THE INFLUENCE OF MICRONUTRIENTS ON GROWTH PERFORMANCE OF GINGER (*Zingiber officinale* Rosc.) CV. MAHIMA

Abstract

The present investigation entitled, "The influence of micronutrients on growth performance of ginger (*zingiber officinale*) cv. mahima" was conducted at All India Co-ordinated Research Project on Spices, Asond Block, Central Experiment Station, Wakawali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during 2023-24. Experiment was laid out with **total nine treatments and three replications each** in present study. The experimental findings revealed that the treatment, T_1 i.e. RDF + Foliar Spray of $ZnSO_4$ @ 0.5 % recorded better results in number of tillers per platnt (12.57), plant height (77.65 cm), number of leaves per plant (76.03), leaf length (23.25 cm) and leaf width (3.08 cm). Thus, it was concluded that the treatment T_1 (RDF + Foliar Spray of $ZnSO_4$ @ 0.5 %) was found to be the best for growth performance of ginger (*Zingiber officinale* rosc.) under Konkan agroclimatic conditions.

Keywords: ginger, micronutrient, foliar spray, growth

1. Introduction

Ginger (*Zingiber officinale* Rosc.) is one of the oldest known spices valued for its distinctive aroma and pungency. Ginger is valuable medicinal and culinary crop. It strengthens immunity and is a rich source of minerals and physiologically active compounds. Ginger is utilized in both fresh and dried form. It is mostly used as spice, for candies, pickles and as a medicinal herb for the treatment of gastrointestinal diseases, including dyspepsia, nausea and diarrhea. In India, ginger is cultivated across 1,90,010 hectares, yielding 22,42,780 tons. It is grown in 21 states, with major production concentrated in Madhyapradesh, Karnataka, the northeastern states, Sikkim, Orissa, West Bengal, Andhra Pradesh and Maharashtra. (Anon., 2024).

Ginger is a long duration and heavy feeder crop and responds well to manuring and is also affected by deficiency of micronutrients. Micronutrients are required in small quantity but optimizing them gives higher crops yield with substantial economic as well as health benefits. Micronutrients are the essential elements required for growth and development of a crop is very much necessary as of major nutrients. Nowadays micronutrient deficiency is a prevalent issue in ginger growing soils and application of micronutrient particularly zinc (Zn) and boron (B) enhance the growth of the crop especially in deficient soils (Parthasarathy *et al.,* 2010). Micronutrients can play an important role in disease control of spice crop like ginger. Thus, there is an urgent need to augment supplies of customized fertilizers supplying the micronutrients sufficiently to support the overall need of nutrient. Application of micronutrients showed positive impact on different crops (Barbosa *et al*., 2016; Sarker *et al*., 2018; Alkarawi and Hasan, 2021). Research focused on specific cultivars like Mahima is valuable because different cultivars may respond differently to nutrient management practices. This study provides insights specific to Mahima variety, which can be useful for cultivar-specific agricultural recommendations.

Ginger is a non-traditional crop in Konkan region of Maharashtra. However, the climatic and soil conditions seem to be suitable for its cultivation in this region. The successful introduction of this crop in a large area will not only provide an opportunity to generate income but will also be an option for crop diversification.Very scanty information is available with respect to the effect of zinc, boron, iron and manganese on the growth of ginger. Keeping these points in view, present investigation was undertaken.

