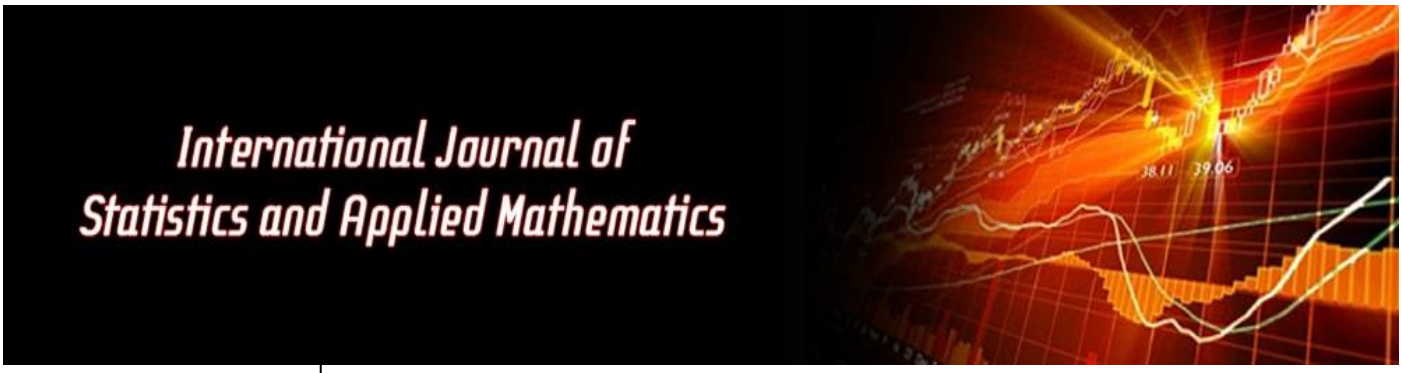

ISSN: 2456-1452
Maths 2023; SP-8(6): 811-818
© 2023 Stats & Maths
https://www.mathsjournal.com
Received: 12-08-2023
Accepted: 14-09-2023

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Genetic parameters for different characters of the brinjal (*Solanum melongena* L.) in F_4, F_5 and F_6 generation of the cross (Tuni local × EC-169089)

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Abstract
The present investigation entitled "Genetic studies in advanced generations for yield and yield contributing traits in brinjal (*Solanum melongena* L.)" was conducted at College of Horticulture, Venkataramannagudem, Andhra Pradesh during *Kharif*-2020, *Rabi*-2020 and *Kharif*-2021. The F_4, F_5 and F_6 generations of the cross (Tuni local × EC-169089) were evaluated with the objective of selecting superior genotypes through pedigree method of selection for economically important traits and to assess the various genetic parameters for the brinjal crop improvement. The data from advanced generations were collected and statistically analyzed to compute mean, range, phenotypic and genotypic coefficients of variance, heritability, expected genetic advance, genetic advance as per cent mean, genetic gain.
In the cross (Tuni local x EC-169089) the per cent genetic gain from F_4 to F_5 and F_5 to F_6 generation for the yield contributing characters were; yield per plant (23.44 and 11.86), plant height (3.26 and 4.38), number of primarybranches (4.78 and 1.52), number of fruits per inflorescence (3.89 and 6.66), fruit length (10.21 and 9.27), fruit girth (1.73 and 11.21), number of fruits per plant (16.26 and 0.67), average fruit weight (6.78 and 11.36), fruit firmness (2.96 and 0.41) and phenols (-0.63 and -7.96) respectively. Four promising plants were selected in F_6 generation and selfed for further preliminary yield trials.

Keywords: Genetic studies, Mean, Range, PCV, GCV, heritability, genetic advance and genetic gain

Introduction
Brinjal (*Solanum melongena* L.) is a solanaceous vegetable with chromosome number 2n=2x=24. It is a perennial vegetable but commercially grown as annual crop. Because of it's highest production potential and availability to consumers, it is often referred as poor man's vegetable. It is essentially tropical and sub-tropical crop grown extensively in India, Bangladesh, Pakistan, China, Japan and Philippines.
In India, egg plant occupies an area of 7.36 lakh hectares with an annual production of 127.77 lakh tonnes and the productivity stands at 17.36 tonnes per hectare. In Andhra Pradesh, it is grown over an area of 0.69 lakh hectares with annual production of 12.40 lakh tonnes and productivity of 17.97 tonnes per hectare (NHB, 2019-20). In initial days of crop improvement mass selection was practiced by the breeders and resulting varieties were non-uniform in terms of many traits. Consumer demand for uniform, good quality produce is increasing day by day and obviously the farmer should produce market demanded produce and at the same time the cultivated genotypes should be high yielding and resistant to biotic and abiotic stresses.
For achieving uniformity, pure line selection, hybridization followed by pedigree/bulk selection and heterosis breeding (F_1 hybrids) are the best methods. But in often cross-pollinated crops like brinjal, pure lines are mostly preferred by the farmers because of ease of seed production. Hybridization followed by selection is widely followed method for developing high yielding genotypes in solanaceous vegetables. After hybridization, selfing is done to get the variability. Recombination and segregation leads to release of genetic variability in segregating populations. Estimation of nature and magnitude of variability, heritability of yield contributing and other traits is immense importance. The available variability can be portioned into heritable and non-heritable components.

If greater the available genetic variability more is the chance for getting better genotypes by direct selection (Vavilov, 1951) [19].

