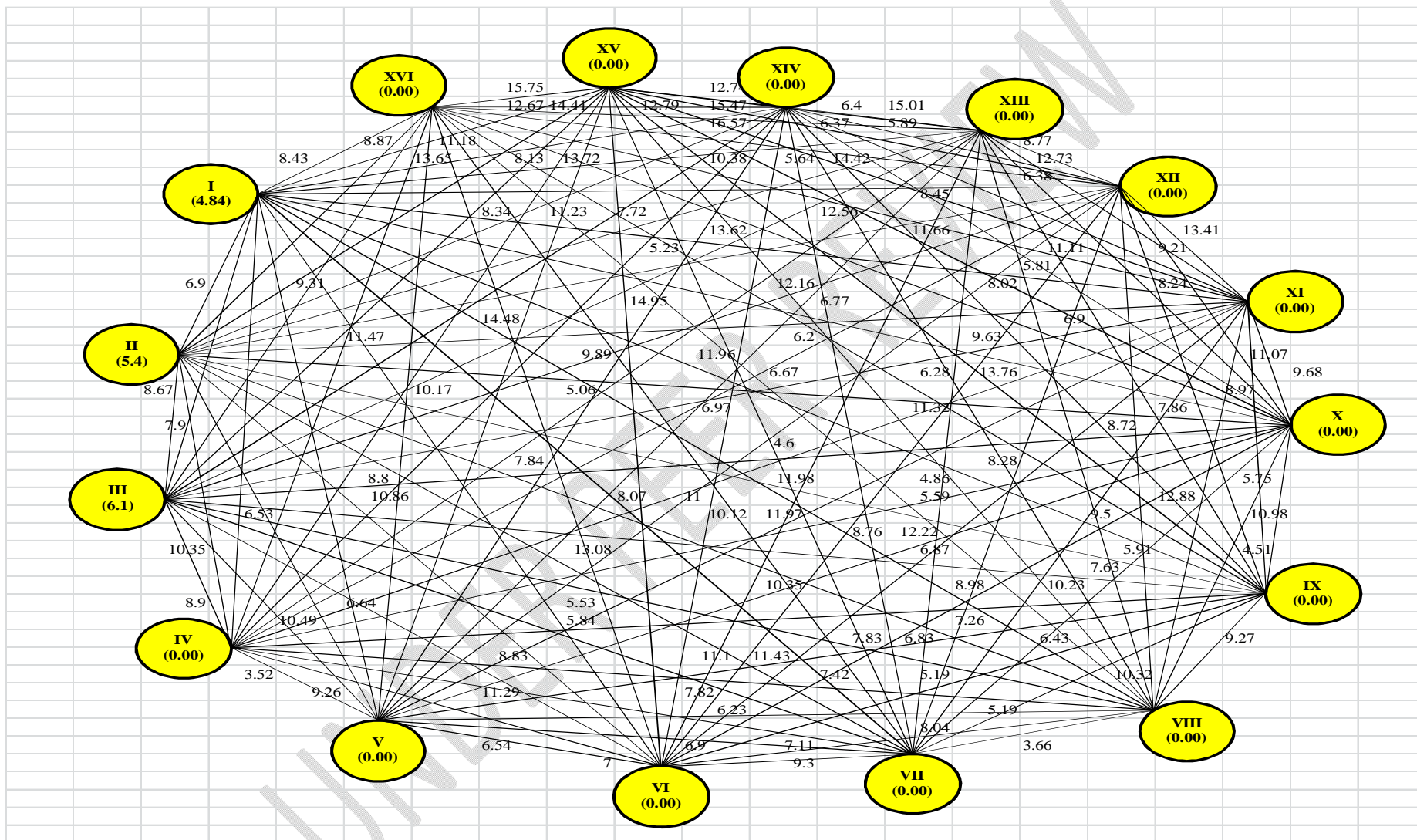
Valuesin parenthesisindicates thedegrees offreedom.



