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INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH, FLOWERING BEHAVIOUR AND YIELD OF BRINJAL (*SOLANUM MELONGENA* L.) CV. PUSA PURPLE ROUND

Ram Baboo[1]*, Shashi Bala[1], Lalu Prasad[2], Ramesh Rajbhar[2], Rakesh Kumar[2] and Vipin[2]

[1]Department of Horticulture, College of Agriculture Science, Udai Pratap College (An Autonomous Institution), Varanasi, U.P., India.

[2]Department of Vegetable Science, ANDUA&T, Kumarganj, Ayodhya, U.P., India.

*Corresponding author E-mail : rambaboo150@gmail.com

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ABSTRACT

The present study was conducted at the College of Agriculture Science Udai Pratap College (An Autonomous Institution), U.P., India during the *Rabi* season of 2017 and 2018. Plant material consisted of 9 treatments of brinjal including T_1 (RDF 100%), T_2 (50% NPK + 50% FYM), T_3 (50% NPK + 50% FYM + *Azotobacter*), T_4 (50% NPK + Vermicompost), T_5 (50% NPK+VC+ *Azotobacter*), T_6 (75% NPK +25% FYM), T_7 (75% NPK+25% Vermicompost), T_8 (50% NPK+25%VC + 25% FYM+*Azotobacter*) and T_9 (50% NPK + *Azotobacter*) in randomized block design (RBD)with three replications. Evaluation was done for different growth and yield traits. The observations were recorded for eight growth and four yield characters. The results revealed that the application of T_8 (50% NPK + 25% VC + 25% FYM + *Azotobacter*) recorded significantly higher plant height at 30, 60, 90 and 120 days after transplanting (24.92, 36.51, 70.11 and 75.43 cm), Number of leaves per plant was observed (25.17, 75.67, 97.08 and 109.05 cm), length of leaf (32.33, 55.63, 69.81 and 78.81 cm), fruit length (14.87 cm), fruit diameter (6.42 cm), fresh fruit weight (49.67 g), dry fruit weight (30.67 g), harvest maturity (92.67 days), no. of fruit/ plant (28.22), fruit yield/plant (11.40 kg), fruit yield/plot (342.00 kg) and fruit yield/ha (85.50 q/ha) followed by T_9 (50% NPK + *Azotobacter*).

Key words : Brinjal, Integrated nutrient management, Organic fertilizers, Growth, Yield.

Introduction

The Solanaceae family includes the significant herb known as brinjal, which has chromosomal number 2n = 24. Brinjal (*Solanum melongena* L) often known as Aubergine or eggplant) is a popular vegetable crop produced all over the world, with a strong presence in Asia (Meherunnahar and Paul, 2009). It is among the most well-liked, tasty, and beneficial vegetable crops. The brinjal that is grown is an Indian crop that has been farmed for a very long period (Thompson and Kelly, 1957), with its origins mostly in the Indo Burma region (Vavilov, 1951).

India and other Asian nations including Bangladesh, Pakistan and the Philippines are important producers of brinjal; other major producers include China, Turkey, Japan, Egypt, Indonesia, Iraq, Italy, Syria and Spain. Brinjal is grown in warm climates. Brindaoli, when unripe, are mostly utilized as cooked vegetables in a variety of recipes, as well as a starting point for pickles and dehydration (Singh, 1963). According to Nandkarni's 1927 research, eggplant has therapeutic properties. The fruit is utilized as a "toothache" cure and is also highly advised for anyone experiencing liver issues. A useful treatment for diabetics is green brinjal. Ayurveda uses fruit as a starter, aphrodisiac and "cardiotonic"; it also has laxative and anti-inflammatory properties.

India is the birthplace of brinjal, which is widely grown and consumed by nearly every household in numerous states. According to the National Horticulture Database, 1.17 hectares were planted with brinjal in 2017–18, yielding 20.13 lakh tonnes of fruit and 17.07 mt/ha of

productivity. Regarding brinjal production, which accounts for 15.75% of the crop at the national level. After West Bengal, Odisha comes in second. Among the tropical vegetables growing most frequently in India is brinjal. The highly nutritious vegetable brinjal offers the following nutrients: 52.0 mg of chlorine, 47.0 mg of phosphorus, 44.0 mg of sulphur, 6.4 mg of vitamin A, 18.0 mg of calcium, 24 kcal of energy, 1.3 g of fiber, 0.9 mg of iron, 1.4 g of protein, 12.0 mg of vitamin C, and 18.0 mg of oxalic acid are all present in 100g of brinjal (Paul *et al*, 2022).

