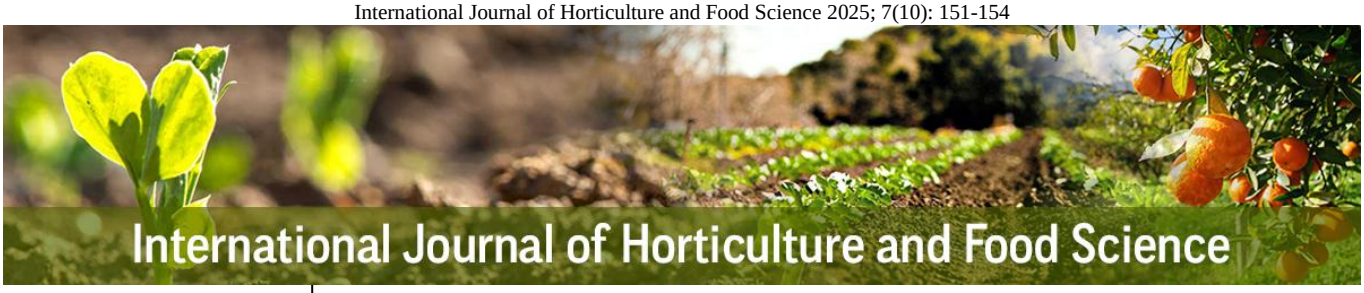

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Effect of NAA levels on growth, yield and quality of different brinjal (*Solanum melongena* L.) varieties

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Abstract
A field experiment was carried out at Agricultural Research Farm, School of Agricultural Sciences, Jaipur National University, Jaipur, Rajasthan during *kharif*, 2025on sandy loamy soil. The study employed a Factorial Randomized Block Design, replicated thrice, with twelve treatments four NAA levels (control, 30, 50, and 70 ppm) and three brinjal varieties (Pusa Purple Round, Pusa Kranti, Hybrid Mahy-Kalpataru). Results demonstrated that foliar application of NAA at 50 ppm significantly enhanced growth and yield attributes, including maximum plant height (69.41 cm), number of branches (16.04), fruit number per plant (16.63), fruit length (17.74 cm), fruit diameter (7.37 cm), average fruit weight (101.26 g), fruit yield (51.46 t/ha), and B:C ratio (4.32). Hybrid Mahy-Kalpataru emerged as the best performing variety, with maximum fruit yield (49.98 t/ha), gross return (₹8,49,740/ha), net return (₹6,84,977/ha), and B:C ratio (4.16). The combination of Hybrid Mahy-Kalpataru with 50 ppm NAA produced the highest fruit yield (62.17 t/ha) and economic return. The findings suggest that NAA (50 ppm) and Hybrid Mahy-Kalpataru together optimize brinjal productivity and profitability under semi-arid Rajasthan conditions.

Keywords: Brinjal, naphthalene acetic acid, varieties, growth parameters, yield, economics, *kharif*.

1. Introduction
Brinjal (*Solanum melongena L.*), widely recognized as eggplant, is a prominent Solanaceae crop vital in tropical and subtropical regions; India leads in both cultivated area and production (Mishra *et al*., 2023) [10]. India grows brinjal on 718,000 hectares, producing about 13.5 million metric tonnes annually, with major hubs in West Bengal, Odisha, Andhra Pradesh, Maharashtra, and Rajasthan. The crop's ecological flexibility enables successful cultivation across diverse agro-climatic zones, benefitting both smallholder and commercial growers (Yadav *et al*., 2019) [15]. Nutritionally, brinjal enhances diets with minerals like iron, calcium, phosphorus, potassium, and key vitamins B1, B6, and C, along with bioactive compounds such as nasunin and chlorogenic acid, which support cardiovascular health, glycaemic control, and cellular protection (Ali *et al*., 2024) [3]. Despite agronomic adaptability, brinjal faces challenges limiting performance, such as inconsistent fruit set, variable quality, pests (notably the fruit and shoot borer), and diseases like bacterial wilt and Phomopsis blight (Shrivastav *et al*., 2024) [13].
Seasonal climatic fluctuations and genetic diversity cause significant variation in plant architecture and yield. Varietal differences are clear among Pusa Purple Round (adaptability/round fruits), Pusa Kranti (high yield/resilience), and Hybrid Mahy-Kalpataru (hybrid vigour/performance), with quality and uniformity affecting market appeal. To overcome these, growers and researchers turn to refined agronomic technologies, notably plant growth regulators (PGRs). Naphthalene acetic acid (NAA), a synthetic auxin, stimulates cell elongation, growth coordination, and flower and fruit set via improved nutrient allocation and hormonal interactions (Khan *et al*., 2023) [9]. Well-timed NAA application at critical growth stages boosts branching, fruit retention, yield, and marketable quality (Abd-Elgawad *et al*., 2009) [1], though concentration-dependent responses and varietal sensitivities require careful management. Systematic genotype-PGR interaction studies are needed to clarify differences among cultivated varieties and hybrids. Prior research has mainly assessed single varieties under fixed NAA regimes, limiting broad application. Quality traits—dry matter percentage, TSS, oxalic acid, and nutritive value—remain insufficiently explored, particularly for Rajasthan's arid soils, where adaptation and

input management are crucial.

