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Effect of 1-napthaleneacetic acid (NAA) on growth and yield of brinjal (*Solanum melongena* L.) Cv Pusa purple cluster Kanpur, India

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Abstract
An experiment was conducted at at the field of Rama University during February to June 2021 to assess the growth and yield performance of brinjal under different level of NAA. The experiment was carried out in Randomized Complete Block Design. There were 5 treatment comprising T1 (0 ppm NAA), T2 (20 ppm NAA), T3 (40 ppm NAA), T4 (60 ppm NAA) and T5 (80 ppm NAA) which was replicated four times. 1-Napthaleneacetic acid (NAA) levels showed significant effect on all growth and yield parameters. The result revealed that highest plant height, number of primary branches/plant, plant spreading, number of leaves/plant, days taken to first flowering, number of flowers/plant, fruit number/plant, average weight of fruit/plant, fruit diameter and total yield among the different treatment were statistically significant. Plot treated with 80 ppm of NAA produced the maximum fruit yield (65.46 t/ha) and had better plant height, fruit length, number of fruit per plant and days taken to first flowering. Maximum plant height (104.48 cm), plant spreading (105.6 cm), number of leaves (162.7) and highest number of primary branches/plant (21.27) was observed in T5 (80 ppm NAA). Fruit length/fruit (13.00 cm), average weight of fruit/plant (1.768 kg) and highest fruit diameter (32.85 mm) was observed in T5 (80 ppm NAA). Thus, appropriate level i.e. 80 ppm of NAA is better for brinjal production at Rama University, mandana, Kanpur condition.

Keywords: Brinjal, NAA level, yield

Introduction
Brinjal or eggplant ranks among the top five most important vegetable crops, in Asia and the Mediterranean (Frary *et al.*, 2007) [5].

Brinjal or eggplant (Solanum melongena L. 2n=24) is a vegetables from solanaceae family that has originated from warm India and China region (Lawande, 1998) [8]. Brinjal or eggplant or aubergine (French name) is also known as `baigan', or `Vankaya'. It is an economically important crop in Asia, Africa and sub-tropics (India, Central America) and it is also cultivated in some warm temperature region of the Mediterranean and South America (Sihachkr D. *et al.*, 1993) [17]. Eggplant is said to be good for diabetic patients as is known to have some ayurvedic medicinal properties. A brinjal fruit is known for being low in caloric value and is considered among the healthiest vegetables for its high content of vitamins, minerals and bioactive compounds for human health (Raigon *et al.*, 2008; Plazas *et al.*, 2014b; Docimo *et al.*, 2016) [15, 14, 4]. In this respect, in the terms of the oxygen radical absorbance capacity, brinjal is ranked among top 10 vegetables (Cao *et al.*, 1996) [1]. Zenia and Halina, (2008) [20] brinjal is also a rich source of potassium, mangnesium, calcium and iron.

Plant growth regulators are the organic compound other than nutrient that affects the physiological process of growth and development in plant when applied in low concentration. Plant growth regulator like promoters, inhibitors or retardants play a key role in controlling in internal mechanism of plant by interacting with key metabolic process such as, nucleic acid metabolic process such as, nucleic acid metabolism and protein synthesis Revanappa *et al.*, 1998 [16]. Application of NAA on brinjal produced large number of branches and increased fresh weight and yield of fruits (Revanepa *et al.*, 1998) [16]. Brinjal plants treated with NAA resulted in highest number of flowers per plant, fruit set percentage and fruit yield per plant (Gvaskar, 2004) [6]. In eggplant, fruit set is sometimes insufficient and growth regulators are used to enhance fruit setting process which are mostly auxin-like substances (Pessarakli and Dris, 2003) [12]. Plant growth regulator like promoters, inhibitors or retardants play a key role

