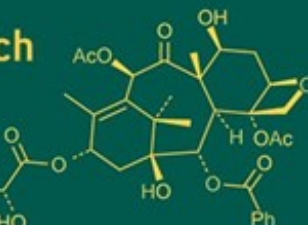
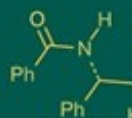
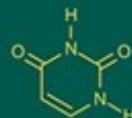
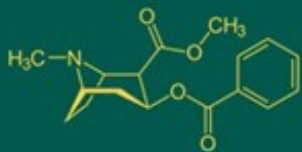


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
Indexing: Embase
IJABR 2026; SP-10(10): 635-641
www.biochemjournal.com
Received: 09-08-2026
Accepted: 25-09-2026
Published: 08-10-2026

The names and affiliations of all authors are provided below, following the references.

Evaluating direct and indirect pathways of essential yield-attributing traits for crop improvement in brinjal (*Solanum melongena* L.)

Diksha Sangh Mitra¹, Sanjay Kumar², GC Yadav³, Dinesh Kumar Meena⁴, Sunil Kumar Rawat⁵, Ratan Kumar Pal⁶, Shubham Patel⁷

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i10Sh.10354>

ABSTRACT

This study was conducted at the Horticulture Research Farm-I, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, India, during two consecutive Rabi seasons (2024–25 and 2025–26) to evaluate the genotypic and phenotypic correlation coefficients for 51 genotypes, comprising 12 lines, 3 testers, and 36 F1 hybrids, among eighteen quantitative, phenological, and biochemical traits in brinjal (*Solanum melongena* L.) across individual years (Y1 and Y2) and pooled. Both phenotypic and pooled genotypic path coefficient analyses demonstrated that reducing sugar (0.5921 phenotypic / 0.6926 genotypic), plant height (0.5299 / 0.6422), number of fruits per cluster (0.4329 / 0.4860), average fruit weight (0.3362 / 0.3033), and fruit polar length (0.3104 / 0.3731) exerted substantial positive direct effects on total yield per plant. Days to 50% flowering (0.3010) also contributed significantly at the genotypic level. Furthermore, reducing sugar, plant height, and number of fruits per cluster functioned as primary indirect pathways mediating the positive influence of other morphological and biochemical traits on productivity. Consequently, direct selection targeting these key attributes should be prioritized in brinjal breeding programs to effectively develop high-yielding genotypes.

Keywords: *Solanum melongena*, Genotypic, Phenotypic, Path coefficient analysis, Direct selection, Total yield per plant

Introduction

Brinjal (*Solanum melongena* L.) is a major solanaceous vegetable crop ($2n = 2x = 24$) widely cultivated across tropical and subtropical regions owing to its high yield potential, wide adaptability, and diverse fruit forms, sizes, and color profiles making it a staple dietary crop for resource-poor and rural populations hence, referred as "poor man's crop" (Kumar *et al.*, 2023) [1]. Cultivated since ancient times, its primary center of origin and diversity is India (Thompson *et al.*, 1957; Vavilov, 1926) [2, 3]. In Indian horticulture, it remains an indispensable indigenous vegetable, rich in dietary fiber, minerals, and antioxidants. Current estimates indicate that India produces over 12.99 million metric tonnes annually from 683.1 thousand hectares (Anonymous 2023-24) [4]. Structurally, brinjal possesses hermaphrodite, actinomorphic flowers exhibiting heterostyly (Kowalska, 2006) [5] and a bicarpellary, syncarpous, hypogynous ovary with basal placentation. Although predominantly self-pollinated, natural cross-pollination of 6–10% occurs via insect vectors like bees, ants, and thrips (Mal *et al.* 2022) [6].

Brinjal (eggplant) is widely grown across India, particularly in Odisha, West Bengal, Bihar, Uttar Pradesh, Madhya Pradesh, Gujarat, Maharashtra, Karnataka, and Andhra Pradesh, though it struggles at high altitudes. The plant requires a long, warm growing season, with the primary harvest occurring during the autumn and winter months. Ideal growth occurs between 25 °C and 30 °C, while temperatures below 15 °C significantly hinder development. For optimal seed germination, 25 °C is ideal—though germination can occur between 15 °C and 30 °C—and seedlings transplant best at temperatures around 20 °C. (Swarup, 2014) [7]

To meet escalating market demands, maximizing unit-area yield and enhancing fruit quality remain key priorities for plant breeders. However, because total yield per plant is a complex polygenic trait influenced heavily by the environment, direct selection for yield alone is often inefficient. In this context, path coefficient analysis serves as a vital biometrical tool by partitioning simple correlation coefficients into direct and indirect effects. By identifying key yield-contributing morphological and biochemical components such as fruit weight, fruits per plant, plant height, and fruit length, path analysis enables breeders to formulate effective, trait-specific direct selection strategies to accelerate the development of high-yielding brinjal genotypes.