This study rigorously evaluates different NAA concentrations on brinjal growth, yield, and quality for varieties Pusa Purple Round, Pusa Kranti, and Hybrid Mahy-Kalpataru. Field experiments will quantify growth, flowering, yield, and key quality indices to identify genotype-specific NAA recommendations suited for semi-arid Indian conditions. An integrative approach—statistical, comparative, and economic aims to provide practical guidance for sustainable productivity in brinjal cultivation, addressing agronomic challenges and advancing scientific application of PGRs for crop improvement and food security in India.

Materials and Methods

The experiment was conducted from August 2025 to November 2025 at the Crop Research Farm of Jaipur National University, located at 75°85'99" E longitude and 26°84'79" N latitude, altitude 431 meters AMSL, about 17 km from Jaipur. The sandy loam soil is typical of Jaipur's semi-arid subtropical zone. Twelve treatments included four NAA levels (control, 30, 50, and 70 ppm) and three brinjal varieties (Pusa Purple Round, Pusa Kranti, Hybrid Mahy-Kalpataru), arranged in a factorial randomized block design with three replications, totalling 36 plots. Field preparation included FYM at 20 t/ha, recommended NPK (100:60:60 kg/ha), and standard agronomic and plant protection practices. NAA was sprayed at 30 and 60 days after transplanting. Growth and yield observations included plant height, number of branches, days to flowering, fruit count, fruit length and diameter, average fruit weight, fruit yield per plant and hectare, and quality parameters (TSS, vitamin C), all recorded using standard methods and statistically analysed via ANOVA (Gomez and Gomez, 1984) [8].

3. Results and Discussion

3.1 Plant Height (cm)

Data from Table 1 indicate that plant height was significantly affected by NAA treatments as well as varietal differences. The maximum plant height (69.41 cm) was recorded at 50 ppm NAA application (N_2), which was significantly higher than other treatments and the control (60.73 cm). Hybrid Mahy–Kalpataru (72.85 cm) exhibited the greatest plant height among varieties, likely due to its hybrid vigour. The increase in plant height under 50 ppm NAA can be attributed to the auxinic effect of NAA, which promotes cell division and elongation and stimulates vegetative growth. These results are consistent with earlier findings on brinjal and other crops, confirming positive roles of NAA in promoting shoot elongation and plant stature (Patel *et al*., 2022; Amin *et al*., 2025; Singh, 2010; Khan & Nabi, 2023) [12, 4, 10, 9].

Table 1: Effect of NAA levels and varieties on growth parameters of brinjal.

Treatments	Plant height (cm)	Number of branches / plants	Days to first flowering	Days to 50 % Flowering	Number of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Average fruit weight (g)
Effect of NAA levels								
N_0-Control	60.73	11.52	49.03	59.94	10.73	9.34	6.45	78.09
N_1-NAA @ 30ppm	62.96	13.36	47.01	55.75	13.04	12.69	6.68	95.74
N_2- NAA @ 50ppm	69.41	16.04	43.68	48.88	16.63	17.74	7.37	101.26
N_3- NAA @ 70ppm	67.45	15.20	45.27	52.16	15.85	16.57	7.18	92.79
SEm±	0.95	0.27	0.49	1.02	0.35	0.51	0.10	5.03
CD @5%	2.80	0.80	1.45	2.99	1.02	1.49	0.30	14.76
Effect of varieties								
V_1-Pusa Purple Round	65.56	13.26	48.18	57.97	9.52	11.63	8.16	111.80
V_2-Pusa Kranti	57.00	14.37	46.83	55.75	14.98	13.59	5.53	75.49
V_3-Hybrid Mahy- Kalpataru	72.85	14.46	43.74	48.83	17.68	17.03	7.07	88.62
SEm±	0.83	0.24	0.43	0.88	0.30	0.44	0.09	4.36
CD @5%	2.42	0.69	1.25	2.59	0.88	1.29	0.26	12.78

3.2 Number of Branches per Plant

Application of NAA at 50 ppm (N_2) led to the highest number of branches per plant (16.04), followed by 70 ppm and 30 ppm, while the control recorded the lowest (11.52). Hybrid Mahy–Kalpataru also produced the maximum number of branches (14.46). This increase results from the physiological action of NAA, which enhances axillary bud growth and branching. These findings agree with those of Amin *et al*. (2025) [4] and Patel *et al*. (2022) [12] who noted increased branching in brinjal with optimal NAA application.

