Studies on genetic variability and associations of Fruit and Shoot Borer Infestation for yield attributing traits in transgressive segregating populations of brinjal (*Solanum melongena* L.)

Abstract

In the F2 generation of eggplants, resulting from the crosses between Bilichandubadane and Mullubadane in the F1 generation, a considerable level of variability was observed. These eggplant varieties, cultivated in an augmented design at ZARS Shimogga during the Kharif season of 2017, display numerous significant plant breeding characteristics and hold great potential for further improvement under varying growing conditions. The F2 investigation unveiled substantial diversity in nine quantitative traits. The strong correlation between the Genetic Coefficient of Variation (GCV) and Phenotypic Coefficient of Variation (PCV) values suggests that environmental factors have a relatively minor influence on the expression of these studied traits. Importantly, characteristics such as the number of fruits per plant, the number of primary branches, and the number of flowers per plant exhibited a substantial genetic contribution, as indicated by their high GCV and PCV values, in addition to significant broad sense heritability and genetic advancement. This implies that these traits are mainly governed by additive genes and can be effectively enhanced through selection without necessitating progeny testing. Furthermore, the high heritability values observed for most traits indicate considerable potential for improving yield and its components through selective breeding. Differences in mean values among the parent plants in various characteristics suggest the involvement of diverse parent plants in the crosses studied. Additionally, the F2 plants displayed superior performance in most traits compared to either of the parent plants, which can be attributed to the phenomenon of transgressive segregation.

Key words: genetic variability, eggplants, Fruit and Shoot Borer

Introduction:

“Aubergine, scientifically known as Solanum melongena L., stands as one of India's most widespread and indispensable vegetable crops, often dubbed the "Monarch of Vegetables." This highly productive crop is often referred to as the "humble man's crop." Belonging to the Solanaceae family, aubergine has its roots in the Indo-Burma region and China. In India, it ranks second in both cultivation area and production, with 6.69 lakh hectares dedicated to its growth, yielding an annual production of 124.01 lakh metric tonnes and an average productivity of 19 tonnes per hectare” (Anonymous, 2016). In Karnataka, it occupies an area of 15.8 thousand

hectares, producing 4.03 lakh metric tonnes annually, with a productivity of 25.4 tonnes per hectare.

Aubergine, also recognized as brinjal, is a perennial plant but is commercially cultivated as an annual crop. The inflorescence can be solitary or form clusters of 2-5 flowers, a characteristic that varies among different varieties. Its flowers are complete and hermaphroditic, with heterostyly being a common feature. Brinjal is regarded as moderately nutritious, providing essential carbohydrates (4.0 g), proteins (1.4 g), fiber (1.3 g), vitamin-A (124 IU), phosphorus (47 mg), potassium (2.0 mg), and iron (0.3 mg). It is recommended for various health conditions such as diabetes, asthma, cholera, and bronchitis, and it's known to protect brain cell membranes from damage.

Materials and Methods:

The field study in this research involved the top two crosses from the F_1 generation, including one control from a private seed company in Shivamogga. These crosses were established between specific line and tester varieties, and the most promising combinations were selected. The experiment took place at ZAHRS, Shivamogga, and utilized the F2 population and control varieties. Sowing occurred in the third week of July 2017, with seedlings transplanted into the main field after 22 days at a spacing of 90 cm between rows and 60 cm between plants. The cultivation adhered to recommended agricultural practices, including the use of vermicompost and coco peat in seedling trays covered with black polythene for germination. The main field was prepared with fine tilth, incorporating 25 t/ha of FYM. Ridges and furrows were established at 90 cm spacing, with 24 plants planted on each ridge, covering a plot area of 6.75 m^2. Standard agronomic practices were followed to maintain a healthy crop.

Observations were recorded for various characteristics, including days to initial flowering, plant stature (cm), number of primary branches per plant, number of flowers per plant, fruit length (cm), fruit width (cm), number of fruits per plant, number of fruits per cluster, and fruit yield per plant (kg).