Corresponding Author:

Sanjay Kumar

Senior Professor,
Department of
Horticulture, School of
Agricultural Sciences and
Technology, Babasaheb
Bhimrao Ambedkar
University (A Central
University), Lucknow, (U.P.)
India

2. Materials and Methods

The study was conducted at the Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar Pradesh, India, during the *Rabi* season. Path coefficient analysis was performed using pooled data from two consecutive years (2024–25 and 2025–26) to identify important yield-contributing traits in brinjal. Geographically, the experimental site falls under a humid, subtropical climate and is located between 24.47° and 26.56° N latitude and 82.12° and 83.98° E longitude at an altitude of 113m above mean sea level in the Gangetic Alluvial Plains of Eastern Uttar Pradesh. The soil type of the experimental site was sandy loam with an average fertility level and pH in the range of 7.5–8.5. The field of the experimental site represented an ideal spatial unit in respect of texture, makeup, and fertility status. The row-to-row spacing was 75 cm, and the plant-to-plant spacing was 60 cm. Each experimental plot consisted of two rows, each 3 m long. The experiment was laid out in a Randomized Block Design (RBD) with three replications for each treatment to identify the prominent quantitative traits correlated with enhanced fruit yield in brinjal. To support optimal crop growth and development, the recommended intercultural practices and doses of fertilizers (RDF) were applied.

Path-coefficient analysis was carried out according to Dewey and Lu (1959) [8]. Total fruit yield was assumed to be the dependent variable (effect) which was influenced by the 17 independent morphological and biochemical characters. The variation in fruit yield unexplained by the 17 characters was assumed to be contributed by a residual factor (*X*). The path coefficient was calculated using the following formula:

$$r_{iy} = P_{iy} + \sum_{j \neq i}^{17} r_{ij} P_{jy} \text{ for } i, j = 1, 2, \dots, 17.$$

Where,

r_{iy} = Genotypic/phenotypic correlation coefficient between the i^{th} character and total fruit yield per plant (*Y*).

P_{iy} = Direct effect of the i^{th} character on total fruit yield per plant (*Y*).

r_{ij} = Inter-correlation coefficient between the i^{th} and j^{th} independent characters.

P_{jy} = Direct effect of the j^{th} character on total fruit yield per plant (*Y*). The above equation can be written in the form of a matrix.

$$[A] \ 17 \times 1 = [B] \ 17 \times 17 \times [C] \ 17 \times 1$$

Where,

[*A*] is the 17x1 column vector of correlation coefficients between independent traits and yield (r_{iy})

[*B*] is the 17x17 matrix of inter-correlation coefficients among the 17 independent traits (r_{ij}), and

[*C*] is the 17x1 column vector of direct effects (P_{iy})

The **Residual Factor** was calculated as follows:

$$P_{xy} = \sqrt{1 - R^2}$$

Where,

$$R^2 = \sum_{i=1}^{17} P_{iy} r_{iy}$$

In the above equations:

P_{xy} = Path coefficient of the residual variation (residual effect).

R^2 = Coefficient of determination.

P_{iy} = Direct effect of the i^{th} independent character on total fruit yield per plant (*Y*), where $i = 1, 2, \dots, 17$.

r_{iy} = Correlation coefficient between the i^{th} independent character and total fruit yield per plant (*Y*).

r_{ij} = Inter-correlation coefficient between any two independent characters (i and j), covering all possible trait combinations ($r_{1,2}$ to $r_{16,17}$).

Parameters recorded

There were eighteen parameters recorded for the given experiment. They are depicted below: days to 50% flowering, plant height (cm), primary branches per plant, fruit polar length (cm), fruit equatorial circumference (cm), number of fruits per plant, days to first fruit harvest, average fruit weight (g), length of calyx (cm), length of pedicel (cm), number of fruits per cluster, total soluble solids (TSS) (°B), ascorbic acid content (mg/100g), reducing sugar (%), non-reducing sugar (%), total sugar (%), dry matter content (%), and fruit yield per plant (kg). The data recorded were analysed by analysis of variance (Panse *et al.*, 1978) [9]. The path coefficients were calculated using the approach proposed by Wright (1921) [10] and refined by Dewey and Lu (1959) [8].