Heritability can be measured by the genetic relationship between the parent and offspring. Greater the heritable variation, the possibility of fixing the characters by selection methods is higher. Genetic advance is helpful to devise the effect of selection. Heritability and genetic advance studies are of immense use to identify whether the observed variation for a particular character is due to genotype or environment. Hybridization followed by selection in the segregation generations (pedigree/ bulk method of breeding) is one of the widely used breeding methods to develop varieties in self-pollinated as well as often cross-pollinated vegetable crops including brinjal. There are fair chances of isolation of transgressive segregants also in this procedure (Briggs and Allard, 1953 and Singh, 2002) [17, 3]. Many high yielding varieties in brinjal *viz*., Pusa purple long, Pusa purple cluster, Pusa kranti, Pusa bhairav, Pusa Shymala, Pusa Anmol, Arka shirish, Arka sheel, Arka keshav, Arka Nidhi, Arka Neelkanth, Arka Kusumakar *etc.*, have been developed through hybridization followed by pedigree selection.

Material and Methods

In order to develop superior recombinant genotypes in brinjal, hybridization programme was initiated with the cross Tuni local × EC-169089 at College of Horticulture, Venkataramannagudem, during *Kharif*, 2016 and selection was exercised in F_2, F_3 generations during *Kharif*, 2019 and *Rabi*, 2019 respectively. The fifteen top performing plants selected from F_3 generation were selfed to get F_4 generation for the present study.

Evaluation of F_4 generation

During *Kharif*, 2020-21, 15 progenies of Tuni local × EC-169089 were raised with a spacing of 75 cm × 75 cm in a Randomized Block Design with three replications. Each progeny in each replication had 10 individual plants and a total of 30 plants over three replications per progeny were accommodated to exercise selection and nine top performing plants across the seven crosses were selected and selfed to get F_5 generation for the present study.

Evaluation of F_5 generation

During *Rabi*, 2020-21, nine progenies of Tuni local × EC-169089 were raised with a spacing of 75 cm × 75 cm in a Randomized Block Design with three replications. Each progeny in each replication had 10 individual plants and a total of 30 plants over three replications per progeny were accommodated to exercise selection and three top performing plants across the seven crosses were selected and selfed to get F_6 generation for the present study.

Evaluation of F_6 generation

During *kharif*, 2021-22, three progenies of Tuni local × EC-169089 were raised with a spacing of 75 cm × 75 cm in a Randomized Block Design with three replications. Each progeny in each replication had 10 individual plants and a total of 30 plants over three replications per progeny were accommodated to exercise selection and four promising plants were selected and selfed to get F_7 seed.

Results and Discussion

Observations were taken for all the individual plants separately and the data was statistically analyzed to compute mean, range, phenotypic and genotypic coefficients of variance, heritability, expected genetic advance, genetic advance as per cent mean, genetic gain in F_4, F_5 and F_6 generation for the cross Tuni local × EC-169089 was presented as follows.

Plant height (cm)

The values for plant height ranged from 66.80 to 102.47 with a mean of 91.24 in F_4 generation. In F_5 generation, the values for it ranged from 80.06 to 100.80 with a mean of 94.22. The per cent of genetic gain for plant height was 3.26 per cent from F_4 to F_5 generation, whereas in F_6 generation it ranged from 94.80 to 100.80 with a mean of 98.35. The per cent of genetic gain for plant height was 4.38 per cent from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values for plant height were 12.03 and 8.86 respectively. In F_5 the PCV value was 7.40 and GCV value was 6.71 and the values of PCV and GCV were low (3.12 and 2.24) respectively in F_6 generation. These results are in conformity with the findings of Prabhu *et al*. (2009) [12], Nilakh *et al*. (2017) [11] and Neelambika *et al*. (2020) [8]

The heritability for this trait was 54.20, 82.30 and 51.70 per cent in F_4, F_5 and F_6 respectively. Genetic advance for this trait was 12.26 per cent in F_4, 11.82 per cent in F_5 and in F_6 it was 3.27 per cent. Genetic advance expressed as per cent of mean was 13.44, 12.55 and 3.33 in F_4, F_5 and F_6 respectively.

The values recorded for PCV and GCV for this trait were low in F_4, F_5 and F_6 generations indicating less variation among the replications i.e. low error/environmental variance. However, in F_6 generation the values were less than that of F_4 and F_5 generation indicating decrease in variability due to selection. Moderate to high heritability coupled with low to moderate genetic advance in F_4, F_5 and F_6 generations, indicating parental genotypes might have possessed both additive and non-additive genes for mean plant height in different magnitudes. These results are in consonance with findings of earlier workers for transgressive segregants with Prabhu *et al*. (2009) [12], Nilakh *et al*. (2017) [11] and Neelambika *et al*. (2020) [8].

Plant spread N-S (cm)

The variation for this character ranged from 67.73 to 83.53 with an average of 75.34 in F_4 generation. In F_5 generation, the values for the trait ranged from 80.06 to 100.80 with a mean of 94.22. The per cent of genetic gain for plant spread was 7.02 per cent from F_4 to F_5 generation, whereas in F_6 generation, it was ranged from 78.93 to 85.20 with a mean of 83.14. The per cent of genetic gain for plant spread was 2.98 per cent from F_5 to F_6 generation.

In F_4 population, the PCV value was 10.61 and GCV value was 3.47. In F_5 generation the PCV and GCV values were low (5.07 and 3.23 respectively) and the estimates of PCV and GCV were low (5.60 and 1.55 respectively) in F_6 generation. The heritability for this trait was 10.70, 40.50 and 7.70 per cent in F_4, F_5 and F_6 generations respectively. Genetic advance for this trait was 1.76 per cent in F_4, while genetic advance in F_5 was 3.42 per cent and it was 0.74 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 2.33, 4.23 and 0.89 in F_4, F_5 and F_6 generations respectively.

Low estimates of PCV and GCV from F_4 to F_6 generation indicating the presence of less genetic variability as a result of which it can be expected that selection has scope to improve this trait at less magnitude. Moderate to low heritability coupled with low genetic advance and genetic advance

expressed as per cent of mean was recorded for this trait is indicative of non-additive gene action. The medium heritability might be exhibited due to favourable influence of environment rather than genotype and selection for this trait may not be rewarding. The results are similar with findings of Surabhi *et al*. (2020) [18].