Results and Discussion:

Phenotypic Coefficient of Variation (PCV):

The estimates of PCV indicated notable variation for the number of flowers, number of fruits per cluster, number of primary branches, and number of fruits per plant, implying significant diversity within the populations. Moderate PCV values were observed for plant stature, fruit yield per plant, and fruit length, while lower PCV values were recorded for days to initial flowering and fruit width (cm). These results align with earlier research on similar traits (Reena and Mehta, 2009; Ansari, 2010).

Genotypic Coefficient of Variation (GCV):

High GCV values were found for the number of primary branches per plant, number of flowers, and number of fruits per plant, indicating substantial genetic diversity. Moderate GCV values were noted for the number of fruits per cluster and plant stature, while days to initial flowering, fruit length, fruit width, and fruit yield per plant exhibited low GCV values. These findings are consistent with previous studies (Arunkumar *et al*., 2014; Swaroop and Sharma, 2000; Ansari, 2000).

The disparity between PCV and GCV estimates reflects the impact of environmental factors on heritability. In the Bilichandu badane × Mullu badane population, substantial heritability was observed for several traits, including the number of primary branches per plant. However, fruit length, number of fruits per cluster, and fruit yield per plant showed low heritability. This corresponds with prior research on heritability (Samlindsujin *et al*., 2017; Ansari, 2010).

Genetic Advance as Percent Mean (GAM):

"In the Bilichandu badane × Mullu badane population, substantial GAM was found for the number of primary branches, number of flowers per plant, number of fruits per plant, and plant stature". [16] Moderate GAM was observed for days to initial flowering and the number of fruits per cluster, while low

heritability coupled with GAM was seen for days to 50 percent flowering, fruit width, fruit length, and fruit yield per plant. These results align with previous research on genetic advance as a percent mean (Nayak and Nagre, 2013; Ansari et al., 2010; Ambade, 2008). Descriptive statistical parameters, including mean, range, skewness, and kurtosis, for all nine traits in the F2 generation of the Bilichandubadane × Mullubadane cross, are presented in Table 2. "A positively skewed distribution suggests the involvement of multiple segregating genes, with a predominant presence of decreasing effects and dominance-based complementary interactions in the inheritance of the number of flowers. Traits like number of flowers per plant, number of primary branches per plant, number of fruits per plant, and fruit length (cm) display an inheritance pattern characterized by positively skewed distributions. To achieve significant genetic gain for these traits, extensive selection from the existing variability is necessary" (Roy, 2000). This means that to maximize the expression of desirable traits, rigorous selection among available variations is crucial.

Conversely, traits such as days to initial flowering and plant stature display negatively skewed platykurtic distributions. This implies that these traits are influenced by a multitude of dominant genes, most of which exert increasing effects, and they involve a form of epistasis known as duplicate epistasis in their inheritance. The presence of dominance and duplicate epistasis in these traits serves to shield individual plants from the potential adverse impacts of deleterious alleles present within the existing genetic diversity (Roy, 2000).

In the case of the number of fruits per cluster, a positively skewed leptokurtic distribution is evident. This distribution pattern indicates the involvement of a relatively smaller number of

segregating genes, the majority of which have decreasing effects on the inheritance of this trait (Table 2).

Transgressive segregants represent genotypes that surpass the performance limits of both parent plants in a favorable direction during the segregating generations, especially within the F2 generation. This phenomenon of transgressive segregants can be attributed to the amalgamation of advantageous genes (positive alleles) from diverse parents and additive gene interactions (Table 3).

The exceptional performance of these segregants can be linked to specific component traits. For example, Plant Number 7 exhibited the highest fruit yield per plant, likely owing to factors such as the number of fruits per plant, the number of primary branches, and fruit yield per plant. Plant Number 93's superior performance can be attributed to component traits such as the number of fruits per plant, the number of flowers per plant, plant stature, and fruit yield per plant. Similarly, the outstanding performance of Plant Number 116 may be attributed to component traits including the number of fruits per plant, the number of flowers per plant, plant stature, fruit length, and fruit yield per plant.

