RESEARCH ARTICLE
Performance of Brinjal (Solanum melongena L) Germplasm for Shoot and Fruit Borer Infestation and Marketable Yield
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ABSTRACT
The present field experiment was aimed to evaluate the tolerance level to shoot, fruit borer infestation, and yield traits with 174 brinjal accessions at the University orchard, Department of Vegetable crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. Among the evaluated accessions, the Acc- EC 490062, Acc - EC 144139-D and Acc - IC 344646 were identified as the best performers as they showed favorable effects for earliness to flowering and harvest, number of fruits per plant and yield. In addition, they recorded the lowest level of shoot and fruit borer infestation with a high marketable yield. The least incidence of shoot borer (13.97 %) was registered in the accession EC 144139-D, EC 490062 (14.35 %), followed by the accession IC 344646 (15.74 %). Whereas the minimum infestation of fruit borer was recorded by the accessions EC 490062 (13.18 %), EC 144139-D (13.52 %), and IC 344646 (13.67 %). The maximum marketable yield per plant (3.46 kg) was registered by the Acc - EC 490062 followed by Acc - EC 144139-D (3.80 kg) and Acc- IC 344646 (3.64 kg). The genotypes acknowledged in the current investigation can be explored as parents in future crop improvement programmes of brinjal.

Keywords: Brinjal Accessions; Plant Traits; Earliness; Fruit Traits; Shoot and Fruit Borer Infestations; Marketable Yield

INTRODUCTION
Vegetable cultivation plays a vital role in making the cropping system more remunerative. There are plenty of reasons, which hinder the production levels of vegetable crops. They are, non-availability of suitable cultivars/varieties, high cost of the desirable seed/planting materials, damage of pests and diseases and change of climatic conditions, etc. To overcome these problems, selecting the best genotypes from the germplasm pool that will serve as a basic material in crop improvement programmes to develop suitable high yielding varieties with resistance to biotic and abiotic stresses gains importance.

Brinjal is a common vegetable grown throughout India. Nevertheless, it has its regional specificity based on its color, size, shape, stripes on the surface, thorniness, etc. The nutritional value of brinjal per 100g according to the United States Department of Agriculture (USDA), shows that brinjal fresh weight comprises 0.3 per cent minerals, 0.3 per cent fat, 1.3 per cent fiber, 1.4 per cent protein, 4 per cent of various vitamins and carbohydrates (A and C) and 92.7 percent moisture. It is a good source of potassium, phosphorus, calcium, iron and the vitamin B group. Besides its nutritional quality, brinjal has numerous health benefits in orthodox and traditional medicine. Although brinjal is not so popular for its high health-promoting micronutrients, it has low calories and low fat, making it valuable in diets. Remarkably, available literature suggested that brinjal is used as a medicine in different parts of the world for various illnesses (Oladosu, 2021).

The germplasm collection could be a source of desirable traits for improving existing brinjal varieties in the country. In addition, the global interest in the development of cultivars has encouraged germplasm collection and preservation. Hence, these resources are important to plant breeders as a reservoir of genetic variation. Characterization and evaluation of plant germplasm are vital for identifying desirable accessions for utilization in breeding programs (Upadhyaya et al., 2008). The importance of utilization and development of varieties towards high yield and high marketable yield to supply high-value brinjal to the market is highly essential to enhance the profitability to the growers.

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Knowledge of agro-morphological genetic variation and cropping conditions on vegetative and yield-related traits plays a significant role in varietal improvement and production of brinjal (Sulaiman et al., 2020). In any selection programme, the mean performance of the genotypes for individual characters serves as an essential criterion for discarding the undesirable types. This indicates that germplasm studies may act as a potential source and offer scope for the selection of high-yielding genotypes with desirable horticultural attributes. Hence the potential of germplasm act as genetic resources, “Evaluation and identification of suitable cultivars is mandatory” for maintaining plant genetic resources to identify the best types and use them in the further breeding programme. Therefore, the present investigation was undertaken to characterize brinjal accessions collected from NBPGR, New Delhi, by assessing the performance of brinjal accessions for important plant traits and shoot and fruit borer resistance, marketable yield to identify the best performing accessions.