An organic fertilizer with specific advantageous bacteria for farming is called bio-fertilizer. It is essential to the growth and viability of green and organic agriculture. The results of an investigation into the impact of biofertilizers on the physiological growth of eggplant indicate that commercial biofertilizers were not as effective as biofertilizers made mostly of beneficial bio-inoculants. Crop yield and nutrient utilization efficiency are increased when chemical fertilizers are combined with biofertilizers.

Material and Methods

Experimental site

In the Ramadan of 2017–18, the current experiment was set up in the Research Field of the Department of Horticulture at Udai Pratap College in Varanasi. The experimental site's land topography was nearly homogeneous and had sufficient surface drainage. The experimental site has a medium level of internal drainage. Meteorological data during entire crop season is given in Table 1.

Table 1 : Meteorological data during entire crop season at Varanasi (2017).

Week no.	Month & Date	Rainfall (mm)	Temperature (°C)		R.H. (%)	
			Max	Min	Morn.	Even
1st week	Sep 03-09	1.0	34.7	26.2	86	61
2nd week	10-16	0.0	34.8	26.7	88	65
3rd week	17-23	21.2	32.3	24.8	91	74
4th week	24-30	0.0	33.4	25.3	91	66
1st week	Oct 01-7	0.0	33.3	25.2	89	71
2nd week	08-14	0.0	32.7	24.8	86	70
3rd week	15-21	0.0	30.7	21.0	88	71
4th week	22-28	0.0	34.1	17.4	88	41
5th week	29-04	0.0	30.1	16.8	92	52
1st week	Nov 05-11	0.0	30.3	15.8	92	50
2nd week	12-18	0.0	29.1	15.1	91	48
3rd week	19-25	0.0	24.7	11.4	85	37
4th week	26-02	0.0	26.4	8.5	91	37
1st week	Dec 03-09	0.0	25.7	9.3	90	54
2nd week	10-16	0.0	26.2	11.2	86	46
3rd week	17-23	0.0	23.5	8.8	84	50
4th week	24-31	0.0	21.2	8.2	92	61
1st week	Jan 01-07	0.0	20.1	11.6	95	76
2nd week	8-15	0.0	20.7	8.2	91	44
3rd week	16-23	0.0	23.0	8.8	90	49
4th week	24-30	1.0	24.4	10.9	90	58
1st week	31 Jan-6 Feb	0.0	25.4	10.8	91	47
2nd week	7-14	0.0	26.2	12.3	87	53
3rd week	15-22	0.0	27.7	13.0	81	41
4th week	23-2March	0.0	29.7	13.1	83	43
1st week	3-10	0.0	29.6	14.6	71	38
2nd week	11-18	0.0	28.7	12.3	81	39
3rd week	19-26	0.0	33.2	17.6	81	36
4th week	27-3 April	0.0	38.5	20.1	64	30

Source: BHU, Varanasi.

Table 2 : Details of nine treatments used in the study.

Treatment symbol	Treatment detail
T_1	RDF (100%)
T_2	50% NPK + 50% FYM
T_3	50% NPK + 50% FYM + *Azotobacter*
T_4	50% NPK + Vermicompost
T_5	50% NPK+VC+ *Azotobacter*
T_6	75% NPK +25% FYM
T_7	75% NPK+25% Vermicompost
T_8	50% NPK+25%VC +25% FYM+*Azotobacter*
T_9	50% NPK + *Azotobacter*

Design of experiment

Three replications of the experiment were set up using Randomized Block Design (RBD). Every replication has nine different treatments. In every replication, every treatment was randomized in isolation. The layout plan is provided below:

Design : Randomized Block Design (RBD)
Replication : 3
Treatment : 9

Total number of plots	: 27
Plot size	: 2.07 × 1.63 m
Net plot size	1.67m × 1.23m
Row to row distance (R-R)	: 75 cm
Plant to plant distance (P-P)	: 60 cm
Total area	: 12m × 31m (372 m^2)
Crop	: Brinjal (*Solanum melongena* L.)
Variety	: Pusa Purple Round
Season	: *Rabi* 2017-18

Throughout the experimentation phase, the data on different factors were separated into two categories: growth parameters and yield parameters. The data were entered in accordance with normal protocol.