Table 1. List of the genotypes and F₁ hybrids included in the experiment

S.No	Notations	Genotypes
Lines		
1	L1	Pusa Kranti
2	L2	Arka Nidhi
3	L3	Kashi Taru
4	L4	Kashi Prakash
5	L5	NDB-3
6	L6	Pant Rituraj
7	L7	Pusa Purple Long
8	L8	Pant Samrat
9	L9	Punjab Barsati
10	L10	Pusa Purple Cluster
11	L11	NDB Sel 16-1
12	L12	NDB-25
Testers		
1	T1	Punjab Sadabahar ©
2	T2	BRVAR-9
3	T3	NDB-2
F₁ Hybrids		
1	L1 X T1	Pusa Kranti x Punjab Sadabahar
2	L1 X T2	Pusa Kranti x BRVAR-9
3	L1 X T3	Pusa Kranti x NDB-2
4	L2 X T1	Arka Nidhi x Punjab Sadabahar
5	L2 X T2	Arka Nidhi x BRVAR-9

(continued on next page)

S.No	Notations	Genotypes
6	L2 X T3	Arka Nidhi x NDB-2
7	L3 X T1	Kashi Taru x Punjab Sadabahar
8	L3 X T2	Kashi Taru x BRVAR-9
9	L3 X T3	Kashi Taru x NDB-2
10	L4 X T1	Kashi Prakash x Punjab Sadabahar
11	L4 X T2	Kashi Prakash x BRVAR-9
12	L4 X T3	Kashi Prakash x NDB-2
13	L5 X T1	NDB-3 x Punjab Sadabahar
14	L5 X T2	NDB-3 x BRVAR-9
15	L5 X T3	NDB-3 x NDB-2
16	L6 X T1	Pant Rituraj x Punjab Sadabahar
17	L6 X T2	Pant Rituraj x BRVAR-9
18	L6 X T3	Pant Rituraj x NDB-2
19	L7 X T1	Pusa Purple Long x Punjab Sadabahar
2	L7 X T2	Pusa Purple Long x BRVAR-9
21	L7 X T3	Pusa Purple Long x NDB-2
22	L8 X T1	Pant Samrat x Punjab Sadabahar
23	L8 X T2	Pant Samrat x BRVAR-9
24	L8 X T3	Pant Samrat x NDB-2
25	L9 X T1	Punjab Barsati x Punjab Sadabahar
26	L9 X T2	Punjab Barsati x BRVAR-9
27	L9 X T3	Punjab Barsati x NDB-2
28	L10 X T1	Pusa Purple Cluster x Punjab Sadabahar
29	L10 X T2	Pusa Purple Cluster x BRVAR-9
30	L10 X T3	Pusa Purple Cluster x NDB-2
31	L11 X T1	NDB Sel 16-1 x Punjab Sadabahar
32	L11 X T2	NDB Sel 16-1 x BRVAR-9
33	L11 X T3	NDB Sel 16-1 x NDB-2
34	L12 X T1	NDB-25 x Punjab Sadabahar
35	L12 X T2	NDB-25 x BRVAR-9
36	L12 X T3	NDB-25 x NDB-2

3. Results and Discussion

Yield is a complex, quantitative trait strongly shaped by environmental conditions, making direct selection for yield inefficient in crop breeding. While simple correlation analysis measures the strength and direction of linear relationships between yield and its component traits, it fails to reveal cause-and-effect mechanisms or quantify the relative importance of individual direct and indirect contributions (Jakhwal *et al.*, 2024) [11]. Path coefficient analysis (Wright 1921; Dewey and Lu 1959) [8, 10] addresses this limitation by partitioning total correlation coefficients into direct and indirect effects. By untangling these cause-and-effect relationships, path analysis identifies key driving traits, allowing plant breeders to establish precise selection criteria and accelerate genetic gain.

Genotypic path coefficient analysis

The genotypic path coefficient analysis was performed using pooled data over both years, with total yield per plant as the dependent variable, to evaluate the direct and indirect influences of component characters across environments. Table 2 showed that reducing sugar had the strongest positive direct effect (0.6926) on total yield per plant. Other traits exhibiting positive direct contributions included plant height (0.6422), number of fruits per cluster (0.4860), fruit polar length (0.3731), average fruit weight (0.3033), days to 50% flowering (0.3010), length of calyx (0.2426), non-reducing sugar (0.0995), primary branches per plant (0.0351), and fruit equatorial length/circumference (0.0110). These observations indicate that direct selection for these characters—particularly reducing sugar, plant height, number of fruits per cluster, fruit polar length, average fruit

weight, and days to 50% flowering—will be highly effective in achieving consistent genetic gains for total yield per plant.