**Table3: Mean performance of sixteen clusters for twelve characters in mung bean**

| Characters     | Days to 50% flowering | Days to maturity | Plant height (cm) | No. of clusters per plant | No. of pods per cluster | No. of pods per plant | No. of seeds per pod | Pod length (cm) | Pod thickness (mm) | 100 seeds weight (g) | Protein content (%) | Seed yield per plant (g) |
|----------------|-----------------------|------------------|-------------------|---------------------------|-------------------------|-----------------------|----------------------|-----------------|--------------------|----------------------|---------------------|--------------------------|
| <b>I</b>       | 37.05                 | 76.00            | 48.25             | 3.83                      | 3.90                    | 13.07                 | 9.33                 | 8.03            | 4.65               | 5.23                 | 22.72               | 6.01                     |
| <b>II</b>      | 36.88                 | 75.63            | 43.30             | 3.13                      | 4.59                    | 13.83                 | 10.79                | 7.76            | 4.48               | 4.53                 | 22.50               | 6.10                     |
| <b>III</b>     | 36.55                 | 76.08            | 48.49             | 3.09                      | 5.59                    | 16.58                 | 8.52                 | 7.38            | 4.25               | 3.97                 | 21.68               | 5.35                     |
| <b>IV</b>      | 38.00                 | 75.50            | 44.30             | 3.85                      | 3.92                    | 13.40                 | 7.71                 | 9.18            | 5.46               | 5.08                 | 22.34               | 4.98                     |
| <b>V</b>       | 38.50                 | 75.00            | 43.87             | 3.86                      | 5.02                    | 15.77                 | 7.55                 | 8.67            | 4.62               | 5.76                 | 22.86               | 6.22                     |
| <b>VI</b>      | 37.50                 | 76.00            | 45.85             | 4.93                      | 2.73                    | 13.60                 | 9.58                 | 8.22            | 4.98               | 6.36                 | 23.00               | 6.95                     |
| <b>VII</b>     | 38.00                 | 77.50            | 56.83             | 4.35                      | 4.06                    | 15.40                 | 7.20                 | 7.34            | 4.00               | 5.51                 | 21.99               | 5.51                     |
| <b>VIII</b>    | 36.00                 | 77.50            | 55.15             | 4.79                      | 3.27                    | 14.50                 | 7.69                 | 8.96            | 4.68               | 5.12                 | 23.42               | 5.16                     |
| <b>IX</b>      | 37.50                 | 75.00            | 49.45             | 3.25                      | 4.72                    | 14.90                 | 9.69                 | 7.63            | 5.15               | 5.60                 | 24.53               | 7.65                     |
| <b>X</b>       | 38.75                 | 75.00            | 41.97             | 4.97                      | 2.32                    | 13.63                 | 7.45                 | 7.74            | 4.62               | 4.86                 | 21.44               | 3.85                     |
| <b>XI</b>      | 36.50                 | 75.50            | 50.02             | 3.35                      | 3.43                    | 13.60                 | 10.02                | 7.39            | 4.18               | 3.73                 | 22.10               | 4.18                     |
| <b>XII</b>     | 37.50                 | 76.00            | 39.48             | 3.00                      | 5.93                    | 16.90                 | 7.09                 | 6.38            | 4.61               | 5.92                 | 21.18               | 6.81                     |
| <b>XIII</b>    | 38.00                 | 77.50            | 51.45             | 3.70                      | 3.63                    | 12.73                 | 5.64                 | 6.94            | 4.28               | 5.38                 | 23.00               | 3.88                     |
| <b>XIV</b>     | 37.00                 | 75.50            | 42.68             | 3.43                      | 5.60                    | 16.20                 | 6.93                 | 6.99            | 4.55               | 4.75                 | 24.36               | 4.61                     |
| <b>XV</b>      | 37.50                 | 76.25            | 53.16             | 2.90                      | 5.95                    | 13.30                 | 10.37                | 6.45            | 4.10               | 3.02                 | 21.00               | 3.64                     |
| <b>XVI</b>     | 38.00                 | 75.00            | 51.42             | 4.53                      | 3.11                    | 13.90                 | 11.31                | 8.56            | 4.76               | 6.54                 | 23.23               | 8.50                     |
| <b>AVERAGE</b> | 37.45                 | 75.94            | 47.85             | 3.81                      | 4.24                    | 14.46                 | 8.55                 | 7.73            | 4.59               | 5.09                 | 22.58               | 5.59                     |

