

## **Studies on Genetic Variability, Heritability and Genetic Advance Studies in Brinjal for Morpho-Economic traits (*Solanum melongena* L.)**

### **Abstract**

In two distinct environments (E1 and E2), the current experiment was set up using a randomized block design with the goal of determining the extent of genetic diversity, heritability, and genetic advancement among 15 yield-related variables in brinjal. The results of the analysis of variance showed that there were notable genetic variations among the genotypes of brinjal, indicating a substantial degree of variability and increasing the potential for selection to improve the relevant features. There was a noticeable variance in mean values between the genotypes for several traits, from modest to wide. For most of the features under investigation, with the exception of days to 50% flowering, moderate to high genotypic coefficient of variation, moderate to high heritability, and genetic advancement as a percentage of mean were reported.

**Keywords:** - Variability, Heritability, Genetic Advance, crop improvement.

### **Introduction**

Brinjal (*Solanum melongena* L.) also known as eggplant or aubergine is an important crop of sub-tropics and tropics. Brinjal is a self-pollinated crop, but cross-pollination has been reported as high as 48%. This is because it has pronounced heterostyly, which favours cross pollination. Fruit setting in long styled flowers varies from 70% to 86.70% in different varieties. In medium styled flowers, fruit set ranges from 12.5% to 55.60%. Earlier, brinjal cultivation was not practiced in the temperate hills but due to rise in temperature during last couple of decades this region has become ideal place for cultivation of brinjal. The period of April to September is suitable for longevity of this crop with remunerative yield of good quality fruits devoid of infestation of insect like borers. According to (Sato et al., 2011), eggplant was known in India in ancient times and probably a native of India was of the opinion that its center of origin was in the Indo Burma region (Vavilov 1928). It is believed that eggplant may have originated in China may be the secondary centre of origin which belongs to economically important family

Solanaceae with basic chromosome number ( $2n=2x=24$ ). The first record of eggplant in Europe was in the fifteenth century, the name was probably derived from the white egg like, fruits. Brinjal is of much importance in the warm areas of far-east being grown extensively in India and other Asian countries like, Bangladesh, Pakistan and Philippines. According to Panse and Sukhatme (1967), it has many medicinal properties in ayurveda; it is used as asthma, appetiser, aphrodisiac, cardio tonic. In Unani system of medicine, roots of brinjal are used to alleviate pain, and fruit is used as cardiogenic, laxative, muturant and reliever of inflammation Ravali et al., (2017). Its leaves are used as narcotics and seeds as stimulant but they are apt to lead to dyspepsia and constipation. White brinjal is also said to be good for diabetic patients Pujer et al., (2017). A great genetic variation is available in brinjal throughout the country with regard to fruit size, shape, colour, growth habit, canopy bearing habit, yield, diseases & insect-pests resistance, as well as quality and adaptability for different localities and for different growing seasons. In addition, variation is also noticed for traits like vegetative growth, maturity and presence or absence of spines on leaves, stem and fruit calyx, among the indigenous material. It has been reported that on an average, the oblong-fruited eggplant cultivars are rich in total soluble sugars, whereas the long-fruited cultivars contain a higher content of free reducing sugars, anthocyanin, phenols, glycoalkaloids (such as solasodine), dry matter, and amide proteins Tirkey et al., (2018). Genetic variability plays an important role in a crop/vegetable in selecting the best genotypes for making rapid improvement in yield and other desirable characters as well as to select the potential parent for hybridization programmes. Genetic improvement of any crop mainly depends on the amount of genetic variability present in the population and the germplasm serves as a valuable source of base population and provide scope for wide variability Madavi et al., (2015). Further, the crop exhibits rich genetic diversity and scope for improvement for various horticultural traits.

Heritable variation can be effectively used with greater degree of accuracy when heritability is studied in conjunction with genetic advance Nayak and Nagre (2013). Heritability is the heritable portion of phenotypic variance. The estimates of heritability help the plant breeder in selection of elite genotypes from diverse genetic populations. Genetic advance estimated by the method of Madavi et al., (2015). Genetic advance denotes the improvement in the mean genotypic values of selected

families over base population and thus helps the breeder to select the progenies in the earlier generation itself. An improvement in yield and quality of brinjal is normally achieved by selecting the genotypes with desirable character combination existing in nature or by hybridization. Categorization of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV) and genetic advance (GA) were done as per (Chaudhary *et al* 2014).

