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Influence of different fertilizer doses on growth and yield of ginger (*Zingiber officinale* Rosc.) Cv. IISR Mahima

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Abstract
The study showed that the fertilizer dose of 125:50:100 kg NPK/ha gave the best results for ginger growth and yield. This treatment significantly improved growth characteristics such as plant height, number of leaves, number of tillers per plant, leaf length, leaf breadth and plant spread. It also recorded the highest yield, including the number, length, girth and weight of both primary and secondary rhizomes, yield/plant. Overall, T_9 (125:50:100 kg NPK/ha) found to be the most effective fertilizer level for maximizing both vegetative growth and yield in ginger Cv. IISR Mahima.

Keywords: Ginger and fertilizer doses

Introduction
Ginger (*Zingiber officinale* Roscoe), a valuable spice crop native to tropical Asia, has been cultivated since ancient times in India for its aromatic underground rhizome. It is nutritionally rich, containing carbohydrates, proteins, fats, fiber, minerals, and bioactive compounds such as gingerol (23-25%), shogaol (18-19%), and α-zingiberene, which contribute to its pungency, aroma, and medicinal properties (Vadivel *et al*., 2006; Swaminathan, 1974) [15, 16]. In Maharashtra, commercial cultivation is concentrated in districts like Satara, Sangli, Pune, and Kolhapur, while in the Konkan region including Ratnagiri and Sindhudurg ginger is mainly grown on a small scale for domestic use (Yadav, 2009) [19]. Konkan's agro-climatic suitability offers considerable scope for expanding ginger cultivation, thereby supporting crop diversification and contributing to improved farm profitability.

As a nutrient-demanding crop, ginger responds significantly to balanced fertilization, especially nitrogen (N), phosphorus (P), and potassium (K). Nitrogen is essential for chlorophyll synthesis and amino acid formation, promoting vigorous vegetative growth and facilitating the uptake of other nutrients (Nayak *et al*., 2020) [4]. Phosphorus supports carbohydrate metabolism and root initiation (Nayak *et al*., 2020) [14]. Potassium enhances yield by regulating enzyme activity, stomatal function, and carbohydrate translocation, which leads to better improved market quality (Haque *et al*., 2007) [1]. Considering the crop's nutrient requirements and the regional potential, the present investigation aims to evaluate the effect of varying NPK fertilizer doses on the growth and yield performance of ginger in the Konkan region.

Materials and methods
A field experiment was conducted during the Kharif season at Nursery No. 4, College of Horticulture, Dapoli, to study the effect of different fertilizer levels on the growth and yield of ginger (*Zingiber officinale* Rosc.) cv. Mahima. The experiment was laid out in a Randomized Block Design (RBD) comprising ten treatments, each replicated three times. The treatment details are presented in Table 1.

The respective fertilizer doses as per the treatment schedule, along with other recommended agronomic practices for ginger cultivation, were uniformly applied across all plots, including the control treatment.

Table 1: Treatment Details

1	T_1	75:50:50 NPK kg/ha
2	T_2	75:50:75 NPK kg/ha
3	T_3	75:50:100 NPK kg/ha
4	T_4	100:50:50 NPK kg/ha
5	T_5	100:50:75 NPK kg/ha
6	T_6	100:50:100 NPK kg/ha
7	T_7	125:50:50 NPK kg/ha
8	T_8	125:50:75 NPK kg/ha
9	T_9	125:50:100 NPK kg/ha
10	T_{10}	Absolute control (No fertilizers)

Results and Discussion

The growth and yield of ginger are greatly influenced by fertilizer levels, as they supply essential nutrients for vital physiological and biochemical functions. Proper nutrient availability enhances growth traits like plant height, leaf number, and leaf length, which in turn contribute to higher yields. Optimal fertilizer doses improve nutrient uptake, support vigorous vegetative growth, and promote rhizome development, making balanced fertilization key to maximizing ginger productivity and ensuring sustainable crop management.

Plant Height (cm)

The study showed that different fertilizer levels significantly affected plant height in ginger, with the tallest plants (83.65 cm) observed in treatment T_9 (125:50:100 kg NPK/ha) and the shortest (55.18 cm) in the control (T_{10}). The increased height may be attributed to balanced NPK nutrition, nitrogen enhancing cell division, elongation while phosphorus accelerates cell multiplication and potassium supports carbohydrate and protein metabolic activities. These findings align with the findings by Verma *et al*. (2009) and Seyie (2011) [17, 14].