Plant spread E-W (cm)

The variation for this character ranged from 65.76 to 83.13 with an average of 75.83 in F_4 generation. In F_5 generation, the mean values for the trait ranged from 74.86 to 85.33 with a mean of 79.19. The per cent of genetic gain for plant spread was 4.43 per cent from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 74.86 to 85.33 with a mean of 80.69. The per cent of genetic gain for plant spread was 1.89 per cent from F_5 to F_6 generation.

The PCV and GCV values were low (9.24 and 4.44), (6.12 and 4.61) and (6.62 and 4.61) respectively in F_4, F_5 and F_6 generation. The heritability for this trait was 23.10, 35.20 and 48.60 per cent in F_4, F_5 and F_6 generations respectively. Genetic advance for this trait was 3.34 per cent in F_4, while genetic advance in F_5 was 3.51 per cent and it was 5.35 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 4.40, 4.44 and 6.63 in F_4, F_5 and F_6 generations respectively.

Low estimates of PCV and GCV indicating the presence of less genetic variability and it was reduced from F_4 to F_6 generation, as a result of which it can be expected that selection has scope to improve this trait at less magnitude. Moderate to low heritability coupled with low genetic advance and genetic advance expressed as per cent of mean was recorded for this trait is indicative of non-additive gene action. The medium heritability might be exhibited due to favourable influence of environment rather than genotype and selection for this trait may not be rewarding. The results are similar with findings of Surabhi *et al*. (2020) [18].

Number of primary branches

The number of primary branches ranged from 4.26 to 7.76 with an average of 6.89 in F_4 generation. In F_5 generation, it ranged from 5.93 to 8.23 with a mean of 7.22. The per cent of genetic gain for number of primary branches was 4.78 per cent from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 6.50 to 7.60 with a mean of 7.11. The per cent of genetic gain for number of primary branches was -1.52 per cent from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were moderate (14.84 and 11.40 respectively). In F_5 the PCV value was 10.75 and GCV value was 9.70 and the estimates of PCV and GCV were low (7.39 and 6.07 respectively) in F_6 generation. The heritability for this trait was 59.00, 81.30 and 67.50 per cent in F_4, F_5 and F_6 generations respectively. Genetic advance for this trait was 1.24 per cent in F_4, while genetic advance in F_5 was 1.30 per cent and it was 0.73 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 18.05, 18.02 and 10.27 in F_4, F_5 and F_6 generations respectively. These results agree with earlier workers of Prabhu *et al*. (2009) [12] and Nilakh *et al*. (2017) [11].

There was little difference between the phenotypic and genotypic coefficient of variation, indicating little environmental influence in the expression of this character from F_4 to F_6 generation. The estimate of heritability was moderate to high coupled with moderate genetic advance as per cent of mean, which indicating the preponderance of additive and non-additive gene action in controlling the trait. Further improvement of this trait would be possible through cyclic hybridization, diallel selective mating and biparental mating.

Days to 50% flowering

Days to 50 % flowering ranged from 39.33 to 49.33 with an average of 44.13 in F_4 generation. In F_5 generation, the values for the trait ranged from 41.66 to 49.33 with a mean of 45.51. The per cent of genetic gain for number of days to 50 % flowering was 3.12 per cent from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 43.66 to 49.33 with a mean of 46.16. The per cent of genetic gain for number of days to 50 % flowering was 1.42 per cent from F_5 to F_6 generation.

The PCV and GCV values were low (9.59 and 3.40), (7.28 and 3.01) and (7.95 and 2.67) in F4, F5 and F6 generations respectively. The heritability for this trait was 12.60, 17.10 and 11.30 per cent in F_4, F_5 and F_6 generations respectively. Genetic advance for this trait was 1.10 per cent in F_4, while genetic advance in F_5 was 1.16 per cent and it was 0.85 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 2.49, 2.56 and 1.85 in F_4, F_5 and F_6 generations respectively. Similar results was reported by Neelambika *et al*. (2020) [8].

Number of flowers per inflorescence

The variation for this trait ranged from 1.70 to 3.20 with a mean of 2.44 in F_4 generation. In F_5 generation, the values for the trait ranged from 2.43 to 3.36 with a mean of 2.75. The per cent of genetic gain for number of flowers per inflorescence was 12.70 per cent from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 2.43 to 3.53 with a mean of 2.97. The per cent of genetic gain for number of flowers per inflorescence was 8.00 per cent from F_5 to F_6 generation.

In F_4 population, the PCV value was high (28.20) and GCV value was moderate (10.97), whereas the PCV and GCV values were moderate (15.11 and 12.03 respectively) and (17.03 and 13.93 respectively) in F_5 and F_6 generation. The heritability for this trait was 15.10, 63.40 and 66.90 per cent in F_4, F_5 and F_6 generations respectively. Genetic advance for this trait was 0.21 per cent in F_4, 0.58 per cent in F_5 and it was 0.64 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 8.80, 19.72 and 23.48 in F_4, F_5 and F_6 generations respectively. These results are in conformity with the findings of Raval *et al.* (2017) [14], Balasubramaniyam *et al*. (2021) [2].