### **Materials and Methods**

The present experiment was carried out at Horticultural Research Centre, H.N.B. Garhwal University, Srinagar, (Garhwal) Uttarakhand during kharif season of the year 2016. The material for the present study comprised fifteen genotypes collected from different geographical regions of the country. The experiment was laid out in randomized block design having 15 genotypes replicated thrice to test the variation in genotypes (Gavade and Ghadage, 2015). The net plot size was 1.2 m × 3 m. The seedlings were planted in a fashion accommodating 10 plants in each treatment at spacing of 60cm line to line and 60cm plant to plant. All the scientific agronomic package of practices was followed to raise a healthy crop except spraying of insecticides to control the shoot and fruit borer, phomopsis blight diseases, white fly and leaf hopper. Five randomly marked plants were observed for recording various plant characters.

### **Experimental data**

Five plants of each accession in each replication were randomly selected for recording the observations on 20 yield and its component characters viz. plant height (cm) at 15 days interval DAT, days to 50 per cent flowering, fruit setting percentage, number of flowers per cluster, number of fruits per cluster, number of clusters per plant, days to first fruit harvesting (Days), fruit length (cm), fruit breadth (cm), average fruit weight (g), number of fruits per plant, number of fruit per kg, number of seeds per fruit, weight of 1000 seeds in gram (Test weight), fruit yield per plant (kg), fruit yield per plot (kg), fruit yield per hectare (q/ha), ascorbic acid (mg/100g), total soluble solids (°Brix) and incidence of shoot and fruit borer. The mean replicated data on various biometric traits were subjected to analysis of variance as per the standard statistical

procedure Panse and Sukhatme (1967). Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated as per the formula suggested by Burton and De-Vane (1953). Heritability (broad sense) was worked out using the formula given by Burton and De-Vane (1953). Genetic advance and genetic gain were calculated as per the formula suggested by Mohammad et al., (2015), Vidya and Kumar (2015), Reshmika et al., (2015), Pujer et al., (2017), Ravali et al., (2017), Tripathy et al., (2017), Rahangdale et al., (2022) and Tirkey et al., (2018).

**Table 1: List of genotypes along with their sources**

| Sr. No. | Genotypes      | Sources         |
|---------|----------------|-----------------|
| 1.      | A-2            | Solan, HP       |
| 2.      | Aassly-14      | Solan, HP       |
| 3.      | Arka Keshav    | IIHR, Bangaluru |
| 4.      | Arka Kusumakar | IIHR, Bangaluru |
| 5.      | Arka Neelkanth | IIHR, Bangaluru |
| 6.      | BH- 12         | Solan, HP       |
| 7.      | BRWER-5        | Solan, HP       |
| 8.      | CH-215         | Solan, HP       |
| 9.      | DWR-31         | Solan, HP       |
| 10.     | H-8            | Solan, HP       |
| 11.     | J C-1          | Solan, HP       |
| 12.     | Local-10       | Solan, HP       |

|     |                     |                 |
|-----|---------------------|-----------------|
| 13. | Local-17            | Solan, HP       |
| 14. | Pusa Purple Cluster | IARI, New Dehli |
| 15. | Rajendra-9          | Solan, HP       |

## RESULTS AND DISCUSSION

### Analysis of variance and genetic variability

The ANOVA (Table 1) showed highly significant differences among the genotypes for all the traits indicating thereby the presence of sufficient variability in the experimental materials. The mean performances of the different genotypes for different traits are presented. The quality contributing traits the mean performance recorded as, the genotype H-8 (12.47 mg) for ascorbic acid showed recorded maximum and minimum by the genotype DWR-31 (4.47 mg), for total soluble solids by the genotype Arka Neelkanth (5.31) showed recorded maximum and minimum by the genotype BH-12 (2.50), for fruit and shoot borer incidence observed by genotype H-8 (13.33%) showed recorded minimum and maximum by the genotype BH-12 (56.67%), for fruit length observed by the genotype JC-1 (15.14 cm) height and by the genotype A-2 (6.73 cm) recorded small fruit, for maximum fruit breadth recorded by the genotype A-2 (6.20 cm) and lowest by Pusa Purple Cluster (3.26 cm). The yield contributing traits are very important for selecting best high yielding hybrids therefore, the genotype BRWRES-5 (103.32 g) for average fruit weight observed recorded maximum and minimum showed by the genotype Arka Keshav (57.90 g), for number of fruit per kg the genotype Arka Keshav (17.30 kg) recorded maximum and minimum showed by the genotype DRWRES-5 (9.68), for number of fruits per plant the observed by genotype Arka Keshav (25.07) showed recorded maximum and minimum showed by the genotype JC-1 (6.47), for number of seed per fruit the genotype Local-17 (671) showed recorded maximum and minimum showed by the genotype BH-12 (248), for weight of 1000 seeds observed by the genotype Rajendra-9 (4.70 g) showed recorded maximum and minimum showed by the genotype JC-1 (2.49 g), and for fruit yield per plant observed by the genotype Arka Keshav (1.990 kg) showed recorded

