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Biophysical and biochemical characterization of brinjal genotypes in resistance to sucking pests infesting brinjal (*Solanum melongena* L.)

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Abstract

Brinjal (*Solanum melongena* L.) is an economically important vegetable crop that suffers severe yield losses due to the infestation of sucking pests, particularly jassid (*Amrasca biguttula biguttula* Ishida) and whitefly (*Bemisia tabaci* Gennadius). The development and utilization of resistant genotypes offer an environmentally safe and sustainable alternative to excessive dependence on chemical insecticides. The present investigation was conducted during rabi 2025-26 at the Main Vegetable Research Station, Anand Agricultural University, Anand, Gujarat, to evaluate ten brinjal genotypes for biophysical and biochemical traits associated with resistance against major sucking pests. The experiment was laid out in a Randomized Block Design with three replications under natural infestation. Biophysical parameters, including plant height, leaf length, leaf width, number of leaves, number of branches, leaf area and trichome density, along with biochemical constituents such as moisture, total soluble sugars, reducing sugars, non-reducing sugars, total phenols and chlorophyll content, were estimated and correlated with pest incidence. Significant variability was observed among the genotypes for both morphological and biochemical traits. Genotype AB 23-06 recorded the lowest jassid population, whereas AB 23-18 and JBL 21-11 exhibited comparatively lower whitefly populations and were categorized as resistant. Trichome density showed a highly significant negative correlation with jassid ($r = -0.971^{**}$) and a significant negative correlation with whitefly ($r = -0.579^*$), while total phenol content also exhibited strong negative associations with jassid ($r = -0.947^{**}$) and whitefly ($r = -0.766^{**}$) populations. In contrast, moisture content and soluble sugars were positively correlated with pest incidence. The findings indicate that higher trichome density and phenolic content, together with lower moisture and sugar contents, contribute significantly to resistance against sucking pests. Genotypes AB 23-06, AB 23-18 and JBL 21-11 may serve as valuable donor parents for developing sucking pest-resistant brinjal cultivars in future breeding programmes.

Keywords: *Solanum melongena*, host plant resistance, trichome density, phenolic compounds, sucking pests

Introduction

Brinjal (*Solanum melongena* L.), commonly known as eggplant or aubergine, is one of the most important solanaceous vegetable crops cultivated extensively in tropical and subtropical regions of the world. India is considered the primary centre of origin and diversity of brinjal (Gleddie *et al.*, 1986) ^[1]. The crop is widely grown because of its adaptability to diverse agro-climatic conditions, year-round availability and economic importance. Brinjal fruits are rich in carbohydrates, vitamins (A, B and C) and essential minerals such as iron, phosphorus and calcium, making them an important component of human nutrition (Shanmugavelu, 1989; Chandrakumar *et al.*, 2008) ^[2, 3].

Despite its economic significance, brinjal production is constrained by the infestation of several insect pests throughout its growth period. More than 30 insect pest species have been reported to infest the crop from nursery to harvest stages. Among these, sucking pests such as jassid, *Amrasca biguttula biguttula* (Ishida), whitefly, *Bemisia tabaci* (Gennadius), aphid, *Aphis gossypii* (Glover) and mite, *Tetranychus cinnabarinus* (Boisduval), are of major economic importance and cause substantial yield losses (Patel *et al.*, 1970) ^[4]. These pests cause direct damage by extracting cell sap from leaves and tender plant parts, resulting in chlorosis, leaf curling, reduced photosynthetic activity, stunted growth and poor plant vigour. Furthermore, jassids are known vectors of little leaf disease in brinjal

(Sarkar and Kulshreshtha, 1978) ^[5]. Yield losses due to insect pest infestation in brinjal have been reported to range from 20 to 89 per cent (Kumar *et al.*, 2015) ^[6].

The incidence and severity of sucking pests are greatly influenced by weather parameters such as temperature, relative humidity and rainfall, which affect their survival, development, reproduction and seasonal abundance (Chatterjee *et al.*, 2018) ^[7]. Although chemical insecticides are widely employed for the management of these pests, their indiscriminate and repeated use has resulted in the development of insecticide resistance, pest resurgence, residue problems and adverse effects on beneficial organisms and the environment (Bogenschutz and Konig, 1976; Bentz *et al.*, 1995; Natarajan, 1986) ^[8, 9, 10]. Consequently, the development and utilization of host plant resistance have emerged as an economically viable, environmentally safe and sustainable approach for the management of sucking pests in brinjal.