Figure 2: Cluster diagram of fortytwo genotypes in mungbean



**Table4: Tentative suggested crossing programme in future for improvement in mungbean**

| Sr. No. | Character to be improved     |                         | Cluster combination within inter-cluster distance | Genotypes possible       | Possible crosses       |
|---------|------------------------------|-------------------------|---|--------------------------|------------------------|
| 1       | Earliness                    | Day to 50% entflowering | VIII×XI(8.97)                                     | MG-2022-42<br>MG-2022-02 | MG-2022-42× MG-2022-02 |
|         |                              | Days to maturity        | IV×V(27.090)                                      | MG-2022-39<br>MG-2022-23 | MG-2022-39×MG-2022-23  |
| 2       | Plant height                 |                         | VII×VIII(3.66)                                    | MG-2022-25<br>MG-2022-42 | MG-2022-25×MG-2022-42  |
| 3       | Number of clusters per plant |                         | VI×X(8.98)  | MG-2022-34<br>MG-2022-24 | MG-2022-34× MG-2022-24 |
| 4       | Number of pods per cluster   |                         | XII × XV (15.47)                                  | MG-2022-14<br>MG-2022-04 | MG-2022-14×MG-2022-04  |
| 5       | Number of pods per plant     |                         | III × XII (9.89)                                  | MG-2022-21<br>MG-2022-14 | MG-2022-21×MG-2022-14  |

|           |                           |                 |                          |                         |
|-----------|---------------------------|-----------------|--------------------------|-------------------------|
| <b>6</b>  | Numberofseedspod          | II × XVI (8.87) | MG-2022-40<br>MG-2022-31 | MG-2022-40 × MG-2022-31 |
| <b>7</b>  | Podlength(cm)             | VIII ×IV(5.19)  | MG-2022-42<br>MG-2022-39 | MG-2022-42×MG-2022-39   |
| <b>8</b>  | Podthickness(mm)          | IX ×IV(7.26)    | MG-2022-11<br>MG-2022-39 | MG-2022-11×MG-2022-39   |
| <b>9</b>  | 100 seedsweight(g)        | VI×XVI(5.53)    | MG-2022-34<br>MG-2022-31 | MG-2022-34×MG-2022-31   |
| <b>10</b> | Protein<br>content(<br>%) | XIV×IX(9.63)    | MG-2022-31<br>MG-2022-11 | MG-2022-31 × MG-2022-11 |
| <b>11</b> | Seedyieldperplant(g)      | IX×XVI(6.2)     | MG-2022-11<br>MG-2022-31 | MG-2022-11 ×MG-2022-31  |

**Table5:Tableincludinglistofgenotypeswithdesirablecharacters**

| <b>Genotypes</b> | <b>Characters</b>                                     | <b>Genotypes</b> | <b>Characters</b>   |
|------------------|---|------------------|---|
| MG-2022-31       | Numberofseedsperpod,Seed yield perplant               | MG-2022-42       | Pod length  |
| MG-2022-42       | Plantheight, Pod length                               | MG-2022-40       | Numberofseedsp erpod  |
| MG-2022-21       | Numberofpods per plant                                | MG-2022-39       | Days to 50 percent flowering,pod length, podthickness   |
| MG-2022-31       | Seed yieldperplant                                    | MG-2022-42       | Days to 50 per cent flowering, Plant height   |
| MG-2022-14       | Number of pods per cluster , Number of pods per plant | MG-2022-31       | Days to maturity,Protein content,numberof clusters per plant,number of seedsper pod, 100 seedsweight,Seed yieldperplant |
| MG-2022-11       | Proteincontent  | MG-2022-11       | Daystomaturity,p roteincontent  |
| MG-2022-18       | Days to 50 per centflowering                          | MG-2022-11       | Days to maturity, Seed yield per plant  |
| MG-2022-42       | Days to 50 per cent flowering, Days to maturity       | MG-2022-24       | Number ofclustersperpla nt  |

**Figure 3: A cluster formation of forty two genotypes by Tocher's method in mung bean.**