maximum and minimum showed by the genotype JC-1 (0.447 kg), for fruit yield per plot by the genotype Arka Keshav (19.90 kg) recorded maximum and minimum showed by the genotype JC-1 (4.47 kg), for fruit yield per hectare showed maximum mean performance by the genotype Arka Keshav (552.78 q) and minimum by the genotype JC-1 (124.08 q), Arka Keshav recorded highest mean performance for plant height (102.93 cm) and lowest by BH-12 (79.43 cm), for early 50 per cent flowering the genotype Arka Keshav (39.33 days) showed and late 50 per cent flowering genotype recorded by DWR-31 (58.67 days), for fruit set percentage the genotype Arka Keshav (78.34 %), recorded maximum and the genotype JC-1 (56.90 %) minimum, for number of flowers per cluster Arka Keshav (5.64) genotype showed highest and the lowest genotype JC-1 (2.04), for number of fruits per cluster the genotype showed maximum Arka Keshav (4.41) and by the genotype JC-1 (1.17) minimum, for number of clusters per plant the genotype showed Arka Keshav (18.50) maximum and by the genotype JC-1 (10.20) minimum, for minimum days to first fruit harvesting the genotype showed Arka Keshav (57.33 days) and maximum days to first fruit harvesting showed by BRWRES-5 (68.00 days), The high mean performance helps in identifying the best genotypes for developing the hybrids with good growth, earliness, and quality and yield parameters.

The estimates of mean, range, genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for 20 quantitative traits in brinjal genotypes are presented in Table 3. Mean and ranges are the simple measures of variability. The range of mean values also revealed sufficient variation for the characters under study. Maximum range of variability was observed by number of seeds per fruit (248 - 671) followed by fruit yield per hectare (124.08-552.78). These findings are in consonance with the findings of earlier workers <sup>[9], [13], [18]</sup>. The characters showing high range of variation have more scope for improvement. The lowest range of mean was recorded for fruit yield per plant (0.447 - 1.990) indicating availability of low variation for its improvement in the experimental material used. The estimate of phenotypic coefficient of variance (PCV) and genotypic coefficient of variance ranged from (6.34- 63.71) and (5.71- 61.58) respectively (Table 3). The PCV was highest for number of fruits per plant (63.71%), fruit and shoot borer incidence % (51.58%), number of fruits per cluster (42.79), fruit yield per hectare (38.10%), fruit yield per plot (38.10%), fruit yield per