in controlling in internal mechanism of plant by interacting with key metabolic process such as, nucleic acid metabolic process such as, nucleic acid metabolism and protein synthesis Revanappa *et al.*, 1998 [16]. Application of NAA on brinjal produced large number of branches and increased fresh weight and yield of fruits (Revanepa *et al.*, 1998) [16]. Brinjal plants treated with NAA resulted in highest number of flowers per plant, fruit set percentage and fruit yield per plant (Gvaskar, 2004) [6]. In eggplant, fruit set is sometimes insufficient and growth regulators are used to enhance fruit setting process which are mostly auxin-like substances (Pessarakli and Dris, 2003) [12]. Plant growth regulator like promoters, inhibitors or retardants play a key role in controlling in internal mechanism of plant by interacting with key metabolic process such as, nucleic acid metabolic process such as, nucleic acid metabolism and protein synthesis (Revanappa *et al.*, 1998) [16].

1-Naphtaleneactic acid (NAA) is an organic compound with formula $C_{10}H_7CH_2CO_2H$. The synthetic plant hormone NAA is from the auxin family. NAA is the commonly used in horticulture crops. The higher concentration of NAA inhibits growth and exerts toxic effect on the plant. So, the optimum concentration is the required for the beneficial effect of NAA. The NAA perhaps interferes with the variation in temperature which in turn affects the flowering and fruit setting adversely. It also affects the physiological process, maturity and produces better quality fruits.

NAA inhibit growth and exert toxic effect of NAA. The NAA perhaps interfere with the variation in temperature with the variation in temperature which in turn effect of flowering and fruit setting adversely. It also affects the physiological process. Imbalance of PGR in brinjal causes flowers and fruit dropping, decrease in quality and decrease in length of fruit and plant. Lower concentration of Auxin results in retarded growth and plants becomes sensitive to disease and pest (Meena *et al.*, 2000) [9].

Material and Methods

The field experiment was conducted at Rama University, Mandhana, Kanpur, UP, India from February 2021 to June 2021.

Pusa purple cluster variety was selected because it had shown better performance and commercial one under Kanpur condition. The seeds were treated with thiram and kept in bowl for overnight and then water is socked with newspaper or cotton cloth then seed was sown in 1.5 cm deep furrows spaced at 10cm apart in a well prepared nursery beds on 1, March 2021. The bed were mulched with straw and covered with white transplant plastic sheet during the day and warm up the bed until seed germination. Irrigation, intercultural operation and plant protection measure were undertaken frequently till the seedling was ready for transplanting. 35DAS seedlings having 4-5 leaves were transplanted in experimental plots. The experiment was carried out in a Randomized Completely Block Design (RCBD) with 5 treatments. Each treatment was replicated four times. The plants were spaced 60×45 cm, i.e. row to row and plant to plant respectively. The total area of the each plot was 3×2.25 m2. The distance of 1m maintained with replication. The space of 0.5 meters was maintained between the plots. There were 5 rows in each plot and 5 plants were planting in each row. So, there were 25 plants in each plot. 5 sample plant from inner rows were selected for observation and recording of the data.

Table 1: Detail of treatment used in study

Treatment	Doses of NAA(ppm)	Amount used per 20 lit.
T1	0 ppm(control)	0 mg
T2	20 ppm	400 mg
T3	40 ppm	800 mg
T4	60 ppm	1200 mg
T5	80 ppm	1600 mg

Vegetative parameter like plant height, number of branches, number of leaves and plant spreading were measured. Plant heights was measured at 60, 75DAT. Number of branches were calculated by visual counting of branches. Numbers of leaves were counted by visual counting of leaves. Plant spreading was measured in 60, 75 DAT. Yield attributing character like fruit length, fruit diameter, total number of fruit per plant, fruit weight, total yield were measured. Fruit length was measured by scale, fruit diameter by vernier caliper, fruit weight by electric weighing machine, total number fruits were counted visually and average was calculated. And total yield was calculated.

The collected data were entered in the sheet of Microsoft Excel sheet and was analyzed by using GENSAT software package.