Number of fruits per inflorescence

The range of variation observed for this trait was 1.66 to 4.04 with a mean of 2.31 in F_4 generation. In F_5 generation, the values for the trait ranged from 1.93 to 3.76 with a mean of 2.40. The per cent of genetic gain for number of fruits per inflorescence was 3.89 per cent from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 2.06 to 2.73 with a mean of 2.56. The per cent of genetic gain for number of fruits per inflorescence was 6.66 per cent from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were 35.64 and 28.44. In F_5, the PCV value was 23.09 and GCV value was 21.88 and the estimates of PCV and GCV were 13.50 and 13.08 respectively in F_6 generation. The heritability for this trait was 63.70, 89.70 and 93.90 per cent in F_4, F_5 and F_6 generations respectively. Genetic advance for this trait was 1.08 per cent in F_4, while genetic advance in F_5 was 1.09 per cent and it was 0.62 per cent in F_6 generation. Genetic

advance expressed as per cent of mean was 46.74, 42.70 and 26.12 in F_4, F_5 and F_6 generations respectively. These are in testament to the work of Priyanka *et al.* (2018) [13], Shilpa *et al.* (2018) [16], Balas *et al.* (2019) [1], Jyothi *et al.* (2019) [8], Surabhi *et al*. (2020) [18].

A high heritability in conjunction with high GAM is observed from F_5 to F_6 generation for this character. A high degree of genetic variability and high heritability accompanied by high GAM indicating the presence of additive gene action which provides greater scope for selection and improvement of this trait through selection.

Days to first harvest

The trait values ranged from 50.66 to 63.66 with a mean of 55.91 in F_4 generation. In F_5 generation, the values for the trait ranged from 5.50 to 3.72 with a mean of 58.03. The per cent of genetic gain for this trait was 3.79 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 57.00 to 61.00 with a mean of 59.25. The per cent of genetic gain for days to first harvest was 2.10 from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were low (8.29 and 5.17 respectively). In F_5 the PCV values were low (5.50 and 3.72 respectively) and the estimates of PCV and GCV were low (4.59 and 2.75 respectively) in F_6 generation. The heritability for this trait was 38.90, 45.80 and 36.00 per cent in F_4, F_5 and F_6 generations respectively. Genetic advance for this trait was 3.71 per cent in F_4, while genetic advance in F_5 was 3.01 per cent and it was 2.01 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 6.64, 5.19 and 3.40 in F_4, F_5 and F_6 generations respectively. Similar results are reported by Nilakh *et al.* (2017) [11].

Low estimates of PCV and GCV indicating the presence of less genetic variability as a result of which it can be expected that selection has scope to improve this trait at less magnitude. Moderate to low heritability with low genetic advance indicates parental genotypes might have possessed both additive and non-additive genes for days to first harvest in different magnitudes, which could be attributed to moderate heritability with low genetic advance.

Days to final harvest

Days to final harvest ranged from 147.33 to 179.00 with a mean of 161.48 in F_4 generation. In F_5 generation, the values for the trait ranged from 150.66 to 175.33 with a mean of 162.58. The per cent of genetic gain for this trait was 0.68 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 151.00 to 172.00 with a mean of 163.33. The per cent of genetic gain for days to final harvest was 0.46 from F_5 to F_6 generation.

The PCV and GCV values were low (8.22 and 5.66 respectively), (6.49 and 6.00 respectively) and (6.53 and 5.90 respectively) in F_4, F_5 and F_6 generation. The results are in line with Nilakh *et al*. (2017) [11], Ravali *et al*. (2017) [14] and Balas *et al*. (2019) [1]. The heritability for this trait was 47.50, 85.30 and 81.70 per cent in F_4, F_5 and F_6 generations respectively. Genetic advance for this trait was 12.98 per cent in F_4, while genetic advance in F_5 was 18.66 per cent and it was 17.87 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 8.04, 11.42 and 10.99 in F_4, F_5 and F_6 generations respectively. These results are in corroboration with the observations of Ravali *et al.* (2017) [14] and Balas *et al.* (2019) [1].

Low estimates of PCV and GCV indicated the presence of less genetic variability as a result of which it can be expected that selection has scope to improve this trait at less magnitude as resulted in less genetic gain from F_4 to F_5 (0.68) and from F_5 to F_6 (0.46) for this trait. High heritability with low genetic advance over mean indicates high influence of favourable environment rather than the genotype, selection of such traits may not be effective.

Fruit length (cm)

Fruit length values ranged from 6.10 to 9.79 with a mean of 7.73 in F_4 generation. In F_5 generation, the values for the trait ranged from 7.38 to 9.96 with a mean of 8.52. The per cent of genetic gain for this trait was 10.21 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 8.82 to 9.96 with a mean of 9.31. The per cent of genetic gain for this trait was 9.27 from F_5 to F_6 generation.

In F_4 generation, the PCV and GCV values were moderate (14.89 and 13.20 respectively). In F_5 the PCV value was 10.92 and GCV value was 10.47. Similar result was reported by Nilakh *et al*. (2017) [11]. The estimates of PCV and GCV were low (5.40 and 4.97 respectively) in F_6 generation. The results are in line with Prabhu *et al*. (2009) [12] and Mehboob *et al*. (2017) [7] and Neelambika *et al*. (2020) [8].

The heritability for this trait was 78.60, 91.90 and 84.90 per cent in F_4, F_5 and F_6 generations respectively. Genetic advance for this trait was 1.86 per cent in F_4, while genetic advance in F_5 was 1.76 per cent and it was 0.88 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 24.11, 20.67 and 9.45 in F_4, F_5 and F_6 generations respectively. The results are in line with Prabhu *et al*. (2009) [12].

Moderate PCV and GCV values coupled with high heritability and high genetic advance as per cent of mean recorded by this trait indicating the role of additive gene action in the inheritance of this trait. This can be improved through direct phenotypic selection.