plant (38.10%), number of seeds per fruit (36.59%), ascorbic acid (36.15%). Similarly, GCV was also highest for number of fruits per plant (61.58%), fruit and shoot borer incidence % (38.93 %), number of seeds per fruit (35.19%), fruit yield per plant (34.85%), fruit yield per plot (34.85%), fruit yield per hectare (34.85%), number of fruits per cluster (34.29), number of flowers per cluster (31.01%), Ascorbic acid (30.81%), and fruit length (30.63). The PCV and GCV were lowest for Plant height at 60 and fruit set percentage DAT (6.34 & 5.71). In general, for all the characters under study, PCV were slightly higher than the corresponding GCV indicating prevalence of environmental influence on expression of these traits. However, the difference between PCV and GCV being very low for majority of the characters suggesting more prevalence of genetic governance of these characters and thus selection on phenotypic basis would hold good. The PCV and GCV values were classified as low (<15.00 %), moderate (15-30%) and high (>30%). In the present investigation PCV and GCV were high for number of fruits per plant (63.71 & 61.58), fruit and shoot borer incidence % (51.58 & 38.93), number of fruits per cluster (42.79 & 34.29), fruit yield per hectare (38.10 & 34.85), fruit yield per plot (38.10 & 34.85), fruit yield per plant (38.10 & 34.85), number of seeds per fruit (36.59 & 35.19), ascorbic acid (36.15 & 30.81). The characters like, average fruit weight (20.95), stem girth (19.07% & 18.90 %), plant spread (11.31% & 11.28%), days to first flowering (14.09% & 13.98%), days to 50 per cent flowering (11.61% & 11.56%) has moderate PCV. average fruit weight (20.95 & 19.75), number of fruits per kg (20.36 & 18.89), test weight of seeds (22.86 & 19.99), number of clusters per plant (19.52 & 16.49), fruit breadth (18.46 & 16.27). In the present investigation it was also evident that difference between PCV and GCV were low for all the character studied. It indicates more of genetic control than environment in governing these traits and scope and importance of germplasm used in future selection for crop breeding.

### **Heritability and genetic advance**

Estimates of heritability in broad sense ( $h^2$ ), genetic advance (GA) and genetic advance as percentage of mean (GAM) are presented in (table 4). Heritability, GA and GAM values ranged between 16.18- 92.48%, 4.73 - 69.71%, 0.71 - 249.08% respectively. The heritability values were classified as low (<50.00%), moderate (50.00- 80.00%) and high (>80.00%) while,

GA and GAM as low (< 25.00%), moderate (25-50%) and high (>50.00%) as suggested by Johanson *et al.* [16]. Estimates of heritability were high (>80.00%) for all the traits viz, for number of seeds per fruit (92.48%), fruit length (90.78%), average fruit weight (88.80%), Plant height at 15 DAT (88.03%), 30 DAT (87.89%), 45 DAT (87.05%), number of fruits per plant (86.15%), number of fruits per kg (86.04%), 60 DAT (83.73%), fruit yield per plant (83.66%), fruit yield per plot (83.66%) and fruit yield per hectare (83.66%). Similar results reported by the scientist Gavade and Ghadage (2015), Madhavi *et al.*, (2015), Patel *et al.*, (2015), Shende *et al.*, (2014), Vidya and Kumar (2015), Ravali *et al.*, (2017), Sujin *et al.*, (2017). The estimates of GAM were also high (>50) for number of seed per fruit (69.71%), number of fruits per plant (67.82%), fruit yield per plant (65.67%), fruit yield per plot (65.67%), fruit yield per hectare (65.67%), Fruit and shoot borer incidence (60.53%), number of fruits per kg (59.31%), fruit length (57.27%), number of fruits per cluster (56.61%) and ascorbic acid (52.83%). The moderate GAM (25-50%) was recorded for number of flowers per cluster (46.49%), Average fruit weight (38.33%), TSS (38.27%), test weight of seeds (36.02%), Plant height at 15 DAT (30.78%), fruit breadth (29.33%) and number of clusters per plant (28.70). During the selection for the improvement of any character knowledge of both broad sense heritability and GAM are necessary because broad sense heritability is based on total genetic variance and which includes both fixable (additive) and non-fixable (dominance and epistatic) variances. When heritability is mainly due to non-additive genetic effects (dominance and epistasis) genetic advance will be low, while in cases where heritability is chiefly due to additive gene effects, a high genetic advance may be expected. In the present investigation, except for first flowering node, high GAM coupled with high heritability has been observed for all the characters is the indication of prevalence of additive genetic effects (fixable) involved in their expression and predicted to show good response to phenotypic based selection in crop improvement programme. Hence, it is advisable for straight phenotype-based selection to improve these characters. High heritability along with high GAM estimates are also obtained Singh *et al.*, (2013a), Kumar *et al.*, (2013b), Chaudhary and Kumar (2014) and Mili *et al.*, (2014) and Barela *et al.*, (2022).

Being primary centre of origin, India has accumulated a wide range of variability in brinjal. The existing variability can be used to further enhance the yield level of the brinjal cultivars by following appropriate breeding strategies. Major yield contributing characters is identified and selection for these traits will be helpful in getting increased yield of this crop. Diverse genotypes can be utilized for hybridization programme also. Based on the results obtained it was concluded that high genetic variability and heritability estimates obtained for most of the earliness, growth, yield and its components including quality indicated the prevalence of additive genetic effects (fixable) governing their expression. Therefore, direct selection based on these combinations of traits help in harnessing for selecting good genotypes with high yield per plant in improvement programmes.