In contrast, the strongest negative direct effect on total yield per plant was recorded for total sugar (-0.6721), followed by dry matter content (-0.4288), total soluble solids (-0.3577), days to first fruit harvest (-0.2920), length of pedicel (-0.1775), ascorbic acid (-0.0839), and number of fruits per plant (-0.0632). These traits contributed adversely to yield through their direct pathways in the pooled evaluation. These results are in agreement with the findings of Bansal *et al.* (2008) [12], Singh *et al.* (2011) [13], Singh *et al.* (2017) [14], Singh *et al.* (2020) [15], Kumar *et al.* (2021) [16], Sakariya *et al.*, 2022) [17], Kumar *et al.* (2023) [18], and Rathod *et al.*, 2023) [19].

Reducing sugar served as a paramount positive indirect pathway for multiple characters. High positive indirect effects on total yield per plant were expressed through reducing sugar by total sugar (0.6755), length of pedicel (0.2670), primary branches per plant (0.2402), fruit equatorial circumference (0.2175), number of fruits per plant (0.2091), fruit polar length (0.2016), plant height (0.1943), ascorbic acid (0.1743), and total soluble solids (0.1321). Additionally, plant height acted as a major positive indirect contributor to average fruit weight (0.3122), total soluble solids (0.3150), fruit equatorial circumference (0.2822), length of pedicel (0.2778), ascorbic acid (0.2068), total sugar (0.1958), primary branches per plant (0.1911), reducing sugar (0.1801), and fruit polar length (0.1716). Furthermore, number of fruits per cluster mediated substantial positive indirect contributions to number of fruits per plant (0.3043), dry matter content (0.2558), fruit polar length (0.1970), primary branches per plant (0.1558), total soluble solids (0.1299), length of calyx (0.1260), and length of pedicel (0.1218).

In contrast, marked negative indirect effects on total yield per plant were registered through total sugar by length of pedicel (-0.3055), fruit equatorial circumference (-0.2456), fruit polar length (-0.2442), number of fruits per plant (-0.2389), primary branches per plant (-0.2350), ascorbic acid (-0.2067), and plant height (-0.2049). Additionally, dry matter content exerted adverse indirect effects through number of fruits per cluster (-0.2257), number of fruits per plant (-0.2163), and fruit polar length (-0.1480). The total soluble solids (TSS) contributed negatively through average fruit weight (-0.2192) and plant height (-0.1755). Negative indirect influences were also mediated through days to first fruit harvest by number of fruits per cluster (-0.2568), fruit polar length (-0.2543), and days to 50% flowering (-0.2313).

2. Phenotypic path coefficient analysis

The phenotypic path coefficient analysis was performed using pooled data over both years, with total yield per plant as the dependent variable, to determine the direct and indirect influence of component traits across environments at the phenotypic level. **Table 3** showed that reducing sugar had the strongest positive direct effect (0.5921) on total yield per plant. Other traits exhibiting positive direct contributions included plant height (0.5299), number of fruits per cluster (0.4329), average fruit weight (0.3362), fruit polar length (0.3104), length of calyx (0.1602), days to 50% flowering (0.1575), non-reducing sugar (0.0977), and primary branches per plant (0.0864). These findings indicate that direct selection for these characters, particularly reducing sugar, plant height, number of fruits per cluster, average fruit weight, and fruit polar length, will be highly effective for phenotypic yield improvement.

Inverse to this, the strongest negative direct effect on total yield per plant was recorded for total sugar (-0.5452), followed by dry matter content (-0.3357), total soluble solids (-0.2506), length of pedicel (-0.1786), days to first fruit harvest (-0.1498), number of fruits per plant (-0.0329), fruit equatorial length/circumference (-0.0306), and ascorbic acid (-0.0006). These traits contributed adversely to yield through their direct pathways in the pooled evaluation. Similar results have been reported by *Maurya et al. (2026)* [20].