Number of leaves per plant

The study revealed that fertilizer levels significantly influenced the number of leaves per plant in ginger, with the highest leaf count (132.36) observed in treatment T_9 (125:50:100 kg NPK/ha) and the lowest (57.51) in the control (T_{10}). The increase in leaf number may be due to the combined effects of nitrogen, phosphorus, and potassium, where nitrogen promotes cell division, elongation, and leaf development, phosphorus accelerates cell multiplication, and potassium supports carbohydrate and protein metabolism. These findings are supported by Seyie (2011) [17], who also reported enhanced leaf production with fertilizer application.

Leaf length (cm)

The study showed that different fertilizer levels significantly affected leaf length in ginger, with the longest leaves (23.70 cm) observed in treatment T_9 (125:50:100 kg NPK/ha) and the shortest (17.03 cm) in the control (T_{10}). The increase in leaf length may be attributed to balanced NPK application, where nitrogen promotes cell division and elongation, phosphorus aids in root development and cell multiplication, and potassium maintains cellular turgor pressure. These findings align with those reported by Priyanka (2018) [10] in mango ginger.

Table 2: Effect of fertilizer doses on growth attributes of ginger

Treatment detail	Growth attributes		
	Plant height (cm)	No. of leaves per plant	Leaf length (cm)
T_1: 75:50:50 kg NPK/ha	73.28	100.30	19.83
T_2: 75:50:75 kg NPK/ha	73.16	102.49	20.77
T_3: 75:50:100 kg NPK/ha	73.49	103.13	21.46
T_4: 100:50:50 kg NPK/ha	75.96	107.46	21.57
T_5: 100:50:75 kg NPK/ha	77.01	109.74	21.77
T_6: 100:50:100 kg NPK/ha	79.89	112.54	22.24
T_7: 125:50:50 kg NPK/ha	76.75	108.37	21.68
T_8: 125:50:75 kg NPK/ha	82.47	126.75	23.56
T_9: 125:50:100 kg NPK/ha	83.65	132.36	23.70
T_{10}: Absolute control	55.18	57.51	17.03
Mean	75.08	106.07	21.36
Range	55.18 - 83.65	57.51 - 132.36	17.03 - 23.70
S.E.m (±)	0.47	0.78	0.04
C. D. @ 5%	1.41	2.33	0.13
F test	SIG	SIG	SIG

Yield per plant (g)

The study revealed that treatment T_9 (125:50:100 kg NPK/ha) produced the highest per plant yield (387.69 g), while the lowest (98.20 g) was recorded in the control (T_{10}), indicating the positive impact of balanced NPK fertilization on ginger productivity. The increased yield may be attributed to nitrogen promoting vegetative growth and leaf expansion, phosphorus enhancing root development and energy transfer, and potassium supporting enzyme activation, carbohydrate movement, and stress tolerance. Similar findings were reported in ginger and Priyanka (2018) [10] in mango ginger.

Yield per plot (kg)

The study showed that the highest plot yield (11.17 kg) was recorded in treatment T_9 (125:50:100 kg NPK/ha), while the lowest (2.80 kg) was observed in the control (T_{10}), highlighting the beneficial effect of balanced NPK fertilization on ginger rhizome productivity. The increase in yield may be attributed to nitrogen enhancing vegetative growth and chlorophyll content, phosphorus promoting root development and energy transfer, and potassium regulating stomatal function, enzyme activity, and carbohydrate translocation. Similar results were reported by Neeraja (2015) [5] in turmeric in ginger.

Table 3: Effect of fertilizer doses on yield parameters of ginger

Treatment detail	Yield parameters	
	Yield/plant (g)	Yield/plot (kg)
T_1: 75:50:50 kg NPK/ha	196.30	5.30
T_2: 75:50:75 kg NPK/ha	217.52	6.00
T_3: 75:50:100 kg NPK/ha	225.80	6.16
T_4: 100:50:50 kg NPK/ha	233.24	6.58
T_5: 100:50:75 kg NPK/ha	241.17	6.73
T_6: 100:50:100kg NPK/ha	248.58	7.08
T_7: 125:50:50 kg NPK/ha	307.31	8.85
T_8: 125:50:75 kg NPK/ha	333.66	9.71
T_9: 125:50:100kg NPK/ha	387.69	11.17
T_{10}: Absolute control	98.20	2.80
Mean	248.95	7.04
Range	98.20 - 387.69	2.80 - 11.17
S.E.m (±)	9.63	0.28
C. D. @ 5%	28.61	0.84
F test	SIG	SIG

Conclusion

The study concluded that the fertilizer dose of 125:50:100 kg NPK/ha (T_9) was the most effective for enhancing both vegetative growth and yield in ginger Cv. IISR Mahima, showing significant improvement in growth traits and recording the highest yield per plant and per plot.

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