**MATERIAL AND METHODS**

The present brinjal evaluation study was conducted at the University Orchard, Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. Around 174 genotypes (170 accessions and four check varieties) were evaluated along with two more check varieties of brinjal viz., CO1 and CO2 released from Tamil Nadu Agricultural University, Coimbatore. Around 174 genotypes (170 accessions and four check varieties) were utilized for the study. Seeds were sown in the nursery and the seedlings were transplanted in the main field after 30 days. The experiment was laid out in “Augmented Block Design”. Required cultural operations like watering, manuring and weeding were done periodically by adopting standard cultural practices. A random of five plants were marked for recording observations in each accession. The observations were recorded on plant traits viz., plant height and no. of branches, flowering, earliness to flowering and fruit harvest, fruit and yield traits viz., single fruit weight, fruit length, fruit girth, fruit weight, no. of fruits per plant, yield per plant, shoot and fruit borer infestation and marketable yield per plant. The obtained data were subjected to statistical analysis as suggested by Panse and Sukhatme, 1985.

**RESULTS AND DISCUSSION**

The recorded observations were statistically analyzed and the mean values were tabulated and presented in Table 1. The statistical analysis revealed highly significant differences among the genotypes for all the traits indicating the presence of sufficient variability in the experimental material. The selection of suitable parents is an essential criterion for the success of a crop improvement program. The research conducted by Srivastava (2020) revealed that eggplant germplasm had ample genetic variation portrayed through agro-morphological characterization.

| Acc No. | Plant height (cm) | No. of branches | Days to 50% Flowering | Days to first harvest | Single fruit weight (g) | Fruit length (cm) | Fruit girth (cm) | Number of fruits | Yield per plant (kg) | Shoot borer incidence (%) | Fruit borer incidence (%) | Marketable yield (kg) |
|---------|------------------|-----------------|-----------------------|----------------------|------------------------|------------------|-----------------|-----------------|-----------------------|--------------------------|--------------------------|------------------------|
| EC 111317 | 63.47           | 9.87            | 70.53                 | 87.73                | 68.57                  | 10.32            | 13.84           | 38.43           | 2.63                  | 19.57                    | 29.86                    | 1.85                   |
| EC 112773 | 86.32           | 7.25            | 77.33                 | 97.53                | 107.82                 | 10.36            | 15.17           | 30.52           | 3.29                  | 18.71                    | 22.32                    | 2.56                   |
| EC 144139-D | 87.59          | 12.43           | 56.33                 | 66.63                | 78.66                  | 11.92            | 13.54           | 55.84           | 4.40                  | 13.97                    | 13.52                    | 3.80                   |
| EC 169079 | 89.32           | 8.54            | 65.73                 | 75.87                | 82.54                  | 16.43            | 7.35            | 36.74           | 3.03                  | 15.62                    | 28.43                    | 2.17                   |
| EC 169757 | 55.56           | 9.35            | 60.33                 | 82.38                | 52.36                  | 6.74             | 6.32            | 37.62           | 1.97                  | 18.34                    | 22.17                    | 1.54                   |
| EC 304072 | 76.47           | 5.55            | 65.63                 | 89.76                | 58.84                  | 8.70             | 6.22            | 40.15           | 2.36                  | 19.75                    | 20.54                    | 1.88                   |
| EC 305048 | 65.38           | 7.68            | 68.73                 | 91.45                | 56.54                  | 8.43             | 6.52            | 36.45           | 2.06                  | 21.86                    | 18.78                    | 1.68                   |
| EC 305056 | 82.47           | 7.43            | 66.33                 | 93.53                | 66.86                  | 9.37             | 7.24            | 25.83           | 1.73                  | 20.43                    | 19.21                    | 1.40                   |
| EC 305070 | 106.28          | 6.85            | 68.37                 | 83.53                | 72.64                  | 8.52             | 9.86            | 32.34           | 2.35                  | 16.52                    | 18.24                    | 1.93                   |
| EC 305163 | 92.17           | 7.84            | 66.43                 | 89.37                | 81.43                  | 10.48            | 6.39            | 39.42           | 3.21                  | 12.14                    | 27.36                    | 2.34                   |
| EC 315014 | 80.35           | 9.52            | 65.27                 | 87.67                | 65.73                  | 12.32            | 5.42            | 48.78           | 3.21                  | 17.18                    | 15.21                    | 2.73                   |
| EC 316226 | 66.61           | 7.37            | 69.33                 | 93.45                | 60.44                  | 11.42            | 5.86            | 33.54           | 2.03                  | 19.73                    | 23.87                    | 1.55                   |
| EC 316227 | 77.75           | 7.26            | 72.63                 | 98.73                | 59.57                  | 10.36            | 8.62            | 40.17           | 2.40                  | 20.42                    | 26.74                    | 1.76                   |
| EC 316230 | 62.34           | 6.87            | 61.77                 | 87.54                | 66.68                  | 11.24            | 7.53            | 38.25           | 2.55                  | 16.78                    | 19.58                    | 2.06                   |
| EC 316242 | 58.73           | 6.64            | 61.67                 | 86.33                | 48.73                  | 7.36             | 6.52            | 42.76           | 2.08                  | 21.54                    | 30.32                    | 1.45                   |
| EC 316244 | 63.64           | 8.51            | 67.66                 | 81.43                | 68.29                  | 10.74            | 9.67            | 50.32           | 3.34                  | 20.87                    | 23.54                    | 2.56                   |