Growth parameters

Plant height (cm) : At 30, 60, 90 and 120 days following transplanting, the height of the main stem was measured using the meter scale from the ground to the apical bud (leaf apex).

Number of leaves plant^{-1} : After transplanting, the number of leaves on each tagged plant in each treatment was counted 30, 60, 90 and 120 days later.

Fruit length : At 30, 60, 90 and 120 days following transplanting, the fruit's length was measured using a meter scale, starting at the stalk (the place where the fruit attaches to the stem) and ending at the tip of the fruit.

Fruit diameter (cm) : Using a Vernier calliper, the fruit's diameter was measured, and at harvest, the average was noted.

Fresh weight of fruit (g) : Immediately following the harvest, the fruit's fresh weight (g) was determined using an electronic weighing device.

Harvest maturity (days) : When the fruits reached full maturity, they were harvested. From the time of transplanting to the final harvest, days were recorded.

Yield and yield parameters

Number of fruits per plant : During each picking, the number of fruits picked from five randomly chosen plants in each treatment was tallied, added up, and the average number of fruits per plant was determined.

Fruit yield per plot (kg) : At each picking, the weight of the fruits in the plot was noted, and the average weight of the fruits in each plot was computed in kilograms.

Fruit yield (q/ha) : At each picking, the weight of the plot's fruits was noted, as was the average weight of the fruits per quintal.

Results and Discussion

The results of the field experiment entitled, "Influence of integrated nutrient management on growth, flowering and yield of Brinjal (*Solanum melongena* L.) cv. Pusa Purple Round" was carried out at experimental farm, College of Agriculture, Udai Pratap Autonomous College, Varanasi during *Rabi* season of the year 2017-18. Utilizing data from 2017 and 2018, an analysis of variance was conducted for several characters. All treatments showed extremely significant results.

Growth parameters

Plant height (cm) : After transplanting, plants under T8 (50% NPK + 25% VC + 25% FYM + *Azotobacter*) exhibited significantly higher plant heights at 30, 60, 90, and 120 days (24.92, 36.51, 70.11 and 75.43 cm), which were followed by T_9 (application of 50% NPK + Azotobacter). Conversely, under T1 (100% RDF), the lowest plant heights (19.00, 30.12, 62.11 and 70.74 cm, respectively) were noted at 30, 60, 90 and 120 days following transplanting (Table 3).

Mertia and Chauhan (1970) from Udaipur reported that application of nitrogen was effective in increased plant height; number of leaves and brinjal fruits and that 89 kg N + 45 kg P_2O_5 + 45 kg K_2O was proved to be the most effective treatment.

Number of leaves per plant : Significantly higher number of leaves at 30, 60, 90 and 120 days (Table 4) after transplanting was observed 25.17, 75.67, 97.08 and 109.05 cm observed under T_8 50% NPK + 25 % VC + 25% FYM+ *Azotobacter,* which remained statistically at par with as 50% NPK + *Azotobacter.* Whereas, significantly the lowest number of leaves at 30, 60, 90 and 120 DAT as was observed under T_1 (100% RDF).

Nandekar and Sawarkar (1990) reported that NPK application significantly increasedbrinjal plant height and spread, the number of leaves as well as branches plant^{-1} and fruit length, diameter and weight as compared with the unfertilized control. The highest NPK rate (120 kg N + 75 kg P_2O_5 + 45 kg K_2O ha^{-1}) gave the best results.

Length of leaf (cm) : Significantly higher length of leaves(Table 5) recorded at 30, 60, 90 and 120 days after transplanting (32.33, 55.63, 69.81 and 78.81 cm) under treatment T8 with 50% NPK +25% VC + 25% FYM + *Azotobacter* followed by T9 (50% NPK + *Azotobacter*). Whereas, significantly lower length of leaves at 30, 60, 90 and 120 days after transplanting (21.08, 45.30, 59.94 and 70.94 cm) was observed under treatment T_1 (100% RDF).

Fruit length (cm) : Significantly higher fruit length

Table 3 : Plant height of brinjal cv. Pusa Purple Round at 30, 60, 90 and 120 DAT as influenced by INM treatments.