Fruit girth (cm)

Fruit girth ranged from 8.61 to 16.55 with a mean of 12.71 in F_4 generation. In F_5 generation, the values for the trait ranged from 9.49 to 15.94 with a mean of 12.93. The per cent of genetic gain for this trait was 1.73 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 12.66 to 15.94 with a mean of 14.38. The per cent of genetic gain for this trait was 11.21 from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were 18.76 and 15.38 respectively. In F_5 the PCV value was 16.76 and GCV value was 16.47 and the estimates of PCV and GCV were 9.99 and 9.41 respectively in F_6 generation. The results are in line with Nilakh *et al*. (2017) [11], Balas *et al*. (2019) [1]. The heritability for this trait was 67.30, 96.50 and 88.60 per cent in F_4, F_5 and F_6 generations respectively. Genetic advance for this trait was 3.36 per cent in F_4, while genetic advance in F_5 was 4.23 per cent and it was 2.62 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 25.99, 33.33 and 18.24 in F_4, F_5 and F_6 generations respectively. These results are in corroboration with the observations of Balas *et al*. (2019) [1], Neelambika *et al*. (2020) [8] and Surabhi *et al*. (2020) [18].

Moderate PCV and GCV values coupled with high heritability and moderate to high genetic advance as per cent of mean recorded by this trait indicating the role of additive gene action in the inheritance of this trait. This was improved through direct phenotypic selection from F_4 to F_6 generation resulted in increased genetic gain from F_4 to F_5 (1.73) and from F_5 to F_6 (11.21).

Fruit length to girth ratio

Fruit length to girth ratio values ranged from 0.78 to 0.94 with a mean of 0.86 in F_4 generation. In F_5 generation, the values for the trait ranged from 0.55 to 0.78 with a mean of 0.68. The per cent of genetic gain for this trait was -20.93 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 0.55 to 0.78 with a mean of 0.65. The per cent of genetic gain for this trait was -4.41 from F_5 to F_6 generation.

In F_4 population, the PCV value was 12.40 and GCV values was 6.27. In F_5 the PCV and GCV were 13.07 and 12.17 respectively and the estimates of PCV and GCV were 15.42 and 14.89 respectively in F_6 generation. The heritability for this trait was 25.60, 86.70 and 93.20 per cent in F_4, F_5 and F_6 generation respectively. Genetic advance for this trait was 0.05 per cent in F_4, while genetic advance in F_5 was 0.15 per cent and it was 0.19 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 6.54, 23.35 and 29.62 in F_4, F_5 and F_6 generation respectively. These are in line with the work of Reshmika *et al*. (2015) [15], Neha *et al*. (2016) [9] and Jyothi *et al*. (2019) [8].

Moderate PCV and GCV values coupled with high heritability and moderate to high genetic advance as per cent of mean recorded by this trait indicating the role of additive gene action in the inheritance of this trait. This trait can be improved through direct phenotypic selection.

Fruit volume (cm^3)

Fruit volume ranged from 270.00 to 320.00 with a mean of 294.22 in F_4 generation. In F_5 generation, the values for the trait ranged from 290.00 to 350.00 with a mean of 316.29. The per cent of genetic gain for this trait was 7.50 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 300.00 to 350.00 with a mean of 326.66. The per cent of genetic gain for this trait was 3.27 from F_5 to F_6 generation.

In F_4 generation, the PCV was 13.46 and GCV was 7.33. In F_5 generation the PCV and GCV were 8.42 and 6.36 respectively and the estimates of PCV and GCV were 6.95 and 6.10 respectively in F_6 generation. The heritability for this trait was 29.60, 57.00 and 76.90 per cent in F_4, F_5 and F_6 generation respectively. Genetic advance for this trait was 24.17 per cent in F_4, while genetic advance in F_5 was 31.31 per cent and it was 35.99 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 8.21, 9.90 and 11.02 in F_4, F_5 and F_6 generation respectively. Similar results are reported by Konyak *et al*. (2022) [6].

The smallest difference observed between PCV and GCV values of fruit volume suggested lesser influence of environmental factors on the expression of the trait. High heritability and moderate genetic advance as per cent of mean is recorded from F_5 to F_6 advanced generations indicating the role of additive and non-additive gene action in the inheritance of this trait. This can be improved through cyclic hybridization, diallel selective mating and biparental mating.

Number of fruits per plant

The mean number of fruits per plant recorded 47.28 and it ranged from 26.63 to 59.83 in F_4 generation. In F_5 generation, the values for the trait ranged from 48.66 to 61.56 with a mean of 54.97. The per cent of genetic gain for this trait was 16.26 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 48.66 to 61.56 with a mean of 55.34. The per cent of genetic gain for this trait was 0.67 from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were moderate (20.93 and 18.13) respectively. In F_5 the PCV value was 8.71 and GCV value was 7.10 and the estimates of PCV and GCV were moderate (12.84 and 11.49) respectively in F_6 generation. The heritability for this trait was 75.00, 66.40 and 80.10 per cent in F_4, F_5 and F_6 generation respectively. Genetic advance for this trait was 15.29 per cent in F_4, while genetic advance in F_5 was 6.55 per cent and it was 11.73 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 32.34, 11.92 and 21.19 in F_4, F_5 and F_6 generation respectively. These results agree with earlier workers Prabhu *et al*. (2009) [12], Nilakh *et al*. (2017) [11], Surabhi *et al*. (2020) [18], Balasubramaniyam *et al*. (2021) [2].

Reduced (high to low) PCV and GCV values from F_4 to F_6 generation coupled with high heritability and high genetic advance as per cent of mean recorded by this trait indicating the role of additive gene action in the inheritance of this trait. This trait was improved through direct phenotypic selection, which resulted in increased genetic gain from F_4 to F_5 (16.26) and from F_5 to F_6 (0.67).