Table 1. Mean performance of brinjal accessions
Plant height is one of the important traits that contributed to yield increase. Out of the 170 accessions and four check varieties evaluated, the measured plant height was ranged from 118.73 cm to 33.42 cm. The minimum plant height of 33.42 cm was recorded by the accession IC 420656. Totally 94 accessions recorded more plant height than the grand mean (77.76 cm). The maximum plant height of 118.73 cm was recorded in the Acc - EC 144139-D followed by Acc - EC 490062 (11.63). Variation in the number of harvests from a plant in its entire duration. The range for days to 50 per cent flowering varied from 56.33 days (Acc - EC 144139-D) to 81.36 days (Acc - IC 090132 and Acc - IC 090132). On an average 68.34 days was recorded as a grand mean for this trait. A total number of 78 accessions took a lesser number of days for 50 per cent flowering in the population and the accession IC 099670 recorded 68.34 days for 50 per cent flowering, which was on par with the grand mean. The Acc - EC 144139-D was the earliest one, which took 56.33 days for 50 per cent flowering and the Acc - EC 490062 was the second earliest to register 50% of flowering.

Earliness was also measured based on the number of days taken for the first harvest. Early harvest also facilitates for more number of harvests. Days taken for the first harvest ranged from 65.57 days (Punjab Sadabahar) to 103.33 days (Acc - IC 354525) with a grand mean value of 86.02 days. A total number of 72 accessions recorded a lesser number of days taken for the first harvest than the grand mean. The Acc - EC 490062 was the first which took the least number of days to first harvest (65.57 days). The next best accession was Acc - EC 144139-D, which took 66.63 days for the first harvest. Early flowering and early harvest were reported by Chowdhury et al., (2010) and Nirmala (2012). Similar findings for early harvest in brinjal were registered by Omkar Singh and Kumar (2005), Suneetha et al., (2006), Vaddoria et al., (2007), Chowdhury et al., (2010), Nirmala (2012), Praneetha (2016) and Srivastava et al., (2019).

The fruit weight ranged from 35.16 to 118.32 g. The maximum single fruit weight of 118.32 g was recorded by the accession IC 090871 followed by Acc - EC 144139-D (107.82 g) and Acc - IC 900088 (103.54 g). A similar pattern for different ranges of fruit weight in brinjal was reported by Shafeeq et al., (2007), Kumar et al., (2011), Nirmala (2012), Praneetha (2016) and Srivastava et al., (2019).

Fruit length also contributes to the yield increase and variation was observed among the evaluated accessions for this character. The grand mean for the length of the fruit measured among the evaluated brinjal germplasm was 10.13 cm. A total number of 81 accessions exceeded the mean value for fruit length and 93 accessions recorded a lesser value for the trait.
The maximum fruit length of 16.43 cm was recorded in the Acc - EC 169079, followed by the Acc - IC 344646 (14.84 cm) and Acc - IC 023969 (14.35 cm). The minimum fruit length of 5.3 cm was recorded in the ACC IC 261792. A wide range of fruit length in brinjal was reported by Paikra et al., (2003), Deep et al., (2006), Chowdhury et al., (2010) Kumar et al., (2011), Nirmala (2012) Praneetha (2016), and Srivastava et al., (2019).

Fruit girth is another significant yield contributing character. As low as 4.37 cm to as high 17.65 cm was measured as fruit girth. The grand mean was 8.30 cm. Totally 67 accessions recorded high fruit girth than the grand mean. The maximum fruit girth was measured by the Acc. IC 023771. The next best values for the fruit girth were 15.97 cm (Acc- IC 090871), 15.42 cm (Acc-IC 090132) and 15.17 cm (Acc- EC112773). These findings of varied fruit girth in brinjal are in accordance with Kumar et al., (2011), Nirmala (2012), Praneetha (2016) and Srivastava et al., (2019).