Reducing sugar served as a major positive indirect conduit for multiple characters. Substantial positive indirect effects on total yield per plant were expressed through reducing sugar by total sugar (0.5706), length of pedicel (0.2215), primary branches per plant (0.1995), fruit equatorial circumference (0.1776), number of fruits per plant (0.1779), fruit polar length (0.1691), plant height (0.1550), and ascorbic acid (0.1407). Furthermore, plant height acted as a prominent positive indirect contributor to total soluble solids (0.2432), average fruit weight (0.2410), length of pedicel (0.2192), fruit equatorial circumference (0.2134), total sugar (0.1559), ascorbic acid (0.1424), reduc-

ing sugar (0.1387), primary branches per plant (0.1358), and fruit polar length (0.1339). Additional positive indirect contributions were mediated through number of fruits per cluster by number of fruits per plant (0.2668), dry matter content (0.2234), fruit polar length (0.1738), primary branches per plant (0.1355), and length of calyx (0.1086), as well as through average fruit weight by total soluble solids (0.2024), fruit equatorial circumference (0.1730), length of calyx (0.1695), non-reducing sugar (0.1590), and plant height (0.1529). On the other hand, marked negative indirect effects on total yield per plant were registered through total sugar (TS) by length of pedicel (-0.2391), fruit polar length (-0.1937), fruit equatorial circumference (-0.1916), number of fruits per plant (-0.1911), primary branches per plant (-0.1818), plant height (-0.1604), ascorbic acid (-0.1530), and average fruit weight (-0.1508). Negative indirect influences were also mediated through days to first fruit harvest by number of fruits per cluster (-0.2184), fruit polar length (-0.1999), and days to 50% flowering (-0.1116). Additionally, dry matter content exerted adverse indirect contributions through number of fruits per cluster (-0.1733), number of fruits per plant (-0.1632), and fruit polar length (-0.1155), while total soluble solids (TSS) contributed negatively through average fruit weight (-0.1509) and plant height (-0.1151). The results are in confirmation with the findings of *Yadav et al. (2018)* [21], *Chithra et al. (2020)* [22], *Gangadhara et al. (2023)* [18], and *Jakhwal et al. (2024)* [11].

4. Conclusion

The phenotypic and genotypic path coefficient analyses highlighted the primary role of reducing sugar, plant height, number of fruits per cluster, average fruit weight, and fruit polar length as key drivers of total fruit yield per plant in brinjal. Furthermore, reducing sugar, plant height, and fruits per cluster emerged as major indirect pathways through which associated morphological and biochemical attributes contribute to overall productivity. Therefore, an integrated selection strategy focusing simultaneously on these essential traits provides a highly effective and reliable approach for accelerating genetic gain and developing high-yielding brinjal cultivars in future breeding programs.

Acknowledgement

The authors gratefully acknowledge the Professors of the Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, UP, for sharing their pearls of wisdom with us during the course of this research and for providing insight and expertise that greatly assisted the research. We would also like to show our gratitude to the IIVR, Varanasi, U.P., for providing the research material for the research work.

Competing interests

The authors have declared that no competing interests exist.

Table 2. Direct and indirect effects of seventeen characters on total yield per plant (kg) at genotypic level in brinjal-pooled

