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Effect of foliar sprays of micronutrients on the yield and quality of ginger (*Zingiber officinale* Rosc.)

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ABSTRACT

A field experiment was conducted to assess the effect of foliar application of different micronutrients at different concentration on the yield and quality of ginger. Four different micronutrients i.e., zinc and manganese (0.25, 0.50 and 0.75 %), boron and iron (0.2, 0.3 and 0.4 %) were foliar sprayed at 60, 90 and 120 days after planting. The experiment was laid out in randomized block design in three replications with total thirteen treatments. Among the different treatments, maximum number of rhizome per clump (17.78), length of fingers (12.06 cm), length of clump (21.14 cm) and essential oil content (1.59 %) were observed in the plants sprayed with Zn 0.5%. Whereas, girth of fingers (2.83 cm) and breadth of clump (13.12 cm) were noticed in the plants sprayed with B 0.3%. The highest yield/clump (238.20 g) was produced by plants sprayed with Zn 0.5% which was at par with plants sprayed with B 0.3% (235.99 g) and Mn 0.25% (229.72 g) ha^{-1}. From net return and benefit: cost ratio point of view, the best treatment (Rs 6, 82,423.00/- ha^{-1}and 3.43) was by foliar spray with Zn 0.5% followed by foliar spray with B 0.3% (Rs 6,72,950.00/- ha^{-1} and 3.38, respectively).

Keywords: B: C ratio, ginger, micronutrients, quality, yield

Ginger (*Zingiber officinale* Rosc.) is one of the major spices produced and exported from India. The rhizome of ginger is used as a spice throughout the world besides its use in the alternative system of medicine and plays an important role in primary health care. Ginger is an herbaceous perennial, rhizomatous spice crop containing volatile and non-volatile compounds responsible for the characteristic pungency of the ginger rhizome. Ginger is a long duration and heavy feeder crop and responds well to manuring and is also affected by deficiency of micronutrients. Micronutrients are equally important in plant nutrition as macronutrients, they simply occur in plants and soils in much lower concentrations. Plants grown in micronutrient deficient soils exhibit similar reductions in productivity as those grown in macronutrient deficient soils. Nowadays micronutrient deficiency is a common problem in ginger growing soils and application of micronutrient especially zinc (Zn) improves growth, yield and quality of this crop (Parthasarathy *et al*. 2010). Translocation of the metabolites towards rhizome and roots and photo-assimilate pertaining to essential oil and oleoresin in rhizome decreases due to boron deficiency; the overall rhizome yield and quality also decreases (Dixit *et al.*, 2002). Roy *et al.* (1992) found that micronutrients like Zn, Fe and B with increased rated progressively increased the growth and rhizome yield of ginger. Rapid uptake of nutrients applied to crop foliage ensures a fast response within the plant as micronutrients directly enter the metabolic processes. However, overdosing or application at undesired time can lead to crop damage. For intensive cropping with continuously high yield levels more micronutrients are required, and hence it is best to use more frequent applications at the lower rate (Baloch *et al*., 2008). Keeping these points in view, a field experiment was conducted to assess the effect of micronutrients on the yield and quality of ginger applied through foliar sprays.

MATERIALS AND METHODS

The experiment was conducted at Horticultural Research Station, Mondouri, BCKV for two consecutive years (2012-13and 2013-14). Topographical situation of the experimental site belongs to the Gangetic new alluvial plains of West Bengal. The soil was sandy loam and slightly acidic in nature. In general the experimental site was having uniform fertility and good drainage facility and comes under sub-tropical humid climate as it is situated just south of tropic of cancer. The experiment was laid out in RBD with three replications and 13 treatments and the ginger variety 'Nadia' was used for the experiment. Healthy seed rhizome of 25 g each was treated with a solution mixture of Metalaxyl and Dithane M-45 for thirty minutes and dried overnight in shade. The treated seed rhizomes were planted in the raised beds of size 3 x 1 m at spacing of 30 x 25 cm. Four different micronutrients *i.e.*, zinc and manganese (0.25, 0.50 and 0.75%), Boron and Iron (0.2, 0.3 and 0.4%) were foliar sprayed on ginger at 60, 90 and 120 days after planting. The sources of zinc as zinc sulphate ($ZnSO_4$. $7H_2O$) [21% Zinc], boron as borax ($Na_2B_4O_7$) [10.5 % boron], Mn as manganese sulphate

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($MnSO_4.H_2O$) (32 % Mn) and Fe as ferrous sulphate ($FeSO_4.7H_2O$) [19 %] were used. The ginger plants were sprayed with the micro-nutrients three times at 60th, 90th and 120th days after planting.