Average fruit weight (g)

The average fruit weight was recorded 57.52 and it ranged from 45.16 to 74.26 in F_4 generation. In F_5 generation, the values for the trait ranged from 51.06 to 72.86 with a mean of 61.42. The per cent of genetic gain for this trait was 6.78 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 63.50 to 72.86 with a mean of 68.40. The per cent of genetic gain for this trait was 11.36 from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were 15.69 and 14.38. In F_5 the PCV value was 12.59 and GCV value was 12.07 and the estimates of PCV and GCV were 6.87 and 5.72 respectively in F_6 generation. The heritability for this trait was 84.00, 92.00 and 69.30 per cent in F_4, F_5 and F_6 generation respectively. Genetic advance for this trait was 15.62 per cent in F_4, while genetic advance in F_5 was 14.65 per cent and it was 6.71 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 27.15, 23.85 and 9.8 in F_4, F_5 and F_6 generation respectively.

The difference between GCV and PCV was relatively low, which is indicating that the character is comparatively stable and highly heritable. Moderate PCV and GCV values coupled with high heritability and high genetic advance as per cent of mean recorded by this trait indicating the role of additive gene action in the inheritance of this trait. This trait was improved through direct phenotypic selection resulted in increased genetic gain from F_4 to F_5 (6.78) and from F_5 to F_6 (11.36).

Number of seeds per fruit

The variation for number of seeds per fruit ranged from 270.33 to 396.00 with a mean of 354.33 in F_4 generation. In F_5 generation, the values for the trait ranged from 310.00 to 389.33 with a mean of 347.22. The per cent of genetic gain for this trait was -2.00 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 290.00 to 346.66 with a mean of 317.35. The per cent of genetic gain for this trait was -8.60 from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were 16.25 and 7.43. In F_5 the PCV value was 9.52 and GCV value was 5.72 and the estimates of PCV and GCV were 6.27 and 5.10 respectively in F_6 generation. The heritability for this trait was 20.90, 36.10 and 66.30 per cent in F_4, F_5 and F_6 generation respectively. Genetic advance for this trait was 22.20 per cent in F_4, while genetic advance in F_5 was 24.62 per cent and it was 30.35 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 6.99, 7.09 and 8.56 in F_4, F_5 and F_6 generation respectively.

The PCV was slightly higher than the respective GCV, denoting environmental factors influence on the expression to some degree or other. Moderate to low heritability coupled with low GAM was recorded for this trait is indicative of non-additive gene action. The medium heritability might be exhibited due to favourable influence of environment rather than genotype and selection for this trait may not be rewarding.

Seed weight per fruit (g)

The variation for seed weight per fruit ranged from 3.79 to 5.26 with a mean of 4.09 in F_4 generation. In F_5 generation, the values for the trait ranged from 3.55 to 4.63 with a mean of 3.99. The per cent of genetic gain for this trait was -2.44 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 3.16 to 3.83 with a mean of 3.51. The per cent of genetic gain for this trait was -12.03 from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were 14.27 and 7.41. In F_5 the PCV value was 14.66 and GCV value was 1.56 and the estimates of PCV and GCV were 14.50 and 8.15 respectively in F_6 generation. The heritability for this trait was 27.00, 1.10 and 31.60 per cent in F_4, F_5 and F_6 generation respectively. Genetic advance for this trait was 0.27 per cent in F_4, while genetic advance in F_5 was 0.01 per cent and it was 0.38 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 7.92, 0.34 and 9.43 in F_4, F_5 and F_6 generation respectively.

The PCV was higher than the respective GCV, denoting influence of environmental factors on the expression of this trait to some degree or other. Moderate to low heritability coupled with low GAM was recorded for this trait is indicative of non-additive gene action. The medium heritability might be exhibited due to favourable influence of environment rather than genotype and selection for this trait may not be rewarding.

Firmness of the fruit (kg/cm^2)

The firmness of the fruit ranged from 1.95 to 2.91 with a mean of 2.36 in F_4 generation. In F_5 generation, the values for the trait ranged from 2.15 to 2.78 with a mean of 2.43. The per cent of genetic gain for this trait was 2.96 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 2.34 to 2.54 with a mean of 2.44. The per cent of genetic gain for this trait was 0.41 from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were 17.67 and 4.91. In F_5 the PCV value was 12.80 and GCV value was 7.43 and the estimates of PCV and GCV were 10.96 and 5.50 respectively in F_6 generation. The heritability for this trait was 7.70, 33.70 and 25.20 per cent in F_4, F_5 and F_6 generation respectively. Genetic advance for this trait was 0.06 per cent in F_4, while genetic advance in F_5 was 0.21 per cent and it was 0.13 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 2.81, 8.88 and 5.69 in F_4, F_5 and F_6 generation respectively.

The PCV was higher than the respective GCV, denoting influence of environmental factors on the expression of the trait to some degree or other. Moderate to low heritability coupled with low GAM was recorded for this trait is indicative of non-additive gene action. The medium heritability might be exhibited due to favourable influence of environment rather than genotype and selection for this trait may not be rewarding.

Phenols (mg 100 g^{-1})

The phenols in fruit ranged from 2.41 to 4.02 with a mean of 3.16 in F_4 generation. In F_5 generation, the values for the trait ranged from 2.46 to 3.54 with a mean of 3.14. The per cent of genetic gain for this trait was -0.63 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 2.65 to 3.13 with a mean of 2.89. The per cent of genetic gain for this trait was -7.96 from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were 20.71 and 8.40. In F_5 the PCV value was 20.16 and GCV value was 19.03 and the estimates of PCV and GCV were 8.76 and 7.10 respectively in F_6 generation. The heritability for this trait was 16.50, 89.10 and 65.70 per cent in F_4, F_5 and F_6 generation respectively. Genetic advance for this trait was 0.20 per cent in F_4, while genetic advance in F_5 was 1.17 per cent and it was 0.37 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 7.02, 37.01 and 11.86 in F_4, F_5 and F_6 generation respectively.

