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Effect of plant growth regulators on growth and yield attributes of brinjal (*Solanum melongena* L.)

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Abstract
Brinjal (*Solanum melongena* L.) member of angiospermic family solanaceae is also known as eggplant. The present investigation was carried on Rabi-2021 brinjal cv. Purple round at the Horticultural Research Farm, Sardar Patel University, Balaghat (M.P.). The experiment was laid out in a Randomized Block Design (RBD) with ten treatments in three replication. Three plant growth regulators namely, naphthalene acetic acid (NAA), gibberellic acid (GA_3), and 2,4-dichlorophenoxyacetic acid (2, 4-D). The concentration of NAA (20, 40 and 60 ppm), GA_3 (25, 50 and 75 ppm), and 2,4-D (2, 4 and 6 ppm) were selected for the experiment. The data revealed that maximum fruit yield per plant (3.09 kg) was recorded in the treatment T_6 i.e. GA_3 75 ppm, followed by treatment T_2 i.e. NAA 40 ppm (2.80 Kg) with mean of 2.24 kg. However minimum (1.15 kg) was recorded in treatment T_{10} i. e. control. Among the all three plant growth regulators i.e. NAA and 2,4-D relates to auxins group and GA_3 to the group of gibberellins, GA_3 75 ppm application is very effective for enhancement of vegetative and yield traits.

Keywords: Brinjal (*Solanum melongena* L.), gibberellic acid, 2,4-D, naphthalene acetic acid, growth, yield attributes

Introduction
Brinjal (*Solanum melongena* L.) member of angiospermic family solanaceae is also known as eggplant. It is a popular vegetable crop widely grown in tropics and subtropics (Roychowdhury and Tah, 2011) [7]. The crop is originated in Indo-Burma region (Vavilov 1928) [10]. The fruits of brinjal are known for being low in calories and having a mineral composition beneficial for human health. They are also rich source of Potassium, Magnesium, Calcium and Iron (Zenia *et al.*, 2008) [11]. Brinjal is known to have ayurvedic medicinal properties and is good for diabetic patients. It has also been recommended as an excellent remedy for those suffering from liver complaints (Shukla and Naik 1993) [9]. In India, it is one of the most common, popular and principal vegetable crops grown throughout the country except higher altitudes. The maximum potential yield of brinjal is not achieved due to its poor physiological efficiency, poor plant architecture, poor fruit setting and none synchronize maturity. Application of plant growth regulators (PGRs) may play an important role in proper flowering, fruit setting, synchronize maturity, ripening and thereby increase in the physiochemical efficiency and yield of the crops. The market demand and consumer preference of brinjal depends upon fruit colour, size, shape and stage of maturity.
Use of PGRs may increase the productivity of brinjal in terms of quality and quantity and thereby increase the market price and profitability. The plant growth hormones classified into different categories like Auxin, Gibberellins, Cytokinin, etc. are involved with the physiological activities in plants. Among the plant growth regulators used in present experiment, NAA and 2,4-D relates to auxins group and GA_3 to the group of gibberellins. NAA (Naphthalene acetic acid) is a synthetic plant hormone which is used in plant tissue culture, promotes growth and also adds to induce root formation in various plants. NAA is widely used in horticulture for various purposes. The foliar spray of Napthalene Acetic Acid (NAA) induces higher physiological efficiency including photosynthetic ability of plants. It leads to better growth and yield of several agronomic crops without substantial increase in the cost of production. Nehara *et al.* (2006) [4] observed that NAA increases ethylene formation in plants, which facilitates the efficient translocation of photosynthesis from source to sink. Gibberellic acid increases the plant height, weight Gibberellins stimulate cell division and elongation and seed germinations too Gibberellic acid is an important growth regulator that may have many uses to modify the growth, yield and yield contributing characters of plant (Rafeekher *et al.* 2002) [6].

Therefore, the present investigation was designed to find out the suitable plant growth regulators for increasing the yield potential in brinjal.

Materials and Methods

An experiment was conducted at the Horticultural Research Farm, Sardar Patel University, Balaghat (M.P.) *Rabi* season 2021- 2022. The experiment was laid out in a Randomized Block Design (RBD) with ten treatments in three replication. Three plant growth regulators namely, NAA (20, 40 and 60 ppm), GA3 (25, 50 and 75 ppm), and 2,4-D (2, 4 and 6 ppm) were selected for the experiment.