Treatment	Treatment detail	Plant height (cm)			
		30 DAT	60 DAT	90 DAT	120 DAT
T_1	RDF (100%)	19.00	30.12	62.11	70.74
T_2	50%NPK + 50% FYM	19.42	31.20	63.50	71.00
T_3	50% NPK +50% FYM + *Azotobacter*	20.00	32.50	65.16	72.92
T_4	50%NPK + Vermicompost	20.98	33.84	66.17	73.44
T_5	50% NPK + VC + *Azotobacter*	21.00	33.92	66.92	73.72
T_6	75% NPK + 25% FYM	22.92	34.81	67.72	74.61
T_7	75% NPK + 25% VC	23.00	35.92	68.08	75.08
T_8	50% NPK + 25% VC+ 25% FYM+ *Azotobacter*	24.92	36.51	70.11	75.43
T_9	50%NPK + *Azotobacter*	24.00	36.42	69.10	75.11
	SEm±	**0.28**	**1.26**	**0.30**	**0.30**
	C.D. at 5% level	**0.86**	**0. 86**	**0.90**	**0.91**

Table 4 : Number of leaves/plant of brinjal cv. Pusa Purple Round at 30, 60, 90 and 120 DAT as influenced by INM treatments.

Treatment	Treatment detail	No. of leaves/plant			
		30 DAT	60 DAT	90 DAT	120 DAT
T_1	RDF (100%)	15.20	59.33	63.21	68.90
T_2	50%NPK + 50% FYM	16.40	68.00	77.00	85.50
T_3	50% NPK +50% FYM + *Azotobacter*	17.83	71.69	78.47	87.50
T_4	50% NPK + Vermicompost	21.36	72.00	81.00	89.20
T_5	50% NPK +VC + *Azotobacter*	22.07	72.17	82.66	90.2
T_6	75% NPK + 25% FYM	23.43	73.17	85.05	91.00
T_7	75% NPK + 25% VC	23.71	73.33	93.53	99.03
T_8	50% NPK + 25% VC+ 25% FYM+ *Azotobacter*	25.17	75.67	97.08	109.5
T_9	50%NPK + *Azotobacter*	24.20	75.00	94.18	102.4
	SEm±	**0.78**	**0.78**	**0.76**	**0.57**
	C.D. at 5% level	**2.36**	**2.36**	**2.28**	**1.73**

Table 5 : Length of leaves of brinjal cv. Pusa Purple Round at 30, 60, 90 and 120 DAT as influenced by INM treatments.

Treatment	Treatment detail	Length of leaves/ plant (cm)			
		30 DAT	60 DAT	90 DAT	120 DAT
T_1	RDF (100%)	21.08	45.30	59.94	70.94
T_2	50%NPK + 50% FYM	25.80	49.41	63.83	72.83
T_3	50% NPK +50% FYM + *Azotobacter*	27.47	48.62	64.07	73.08
T_4	50% NPK + Vermicompost	28.67	50.55	65.13	74.13
T_5	50% NPK +VC + *Azotobacter*	29.02	51.73	68.17	77.17
T_6	75% NPK + 25% FYM	30.01	52.00	68.33	77.33
T_7	75% NPK + 25% VC	30.55	53.37	68.67	77.67
T_8	50% NPK + 25% VC+ 25% FYM+ *Azotobacter*	32.33	55.63	69.81	78.81
T_9	50%NPK + *Azotobacter*	31.54	54.13	68.74	77.74
	SEm±	**0.86**	**0.86**	**0.25**	**0.25**
	C.D. at 5% level	**2.59**	**2.59**	**0.76**	**0.76**

(Table 6) at harvest (14.87 cm) was observed under T_8 (50% NPK + 25% VC + 25% FYM + *Azotobacter*), followed by T_9 (50% NPK + *Azotobacter*). Whereas, significantly the lowest fruit length of leaves (8.18 cm) was observed under T_1 (100% RDF).

Sondarva (2018) studied that the when brinjal was grown in open condition with T_{14}: 100% RDF registered maximum number of fruits per plant (24.89), fruit length

Table 6 : Length and diameter of fruit as influenced by INM treatments.