The PCV was slightly higher than the respective GCV, denoting influence of environmental factors on the expression of the trait to some degree or other. The estimate of heritability was high to moderate with moderate genetic advance as per cent of mean, which indicates the influence of non-additive gene action and considerable influence of environment in the expression of this trait, which could be exploited through manifestation of dominance and epistatic components through heterosis.

Yield per plant (kg)

The mean yield per plant was recorded 2.73 and it ranged from 1.59 to 4.06 in F_4 generation. In F_5 generation, the values for the trait ranged from 2.78 to 4.27 with a mean of 3.37. The per cent of genetic gain for this trait was 23.44 from F_4 to F_5 generation, whereas in F_6 generation, it ranged from 3.38 to 4.27 with a mean of 3.77. The per cent of genetic gain for this trait was 11.86 from F_5 to F_6 generation.

In F_4 population, the PCV and GCV values were 28.81 and 26.15. In F_5 generation the PCV value was 15.24 and GCV value was 13.48 and the estimates of PCV and GCV were 12.41 and 9.44 respectively in F_6 generation. The heritability for this trait was 82.40, 78.30 and 57.90 per cent in F_4, F_5 and F_6 generation respectively. Genetic advance for this trait was 1.33 per cent in F_4, while genetic advance in F_5 was 0.83 per cent and it was 0.55 per cent in F_6 generation. Genetic advance expressed as per cent of mean was 48.90, 24.57 and 14.79 in F_4, F_5 and F_6 generation respectively.

The difference between GCV and PCV was relatively low, which indicates that the character was comparatively stable and highly heritable. High to moderate PCV and GCV values coupled with high heritability and high genetic advance as per cent of mean recorded by this trait indicating the role of additive gene action in the inheritance of this trait. This trait was improved through direct phenotypic selection resulted in increased genetic gain from F_4 to F_5 (23.44) and from F_5 to F_6 (11.86).

Table 1: Mean, variability and heritability parameters for different characters in F_4, F_5 and F_6 generation of cross T_2 (Tuni local ×EC-169089).

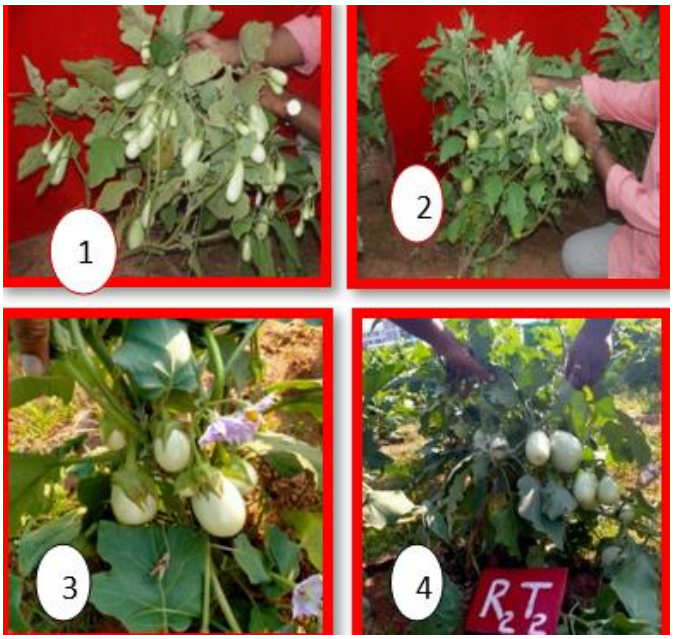
Character	Generation	Mean	Range	PCV	GCV	Heritability (%)	GA at 5%	GAM at 5%	% GG
Plant height (cm)	F_4	91.24	66.80-102.47	12.03	8.86	54.20	12.26	13.44	
	F_5	94.22	80.06-100.80	7.40	6.71	82.30	11.82	12.55	3.26
	F_6	98.35	94.80-100.80	3.12	2.24	51.70	3.27	3.33	4.38
Plant spread N-S (cm)	F_4	75.34	67.73-83.53	10.61	3.47	10.70	1.76	2.33	
	F_5	80.73	76.13-85.20	5.07	3.23	40.50	3.42	4.23	7.02
	F_6	83.14	78.93-85.20	5.60	1.55	7.70	0.74	0.89	2.98
Plant spread E-W (cm)	F_4	75.83	65.76-83.13	9.24	4.44	23.10	3.34	4.40	
	F_5	79.19	74.86-85.33	6.12	3.63	35.20	3.51	4.44	4.43
	F_6	80.69	74.86-85.33	6.62	4.61	48.60	5.35	6.63	1.89
Number of primary branches	F_4	6.89	4.26-7.76	14.84	11.40	59.00	1.24	18.05	
	F_5	7.22	5.93-8.23	10.75	9.70	81.30	1.30	18.02	4.78
	F_6	7.11	6.50-7.60	7.39	6.07	67.50	0.73	10.27	-1.52
Days to 50 % flowering	F_4	44.13	39.33-49.33	9.59	3.40	12.60	1.10	2.49	
	F_5	45.51	41.66-49.33	7.28	3.01	17.10	1.16	2.56	3.12
	F_6	46.16	43.66-49.33	7.95	2.67	11.30	0.85	1.85	1.42
Number of flowers per inflorescence	F_4	2.44	1.70-3.20	28.20	10.97	15.10	0.21	8.80	
	F_5	2.75	2.43-3.36	15.11	12.03	63.40	0.58	19.72	12.70
	F_6	2.97	2.43-3.53	17.03	13.93	66.90	0.64	23.48	8.00
Number of fruits per inflorescence	F_4	2.31	1.66-4.04	35.64	28.44	63.70	1.08	46.74	
	F_5	2.40	1.93-3.76	23.09	21.88	89.70	1.09	42.70	3.89
	F_6	2.56	2.06-2.73	13.50	13.08	93.90	0.62	26.12	6.66

Table Cont….