**Table 2: Analysis of variance (ANOVA) for 20 quantitative characters in brinjal (*Solanum melongena* L.).**

| S.NO | Source of variance            | Mean sum of square |           |           |
|------|-------------------------------|--------------------|-----------|-----------|
|      |                               | Replication        | Treatment | Error     |
|      | <b>D.F.</b>                   | <b>2</b>           | <b>14</b> | <b>28</b> |
| 1.   | <b>Plant height at 15 DAT</b> | 4.505              | 0.216**   | 0.195     |
|      | <b>Plant height at 30 DAT</b> | 8.309              | 0.665**   | 0.364     |
|      | <b>Plant height at 45 DAT</b> | 5.139              | 1.743**   | 0.715     |
|      | <b>Plant height at 60 DAT</b> | 40.444             | 7.248**   | 2.459     |
|      | <b>Plant height at 75 DAT</b> | 177.817            | 0.820**   | 16.231    |
| 2.   | <b>Days to 50% flowering</b>  | 0.622              | 70.707**  | 14.479    |

|            |                                       |         |            |         |
|------------|---------------------------------------|---------|------------|---------|
| <b>3.</b>  | <b>Fruit set percentage</b>           | 14.566  | 115.929**  | 24.633  |
| <b>4.</b>  | <b>No. of flower per cluster</b>      | 0.127   | 2.558**    | 0.283   |
| <b>5.</b>  | <b>No. of fruits per cluster</b>      | 0.014   | 2.054**    | 0.093   |
| <b>6.</b>  | <b>No. of clusters per plant</b>      | 1.408   | 15.286**   | 0.975   |
| <b>7.</b>  | <b>Days to first fruit harvesting</b> | 11.82   | 150.16**   | 36.89   |
| <b>8.</b>  | <b>Fruit length (cm)</b>              | 1.036   | 24.080**   | 1.072   |
| <b>9.</b>  | <b>Fruit breadth (cm)</b>             | 0.039   | 2.143**    | 0.187   |
| <b>10.</b> | <b>Average fruit weight (g)</b>       | 5.985   | 732.36**   | 29.544  |
| <b>11.</b> | <b>No. of fruit per plant</b>         | 1.719   | 74.238**   | 3.776   |
| <b>12.</b> | <b>No. of fruit per kg</b>            | 0.118   | 20.316**   | 1.042   |
| <b>13.</b> | <b>No. of seed per fruit</b>          | 1236.26 | 48711.28** | 1578.33 |
| <b>14.</b> | <b>Seed test weight</b>               | 0.005   | 1.773**    | 0.164   |
| <b>15.</b> | <b>Fruit yield per plant(kg)</b>      | 0.002   | 0.453**    | 0.027   |
| <b>16.</b> | <b>Fruit yield per plot(kg)</b>       | 0.220   | 45.320**   | 2.769   |

|            |                                    |        |            |          |
|------------|------------------------------------|--------|------------|----------|
| <b>17.</b> | <b>Fruit yield per hectare (q)</b> | 192.82 | 34878.97** | 20.72.95 |
| <b>18.</b> | <b>Ascorbic acid</b>               | 3.480  | 19.042**   | 1.352    |
| <b>19.</b> | <b>TSS</b>                         | 0.236  | 2.510**    | 0.316    |
| <b>20.</b> | <b>Fruit and shoot borer %</b>     | 15.555 | 673.650**  | 125.079  |

\*\*Significant at 5% level.