After the preparation of beds, FYM @ 25 t ha^{-1} was applied along with recommended dose of fertilizers (NPK: 80: 50: 60 kg ha^{-1}) in the form of urea, single super phosphate and muriate of potash, respectively. Nitrogen was applied in two split doses, the first dose as basal application and the other split dose at 30 days after planting as top dressing. The entire dose of phosphorus and potash were applied at the time of sowing as basal dose. Mulching was done on the beds immediately after planting by using dried paddy straw as mulching materials. It is repeated 60 days later after weeding and application of second dose of nitrogen. Earthing up was carried out to cover the exposed rhizome as and when necessary. Irrigation was provided immediately after planting and fertilizer application. Depending on the rainfall and soil moisture conditions, further irrigations were given as required. Hand weeding was done at an interval of 30 days from planting until the complete coverage of canopy. The crop was harvested after complete maturity as indicated by withering and drying up of leaves and tillers nine months after planting. Observations on yield and yield parameters were recorded on five randomly selected clumps in each treatment after harvest. Quality parameters such as essential oil, oleoresin content and recovery percentage were estimated using standard procedures (AOAC, 1975) using dried sample. Statistical analysis and interpretation of data was done as given by Panse and Sukhatme (1985). The level of significance used in 'F' and 't' test was at P=0.05. The economic analysis of different treatments was worked out based on corresponding cost of inputs and market prices.

RESULTS AND DISCUSION

Experimental results (Table 1) revealed that foliar spray of different micronutrients had significant influenced on the yield and yield attributes of ginger. Among the different treatments, maximum number of rhizome per clump (17.78), length of fingers (12.06 cm), length of clump (21.14 cm) and yield per clump (238.20 g) were recorded in the plants sprayed with Zn 0.5%. Whereas, girth of fingers (2.83 cm) and breadth of clump (13.12 cm) were recorded highest in the plants sprayed with B 0.3%. There was a marked variation in the recorded yield and yield attributes from micronutrients treated plants as compared with the control (water spray). This might be due to higher accumulation of assimilates to the rhizomes. This is in conformity with the findings of Halder *et al*. (2007); Roy *et al.* (1992); Sengupta and Basudeb (2011) in ginger, who stated that the higher rhizome yield obtained with the micronutrients treated plants compared to control. The application of micronutrients brings about profound changes in various metabolic processes within the plant system and thereby influences the yield potential (Tripathy *et al*., 1999). The increase in the rhizome yield may be due to addition of micronutrients, which accelerated the cumulative effect of finger weight per plant, finger size and number of fingers per plant (Halder *et al.,* 2007). Among the different micronutrients treatment, the best performance was observed in the plants sprayed with Zn 0.5%. However, the performance among individual micronutrient with different concentrations can also be compared in order to realize the best concentrations among the individual micronutrients. Among the different zinc concentrations, Zn @ 0.5% recorded the best performance and highest yield (238.20 g clump^{-1}). Among the different concentrations of Boron, B @ 0.3% produced the best yield (235.99 g clump^{-1}) and was also the second best treatment overall. Among the different concentrations of Manganese foliar spray, Mn @ 0.25% produced the best yield (229.72 g clump^{-1}) and Fe @ 0.4% produced the best yield (194.11 g clump^{-1}) of ginger compared to the other concentrations of Iron sprayed to the plants. Overall the control (water spray) performed the least with lowest yield (151.37 g clump^{-1}) which clearly demonstrated the beneficial effect of micronutrients on the yield of ginger.