Table 2: Effect of NAA levels and varieties on quality, yield and economics of brinjal production

Treatments	TSS (^{0}Brix)	Vitamin C (mg/100 g)	Fruit yield per plant (g)	Fruit yield (t/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C Ratio
Effect of NAA levels							
N_0-Control	5.22	9.79	858.42	27.25	463335	299535	1.83
N_1-NAA @ 30ppm	5.41	10.14	1212.21	38.49	654293	489963	2.98
N_2- NAA @ 50ppm	5.97	11.18	1620.89	51.46	874873	710523	4.32
N_3- NAA @ 70ppm	5.79	10.85	1422.93	45.18	768024	603654	3.67
SEm±	0.08	0.15	10.23	0.32	5521	5521	0.03
CD @5%	0.24	0.45	30.00	0.95	16193	16193	0.10
Effect of varieties							
V_1-Pusa Purple Round	5.23	9.86	1113.07	35.34	600778	436915	2.66
V_2-Pusa Kranti	5.76	10.64	1148.45	36.46	619877	455864	2.78
V_3-Hybrid Mahy- Kalpataru	5.81	10.96	1574.32	49.98	849740	684977	4.16
SEm±	0.07	0.13	8.86	0.28	4782	4782	0.03
CD @5%	0.21	0.39	25.98	0.82	14024	14024	0.09

Interaction Table 2.1: Effect of NAA levels and varieties on Fruit yield per plant (g) of brinjal.

Varieties	NAA levels			
	Control	30ppm	50ppm	70ppm
Pusa Purple Round	546.04	1090.60	1555.64	1259.98
Pusa Kranti	730.95	1161.93	1349.02	1351.90
Hybrid Mahy- Kalpataru	1298.28	1384.11	1958.00	1656.89
SEm±	17.72			
CD @5%	51.96			

Interaction Table 2.2: Effect of NAA levels and varieties on fruit yield (t/ha) of brinjal.

Varieties	NAA levels			
	Control	30ppm	50ppm	70ppm
Pusa Purple Round	17.34	34.63	49.39	40.00
Pusa Kranti	23.21	36.89	42.83	42.92
Hybrid Mahy- Kalpataru	41.22	43.95	62.17	52.61
SEm±	0.56			
CD @5%	1.65			

Interaction Table 2.3: Effect of NAA levels and varieties on net returns (Rs/ha) of brinjal production

Varieties	NAA levels			
	Control	30 ppm	50 ppm	70 ppm
Pusa Purple Round	131278	424671	675658	516055
Pusa Kranti	230930	463023	563983	565520
Hybrid Mahy- Kalpataru	536397	582194	891929	729388
SEm±	9563			
CD @5%	28048			

Interaction Table 2.4: Effect of NAA levels and varieties on B:C ratio of brinjal production

Varieties	NAA levels			
	Control	30ppm	50ppm	70ppm
Pusa Purple Round	0.80	2.59	4.12	3.15
Pusa Kranti	1.41	2.82	3.44	3.44
Hybrid Mahy- Kalpataru	3.26	3.53	5.41	4.42
SEm±	0.06			
CD @5%	0.17			

3.3 Days to First Flowering

NAA foliar application at 50 ppm (N_2) significantly advanced flowering, with the earliest days to first flowering (43.68 days) compared to the control (49.03 days) and other concentrations. Hybrid Mahy–Kalpataru flowered earliest (43.74 days) among the varieties. This observation supports the conclusion that exogenous auxin application accelerates physiological processes related to flowering by stimulating endogenous hormonal activity. Comparable results have been reported in recent brinjal studies (Amin *et al*., 2025; Singh, 2010; Ahmad *et al*., 2024) [4, 10, 2].

3.4 Days to 50% Flowering

A significantly earlier mean for days to 50% flowering was noted with 50 ppm NAA (48.88 days), compared to control (59.94 days). Among varieties, Hybrid Mahy–Kalpataru was earliest (48.83 days), revealing both treatment and genotype influence. The promoting effect of NAA on earlier flowering is attributed to its role in faster shoot development and enhanced assimilate partitioning (Patel *et al*., 2022; Amin *et al*., 2025) [12, 4].

3.5 Number of Fruits per Plant

Maximum fruits per plant (16.63) were produced with 50 ppm NAA, with a gradual increase observed from control through 30 to 70 ppm. Hybrid Mahy–Kalpataru excelled among varieties (17.68), attributed to its inherent productivity and possibly greater sensitivity to auxin. This improvement is due to NAA-induced hormone balance that improves flower retention and fruit set, consistent with the role of plant growth regulators reported by Bons & Kaur (2020), Ahmad *et al*. (2024) [2], and Abd-Elgawad *et al*. (2009) [1].