**Table 3 Estimates of genetic parameters of variations for various characters in brinjal**

| Sr. No. | Characters                   | Range          | Mean  | Coefficients of variation (%) |           | Heritability (%) | Genetic gain (%) | Genetic advance |
|---------|------------------------------|----------------|-------|-------------------------------|-----------|------------------|------------------|-----------------|
|         |                              |                |       | Phenotypic                    | Genotypic |                  |                  |                 |
| 1.      | Plant height (cm)15 DAT      | 5.30 – 9.83    | 7.53  | 16.97                         | 15.93     | 88.03            | 2.32             | 30.78           |
|         | 30 DAT                       | 12.23 – 18.77  | 14.39 | 12.06                         | 11.31     | 87.89            | 3.14             | 21.83           |
|         | 45 DAT                       | 30.77 – 38.80  | 34.20 | 6.87                          | 6.41      | 87.05            | 4.21             | 12.32           |
|         | 60 DAT                       | 56.63 – 67.77  | 61.30 | 6.34                          | 5.80      | 83.73            | 6.71             | 10.94           |
|         | 75 DAT                       | 79.43 - 102.93 | 90.31 | 9.27                          | 8.13      | 76.84            | 13.25            | 14.68           |
| 2.      | Days to 50% flowering (days) | 39.33 – 58.67  | 48.62 | 11.21                         | 9.31      | 69.09            | 7.75             | 15.94           |
| 3.      | Number of clusters per plant | 10.20 - 18.50  | 13.17 | 19.52                         | 16.49     | 71.36            | 3.76             | 28.70           |
| 4.      | Fruit set percentage (%)     | 56.90 - 78.34  | 65.92 | 14.20                         | 5.71      | 16.18            | 3.12             | 4.73            |
| 5.      | Number of fruits per cluster | 1.17 - 4.41    | 2.22  | 42.79                         | 34.29     | 64.22            | 1.25             | 56.61           |

|     |                                       |                |        |       |       |       |        |       |
|-----|---------------------------------------|----------------|--------|-------|-------|-------|--------|-------|
| 6.  | Number of flowers per cluster         | 2.04 - 5.64    | 3.27   | 26.45 | 31.01 | 72.79 | 1.53   | 46.49 |
| 7.  | Days to first fruit harvesting (days) | 57.33 - 82.66  | 68.84  | 12.85 | 9.24  | 51.73 | 9.43   | 13.69 |
| 8.  | Fruit length (cm)                     | 6.73 - 15.14   | 9.54   | 29.18 | 30.63 | 90.78 | 5.47   | 57.27 |
| 9.  | Fruit breadth (cm)                    | 3.26 - 6.20    | 4.96   | 18.46 | 16.27 | 77.73 | 1.47   | 29.33 |
| 10. | Average fruit weight (g)              | 57.91 - 103.32 | 77.52  | 20.95 | 19.75 | 88.80 | 29.71  | 38.33 |
| 11. | Number of fruits per plant            | 6.47 - 25.07   | 13.66  | 38.22 | 63.71 | 86.15 | 9.27   | 67.82 |
| 12. | Number of fruits per kg               | 9.68 - 17.30   | 13.42  | 20.36 | 18.89 | 86.04 | 4.84   | 36.09 |
| 13. | Number of seeds per fruit             | 248 - 671      | 357.33 | 36.59 | 35.19 | 92.48 | 249.08 | 69.71 |
| 14. | Weight of 1000 seeds                  | 2.49 - 4.70    | 3.67   | 22.86 | 19.99 | 76.51 | 1.32   | 36.02 |
| 15. | Fruit yield per plant (kg)            | 0.447 - 1.990  | 1.08   | 38.10 | 34.85 | 83.66 | 0.71   | 65.67 |
| 16. | Fruit yield per plot (kg)             | 4.47 - 19.90   | 10.80  | 38.10 | 34.85 | 83.66 | 7.10   | 65.67 |
| 17. | Fruit yield per hectare (q)           | 124.08-552.78  | 300.19 | 38.10 | 34.85 | 83.66 | 197.66 | 65.67 |
| 18. | Fruit and shoot Borer Incidence (%)   | 13.33 - 56.67  | 33.75  | 51.58 | 38.93 | 56.97 | 20.43  | 60.53 |
| 19. | TSS ( <sup>0</sup> Brix)              | 2.50-5.31      | 4.02   | 21.90 | 25.83 | 71.92 | 4.51   | 38.27 |
| 20. | Ascorbic acid (mg/100g),              | 4.47-12.47     | 8.53   | 36.15 | 30.81 | 63.90 | 4.46   | 52.83 |

## REFERENCES

1. **Vidhya, C. and Kumar, N. 2015.** Genetic variability studies in brinjal (*Solanum melongena* L.) for fruit yield and quality. *Electronic J. of PlantBreeding*6(3):668-671.
2. References