Treatment	Treatment detail	Fruit at harvest maturity (cm)	
		Fruit length	Fruit diameter
T_1	RDF (100%)	8.18	3.00
T_2	50% NPK + 50% FYM	9.53	4.35
T_3	50% NPK + 50% FYM + *Azotobacter*	11.93	4.92
T_4	50%NPK + Vermicompost	12.29	5.20
T_5	50% NPK + VC + *Azotobacter*	13.00	5.30
T_6	75% NPK + 25% FYM	13.35	5.87
T_7	75% NPK + 25% VC	13.43	6.26
T_8	50% NPK + 25% VC+ 25% FYM+ *Azotobacter*	14.87	6.42
T_9	50%NPK + *Azotobacter*	13.96	6.40
	SEm±	**0.28**	**0.36**
	C.D. at 5% level	**0.86**	**1.09**

Table 7 : Fresh fruit weight and dry fruit weight as influenced by INM treatments.

Treatment	Treatment detail	Fruit weight at harvest maturity (g)	
		Fresh fruit weight	Dry fruit weight
T_1	RDF (100%)	38.17	18.00
T_2	50%NPK + 50% FYM	39.37	22.00
T_3	50% NPK + 50% FYM + *Azotobacter*	40.20	23.50
T_4	50%NPK + Vermicompost	40.24	24.50
T_5	50% NPK + VC + *Azotobacter*	42.00	25.00
T_6	75% NPK + 25% FYM	42.20	25.40
T_7	75% NPK + 25% VC	42.40	25.69
T_8	50% NPK + 25% VC + 25% FYM+ *Azotobacter*	49.67	30.67
T_9	50%NPK + *Azotobacter*	42.89	26.60
	SEm±	**0.36**	**0.25**
	C.D. at 5% level	**1.09**	**0.76**

(8.64 cm), fruit circumference (14.14 cm), fruit weight (45.64 g), fruit yield (20357.35 kg/ha) as compared to brinjal grown under INM treated teak based silvi-horticultural system.

Fruit diameter (cm) : Significantly higher fruit diameter (Table 6) at harvest (6.42 cm) was observed under treatment T_8 (50% NPK + 25% VC + 25% FYM + *Azotobacter*), followed by T_9 (50% NPK + *Azotobacter*). While, significantly the lowest fruit diameter (3.00 cm) was observed under treatment T_1 (100% RDF).

Fresh fruit weight (g) : Significantly higher fresh fruit (Table 7) weight at harvest (49.67 g) was observed under treatment T_8 (50% NPK + 25% VC + 25% FYM + *Azotobacter*) followed by T_9 (50% NPK + *Azotobacter*). While, significantly the lowest fresh fruit weight at harvest maturity (38.17 g) was observed under treatment T_1 (100% RDF).

Singh and Syamal (1995) observed that application of 100 kg N ha^{-1} produced the maximum number of brinjal fruits and yield; while fruits weight, total soluble solids and ascorbic acid contents were highest at 150 kg N ha^{-1}.

Dry fruit weight (g) : Significantly higher dry fruit weight (Table 7) at harvest (30.67 g) was observed under treatment T_8 (50% NPK + 25% VC + 25% FYM + *Azotobacter*) followed by T_9 (50% NPK + *Azotobacter*). While, significantly the lowest dry fruit weight (18.00 g) was observed under treatment T_1 (100% RDF).

Harvest maturity (days) : Significantly higher harvest maturity (Table 8) in days (92.67) was observed under treatment T_8 with the application of (50% NPK + 25% VC + 25% FYM + *Azotobacter*) followed by T_9 (50% NPK + *Azotobacter*). While, significantly the lowest harvest maturity in days (79.00) was observed under treatment T_1 (100% RDF).

Yield attributes

No. of fruit/ plant : Significantly higher number of fruits per plant (28.22) was observed (Table 9**)** under treatment T_8 (50% NPK + 25% VC + 25% FYM + *Azotobacter*) followed by T_9 (50% NPK + *Azotoacter*). While, significantly the lowest number of fruits per plant (18.84) was observed under treatment T_1 (100% RDF).

Philip (1995) conducted an experiment on brinjal cv. 'Surya' and recorded the maximum number of fruits per plant (12.9), percentage of fruit set (32.5) and mean weight of fruit (68.8 g) with the treatment receiving 75 kg N, 20 kg P_2O_5 and 25 kg K_2O ha^{-1}.