Result and Discussion

Effect of different doses of NAA on vegetative parameter (plant height, number of leaves, number of branches and plant spreading)

The data presented in Table no.2 demonstrate that the effect of NAA in vegetative parameters of brinjal i.e. plant height, number of leaves, number of branches and plant spreading.

Highest plant height was observed with 80ppm of NAA (104.48 cm) which was followed by 60ppm of NAA (100.78 cm), 40ppm of NAA (99.88 cm) and 20ppm of NAA (98.35 cm). In control treatment lowest plant height was observed. This might be due to the rapid increase in cell division and cell elongation in the meristematic region of plant due to the application of NAA. These finding are in accordance with the work reported by Revanappa (1998) [16] and Gupta and Gupta (2000) [7].

Highest leaves number (162.7) was recorded in 80ppm of NAA which was followed by 60ppm of NAA (153.2), 40ppm of NAA (148.2) and 20ppm of NAA (126.3). Lowest leaves number (126.3) was recorded in control treatment. This might be due to the vegetative growth promotion by adequate amount of NAA influences leaves and chlorophyll formation leading to greater photosynthetic formation. The finding are in conformity with the work reported by Revanappa (1998) [16].

Table 2: Effect of different doses of NAA on vegetative parameter (plant height, number of leaves, number of branches and plant spreading)

Treatment	Plant height (cm)75 DAT	No of leaves 75 DAT	Number of primary branches	Spreading (cm) at 75 DAT
T1(Control)	96.00	126.3	15.80	97.3
T2(20 ppm)	98.35	141.6	16.62	98.8
T3(40 ppm)	99.88	148.2	17.20	100.8
T4(60 ppm)	100.78	153.2	19.55	102.3
T5(80 ppm)	104.48	162.7	21.27	105.6
Grand mean	99.90	146.39	16.50	100.97
CV (%)	5.0	3.0	3.2	2.0
SEM (±)	0.39	3.0	0.19	0.20
$LSD_{0.05}$	1.21^{***}	2.66^{***}	0.60^{***}	0.63^{***}

Plant treated with 80ppm of NAA showed higher number of branches (21.27), followed by 60ppm of NAA (19.55), 40ppm of NAA (17.20) and 20ppm of NAA (16.62). Lowest number of branches (15.80) was observed in control treatment. This might be due higher vegetative growth such as plant height, number of leaves from which plant gets sufficient amount of food so the number of branches was more than control. Similar result was observed in the study done by Sharma (1992) [18] and Choudhary and Saraf (1995) [3].

Highest plant spreading (105.6 cm) was observed with 80ppm of NAA, followed by 60ppm of NAA (102.3 cm), 40ppm of NAA (100.8 cm) and 20ppm of NAA (98.8 cm). Lowest plant spreading (97.3 cm) was observed in control treatment. The findings are in accordance with work reported by Si Ya Ping (1996) [13] and Gupta and Gupta (2000) [7].

Effect of different doses of NAA on yield attributing character (fruit number, fruit length, fruit diameter, fruit weight and yield)

The data presented in Table no.3 demonstrate that the effect of NAA in yield attributing character of brinjal i.e. fruit number, fruit length, fruit diameter, fruit weight and yield.

The maximum fruit number (9.82) was recorded from 80ppm of NAA which was followed by 60ppm of NAA (9.25), followed by 40ppm of NAA (8.52) and 20ppm of NAA (7.50). Lowest number of fruit (6.65) was obtained in control treatment. The possible reason for increasing in number of fruit might be due to the rapid and better nutrient translocation from roots apical parts of plant. Results are in conformity with the finding of Gavaskar and Anburani (2004) [6] and Chauhan *et al.* (2007) [2].