3. Ansari, S. F., Mehta, N., Ansari S. and Gavel, J. P. 2011. Variability studies in Brinjal (*Solanum melongena* L.) in Chhattisgarh plains. *Electronic Journal of Plant Breeding*, 2(2): 275-281.
4. Balaji, L., Reddy, P. S., Reddy, R. V. S. K. and Sivaraj, N. 2013. Variability, heritability and genetic advance studies in Brinjal (*Solanum melongena* L.). *Electronic Journal of Plant Breeding*, 4(1): 1097-1100.
5. Barela, A., Shrivastava, M.K., Mohare, S., Rahangdale, S., Jawarkar, S., Amrate, P.K. and Singh, Y., 2022. Morphological Characterization and Recognition of New Traits of Soybean [*Glycine max* (L.) Merrill]. *International Journal of Environment and Climate Change*, 12(12): 1497-1504.
6. Burton, G. W. and Devane, E. W. 1953. Estimating heritability in fall fescue (*Festuca arundinacea*) from replicated clonal material. *Agronomy Journal*, (4): 78-81.
7. Chattopadhyay, A., Dutta, S. and Hazra, P. 2011. Characterization of genetic resources and identification of selection indices of brinjal (*Solanum melongena* L.) grown in Eastern India. *Vegetable Crops Research Bulletin*, 74: 39-49.
8. Chaudhary, P. and Kumar, S. 2014. Variability, heritability and genetic advance studies in eggplant (*Solanum melongena* L.). *Plant Archives*, 14(1): 483-486.
9. Chen, N. C. and Li, H. M. 1996. Cultivation and Seed Production of Eggplant. AVRDC, Annual Publication, 203(64): 246-261. Choudhary B. 1976. *Vegetables* (4th ed.). National Book Trust, New Delhi. Pp. 50-58.
10. Chourasia, H. K. and Shree, S. 2012. Genetic variability in quantitative characters of brinjal (*Solanum melongena* L.). *Journal of Interacademia*, 16(2): 196- 202.
11. Dhaka, S. K. and Soni, A. K. 2012. Genetic variability in brinjal (*Solanum melongena* L.). *The Asian Journal of Horticulture*, 7(2): 537-540.
12. Gavade, R. T. and Ghadage, B. A. 2015. Genetic variability, heritability and genetic advance in segregating generation of Brinjal (*Solanum melongena* L.). *Bioinfolet*, 12(1C): 325- 328.

13. Indires, K. K. M. and Santhosha, H. M. 2011. Genetic variability in brinjal (*Solanum melongena* L.). *Environment and Ecology*, 29(3B): 1686-1688.
14. Johnson, H. W., Robinson, H. F. and Comstock. 1955. Estimates of genetic and environmental variability in soybean. *J. Agric.*, 45: 478-481.
15. Kumar, S. R., Arumugam, T., Anandakumar, C. R., and Premalakshmi, V. 2013. Genetic variability for quantitative and qualitative characters in brinjal (*Solanum melongena* L.). *African Journal of Agricultural Resources*, 8(39): 4956-4959.
16. Madhavi, N., Mishra, A. C., Om Prasad, J., and Bahuguna, N. 2015. Studies on Int.J.Curr.Microbiol.App.Sci (2018) 7(9): 1543-1552 variability, heritability and genetic advance in brinjal (*Solanum melongena* L.). *Plant Archives*, 15(1): 277-281.
17. Mili, C., Bora, G. C., Das, B., and Paul, S. K. 2014. Studies on variability, heritability and genetic advance in brinjal (*Solanum melongena* L.) genotypes. *Direct Research Journal of Agricultural and Food Science*, 2(11): 192-194.
18. Mohammad, R. N. R., Mahdiyeh, P., Abdolrahim, G. and Javad, A. 2015. Variability, heritability and association analysis in eggplant (*Solanum melongena*). *Journal of Agricultural and Biological Science*, 10(12): 464 -468.
19. Nayak, B. R. and Nagre, P.K. 2013. Genetic variability and correlation studies in brinjal (*Solanum melongena* L.). *Internat. J. Appl. Biol. & Pharmaceut. Technol.*, 4(4): 211-215. Panse, V. G. 1957. Genetics of quantitative characters in relation to plant breeding. *Indian J. Genet.*, 17: 318-328.
20. Panse, V. G. and Shukhatme, P. V. 1967. *Statistical Methods for Agricultural Workers*. 2nd ed. ICAR Publications Krishi Anusandhan Bhavan, Pusa, New Delhi-11001.
21. Patel, K., Patel, N. B., Patel, A. I., Rathod, H., and Patel, D. 2015. Study of variability, correlation and path analysis in brinjal (*Solanum melongena* L.). *The bioscan*, 10(4): 2037-2042.
22. Pujer, P., Jagadeesha, R. C., and Cholin, S. 2017. Genetic variability, heritability and genetic advance for yield, yield related components of brinjal (*Solanum melongena* L.) genotypes. *Int. J. Pure App. Biosci.*, 5(5): 872-878.