The number of fruit is the main trait, that directly decides the yield level. It was observed that a minimum of 20.77 fruits to the maximum of 64.75 fruits per plant were registered in different accessions. The Acc - EC 490062 recorded the maximum number of fruits per plant (64.75) followed by Acc- EC 144139-D (55.84) and Acc- IC 344646 (52.47). The minimum number of fruit per plant was recorded in the Acc- IC 354597. The same trend of results for variation in the number of fruits per plant were registered by Chowdhury et al., (2010), Kumar et al., (2011), Nirmala (2012), Praneetha (2016) and Srivastava et al., (2019). The yield per plant decides the economic returns to the growers. The per plant yield ranged from 1.14 kg per plant in the Acc - IC 112934 to 4.45 kg per plant in the Acc- EC 490062. On an average, the evaluated accessions recorded 2.33 kg of yield per plant. The yield of promising accessions are depicted in the figure 1. Various levels of yield in brinjal were registered by Kumar et al., (2011), Nirmala (2012), Praneetha (2016) and Srivastava et al., (2019) in the evaluated germplasm.

When there is no or less shoot and fruit borer damage, naturally increase in yield will be ascertained. The minimum percentage of shoot borer (12.14%) was recorded by Acc-EC 305163 followed by Acc - EC 144139-D (13.97%). The shoot borer infestation was maximum in the ACC IC 261788 (26.34%). The mean shoot borer infestation was 19.55% and 91 accessions recorded lesser shoot borer infestation than the grand mean. The shoot borer infestation is presented in figure 3.

Fruit borer infestation decides the marketable fruit yield per plant. The minimum percentage of fruit borer (13.18 % ) damage was recorded in the Acc - EC 490062 and Acc - EC 144139-D (13.52%). The highest fruit borer infestation of 32.16% was recorded in the ACC IC 111037. The mean for this trait was 22.73 and 90 accessions recorded lower fruit borer infestation than the grand mean. The wide range of shoot and fruit borer infestation in brinjal was also reported by Kamalakkannan et al. (2007), Dehatonde et al. (2010), Nirmala (2012), Praneetha (2016), Suresh et al. (2017) and Srivastava et al. (2019). The fruit borer infestation is presented in the figure 4.

Marketable fruit yield contributes to direct profit for the growers, which are obtained after deducting the fruit borer-infested fruits. The marketable yield ranged from 0.91 kg (Acc- IC 112934) to 3.86 kg and the mean marketable fruit yield per plant was 1.80 kg per plant. The Acc IC 310884 registered on par marketable yield of 1.80 kg with the grand mean value.

The maximum marketable yield per plant (3.46 kg) was recorded by the Acc - EC 490062 followed by Acc- EC 144139-D (3.80 kg) and Acc- IC 344646 (3.64 kg). The same trend of results for various levels of marketable fruit yield in brinjal was also reported by Praneetha (2002), Thangamani (2003), Prabhu (2004), Nirmala(2012), Praneetha (2016) and Srivastava et al., (2019). The marketable yield per plant is presented in figure 2.
The performance of brinjal germplasm from the present study showed that the Acc-IC090132 recorded the maximum plant height and the accessions Acc-EC 144139-D and Acc-EC 490062 registered the maximum number of branches per plant. The Acc-EC 144139-D was the earliest for 50% of flowering followed by Acc-EC 490062. The Acc-EC 490062 was the first one to register early harvest among the accessions evaluated.

The maximum single fruit weight was recorded in the Acc-IC 090871, the maximum fruit length was recorded in the Acc-EC 169079, the maximum fruit girth was measured in the Acc-IC 023771. Maximum number of fruits per plant was recorded in the Acc-EC 490062 followed by Acc-EC 144139-D and Acc-IC 344646. The highest yield per plant was recorded by the Acc-EC 490062 and Acc-EC 144139-D. The accessions Acc-EC 305163 and EC 144139-D recorded the minimum percentage of shoot borer and fruit borer damage. The Acc-EC 490062 followed by Acc-EC 144139-D and Acc-IC 344646 recorded maximum marketable yield per plant. The best accessions identified in the present study can be well utilized for varietal release and to use as parents in breeding programmes for further improvement of the desirable traits.

CONCLUSION

The germplasm evaluation study showed that the Acc-EC 490062, Acc-EC 144139-D, and Acc-IC 344646 were identified as best performers as they recorded desirable characters for earliness to flowering and fruit harvest, to record more number of fruits per plant and yield per plant. Also, they recorded the lowest level of shoot and fruit borer infestation and high marketable yield. Knowledge of morphological genetic variation on vegetative and yield-related traits plays a significant role in varietal improvement and production of brinjal (Solanum melongena L.). Therefore these accessions can be used in brinjal breeding programme to develop superior varieties/hybrids with high yield and low shoot and fruit borer infestation.

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