Host plant resistance is often governed by various morphological, anatomical and biochemical characteristics that influence insect behaviour, feeding preference and development (Webster, 1975) ^[11]. Biophysical traits such as leaf pubescence, trichome density, tissue hardness and structural adaptations interfere with insect feeding and colonization (Chelliah and Srinivasan, 1983) ^[12]. Similarly, biochemical constituents such as phenols, sugars and chlorophyll play a crucial role in determining the susceptibility or resistance of plants to insect pests. Higher phenolic content is generally associated with reduced pest infestation, whereas higher sugar and moisture contents favour pest multiplication and survival (Jat and Pareek, 2003) ^[13].

Identification of resistant genotypes and elucidation of resistance-associated traits are essential prerequisites for developing sustainable integrated pest management strategies and breeding programmes aimed at reducing dependence on chemical insecticides. However, information on the role of biophysical and biochemical traits in conferring resistance to sucking pests in newly developed brinjal genotypes is limited. Therefore, the present investigation was undertaken to characterize different brinjal genotypes based on their biophysical and biochemical attributes and to identify resistance-associated traits against major sucking pests.

Materials and Methods

The present investigation on biophysical and biochemical characterization of brinjal (*Solanum melongena* L.) genotypes for resistance against major sucking pests was carried out during *rabi*, 2025-26 at the Main Vegetable Research Station (MVRS), Anand Agricultural University, Anand, Gujarat, India. The experimental site is situated at 22°35' N latitude and 72°55' E longitude with an elevation of 45.1 m above mean sea level and falls under the middle Gujarat agro-climatic zone. The biochemical analyses were conducted in the Department of Biochemistry and Plant Physiology, B.A. College of Agriculture, Anand Agricultural University, Anand.

Ten brinjal genotypes viz., AB 23-18, AB 22-12, AB 23-05, AB 23-06, JBL 21-11, JBL 23-17, NBL 21-06, NBL 24-06, GAB 6 and Pb. Sadabahar were evaluated under field conditions. The experiment was laid out in a Randomized Block Design (RBD) with three replications. Healthy seedlings were transplanted on 17 September 2025 at a

spacing of 90 × 60 cm. The recommended package of practices was followed uniformly for all the treatments. A fertilizer dose of 100:50:50 kg N-P-K ha⁻¹ was applied, wherein the entire quantity of phosphorus and potassium and half of the nitrogen were applied as basal, while the remaining nitrogen was top-dressed in two equal splits at 30 and 60 days after transplanting. No insecticidal sprays were applied during the crop season to permit natural infestation and population build-up of sucking pests.

The incidence of major sucking pests, namely jassid, *Amrasca biguttula biguttula* (Ishida), and whitefly, *Bemisia tabaci* (Gennadius), was recorded at weekly intervals from one week after transplanting until final harvest. Five plants were randomly selected and permanently tagged in each plot for recording observations. The populations of jassids and whiteflies were counted on three leaves per plant, comprising one leaf each from the upper, middle and lower canopy, and the mean population per three leaves was computed.

Biophysical parameters associated with resistance, viz., plant height (cm), leaf length (cm), leaf width (cm), number of leaves per plant, number of branches per plant, leaf area (cm²) and trichome density, were recorded at 60 days after transplanting from five randomly selected plants in each replication. Leaf area was measured using a digital leaf area meter and expressed in cm². Trichome density was determined from fully expanded leaves collected from the middle canopy and the number of trichomes present on the midrib, veins and lamina was counted under a stereoscopic microscope and expressed as number of trichomes/cm².

Leaf samples collected during vegetative and flowering stages were used for estimation of biochemical constituents associated with resistance. Moisture content was estimated by the hot air oven method (AOAC, 2000) ^[14]. Total chlorophyll content was determined by the dimethyl sulphoxide (DMSO) extraction method of Hiscox and Israelstam (1979) ^[15]. Total soluble sugars and reducing sugars were estimated following the methods of Dubois *et al.* (1956) ^[16] and Nelson (1944) ^[17], respectively, while non-reducing sugars were calculated by subtracting reducing sugars from total soluble sugars. Total phenol content was estimated according to the method described by Bray and Thorpe (1954) ^[18]. The biochemical constituents were expressed on fresh weight basis.