CHRS	D50F	PH	NPB	FPL	FEC	NFP	DFFH	AFW	LC	LP	NFPC	TSS	RS	NRS	TS	AC
D50F	0.3010	0.0027	-0.0112	-0.2491	-0.0018	0.0287	-0.2313	-0.0741	-0.0988	0.0250	-0.1573	-0.0300	-0.0416	-0.0253	0.0806	-0.017
PH	0.0013	0.6422	0.0104	0.0997	0.0048	-0.0085	0.0213	0.1474	0.0502	-0.0768	-0.0040	-0.1755	0.1943	0.0157	-0.2049	-0.02
NPB	-0.0960	0.1911	0.0351	0.1635	0.0023	-0.0191	0.1070	0.0426	0.0212	-0.0841	0.1558	-0.0168	0.2402	0.0058	-0.2350	-0.01
FPL	-0.2010	0.1716	0.0154	0.3731	0.0035	-0.0457	0.1990	0.0719	0.0596	-0.0670	0.1970	-0.0352	0.2016	0.0342	-0.2442	-0.03
FEC	-0.0500	0.2822	0.0073	0.1187	0.0110	-0.0161	0.0111	0.1610	0.0617	-0.0461	-0.0134	-0.0987	0.2175	0.0264	-0.2456	-0.04
NFP	-0.1369	0.0868	0.0106	0.2701	0.0028	-0.0632	0.1642	0.0420	0.0340	-0.0504	0.3043	-0.0144	0.2091	0.0261	-0.2389	-0.02
DFFH	0.2384	-0.0469	-0.0129	-0.2543	-0.0004	0.0355	-0.2920	-0.0886	-0.0647	0.0432	-0.2568	0.0497	-0.1471	-0.0393	0.2013	-0.01
AFW	-0.0735	0.3122	0.0049	0.0885	0.0058	-0.0088	0.0853	0.3033	0.1262	-0.0597	0.0710	-0.2192	0.1179	0.0483	-0.1876	-0.02
LC	-0.1226	0.1329	0.0031	0.0916	0.0028	-0.0089	0.0779	0.1577	0.2426	-0.0090	0.1260	-0.1524	0.0613	0.0154	-0.0837	-0.01
LP	-0.0424	0.2778	0.0166	0.1408	0.0029	-0.0179	0.0711	0.1020	0.0123	-0.1775	0.1218	-0.0906	0.2670	0.0343	-0.3055	-0.03
NFPC	-0.0974	-0.0052	0.0113	0.1512	-0.0003	-0.0395	0.1543	0.0443	0.0629	-0.0445	0.4860	-0.0956	0.0752	0.0226	-0.1072	-0.00
TSS	0.0253	0.3150	0.0016	0.0367	0.0030	-0.0025	0.0405	0.1859	0.1033	-0.0450	0.1299	-0.3577	0.1321	0.0322	-0.1775	-0.02
RS	-0.0181	0.1801	0.0122	0.1086	0.0035	-0.0191	0.0620	0.0516	0.0215	-0.0684	0.0528	-0.0682	0.6926	0.0026	-0.6555	-0.02
NRS	-0.0766	0.1013	0.0021	0.1283	0.0029	-0.0166	0.1152	0.1471	0.0374	-0.0612	0.1103	-0.1159	0.0184	0.0995	-0.1795	-0.02
TS	-0.0361	0.1958	0.0123	0.1355	0.0040	-0.0225	0.0875	0.0847	0.0302	-0.0807	0.0775	-0.0945	0.6755	0.0266	-0.6721	-0.02
AC	-0.0642	0.2068	0.0047	0.1619	0.0054	-0.0158	0.0517	0.0961	0.0576	-0.0680	0.0230	-0.0896	0.1743	0.0256	-0.2067	-0.08
DMC	-0.0788	0.0724	0.0100	0.1288	0.0005	-0.0319	0.0890	0.0067	0.0643	-0.0099	0.2558	-0.0024	0.0162	-0.0152	0.0082	-0.01

Residual effect = 0.177; *, ** significant at 5% and 1% levels, respectively

Abbreviations

D50F: Days to 50% flowering	FEC: Fruit equatorial circumference (cm)	LC: Length of calyx (cm)	RS: Reducing sugar (%)	DMC: Dry matter content (%)
PH: Plant height (cm)		LP: Length of pedicel (cm)	NRS: Non-reducing sugar (%)	TYP: Total yield/plant (kg)
NFP: No. of fruits per plant				
NPB: Primary branches per plant	DFFH: Days to first fruit harvest	NFPC: No. of fruits per cluster	TS: Total sugars (%)	
FPL: Fruit polar length (cm)	AFW: Average fruit weight (g)	TSS: Total soluble solids (°B)	AC: Ascorbic acid (mg/100g)	

(continued on next page)

Table 3. Direct and indirect effects of seventeen characters on total yield per plant (kg) at phenotypic level in brinjal-pooled