2. Material and Methods

An experiment was conducted during the year 2023-24, under the climatic condition of Konkan region at All India Co-ordinated Research Project on Spices, Asond Block, Central Experiment Station, Wakavali, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, having hot and humid climate with the moderate temperature ranging from as low as 7.5ºC to as high as 38.5ºC and average relative humidity ranging from 55 to 100 %. The region receives very high rainfall (above 3000 mm, annually). One month old healthy pro-tray seedlings of Mahima cultivar of ginger were used for planting and are planted at the depth of 5 cm and distance of 30 cm between rows and 25 cm between plants. The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments viz. T_1 (RDF + Foliar Spray of $ZnSO_4$ @ 0.5 %), T_2 (RDF + Foliar Spray of $ZnSO_4$ @ 0.75 %), T_3 (RDF + Foliar Spray of Borax @ 0.2 %), T_4 (RDF + Foliar Spray of Borax @ 0.3 %), T_5 (RDF + Foliar Spray of $MnSO_4$ @ 0.25 %), T_6 (RDF + Foliar Spray of $MnSO_4$ @ 0.5 %), T_7 (RDF + Foliar Spray of $FeSO_4$ @ 0.3 %), T_8 (RDF + Foliar Spray of $FeSO_4$ @ 0.4 %), T_9 (RDF (75:50:50 kg NPK ha^{-1}). For the foliar application of different doses of zinc (0.5% and 0.75%), boron (0.2% and 0.3%), manganese (0.25% and 0. 50%) and iron (0.3% and 0.4%) solutions were prepared by using zinc sulphate, borax, manganese sulphate and ferrous sulphate fertilizer by dissolving the respective weight of chemical fertilizers in 1L of water by

continuous stirring. The spraying was carried out early in the morning by using knapsack hand sprayer. The spraying was done at 60, 90 and 120 days after transplanting.

3. Result and Discussion

3.1 Number of tillers per plant

According to the results of present investigation, significantly highest number of tillers per plant at 90, 120, 150 and 180 DAP were observed in treatment T_1 (7.77, 10.70, 12.07 and 12.57, respectively). While the minimum number of tillers per plant were observed in treatment T_9 (5.40, 7.10, 7.53 and 7.63, respectively). The increase in number of tillers per plant by zinc treated plots might be due to better synthesis of tryptophan being the precursor for auxin synthesis and also it might be due to zinc is effective in regulating plant growth because it forms a part of enzymes system (e.g. carbonic anhydrate), which regulates plant growth. Besides, zinc stimulats photosynthetic activity and its presence is important for protein synthesis (Singh and Dwivedi 2007). Roy *et al*. (1992) also reported increased growth of ginger with application of micronutrients such as zinc, boron and iron through foliar spray.

Table 1. Effect of different micronutrients levels on number of tillers per plant of ginger (cv. Mahima)

Tr.	Treatment detail	Number of tillers per plant				
		60 DAP	90 DAP	120 DAP	150 DAP	180 DAP
T_1	RDF + Foliar Spray of $ZnSO_4$ @ 0.5 %	1.63	7.77	10.70	12.07	12.57
T_2	RDF + Foliar Spray of $ZnSO_4$ @ 0.75 %	1.63	5.79	7.60	9.10	9.27
T_3	RDF + Foliar Spray of Borax @ 0.2 %	1.90	5.74	7.55	9.00	9.13
T_4	RDF + Foliar Spray of Borax @ 0.3 %	1.87	6.70	8.87	10.43	10.83
T_5	RDF + Foliar Spray of $MnSO_4$ @ 0.25 %	1.80	5.87	7.86	9.20	9.30
T_6	RDF + Foliar Spray of $MnSO_4$ @ 0.5 %	1.73	5.68	7.39	8.73	9.12
T_7	RDF + Foliar Spray of $FeSO_4$ @ 0.3 %	2.20	5.67	7.36	8.53	8.53
T_8	RDF + Foliar Spray of $FeSO_4$ @ 0.4 %	1.93	5.63	7.27	8.37	8.50
T_9	RDF (75:50:50 kg NPK ha^{-1})	1.53	5.40	7.10	7.53	7.63
	Range	**1.53-2.20**	**5.40-7.77**	**7.10 - 10.70**	**7.53 - 12.07**	**7.63 - 12.57**
	Mean	**1.80**	**6.04**	**7.97**	**9.22**	**9.43**
	S.Em (±)	**0.28**	**0.35**	**0.43**	**0.36**	**0.43**
	C.D. @ 5%	**NS**	**1.04**	**1.28**	**1.09**	**1.28**