The genotypes were categorized into Highly Resistant (HR), Resistant (R), Moderately Resistant (MR), Low Resistant (LR), Susceptible (S) and Highly Susceptible (HS) classes based on the mean population of sucking pests according to the statistical scale proposed by Patel *et al.* (2002) ^[19]. The experimental data were subjected to analysis of variance (ANOVA) appropriate for a Randomized Block Design as described by Panse and Sukhatme (1985) ^[20]. Correlation coefficients were worked out to determine the relationship between biophysical and biochemical characteristics and the incidence of sucking pests, and the significance of treatment differences was tested at the 5 per cent level of probability.

Results and Discussion

Screening of brinjal genotypes against major sucking pests: The incidence of major sucking pests varied significantly among the evaluated brinjal genotypes, indicating the existence of considerable genetic variability for resistance and susceptibility. Based on the mean population and resistance categorization scale proposed by

Patel *et al.* (2002) ^[19], genotype AB 23-06 recorded the lowest jassid population and was categorized as resistant, whereas AB 23-18 and JBL 21-11 exhibited comparatively lower whitefly populations and were categorized as resistant genotypes. Conversely, Pb. Sadabahar and AB 23-18 harboured comparatively higher populations of sucking pests and were found to be more susceptible.

The observed variation in pest incidence among the genotypes may be attributed to differences in their inherent morphological and biochemical characteristics. The resistant genotypes generally possessed higher trichome density and phenolic content along with lower moisture and sugar contents than the susceptible genotypes. Similar variability in resistance among brinjal genotypes has also been reported by Jat and Pareek (2003) ^[21] and Mani *et al.* (2022) ^[22].

Biophysical characterization of brinjal genotypes

Significant differences were observed among the genotypes for all the biophysical parameters studied, namely plant height, leaf length, leaf width, number of leaves per plant, number of branches per plant, leaf area and trichome density. Such variability suggests the presence of considerable genetic diversity among the tested genotypes, which can be effectively exploited in resistance breeding programmes.

Among all the morphological characters, trichome density showed the strongest association with sucking pest incidence. Correlation analysis revealed a highly significant negative relationship between trichome density and jassid population ($r = -0.971^{**}$) and a significant negative relationship with whitefly population ($r = -0.579^{*}$). The lower incidence of sucking pests on genotypes possessing dense pubescence may be attributed to the role of trichomes as a mechanical barrier that hinders insect movement, stylet penetration, feeding and colonization. Dense trichomes may also modify the microenvironment of the leaf surface, rendering it unsuitable for pest establishment and multiplication.

The present findings corroborate the reports of Jat and Pareek (2003), who observed reduced jassid infestation in brinjal genotypes with higher pubescence. Similar findings were also reported by Ali *et al.* (2012) ^[23], Yasmin *et al.* (2021) ^[24] and Mani *et al.* (2022) ^[22], who identified trichome density as an important morphological marker conferring resistance against sucking insect pests.

Leaf width exhibited a significant negative association with both jassid and whitefly populations, suggesting that genotypes with comparatively narrower leaves were less preferred by sucking pests. In contrast, leaf area exhibited a significant positive association with jassid incidence ($r = 0.566^{*}$). Genotypes possessing larger leaf areas supported higher pest populations, probably because the increased leaf surface provided more feeding sites and favourable microclimatic conditions characterized by higher humidity and moderate temperature. Such conditions facilitate survival, feeding and multiplication of sucking pests. Similar observations have been reported by Yasmin *et al.* (2021) ^[24].

Plant height, number of leaves and number of branches per plant exhibited comparatively weaker associations with pest incidence. Nevertheless, genotypes with luxuriant vegetative growth tended to harbour comparatively higher populations of sucking pests, probably due to increased tissue succulence and the availability of favourable microhabitats

for feeding and reproduction. Similar observations were reported by Yasmin *et al.* (2021) ^[24].

Biochemical characterization of brinjal genotypes

The biochemical constituents of the brinjal genotypes differed significantly during both vegetative and flowering stages, indicating that biochemical composition plays an important role in determining host suitability and resistance against sucking pests.