Character	Generation	Mean	Range	PCV	GCV	Heritability (%)	GA at 5%	GAM at 5%	% GG
Days to first harvest	F_4	55.91	50.66-63.66	8.29	5.17	38.90	3.71	6.64	
	F_5	58.03	53.33-61.00	5.50	3.72	45.80	3.01	5.19	3.79
	F_6	59.25	57.00-61.00	4.59	2.75	36.00	2.01	3.40	2.10
Days to final harvest	F_4	161.48	147.33-179.00	8.22	5.66	47.50	12.98	8.04	
	F_5	162.58	150.66-175.33	6.49	6.00	85.30	18.66	11.42	0.68
	F_6	163.33	151.00-172.00	6.53	5.90	81.70	17.87	10.99	0.46
Fruit length (cm)	F_4	7.73	6.10-9.79	14.89	13.20	78.60	1.86	24.11	
	F_5	8.52	7.38-9.96	10.92	10.47	91.90	1.76	20.67	10.21
	F_6	9.31	8.82-9.96	5.40	4.97	84.90	0.88	9.45	9.27
Fruit girth (cm)	F_4	12.71	8.61-16.55	18.76	15.38	67.30	3.36	25.99	
	F_5	12.93	9.49-15.94	16.76	16.47	96.50	4.23	33.33	1.73
	F_6	14.38	12.66-15.94	9.99	9.41	88.60	2.62	18.24	11.21
Fruit length to girth ratio	F_4	0.86	0.78-0.94	12.40	6.27	25.60	0.05	6.54	
	F_5	0.68	0.55-0.78	13.07	12.17	86.7	0.15	23.35	-20.93
	F_6	0.65	0.55-0.78	15.42	14.89	93.20	0.19	29.62	-4.41
Fruit volume (cm^3)	F_4	294.22	270.00-320.00	13.46	7.33	29.60	24.17	8.21	
	F_5	316.29	290.00-350.00	8.42	6.36	57	31.31	9.90	7.50
	F_6	326.66	300.00-350.00	6.95	6.10	76.90	35.99	11.02	3.27
Number of fruits per plant	F_4	47.28	26.63-59.83	20.93	18.13	75.00	15.29	32.34	
	F_5	54.97	48.66-61.56	8.71	7.10	66.4	6.55	11.92	16.26
	F_6	55.34	48.66-61.56	12.84	11.49	80.10	11.73	21.19	0.67

Table Cont….

Character	Generation	Mean	Range	PCV	GCV	Heritability (%)	GA at 5%	GAM at 5%	% GG
Average fruit weight (g)	F_4	57.52	45.16-74.26	15.69	14.38	84.00	15.62	27.15	
	F_5	61.42	51.06-72.86	12.59	12.07	92.00	14.65	23.85	6.78
	F_6	68.40	63.50-72.86	6.87	5.72	69.30	6.71	9.81	11.36
Number of seeds per fruit	F_4	354.33	270.33-396.00	16.25	7.43	20.90	22.20	6.99	
	F_5	347.22	310.00-389.33	9.52	5.72	36.10	24.62	7.09	-2.00
	F_6	317.35	290.00-346.66	6.27	5.10	66.30	30.35	8.56	-8.60
Seed weight per fruit (g)	F_4	4.09	3.79-5.26	14.27	7.41	27.00	0.27	7.92	
	F_5	3.99	3.55-4.63	14.66	1.56	1.10	0.01	0.34	-2.44
	F_6	3.51	3.16-3.83	14.50	8.15	31.60	0.38	9.43	-12.03
Firmness of the fruit (Kg/cm^2)	F_4	2.36	1.95-2.91	17.67	4.91	7.70	0.06	2.81	
	F_5	2.43	2.15-2.78	12.80	7.43	33.70	0.21	8.88	2.96
	F_6	2.44	2.34-2.54	10.96	5.50	25.20	0.13	5.69	0.41
Phenols (mg 100 g^{-1})	F_4	3.16	2.41-4.02	20.71	8.40	16.50	0.20	7.02	
	F_5	3.14	2.46-3.54	20.16	19.03	89.10	1.17	37.01	-0.63
	F_6	2.89	2.65-3.13	8.76	7.10	65.70	0.37	11.86	-7.96
Yield per plant (Kg)	F_4	2.73	1.59-4.06	28.81	26.15	82.40	1.33	48.90	
	F_5	3.37	2.78-4.27	15.24	13.48	78.30	0.83	24.57	23.44
	F_6	3.77	3.38-4.27	12.41	9.44	57.90	0.55	14.79	11.86



Conclusion

The cross (Tuni local x EC-169089) per cent genetic gain from F_4 to F_5 and F_5 to F_6 generation for the yield contributing characters were; yield per plant (23.44 and 11.86), plant height (3.26 and 4.38), number of primary branches (4.78 and 1.52), number of fruits per inflorescence (3.89 and 6.66), fruit length (10.21 and 9.27), fruit girth (1.73 and 11.21), number of fruits per plant (16.26 and 0.67), average fruit weight (6.78 and 11.36), fruit firmness (2.96 and 0.41) and phenols (-0.63 and -7.96) respectively. Four promising plants were selected in F_6 generation as given below

Salient features of four promising lines in F_6 for further evaluation in Preliminary yield trials

1. Light green elongated oval fruits with clustering habit and heavy yielder.
2. Oblong medium green fruits and tolerant to little leaf.
3. Oblong light green fruits borne in cluster and tolerant to little leaf.

Oblong light green fruits in cluster with little thorns on the calyx, heavy yielder and tolerant to little leaf.

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