The healthy seedling were transplanting one month after sowing at the spacing of 60 cm × 60 cm. During the time of experimentation the observation were recorded from five representative plants in each replication for each treatment. The morphological and yield parameters were recorded i.e. plant height (cm) at 30, 60 and 90 DAT, number of branches per plant at 30, 60 and 90 DAT, days to first and 50% flowering, numbers of leaves per plant, numbers of fruits per plant, fruit length (cm), fruit girth (cm), fresh weight of fruits (g) and fruit yield per plant (g) and fruit yield per ha (t).

Brinjal (*Solanum melongena* L.) cv. Purple round. The experiment was laid out in a Randomized Block Design with ten treatments replicated three times. The details of treatment comprised of GA_3 (25, 50 and 100 ppm), IAA (25, 50 and 100 ppm), NAA (25, 50 and 100 ppm) and control (distilled water)

Result and Discussion

The analysis of variance for all the ten growth and yield traits of brinjal cv. Purple round were studied. The analysis of variance showed a wide range of variation and significant differences for all the traits under study, indicating the presence of sufficient amount of variability.

The maximum plant height (30.66 cm) at 30 DAT was recorded in the treatment T_6 i.e. GA3 75ppm, followed by treatment T_2 i.e. NAA 40ppm (30.02cm) with mean of 26.82cm. At 60 DAT, maximum plant height (45.07cm) was recorded in the treatment T_2 i.e. NAA 40ppm followed by treatment T_6 i.e. GA3 75ppm (44.75cm) with mean of 42.09cm. At 90 DAT, maximum plant height (72.59cm) was recorded in the treatment T_6 i.e. GA_3 75ppm, followed by treatment T_9 i.e. 2, 4-D 6ppm ((69.77cm) with mean of 66.49cm. However, Mukharjee and Datta (1962) [3] reported that plant height was increased by 32 and 62 per cent, respectively with treatment of GA_3.

The maximum number of branches per plat (8.00) at 30 DAT was recorded in the treatment T_3 i.e. NAA 60ppm, followed by treatment T_4 i.e. GA3 25ppm (7.00) with mean of 5.73. At 60 DAT maximum (16.00) was recorded in the treatment T_6 i.e. GA3 75ppm, followed by treatment T_2 i.e. NAA 40ppm (14.00) with mean of 12.27. At 90 DAT maximum (20.67) was recorded in the treatment T_6 i.e. GA_3 75ppm, followed by treatment T_8 i.e. 2,4-D 4ppm (18.33) with mean of 16.70. Similarly, Netam and Sharma (2021) [5] reported maximum number of branches per plant in GA_3 (10ppm) application. The maximum days to 50% flowering (45.00) was recorded in the treatment T9 i.e. 2,4-D 6ppm with mean of 48.03. Similarly minimum days to 50% flowering result reported by Arivazhangan *et al.* (2018) [1] with treatment $GA_3$50ppm.

At 30 DAT maximum number of leaves per plant (23.25) was recorded in the treatment T_2 i.e. NAA 40ppm, followed by treatment T_6 i.e. GA_3 75ppm (21.62) with mean of 19.69. At 60 DAT maximum number of leaves per plant (50.51) was recorded in the treatment T_6 i.e. GA_3 75ppm, followed by treatment T_5 i.e. GA_3 50ppm (44.90) with mean of 40.35. At 90 DAT maximum number of leaves per plant (76.14) was recorded in the treatment T_6 i.e. GA_3 75ppm, followed by treatment T_8 i.e. 2,4-D 4ppm (72.07) with mean of 66.14.