CHRS	D50F	PH	NPB	FPL	FEC	NFP	DFFH	AFW	LC	LP	NFPC	TSS	RS	NRS	TS	AC
D50F	0.1575	0.0073	-0.0263	-0.1998	0.0049	0.0146	-0.1116	-0.0807	-0.0626	0.0234	-0.1393	-0.0203	-0.0347	-0.0243	0.0625	0.0000
PH	0.0022	0.5299	0.0221	0.0784	-0.0123	-0.0039	0.0100	0.1529	0.0297	-0.0739	-0.0071	-0.1151	0.1550	0.0142	-0.1604	0.0000
NPB	-0.0479	0.1358	0.0864	0.1291	-0.0059	-0.0096	0.0492	0.0462	0.0141	-0.0789	0.1355	-0.0106	0.1995	0.0050	-0.1818	0.0000
FPL	-0.1014	0.1339	0.0359	0.3104	-0.0090	-0.0231	0.0964	0.0769	0.0387	-0.0636	0.1738	-0.0247	0.1691	0.0328	-0.1937	0.0000
FEC	-0.0253	0.2134	0.0167	0.0913	-0.0306	-0.0081	0.0037	0.1730	0.0383	-0.0440	-0.0140	-0.0655	0.1776	0.0246	-0.1916	0.0000
NFP	-0.0697	0.0625	0.0252	0.2179	-0.0075	-0.0329	0.0813	0.0463	0.0225	-0.0490	0.2668	-0.0097	0.1779	0.0252	-0.1911	0.0000
DFFH	0.1173	-0.0353	-0.0284	-0.1999	0.0008	0.0179	-0.1498	-0.0935	-0.0411	0.0386	-0.2184	0.0341	-0.1215	-0.0369	0.1563	0.0000
AFW	-0.0378	0.2410	0.0119	0.0710	-0.0158	-0.0045	0.0417	0.3362	0.0807	-0.0578	0.0624	-0.1509	0.0999	0.0462	-0.1508	0.0000
LC	-0.0615	0.0983	0.0076	0.0750	-0.0073	-0.0046	0.0385	0.1695	0.1602	-0.0071	0.1086	-0.1044	0.0513	0.0150	-0.0650	0.0000
LP	-0.0206	0.2192	0.0382	0.1105	-0.0075	-0.0090	0.0324	0.1088	0.0063	-0.1786	0.1033	-0.0604	0.2215	0.0323	-0.2391	0.0000
NFPC	-0.0507	-0.0087	0.0270	0.1246	0.0010	-0.0203	0.0756	0.0484	0.0402	-0.0426	0.4329	-0.0663	0.0642	0.0219	-0.0860	0.0000
TSS	0.0127	0.2432	0.0037	0.0306	-0.0080	-0.0013	0.0204	0.2024	0.0668	-0.0430	0.1145	-0.2506	0.1118	0.0314	-0.1380	0.0000
RS	-0.0092	0.1387	0.0291	0.0886	-0.0092	-0.0099	0.0307	0.0567	0.0139	-0.0668	0.0469	-0.0473	0.5921	0.0028	-0.5254	0.0000
NRS	-0.0391	0.0772	0.0044	0.1044	-0.0077	-0.0085	0.0565	0.1590	0.0246	-0.0592	0.0971	-0.0806	0.0170	0.0977	-0.1400	0.0000
TS	-0.0181	0.1559	0.0288	0.1103	-0.0108	-0.0115	0.0429	0.0930	0.0191	-0.0783	0.0683	-0.0634	0.5706	0.0251	-0.5452	0.0000
AC	-0.0299	0.1424	0.0114	0.1306	-0.0124	-0.0074	0.0220	0.0955	0.0349	-0.0599	0.0292	-0.0577	0.1407	0.0235	-0.1530	0.0000
DMC	-0.0394	0.0518	0.0236	0.1068	-0.0008	-0.0160	0.0423	0.0069	0.0414	-0.0090	0.2234	-0.0025	0.0146	-0.0141	0.0068	0.0000

Residual effect = 0.258; *, ** significant at 5% and 1% levels, respectively

Abbreviations

D50F: Days to 50% flowering	FEC: Fruit equatorial circumference (cm)	LC: Length of calyx (cm)	RS: Reducing sugar (%)	DMC: Dry matter content (%)
PH: Plant height (cm)		LP: Length of pedicel (cm)	NRS: Non-reducing sugar (%)	TYP: Total yield/plant (kg)
NFP: No. of fruits per plant				
NPB: Primary branches per plant	DFFH: Days to first fruit harvest	NFPC: No. of fruits per cluster	TS: Total sugars (%)	
FPL: Fruit polar length (cm)	AFW: Average fruit weight (g)	TSS: Total soluble solids (°B)	AC: Ascorbic acid (mg/100g)	