Regarding resistance to fruit borers, 200 F_2 plants resulting from the Bilichandubadane × Mullubadane cross were categorized as resistant, moderately tolerant, susceptible, or very susceptible. Among these plants, 101 were classified as tolerant, 78 as moderately tolerant, 17 as susceptible, and 4 as very susceptible to fruit borer infestations. It was generally observed that the incidence of fruit borers increased as the crop aged, with a lower population during the vegetative phase compared to the near maturing stage. These findings corroborate the results reported by Nirmala and Irene in 2016, thereby reinforcing the current investigation's validity (Table 4).

Conclusion:

This study has identified promising individual plants with transgressive traits in the F_2 segregating generation of the Bilichandubadane × Mullubadane cross. The potential of these transgressive segregants warrants further evaluation in subsequent generations, offering valuable prospects for their integration into breeding programs.

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Table 1: Estimates of genetic variability parameters for yield and its attributing traits in F_2 generation of Cross Bilichandu badane × Mullu badane

Sl. No.	Characters	Co-efficient of variation		h^2 bs (%)	GAM (%)
		PCV (%)	GCV (%)		
1	Days to first flowering	9.00	8.32	85.32	15.82
2	Plant height (cm)	14.46	13.05	81.51	24.27
3	Number of flowers per plant	26.31	20.66	61.70	33.43
4	Number of fruits per cluster	49.86	19.16	14.77	15.17
5	Number of primary branches	46.60	43.15	85.73	82.30
6	Fruit yield per plant (g)	13.47	3.855	08.20	2.27
7	Number of Fruits per plant	26.25	20.59	61.50	33.25
8	Fruit width (cm)	6.083	4.87	64.15	8.03
9	Fruit length (cm)	16.25	7.62	21.97	7.35

Table 2: Descriptive statistics for nine characters in F_2 generation of cross Bilichandu badane × Mullu badane

Sl. No.	Characters	Mean of Bilichandu badane	Mean of Mullu badane	Mean of F_2	Range		Skewness	Kurtosis	Kurtosis Type
					Min.	Max.			
1	Days to first flowering	50.00	45.00	50.20	37.00	57.00	-0.46	-0.89	P
2	Plant height (cm)	73.20	87.80	84.27	53.00	120.0	-0.02	0.36	P
3	Number of flowers per plant	31.00	27.80	27.19	18.00	49.00	0.04	0.38	P
4	Number of fruits per cluster	1.00	2.00	1.00	1.00	5.00	1.93	4.49	L
5	Number of primary branches	1.60	5.60	4.57	4.00	12.00	0.77	0.27	P
6	Fruit yield per plant (g)	1047.22	1108.00	1123.23	615.15	2765.28	1.43	3.08	M
7	Number of Fruits per plant	31.00	27.80	27.18	20.00	49.00	0.04	0.40	P
8	Fruit width (cm)	4.31	3.07	4.38	3.23	5.17	-0.49	3.07	M
9	Fruit length (cm)	5.71	5.87	6.65	4.54	10.85	0.40	0.41	P

Table 3: Top ten transgressive segregant obtained for number of fruits per plant, fruit yield per plant in F_2 generation of Bilichandu badane × Mullu badane.

Sl.No	Plant number	Number of fruits per plant	Fruit yield per plant (g)
1	P-7	29	2929.85
2	P-31	26	1732.76
3	P-54	28	1857.95
4	P-69	24	1592.53
5	P-93	41	2765.28
6	P-116	30	2023.38
7	P-155	23	1190.57
8	P-158	24	1266.85
9	P-178	20	1059.47
10	P-189	28	1749.17

Table 4: The degree of resistant or susceptible to fruit borer infestation was assigned as per the scale F_2 of cross Bilichandu badana × Mullu badane

Reaction	**Plants**
Tolerant(≤15)	101
Moderately tolerant (16-25%)	78
Susceptible (26-40%)	17
Highly susceptible(≥40%)	4