Fruit yield/plant : Significantly higher fruit yield/ plant (11.40 kg) was observed (Table 9) under treatment T_8 (50% NPK + 25% VC + 25% FYM + *Azotobacter*) followed by T_9 (50% NPK + *Azotobacter*). While, significantly the lowest fruit yield/plant (4.30 kg) was observed under treatment T_1 (100% RDF).

Table 8 : Harvest maturity as influenced by INM treatments.

Treatment	Treatment detail	Harvest maturity (days)
T_1	RDF (100%)	79.00
T_2	50%NPK + 50% FYM	79.40
T_3	50% NPK + 50% FYM + *Azotobacter*	80.40
T_4	50%NPK + Vermicompost	81.60
T_5	50% NPK + VC + *Azotobacter*	82.00
T_6	75% NPK + 25% FYM	83.00
T_7	75% NPK + 25% VC	85.00
T_8	50% NPK + 25% VC+ 25% FYM+ *Azotobacter*	92.67
T_9	50%NPK + *Azotobacter*	88.31
	SEm±	**0.30**
	C.D. at 5% level	**0.91**

Table 9 : No. of fruit/plant and fruit yield/plant as influenced by INM treatments.

Treatment	Treatment detail	No. of fruit/plant	Fruit yield/plant (kg)
T_1	RDF (100%)	18.84	4.30
T_2	50%NPK + 50% FYM	21.44	7.23
T_3	50% NPK + 50% FYM + *Azotobacter*	22.33	8.00
T_4	50%NPK + Vermicompost	22.44	8.08
T_5	50% NPK + VC + *Azotobacter*	24. 13	8.55
T_6	75% NPK + 25% FYM	25.95	9.19
T_7	75% NPK + 25% VC	26.33	9.87
T_8	50% NPK + 25% VC+25% FYM+ *Azotobacter*	28.22	11.40
T_9	50%NPK + *Azotobacter*	27.27	10.19
	SEm ±	**0.29**	**0.30**
	C.D. at 5% level	**0.87**	**0.91**

The highest yield of brinjal have been reported with 120 kg N + 80 kg each of P and K ha^{-1} by Bandopadhyay *et al*. (1972) in Bihar.

Fruit yield/plot : Significantly higher fruit yield/plot (342.00 kg) was observed (Table 10**)** under treatment T_8 (50% NPK + 25% VC + 25% FYM + *Azotobacter*) followed by T_9 (50 % NPK + *Azotobacter*). While, significantly the lowest fresh weight at harvest (130.00 kg) was observed under treatment T_1 (100% RDF).

Table 10 : Fruit yield/plot and fruit yield/ha as influenced by INM treatments.

Treatment	Treatment detail	Fruit yield/ plot (kg)	Fruit yield/ha (q)
T_1	RDF (100%)	130.00	32.00
T_2	50 % NPK + 50% FYM	216.80	54.20
T_3	50% NPK + 50% FYM + *Azotobacter*	240.00	60.00
T_4	50%NPK + Vermicompost	242.40	60.60
T_5	50% NPK + VC + *Azotobacter*	256.40	64.10
T_6	75% NPK + 25% FYM	275.60	68.90
T_7	75% NPK + 25% VC	296.00	74.00
T_8	50% NPK + 25% VC+ 25% FYM+ *Azotobacter*	342.00	85.50
T_9	50%NPK + *Azotobacter*	305.70	76.43
	SEm ±	**1.07**	**0.25**
	C.D. at 5% level	**3.21**	**0.76**

Sulikeri *et al.* (1977) conducting an experiment on eggplant cv. 'Malapur', recorded the highest yield with NPK at 80: 60: 40 kg ha^{-1}.

Fruit yield/ha : Significantly higher fruit yield/ha (85.50 q/ha) was observed (Table 10) under treatment T_8 (50% NPK + 25% VC + 25% FYM+ *Azotobacter*) followed by T_9 (50% NPK + *Azotobacter*). While, significantly the lowest fruit yield/ha at harvest (32.50 q/ha) was observed under treatment T_1 (100% RDF).

Conclusion

The results of this study suggest that integrated nutrition management during the *Rabi* season has a favourable and beneficial impact on increasing yield and growth. Its productivity, yield components and growth qualities were all enhanced by applying 50% NPK + 25% VC + 25% FYM + *Azotobacter*. In order to meet the nutrient needs of brinjal throughout the rabi season, the results unmistakably showed that an integrated use of organic manures in addition to artificial fertilizers is required.

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