Moisture content exhibited a highly significant positive correlation with jassid incidence ($r = 0.830^{**}$) and a significant positive correlation with whitefly population ($r = 0.524^{*}$). Genotypes with higher moisture content supported comparatively greater pest populations. The increased moisture level enhances tissue succulence and facilitates easier penetration of insect stylets and extraction of cell sap. Furthermore, high moisture content improves the nutritional quality and palatability of plant tissues, thereby favouring feeding and multiplication of sucking insects. Similar findings were reported by Balaji and Veeravel (1994) ^[25].

Total soluble sugars and reducing sugars exhibited positive associations with jassid and whitefly populations. Genotypes containing higher amounts of soluble sugars supported comparatively greater pest populations. Sugars constitute readily available sources of energy and play an important role in insect metabolism, growth and reproduction. Higher sugar concentrations enhance host preference and feeding efficiency and therefore favour rapid multiplication of sucking pests. Similar results were obtained by Jat and Pareek (2003) ^[26].

Among all the biochemical constituents, total phenol content exhibited the strongest negative association with sucking pest populations. Correlation analysis revealed highly significant negative relationships between phenol content and jassid ($r = -0.947^{**}$) and whitefly ($r = -0.766^{**}$) populations. Phenolic compounds are known to play an important role in plant defence by acting as feeding deterrents, digestibility reducers and toxic metabolites that adversely affect insect growth and development. Increased phenolic content may also induce antibiosis and reduce host acceptability, thereby lowering pest colonization and multiplication. The present findings are in close conformity with those of Jat and Pareek (2003) ^[26] and Ali *et al.* (2013) ^[27], who reported a negative relationship between phenol content and infestation of sucking pests in brinjal.

Chlorophyll content also exhibited significant associations with pest incidence. Although chlorophyll itself may not directly impart resistance, differences in chlorophyll concentration among the genotypes may reflect differences in physiological vigour and nutritional status, which indirectly influence host preference and pest colonization. Genotypes sustaining lower pest populations generally maintained relatively stable chlorophyll levels, indicating lesser feeding damage and better physiological health. Similar relationships between chlorophyll content and pest infestation have been reported by Balaji and Veeravel (1994) ^[25].

Identification of resistant genotypes

Based on the combined evaluation of pest incidence and associated biophysical and biochemical attributes, genotypes AB 23-06, AB 23-18 and JBL 21-11 were identified as comparatively resistant to major sucking pests. These genotypes were characterized by higher trichome density

and phenolic content coupled with lower moisture and sugar contents. In contrast, susceptible genotypes possessed lower

trichome density and phenol content along with higher moisture and sugar levels.

Table 1: Biophysical parameters of brinjal genotypes associated with resistance against jassids and whiteflies at 60 DAT

Tr. No	Varieties	Number of jassids/leaf	Number of whiteflies /leaf	Biophysical / Morphological characters in brinjal						
				Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Number of leaves/plant	Number of branches/ plant	Trichomes/ cm ² leaf area	Leaf area (cm)
T ₁	AB 23-18	6.05	3.58	65.63 ^a	18.01 ^{abc}	14.20 ^a	174.72 ^{cd}	11.78 ^{bc}	711.90 ^c	156.90 ^b
T ₂	AB 22-12	3.61	4.92	67.25 ^a	15.65 ^{cd}	11.4 ^{abc}	86.28 ^f	5.77 ^{fg}	881.10 ^{ab}	114.47 ^c
T ₃	AB 23-05	3.86	5.18	67.46 ^a	19.33 ^{ab}	11.76 ^{abc}	148.25 ^{de}	5.00 ^g	850.80 ^{ab}	126.27 ^c
T ₄	AB 23-06	3.23	5.48	46.01 ^b	14.06 ^d	9.36 ^{cd}	75.27 ^f	7.92 ^{ef}	919.96 ^a	165.95 ^b
T ₅	JBL 21-11	3.90	3.32	71.97 ^a	21.12 ^a	13.23 ^{ab}	214.22 ^b	10.20 ^{cd}	848.95 ^{ab}	190.66 ^a
T ₆	JBL 23-17	4.31	7.37	71.26 ^a	16.16 ^{bcd}	10.56 ^{bcd}	258.48 ^a	15.23 ^a	803.50 ^{abc}	170.88 ^b
T ₇	NBL 21-06	4.96	4.67	69.32 ^a	20.47 ^a	12.66 ^{ab}	120.28 ^e	13.96 ^{ab}	793.14 ^{abc}	190.64 ^a
T ₈	NBL 24-06	3.63	5.02	51.57 ^b	14.56 ^d	8.03 ^d	68.22 ^f	9.31 ^{de}	852.95 ^{ab}	102.32 ^c
T ₉	GAB 6 (C)	3.35	3.95	45.92 ^b	14.20 ^d	9.56 ^{cd}	81.00 ^f	10.40 ^{cd}	883.73 ^{ab}	107.93 ^c
T ₁₀	Pb. Sadabahar (NC)	5.53	6.07	66.46 ^a	20.20 ^a	11.66 ^{abc}	191.53 ^{bc}	9.76 ^{cde}	766.88 ^{bc}	181.24 ^a
	S. Em. ±	0.26	0.26	0.26	0.96	0.82	8.53	0.69	39.41	6.27
	C. D. at 5%	0.73	0.96	0.96	2.85	2.42	25.34	2.05	117.08	18.63
	C. V. (%)	10.08	9.42	9.42	9.54	11.65	10.39	11.90	8.21	8.91
Correlation coefficient										
	Jassid incidence			0.520	0.068	-0.554*	0.507	0.457	-0.971**	0.566*
	Whitefly incidence			0.443	-0.296	-0.569*	0.548*	0.378	-0.579*	0.134