3.2 Height of plant (cm)

Among the different treatments, significantly maximum plant height at 90, 120, 150 and 180 DAP were noted in treatment T_1 (39.46 cm, 52.89 cm, 71.00 cm and 77.65 cm, respectively). While

minimum plant height was observed in treatment T_9 (33.59 cm, 48.18 cm, 66.81 cm and 70.51 cm, respectively). Zinc is effective in regulation of plant growth. The positive effect of the nutrient on Plant height might be due to the balanced nutrition of macro and micronutrients coupled with better fertilizer use efficiency enhanced the photosynthetic rate and other metabolic processes lead to increase in various plant metabolites responsible for cell multiplication and enlargement (Nayak *et al.*, 2020). Foliar nutrition usually penetrate the cuticle of the leaf or stomata, enter the cells rapidly and fulfill the nutrient demand of the growing plant and thus ameliorate nutrient deficiency (Devi and Shanti 2013). Zinc is the structural constituent of few enzymes including RNA polymerase (Marschner, 2003) and carbonic anhydrase (Hafeez *et al*., 2013) besides activating a large number of enzymes influencing metabolisms of carbohydrate, protein (Hafeez *et al*., 2013) and auxins (Marschner, 2003). Similar increase in plant height of ginger with the application of different doses of zinc, boron and iron was also reported by Shadap *et al.* (2018).

Table 2. Effect of different micronutrients levels on height of plant of ginger (cv. Mahima)

Tr.	Treatment detail	Plant height (cm)				
		60 DAP	90 DAP	120 DAP	150 DAP	180 DAP
T_1	RDF + Foliar Spray of $ZnSO_4$ @ 0.5 %	22.87	39.46	52.89	71.00	77.65
T_2	RDF + Foliar Spray of $ZnSO_4$ @ 0.75 %	22.24	34.73	49.69	68.18	73.04
T_3	RDF + Foliar Spray of Borax @ 0.2 %	22.94	34.89	48.96	67.71	72.09
T_4	RDF + Foliar Spray of Borax @ 0.3 %	22.60	38.80	51.37	69.86	75.84
T_5	RDF + Foliar Spray of $MnSO_4$ @ 0.25 %	23.14	35.67	49.82	68.31	74.37
T_6	RDF + Foliar Spray of $MnSO_4$ @ 0.5 %	22.38	34.41	48.47	67.55	71.46
T_7	RDF + Foliar Spray of $FeSO_4$ @ 0.3 %	22.62	34.24	48.42	67.41	71.38
T_8	RDF + Foliar Spray of $FeSO_4$ @ 0.4 %	22.63	34.42	48.87	67.67	71.81
T_9	RDF (75:50:50 kg NPK ha^{-1})	23.15	33.59	48.18	66.81	70.51
	Range	**22.24 - 23.15**	**33.59 - 39.46**	**48.18-52.89**	**66.81 - 71.00**	**70.51 - 77.65**
	Mean	**22.73**	**35.58**	**49.63**	**68.26**	**73.13**
	S.Em (±)	**0.55**	**0.70**	**0.62**	**0.38**	**1.06**
	C.D. @ 5%	**NS**	**2.11**	**1.85**	**1.15**	**3.18**

3.3 Number of leaves per plant

The maximum number of leaves per plant (76.03) was noticed in treatment T_1 [RDF + Foliar Spray of $ZnSO_4$ @ 0.5 %] whereas, the minimum number of leaves per plant (61.57) was observed in treatment T_9 [RDF (75:50:50 kg NPK ha^{-1})]. Application of different micronutrient especially zinc (Zn) improves growth, yield and quality of the ginger crop (Parthasarathy *et al.,* 2010). Zinc is critical for chlorophyll synthesis, which enhances photosynthesis. Improved photosynthesis contributes to better growth and yield (Roy *et al.,* 1992).