3.6 Fruit Length (cm)

Fruit length increased significantly under NAA treatments, peaking at 17.74 cm with 50 ppm and at 17.03 cm for Hybrid Mahy–Kalpataru. Auxins are known to increase fruit cell elongation and size; these values align with prior reports indicating that moderate NAA applications tend to maximize fruit dimension (Patel *et al*., 2022; Amin *et al*., 2025) [12, 4].

3.7 Fruit Diameter (cm)

The greatest fruit diameter (7.37 cm) was observed with 50 ppm NAA, while Pusa Purple Round (8.16 cm) registered the highest among varieties. The positive effect of NAA on fruit expansion may be attributed to increased assimilate flow to developing fruits and reduced drop. Results correlate with findings in analogous studies by El-Khayat (2019) [7] and Khan & Nabi (2023) [9].

3.8 Average Fruit Weight (g)

The average fruit weight peaked at 101.26 g under the 50 ppm NAA treatment, followed by NAA 70 ppm and 30 ppm. Among varieties, Pusa Purple Round recorded the highest average fruit weight (111.80 g), which may be inherent to its genetics. These results suggest that moderate NAA concentrations increase fruit size and weight, in agreement with research by Ahmad *et al*. (2024) [2], Amin *et al*. (2025) [4], and Moniruzzaman *et al*. (2014) [11].

3.9 Total Soluble Solids (°Brix)

Table 2 data reveal that brinjal TSS increased with rising NAA levels, reaching a maximum (5.97 °Brix) at 50 ppm, significantly outperforming the control (5.22 °Brix). Hybrid Mahy–Kalpataru led among varieties (5.81 °Brix). Positive impacts on TSS content with NAA are linked to better carbohydrate translocation and metabolic regulation, echoing findings by Ahmad *et al*. (2024) [2] and El-Khayat (2019) [7].

3.10 Vitamin C Content (mg/100 g)

Application of 50 ppm NAA (11.18 mg/100 g) and selection of Hybrid Mahy–Kalpataru (10.96 mg/100 g) yielded maximum vitamin C content, showing significant improvement over control. This is attributed to auxin-activated biosynthesis pathways for ascorbic acid, as confirmed by Ali *et al*. (2024) [3] and Singh (2010) [14].

3.11 Fruit Yield per Plant and per Hectare

Fruit yield per plant (1620.89 g) and per hectare (51.46 t/ha) were significantly higher at 50 ppm NAA, followed by 70 ppm, 30 ppm, and lastly control. Hybrid Mahy–Kalpataru (1574.32 g/plant; 49.98 t/ha) surpassed all varieties. These results suggest that optimal NAA enhances overall productivity by improving both vegetative and reproductive development. Comparable trends are well documented

(Ahmad *et al*., 2024; Moniruzzaman *et al*., 2014; Amin *et al*., 2025) [2,11, 4].

3.12 Economic Analysis
The highest gross return (₹874,873/ha), net return (₹710,523/ha), and B:C ratio (4.32) were achieved with the 50 ppm NAA treatment, confirming its profitability. Hybrid Mahy–Kalpataru was also most profitable among varieties (B:C 4.16). Enhanced economics with NAA applications at optimal levels result from significant yield improvements and enhanced fruit quality, as noted in past profitability studies (Moniruzzaman *et al*., 2014; Bons & Kaur, 2020) [11].

3.13 Interaction Effects
Analysis further revealed that the combination of Hybrid Mahy–Kalpataru and 50 ppm NAA (V_3N_2) produced the optimum results for yield (62.17 t/ha), net return (₹8,91,929/ha), and B:C ratio (5.41). This demonstrates that varietal performance is amplified by appropriate PGR management, due to underlying genetic potential and superior auxin response. These outcomes match with recent literature emphasizing the importance of variety × treatment interactions for maximizing horticultural profitability (Anis *et al*., 2016; Bons & Kaur, 2020; Khan & Nabi, 2023) [5, 6, 9].

4. Conclusion
The study comprised 12 treatments combining four levels of NAA (control, 30, 50, and 70 ppm) and three brinjal varieties, conducted at Crop Research Farm on sandy loamy soil in rabi, 2024–25. Foliar NAA application at 50 ppm led to significant improvement in growth, yield, and fruit quality attributes, particularly plant height, branching, fruit size, and yield (51.46 t/ha). Hybrid Mahy-Kalpataru was the top variety for yield (49.98 t/ha), fruit number, and economic returns. The best result was achieved with Hybrid Mahy-Kalpataru and 50 ppm NAA (62.17 t/ha yield, highest net return and B:C ratio). The findings recommend foliar application of 50 ppm NAA and selection of Hybrid Mahy-Kalpataru for optimized brinjal production under semi-arid Rajasthan conditions.

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