Notes: 1. DAT- Days after Transplanting, 2. Treatment means with the letter (s) in common are not significantly different as per Dunnett New Multiple Range Test (DNMRT) at 5% level of significance, 3. *Significant at 0.05% level, ** Significant at 0.01% level

Table 2: Biochemical constituents of brinjal genotypes and pest population at vegetative stage (30 DAT)

Genotypes/cultivars	Number of jassids/leaf	Number of whiteflies/leaf	Biochemical constituents					
			Moisture (%)	Total soluble sugars (mg/g)	Total reducing sugars (mg/g)	Total phenols (mg/g)	Total chlorophyll (mg/g)	Non-reducing sugars (mg/g)
AB 23-18	4.96	4.89	93.20 ^a	3.70 ^a	3.44 ^{ab}	1.05 ⁱ	1.17 ^a	1.65 ^a
AB 22-12	2.75	3.78	82.86 ^{def}	2.95 ^d	2.66 ^{def}	2.39 ^c	0.59 ^c	1.34 ^b
AB 23-05	2.94	4.25	88.40 ^{abc}	3.03 ^{cd}	3.04 ^{bcd}	2.16 ^c	0.68 ^{bc}	1.04 ^b
AB 23-06	2.19	2.94	81.62 ^{ef}	1.89 ^g	1.96 ^g	2.96 ^a	0.59 ^c	1.01 ^b
JBL 21-11	3.12	2.15	87.47 ^{bcd}	2.22 ^f	2.81 ^{cdef}	2.19 ^{de}	0.88 ^{abc}	0.44 ^c
JBL 23-17	4.25	4.88	88.53 ^{abc}	3.19 ^{bcd}	3.17 ^{abcd}	1.88 ^f	0.92 ^{abc}	1.01 ^b
NBL 21-06	4.59	3.97	91.53 ^{ab}	3.36 ^{abc}	3.31 ^{abc}	1.53 ^g	0.98 ^{ab}	1.15 ^b
NBL 24-06	2.89	3.12	85.50 ^{cde}	2.56 ^e	2.51 ^{ef}	2.27 ^d	0.69 ^{bc}	0.55 ^c
GAB 6 (C)	3.12	2.14	79.50 ^f	2.40 ^{ef}	2.32 ^{fg}	2.51 ^b	0.92 ^{abc}	1.02 ^b
Pb. Sadabahar (NC)	4.51	4.55	92.16 ^{ab}	3.49 ^{ab}	3.67 ^a	1.21 ^h	0.92 ^{abc}	1.30 ^b
S. Em. ±	0.24	0.26	1.50	0.09	0.09	0.03	0.03	0.03
C. D. at 5%	0.56	0.66	4.43	0.34	0.26	0.31	0.10	0.08
C. V. (%)	9.44	10.56	2.98	5.50	5.45	2.93	7.26	4.97
Correlation coefficient								
	Jassid incidence		0.830**	0.857**	0.861**	-0.947**	0.946**	0.503
	White fly incidence		0.524*	0.726**	0.744**	-0.766**	0.762**	0.551*