Table 3. Effect of different micronutrients levels on number of leaves per plant of ginger (cv. Mahima)

Tr.	Treatment detail	Number of leaves per plant				
		60 DAP	90 DAP	120 DAP	150 DAP	180 DAP
T_1	RDF + Foliar Spray of $ZnSO_4$ @ 0.5 %	8.87	33.67	64.63	72.57	76.03
T_2	RDF + Foliar Spray of $ZnSO_4$ @ 0.75 %	7.93	27.50	57.57	61.67	63.80
T_3	RDF + Foliar Spray of Borax @ 0.2 %	7.27	26.40	56.87	61.53	63.00
T_4	RDF + Foliar Spray of Borax @ 0.3 %	8.87	33.07	61.10	70.00	72.73
T_5	RDF + Foliar Spray of $MnSO_4$ @ 0.25 %	8.93	27.57	58.13	62.80	64.37
T_6	RDF + Foliar Spray of $MnSO_4$ @ 0.5 %	7.53	26.67	56.97	61.63	63.17
T_7	RDF + Foliar Spray of $FeSO_4$ @ 0.3 %	7.90	26.50	56.37	61.37	62.77
T_8	RDF + Foliar Spray of $FeSO_4$ @ 0.4 %	8.20	27.27	55.43	61.17	62.37
T_9	RDF (75:50:50 kg NPK ha^{-1})	7.57	26.03	53.50	60.07	61.57
	Range	**7.27 - 8.93**	**26.03 - 33.67**	**53.50 - 64.63**	**60.07 - 72.57**	**61.57 - 76.03**
	Mean	**8.12**	**28.30**	**57.84**	**63.64**	**65.53**
	S.Em (±)	**0.47**	**0.74**	**1.29**	**0.79**	**0.84**
	C.D. @ 5%	**NS**	**2.21**	**3.87**	**2.36**	**2.52**

3.4 Leaf length (cm)

The data showed that, significantly highest leaf length at 90, 120, 150 & 180 DAP were observed in treatment T_1 (14.62 cm, 20.02 cm, 21.70 cm and 23.25 cm, respectively). The minimum leaf length was noticed in treatment T_9 (26.03, 53.50, 60.07 and 61.57, respectively). Improved photosynthesis efficiency, facilitated by optimal micronutrient levels, can contribute to increased leaf growth. Higher levels of chlorophyll, which are supported by micronutrients, enhance the plant's ability to capture light and convert it into energy, promoting longer leaf development. Zinc stimulates photosynthetic activity. Boron plays an important role in cell division as well as nitrogen metabolism, carbohydrate metabolism and water relation in plants. The results in this experiment are also in agreement with the findings of (Halder *et al.*, 2007a) who reported increased growth of ginger plants with the application of micronutrients.

Table 4. Effect of different micronutrients levels on leaf length of ginger (cv. Mahima)

Tr.	Treatment detail	Leaf length (cm)				
		60 DAP	**90 DAP**	**120 DAP**	**150 DAP**	**180 DAP**
T_1	RDF + Foliar Spray of $ZnSO_4$ @ 0.5 %	10.11	14.62	20.02	21.70	23.25
T_2	RDF + Foliar Spray of $ZnSO_4$ @ 0.75 %	10.39	12.11	18.74	20.20	21.21
T_3	RDF + Foliar Spray of Borax @ 0.2 %	9.95	11.97	18.71	20.09	21.12
T_4	RDF + Foliar Spray of Borax @ 0.3 %	10.33	14.15	19.95	21.47	23.03
T_5	RDF + Foliar Spray of $MnSO_4$ @ 0.25 %	9.99	12.12	18.82	20.45	21.66
T_6	RDF + Foliar Spray of $MnSO_4$ @ 0.5 %	10.14	11.82	18.67	19.75	21.01
T_7	RDF + Foliar Spray of $FeSO_4$ @ 0.3 %	10.18	11.61	17.91	19.35	20.20
T_8	RDF + Foliar Spray of $FeSO_4$ @ 0.4 %	10.22	11.78	18.15	19.72	20.90
T_9	RDF (75:50:50 kg NPK ha^{-1})	10.18	11.59	17.88	19.15	19.26
	Range	**9.95 - 10.39**	**11.59 - 14.62**	**17.88 - 20.02**	**19.1 - 21.70**	**19.26 - 23.25**
	Mean	**10.17**	**12.42**	**18.76**	**20.21**	**21.29**
	S.Em (±)	**0.20**	**0.31**	**0.38**	**0.35**	**0.42**
	C.D. @ 5%	**NS**	**0.92**	**1.12**	**1.06**	**1.27**