It is evident from the results that the essential oil and oleoresin content of the rhizomes sprayed with different micronutrients were higher compared to the control, even though the data were non-significant. The increased may be due to the increase in the accumulation of organic acids, amino acids and sugar metabolites and their transport from leaves to the rhizome especially in case of Zn application. Micronutrients application enhanced the source sink relation and improved the yield. Hamza *et al.* (2013) reported that application of Zn fertilization produced non-significant results with respect to essential oil and oleoresin content of ginger rhizomes which is in conformity with the findings of the present investigation. However, dry recovery percentage showed significant result and maximum dry recovery percentage was obtained from the plants sprayed with B 0.3% (21.30%) which was closely followed by Zn 0.5% (21.04%) and Mn 0.25% (21.01%) compared to the lowest in the control (18.63%).

From net return and benefit : cost ratio point of view the best treatment (Rs 6,82,423.00/- ha^{-1}and 3.43 respectively) was by foliar spray with Zn 0.5% followed by foliar spray with B 0.3% (Rs 6,72,950.00/- ha^{-1} and

Table 1: Effect of different micronutrients on the yield, yield attributing parameters and quality of ginger (mean of 2 years)

Treatments	No. of rhizome clump $^{-1}$	Girth of fingers (cm)	Length of fingers (cm)	Length of clump (cm)	Breadth of clump (cm)	Yield clump $^{-1}$ (g)	Essential oil (%)	Oleoresin (%)	Recovery (%)	Cost (Rs)	Net return (Rs ha $^{-1}$)	B:C ratio
Zn 0.25 %	17.25	2.71	11.67	20.28	12.41	215.78	1.57	4.63	20.85	637923.00	637923.00	3.20
Zn 0.5 %	17.78	2.80	12.06	21.14	12.98	238.20	1.59	4.67	21.04	682423.00	682423.00	3.43
Zn 0.75 %	17.25	2.71	11.67	20.23	12.46	216.09	1.58	4.64	20.73	636923.00	636923.00	3.20
B 0.2 %	16.97	2.65	11.54	19.70	12.00	205.48	1.56	4.60	20.72	612450.00	612450.00	3.08
B 0.3 %	17.75	2.83	12.02	21.12	13.12	235.99	1.59	4.68	21.30	672950.00	672950.00	3.38
B 0.4 %	16.46	2.55	11.14	18.68	11.20	185.74	1.53	4.56	20.28	560950.00	560950.00	2.82
Mn 0.25 %	17.59	2.79	11.86	20.92	12.94	229.72	1.59	4.69	21.01	666872.20	666872.20	3.34
Mn 0.5 %	16.73	2.60	11.35	19.21	11.63	193.41	1.55	4.60	20.49	593872.20	593872.20	2.97
Mn 0.75 %	16.09	2.50	10.85	17.81	10.69	175.41	1.52	4.52	19.78	519372.20	519372.20	2.60
Fe 0.2 %	16.03	2.50	10.85	17.81	10.76	177.01	1.52	4.51	19.80	520231.00	520231.00	2.61
Fe 0.3 %	16.29	2.52	10.99	18.29	10.96	181.27	1.52	4.54	20.06	543731.00	543731.00	2.73
Fe 0.4 %	16.72	2.60	11.37	19.24	11.62	194.11	1.56	4.59	20.49	597731.00	597731.00	3.00
Control	13.20	2.37	9.08	16.33	9.53	151.37	1.50	4.44	18.63	451645.00	451645.00	2.27
SEm(±)	**0.229**	**0.040**	**0.182**	**0.277**	**0.168**	**2.780**	**0.021**	**0.065**	**0.344**	-	-	-
CD(P=0.05)	**0.67**	**0.12**	**0.53**	**0.81**	**0.49**	**8.11**	**NS**	**NS**	**1.00**	-	-	-

3.38, respectively) and Mn 0.25% (Rs 6,66,872.20/- ha^{-1} and 3.34, respectively) and the lowest in control - water spray (Rs 4,51,645.00/- $ha^{-1}$and 2.27, respectively), which clearly indicating the benefits of spraying micronutrients to boost the yield of ginger.

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