Notes: 1. DAT- Days After Transplanting, 2. Treatment means with the letter (s) in common are not significantly different as per DNMRT at 5% level of significance, 3. *Significant at 0.05% level, ** Significant at 0.01% level

Table 3: Biochemical constituents and pest population at flowering stage (60 DAT)

Varieties	Number of jassids/leaf	Number of whiteflies/leaf	Biochemical constituents					
			Moisture (%)	Total soluble sugars (mg/g)	Total reducing sugars (mg/g)	Total phenols (mg/g)	Total chlorophyll (mg/g)	Non-reducing sugars (mg/g)
AB 23-18	6.05	3.58	85.20 ^a	5.09 ^a	2.52 ^a	2.13 ^e	0.83 ^a	1.06 ^{ab}
AB 22-12	3.61	4.92	77.00 ^{cde}	4.01 ^c	1.88 ^{ef}	3.34 ^{abc}	0.49 ^d	1.12 ^{ab}
AB 23-05	3.86	5.18	82.15 ^{abc}	4.08 ^c	2.05 ^{cde}	3.13 ^{bc}	0.51 ^d	0.97 ^{ab}
AB 23-06	3.23	5.48	76.90 ^{de}	2.96 ^d	0.90 ^g	3.75 ^a	0.48 ^d	0.89 ^{ab}
JBL 21-11	3.90	3.32	83.31 ^{ab}	3.25 ^d	1.92 ^{ef}	3.32 ^{abc}	0.55 ^d	0.29 ^d
JBL 23-17	4.31	7.37	81.72 ^{abcd}	4.19 ^c	2.45 ^{ab}	2.77 ^{cd}	0.70 ^c	0.76 ^{bc}
NBL 21-06	4.96	4.67	78.40 ^{bcd}	4.46 ^{bc}	2.28 ^{abc}	2.33 ^{de}	0.74 ^{bc}	1.00 ^{ab}
NBL 24-06	3.63	5.02	83.36 ^{ab}	3.06 ^d	1.99 ^{ef}	3.29 ^{abc}	0.72 ^{bc}	0.47 ^{cd}
GAB 6 (C)	3.35	3.95	73.82 ^e	3.34 ^d	1.64 ^f	3.56 ^{ab}	0.75 ^{bc}	0.74 ^{bc}
Pb. Sadabahar (NC)	5.53	6.07	81.62 ^{abcd}	4.97 ^{ab}	2.26 ^{abc}	2.16 ^e	0.78 ^{ab}	1.23 ^a
S. Em.	0.24	0.26	1.69	0.11	0.09	0.10	0.06	0.02
C. D. at 5%	0.73	1.69	4.43	0.34	0.26	0.31	0.10	0.08
C. V. (%)	10.08	9.42	3.56	5.11	5.59	6.28	6.18	4.6
Correlation coefficient								
	Jassid incidence		0.546*	0.838**	0.568*	-0.969**	0.914**	0.489
	White fly incidence		0.384	0.841**	0.473	-0.596*	0.716**	0.393

Notes: 1. DAT- Days after Transplanting, 2. Treatment means with the letter (s) in common are not significantly different as per DNMR at 5% level of significance, 3. *Significant at 0.05% level, ** Significant at 0.01% level

Conclusion

The present investigation revealed considerable variability among the evaluated brinjal genotypes with respect to their response to major sucking pests and associated biophysical and biochemical characteristics. Higher trichome density and total phenol content were significantly and negatively associated with the incidence of jassid and whitefly, indicating their important role in imparting resistance. Conversely, increased moisture content and soluble sugars favoured pest infestation and multiplication. Based on the combined assessment of pest incidence and resistance-associated traits, genotypes AB 23-06, AB 23-18 and JBL 21-11 were identified as comparatively resistant and may serve as potential donor parents in resistance breeding programmes. The study demonstrated that trichome density and phenol content can be utilized as reliable selection markers for developing high-yielding and sucking pest-resistant brinjal cultivars, thereby contributing to sustainable pest management and reducing dependence on chemical insecticides.

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