23. Rahangdale, S., Singh, Y., Parte, D., Barela, A. and Gour, L. 2022. Phenotypic Study of JNPT Lines of Rice (*Oryza sativa* L.) derived from Indica x Japonica Subspecies. *Frontiers in Crop Improvement*, 10(5): 2603-8234.
24. Ravali, B. K., Reddy, R., Saidaiah, P. and Shivraj, N. 2017. Variability, Heritability and Genetic advance in brinjal (*Solanum melongena* L.). *International Journal of Current Microbiology and Applied Sciences*, 6(6): 42-47.
25. Reshmika, P. K., Gasti, V. D., Evoor, S., Jayappa, J. and Mulge, R. 2015. Genetic variability studies for growth, earliness, yield and quality parameters in brinjal (*Solanum melongena* L.). *Environment & Ecology*, 33 (2): 761-766.
26. Sato, Y., Itagaki, S., Kurokawa, T., Ogura, J., Kobayashi, M., Hirano, T., Sugawara, M. and Iseki, K. 2011. In vitro and in vivo antioxidant properties of chlorogenic acid and caffeic acid. *International Journal of Pharmaceutics*, 403:136-138.
27. Shekar, K. C., Ashok. P. and Sasikala, K. 2012. Studies on heritability and multivariate analyses in brinjal (*Solanum melongena* L.) *Vegetable crops resource Bulletin*, 76: 79-88.
28. Shende, K. G., Birajdar, U. M., Bhalekar, M. N. and Patil, B. T. 2014. Correlation and path analysis in eggplant (*Solanum melongena* L.). *South Indian Horticulture Journal*, 39(1): 108-110.
29. Singh, O., Singh, B., Singh, K. V., Chand, P. and Vaishali. 2013. Studies on genetic variability in brinjal (*Solanum Melongena* L.). *Annals of Horticulture*, 6(2): 279-283.
30. Sujin, G. S., Karuppaiah, P. and Saravanan, K. 2017. Genetic variability and correlation studies in brinjal (*Solanum melongena* L.). *Indian Journal of Agricultural Resource*, 51(2): 112-119.
31. Thangavel, P., Thirugnanakumar, S. and Baradhan, G. 2011. Studies on genetic variability, heritability and genetic advance in segregating generations of brinjal (*Solanum melongena* L.). *Plant Archives*, 11(1): 453-456.
32. Tirkey, M., Saravana, S and Pushpa lata. 2018. Studies on variability, heritability and genetic advance for yield and its attributes in brinjal (*Solanum melongena* L.). *Journal of Int.J.Curr.Microbiol.App.Sci* (2018) 7(9): 1543-1552  
*Pharmacognosy and Phytochemistry*, 1181-1183

33. Tripathy, B., Dhananjay, S., Jangde, B. P. and Bairwa, P. L. 2017. Genetic variability and heritability studies in brinjal (*Solanum melongena* L.). *Journal of Pharmacognosy and Phytochemistry*, 10: 109-116.
34. Vidhya, C. and Kumar, N. 2015. Genetic variability studies in Brinjal (*Solanum melongena*) for fruit yield and quality. *Electronic Journal of Plant Breeding*, 6(3): 668-671 Vidhya, C. and Kumar, N. 2015. Genetic variability studies in Brinjal (*Solanum melongena*) for fruit yield and quality. *Electronic Journal of Plant Breeding*, 6(3): 668-671.
35. Weber, C. R. and Moorthy, H. R. 1952. Heritable and non- heritable relationship and variability of oil content and agronomic characters in the F<sub>2</sub> generation of soyabean crosses. *Agronomy Journal*, 44: 202-209.