3.5 Leaf width (cm)

The significantly highest leaf width at 120, 150 & 180 DAS were observed in treatment T_1 (2.85 cm, 2.97 cm and 3.08 cm, respectively). The minimum leaf width was noticed in treatment T_9 (2.41 cm, 2.46 cm and 2.56 cm, respectively). Zinc and iron are very effective in regulating plant growth because it forms a part of enzymes system (e.g. carbonic anhydrate), which regulates plant growth. Besides, zinc stimulats photosynthetic activity and its presence is important for protein synthesis (Singh and Dwivedi 2007). Similar increase in leaf width of ginger with the application of different doses of zinc, boron and iron was also reported by Shadap *et al*. (2018).

Table 5. Effect of different micronutrients levels on leaf width of ginger (cv. Mahima)

Tr.	Treatment detail	Leaf width (cm)				
		60 DAP	**90 DAP**	**120 DAP**	**150 DAP**	**180 DAP**
T_1	RDF + Foliar Spray of $ZnSO_4$ @ 0.5 %	1.53	2.46	2.85	2.97	3.08
T_2	RDF + Foliar Spray of $ZnSO_4$ @ 0.75 %	1.46	2.35	2.65	2.67	2.85
T_3	RDF + Foliar Spray of Borax @ 0.2 %	1.36	2.41	2.60	2.65	2.83
T_4	RDF + Foliar Spray of Borax @ 0.3 %	1.58	2.53	2.75	2.87	3.03
T_5	RDF + Foliar Spray of $MnSO_4$ @ 0.25 %	1.49	2.39	2.67	2.68	2.85

T_6	RDF + Foliar Spray of $MnSO_4$ @ 0.5 %	1.51	2.45	2.56	2.60	2.80
T_7	RDF + Foliar Spray of $FeSO_4$ @ 0.3 %	1.39	2.33	2.44	2.50	2.67
T_8	RDF + Foliar Spray of $FeSO_4$ @ 0.4 %	1.39	2.46	2.57	2.64	2.80
T_9	RDF (75:50:50 kg NPK ha^{-1})	1.49	2.31	2.41	2.46	2.56
	Range	**1.36 - 1.58**	**2.31 - 2.53**	**2.41 - 2.85**	**2.46 - 2.97**	**2.56 - 3.08**
	Mean	**1.47**	**2.41**	**2.61**	**2.67**	**2.83**
	S.Em (±)	**0.06**	**0.05**	**0.05**	**0.07**	**0.05**
	C.D. @ 5%	**NS**	**NS**	**0.16**	**0.20**	**0.16**

4. Conclusion

On the basis of results found from the present experiment, it can be concluded that foliar application of different micronutrient was found beneficial for growth performance of ginger crop. Treatment T_1 - RDF + Foliar Spray of $ZnSO_4$ @ 0.5 % was significantly superior in terms of number of tillers per plant (12.57), plant height (77.65 cm), number of leaves per plant (76.03), leaf length (23.25 cm) and leaf width (3.08 cm).

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Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOYT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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