References

- Kumar S, Yadav G, Prajapati J, Kumar L, Yadav L. Estimation of Genetic Variability and Response to Selection in Brinjal (*Solanum melongena* L.). 2023;15:211-214.
- Thompson HC, Kelly WC. Vegetable crops. New York: McGraw Hill Book Co. Inc. 1957.
- Vavilov NI. Studies on the origin of cultivated plants. Bull. Appl. Bot. Pl. Breed. 1926;16:139-248.
- Anonymous. Horticultural Statistics at a Glance 2024: State-wise and Crop-wise Production & Productivity Data. Horticulture Statistics Unit, Economics, Statistics & Evaluation Division, Department of Agriculture & Farmers Welfare, Government of India, New Delhi; 2023-24.
- Kowalska G. Eggplant (*Solanum melongena* L.) flowering and fruiting dynamics depending on pistil type as well as way of pollination and flower harmonization. Folia Hort. 2006;18(1):17-29.
- Mall D, Gandhi A, Gharde SK. Heterostyly in Brinjal. Indian Farmer. 2022;9(06):255-258.
- Swarup V. Vegetable science and technology in India. Kalyani Publisher. 2014;332.
- Dewey DR, Lu KN. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron. J. 1959;51:515-518.
- Panse VG, Sukhatme PV. Statistical methods for agricultural workers. New Delhi: ICAR; 1978. Pp. 97-151.
- Wright. Correlation and Causation. Journal of Agricultural Research. 1921;20:557-585.
- Jakhwal R, Kumar V, Kapoor N, Prakash S, Gupta S, Singh G. Identification of Key Traits for Yield Improvement in Brinjal through Correlation and Path Coefficient Analysis. Journal of Advances in Biology & Biotechnology. 2024;27(10):240-250.
- Bansal S, Mehta AK. Genotypic correlation and path analysis in brinjal (*Solanum melongena* L.). Natnl. J Plant Improv. 2008;10:34-36.
- Singh AK, Tripathi MK, Rai VK, Mishra R. Character association and path coefficient analysis in brinjal (*Solanum melongena* L.). Environ & Ecol. 2011;29:1201-1203.
- Singh N, Singh DK, Pandey P, Panchbhayia A, Rawat M. Correlation and Path Coefficient Studies in Okra (*Abelmoschus esculentus* (L.) Moench). Int. J. Curr. Microbiol. App. Sci. 2017;6(7):1096-1101.
- Singh SA, Sharma DH, Dogra KR, Aditika, Ujjawal V. Correlation and path coefficient analysis for yield and yield contributing traits in brinjal (*Solanum melongena* L.). International Journal of Current Microbiology and Applied Sciences. 2020;Spl 11:1770-1777.
- Kumar RD, Priya RS, Savitha BK, Ravikesavan R, Muthukrishnan N. Correlation and path analysis studies on yield and yield components in brinjal (*Solanum melongena* L.). Electronic Journal of Plant Breeding. 2021;12(1):249-252.

17. Sakariya SG, Vaddoria MA, Gohil PP, Babreya KK, Gamit GC. Path analysis studies in brinjal (*Solanum melongena* L.). Pharmaceutical Innovation Journal. 2022;11(4):953-955.
18. Gangadhara K, Abraham M, Verma AK, Ashvathama VH, Kumar R, Yadav V. Correlation and path analysis for growth, yield, quality and incidence of shoot and fruit borer in brinjal (*Solanum melongena* L.). International Journal of Environment and Climate Change. 2023;13(10):2204-2210.
19. Rathod D, Tandel T, Sarkar M, Ahlawat TR, Patel AI, Vashi JM, Bambharolia RP, Varshney N, Emmi S, Chaudhari BN. Study on correlation and path analysis in brinjal (*Solanum melongena* L.). The Pharma Innovation Journal. 2023;12(12):3328-3330.
20. Maurya HK, Lata R, Yadav GC, Singh H, Meena ML, Sundar S. Determination of Important Yield-Attributing Traits in Tomato (*Solanum lycopersicum* L.) through Path Coefficient Analysis. Journal of Advances in Biology & Biotechnology. 2026;29(6):823-832.
21. Yadav S, Singh VB, Maurya R, Thapliyal V. Correlation and path coefficient analysis in brinjal (*Solanum melongena* L.). International Journal of Current Microbiology and Applied Sciences. 2018;7(11):3182-3190.
22. Chithra K, Srinivasa V, Varalakshmi B, Kolakar SS, Asha AB. Correlation and path analysis in segregating population of brinjal (*Solanum melongena* L.). Journal of Pharmacognosy and Phytochemistry. 2020;9(5):2457-2459.

How to cite this article: Mitra DS, Kumar S, Yadav G, Kumar Meena D, Kumar Rawat S, Kumar Pal R, et al. Evaluating direct and indirect pathways of essential yield-attributing traits for crop improvement in brinjal (*Solanum melongena* L.). *International Journal of Advanced Biochemistry Research*. 2026;SP-10(10):635-641. doi: <https://www.doi.org/10.33545/26174693.2026.v10.i10Sh.10354>

Authors

Diksha Singh Mitra

Research Scholar, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, (U.P.) India

Sanjay Kumar

Senior Professor, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, (U.P.) India

GC Yadav

Professor, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, (U.P.) India

Dinesh Kumar Meena

Research Scholar, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, (U.P.) India

Sunil Kumar Rawat

Research Scholar, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, (U.P.) India

Ratan Kumar Pal

Research Scholar, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, (U.P.) India

Shubham Patel

Research Scholar, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, (U.P.) India