For trait number of fruits per plant maximum (32.33) was recorded in the treatment T_5 i.e. GA_3 50ppm, followed by treatment T_2 i.e. NAA 40ppm (30.67) with mean of 26.20. The fruit length recorded maximum (10.20cm) in the treatment T_8 i.e. 2,4-D 4ppm, followed by treatment T_5 i.e. GA_3 50ppm (10.03cm) with mean of 9.03cm. The maximum fruit girth (17.27cm) was recorded in the treatment T_5 i.e. GA_3 50ppm, followed by treatment T_3 i.e. NAA 60ppm (17.00cm) with mean of 15.75cm. The maximum fresh weight of fruit (58.00g) was recorded in the treatment T_2 i.e. NAA 40ppm, followed by treatment T_9 i.e. 2,4-D 6ppm (57.67g) with mean of 54.80g. The data revealed that maximum fruit yield per plant (3.09kg) was recorded in the treatment T_6 i.e. GA_3 75ppm, followed by treatment T_2 i.e. NAA 40 ppm (2.80Kg) with mean of 2.24kg. Similar result of maximum number of fruits per plant with treatment GA_3 50ppm reported by Kropi *et al.* (2018) [2] and Arivazhagan *et al.* (2018) [1]. The maximum fruit yield per hectare (39.10 t) was recorded in the treatment T_3 i.e. NAA 60ppm, followed by treatment T_6 i.e. GA_3 75ppm (37.80t) with mean of 31.59 t. the growth regulators used in the present investigation significantly increased the plant height and number of leaves per plant at all stages. The application of growth promotive substances increased the plant height and such effect was due to increased photosynthetic activity, enhancement in the mobilization of photosynthates, rapid increase in sugars, there by changing in the membrane permeability (Shukla *et al.*, 1997) [8].

Table 1: Effect of growth regulators on morphological parameters in brinjal cv. Purple round

Treatment	PGR	Concentration	Plant height			Number of branches per plant			Days to 50% flowering	Number of leaves per plant			Number of fruit per plant	Fruit length (cm)	Fruit girth (cm)	Fresh weight of fruit (g)	Fruit yield per plant (kg)	Fruit yield per hectare (t)
			30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT		30 DAT	60 DAT	90 DAT						
T_1	NAA	20 ppm	25.54	40.17	61.53	5.00	12.00	14.67	49.67	19.96	39.95	60.18	24.33	8.00	14.67	57.00	2.28	32.00
T_2	NAA	40 ppm	30.02	45.07	69.26	5.33	14.00	17.33	46.00	23.25	41.22	67.97	30.67	9.83	16.40	58.00	2.80	39.60
T_3	NAA	60 ppm	27.43	40.25	67.97	8.00	13.67	17.30	47.67	21.26	39.74	71.22	26.67	8.83	17.00	64.00	2.28	35.27
T_4	GA3	25 ppm	23.65	40.04	66.10	7.00	10.33	15.67	51.00	17.11	38.22	63.58	27.00	8.97	15.80	53.33	1.73	31.27
T_5	GA3	50 ppm	29.07	42.82	70.34	5.67	13.33	18.33	43.00	21.33	44.90	69.88	32.33	10.03	17.27	54.67	2.27	36.40
T_6	GA3	75 ppm	30.66	44.75	72.59	6.67	16.00	20.67	48.33	21.62	50.51	76.14	25.67	9.90	16.60	53.00	3.09	33.13
T_7	2, 4-D	2 ppm	26.87	43.83	66.38	5.00	11.67	16.33	48.67	17.83	38.22	61.07	21.00	8.40	14.53	50.67	2.16	27.33
T_8	2, 4-D	4 ppm	27.10	42.10	68.37	4.67	10.67	18.33	47.67	19.13	40.45	72.07	29.67	10.20	16.97	55.00	2.20	28.83
T_9	2, 4-D	6 ppm	27.80	44.63	69.77	5.67	11.67	18.00	45.00	20.87	40.07	68.11	27.33	9.40	15.93	57.67	2.45	30.53
T_{10}	Control		20.05	37.25	51.47	4.33	9.33	10.33	53.33	14.55	30.22	51.17	17.33	6.70	12.33	44.67	1.15	22.67
Mean			26.82	42.09	66.49	5.73	12.27	16.70	48.03	19.69	40.35	66.14	26.20	9.03	15.75	54.80	2.24	31.70
S.Em			0.28	1.37	0.70	0.74	0.77	0.64	1.04	0.81	1.04	1.03	0.84	0.23	0.32	0.86	0.14	0.95
CD (5%)			0.84	4.06	2.09	2.21	2.30	1.89	3.10	2.41	3.10	3.07	2.48	0.67	0.94	2.56	0.43	2.83

Conclusion

In present investigation among the all three plant growth regulators i.e. NAA and 2,4-D relates to auxins group and GA_3 to the group of gibberellins, GA_3 75ppm application is very effective for enhancement of vegetative and yield traits of brinjal cv. purple round. These application offers great potential in brinjal for yield and yield attributing characters.

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