Highest fruit length (13.00 cm) was obtained from plant receiving the 80ppm of NAA followed by 60ppm of NAA (12.05 cm), 40ppm of NAA (11.28cm) and 20ppm of NAA (10.75 cm) while lowest fruit length (9.30 cm) is obtains in control. The size fruit length was significantly increased it is due to application of NAA which causes stimulation of fruit growth that result in increased fruit weight, fruit length and fruit diameter. Finding is in conformity with work reported by Sorte *et al.* (2001) [19], Meena and Dhaka (2003) [3].

The maximum diameter (32.95 mm) was recorded from 80ppm of NAA which was followed by 60ppm of NAA (30.43 mm), followed by 40ppm of NAA (29.12 mm) and 20ppm of NAA (27.45 mm). Lowest fruit diameter (25.15 mm) was obtained in control treatment. The size of fruit was increased by the growth regulator (NAA). The diameter of fruit was significantly increased it is due to application of NAA which causes stimulation of fruit growth that result in increased fruit weight, fruit length and fruit diameter. These results are in conformity with the finding of Sorte *et al.* (2001) [19], Meena and Dhaka (2003) [10] and Chauhan *et al.* (2007) [2].

The maximum fruit weight (62.80 gm) was recorded from 80 ppm of NAA which was followed by 60 ppm of NAA (58.58 gm), 40 ppm of NAA (52.93 gm) and 20 ppm of NAA (48.43 gm). Lowest fruit weight (45.38 gm) was obtained in control treatment. The size and weight of fruit is also important aspects as these characters are useful for yield as well as consumer acceptability. The size of fruit was significantly increased it is due to application of NAA which causes stimulation of fruit growth that result in increased fruit weight, fruit length and fruit diameter. These results are in conformity with finding of Choudhary and Saraf (1995) [3], Sorte *et al.* (2001) [19] and Meena and Dhaka (2003) [10].

Table 3: Effect of different doses of NAA on yield attributing character (fruit number, fruit length, fruit diameter, fruit weight and yield)

Treatment	No of fruit	Fruit length (cm)	Diameter of fruit (mm)	Fruit weight(gm)	Yield per plant (kg)
T1(Control)	6.65	9.3	25.15	45.38	0.805
T2(20 ppm)	7.50	10.75	27.45	48.43	1.00
T3(40 ppm)	8.52	11.28	29.12	52.93	1.27
T4(60 ppm)	9.25	12.05	30.43	58.58	1.708
T5(80 ppm)	9.82	13.00	32.95	62.80	1.768
Grand mean	8.35	11.27	29.02	53.62	1.312
CV (%)	9.0	1.1	5.0	1.0	8.1
SEM (±)	0.10	0.12	0.32	0.65	0.023
$LSD_{0.05}$	0.32^{***}	0.37^{***}	1.01^{***}	2.004^{***}	0.071***

Highest yield per plant (1.768 kg) was recorded in 80 ppm of NAA and followed by 60 ppm of NAA (1.708 kg), 40 ppm of NAA (1.278 kg) and 20 ppm of NAA (1.00 kg). The lowest yield per plant (0.805 kg) was recorded in control treatment. The fruit yield per plant is significantly increased with the application of NAA as compared to control. Application of NAA at 80 ppm recorded highest fruit yield per plant. The possible reason for increase in number of fruits and fruit yield per plant was that the plant remained physiologically more active to build up sufficient food material for producing more number of flowers and fruits, ultimately leading to higher fruit yield per plant. These results are in conformity with the finding of Sharma *et al.* (1992) [18], Patel *et al.* (1997), Gavaskar and Anburani (2004) [6] and Chauhan *et al.* (2007).

Conclusion

Based on the results, of this study it can be realized that among the treatments, 80ppm of NAA was found effective in improving plant height, number of branches, plant spreading, length of fruit, diameter of fruit, no. of fruit per plant, weight of fruit, yield per plant and yield per hectare.

From the study it can be concluded that the use of optimum doses of NAA is more profitable either in context of growth and yield of brinjal.

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