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EFFECT OF ZINC AND BORON NUTRITION ON GROWTH AND YIELD OF MANGO GINGER GROWN IN HOMESTEADS

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Abstract: *A field experiment was conducted in mango ginger, a less exploited spice crop of homesteads in Kerala, to assess the effect of zinc and boron on the growth and yields. Grow bag cultivated mango ginger responded well to the micronutrients when integrated with inorganic NPK while organic sources given to satisfy the NPK requirements without additional Zn/ B was adequate recording yields on par with inorganic + Zn + B application. Application of Zn and B along with organic manures reduced rhizome yields in mango ginger. Economic analysis revealed integration of boron with chemical NPK to be most profitable while organic nutrition can be recommended for grow bag cultivation of mango ginger if the organic sources are available/ produced in situ.*
Keywords: *boron, deficiency, grow bag, homestead, mango ginger, zinc*

Introduction: Multi nutrient deficiencies impairing yields in crops have been a common occurrence in farming today. More than the major nutrients, it is the deficiency of micro nutrients that assumes importance and attempts on their management using specific sources have shown promising results [1-3]. Zinc and boron are two important micronutrients that are reported deficient in Kerala soils [4]. It is reported [5] that 70 % samples collected from the districts in Kerala to be deficient in Boron while 2 to 40 % soils of Kerala are deficient in Zinc [6]. Mango ginger (*Curcuma amada* Roxb.), belonging to the family Zingiberaceae and resembling turmeric plant is characterized by the rhizomes with odour of raw mangoes but no pungency [7]. The crop finds extensive use in indigenous systems of medicine, apart from the culinary preparations in which the rhizomes are used [8]. Nevertheless, the crop is conventionally underexploited and its cultivation is limited to homesteads. Studies on the yield variability of the accessions collected from the households of Kerala range from 30g to 1230g per plant [9]. This necessitates an investigation on the scientific management of the crop. Taking into account, it is pertinent that nutrient management in mango ginger should be attended to. Mango ginger performs well in grow bag containers and can be recommended for inclusion in terrace gardens. In this background an investigation was undertaken to assess the response of mango ginger to zinc and boron nutrition integrated with NPK sources in homesteads.

Materials and Methods

The experiment was laid out at Farming Systems Research Station, Sadanandapuram, Kottarakkara (latitude $9^0$16'N, longitude76^{0}37'E, altitude 91.44m above MSL) under Kerala Agricultural University as part of the research project on 'Socioeconomic analysis and participatory development of homesteads in Kerala". Grow gags of 40 cm x 24 cm x 24 cm were filled with potting mixture of soil: farm yard manure: vermicompost in 2 : 1: 1 ratio and mango ginger rhizomes of size 25g were planted during May 2015. The analysis of the chemical status of the potting mixture revealed acidic pH and medium status for available N, P and K. The package of practices recommendation [10] of 100:50:50 kg NPK ha^{-1} with and without zinc and boron for nutrient management were adopted as treatments-

T1: 100 % RDN organic (three splits, basal, 1 and 2 MAP) + $ZnSO_4$ (foliar 2% 1 MAP)

T2:100 % RDN organic (three splits, basal, 1 and 2 MAP) + borax (foliar 1% 1 MAP)

T3: 100 % RDN organic (three splits, basal, 1 and 2 MAP) + $ZnSO_4$ (foliar 2% 1 MAP) + borax (foliar 1% 2 MAP)
T4: 100 % RDN inorganic (two splits basal and 1 ½ MAP) + $ZnSO_4$ (foliar 2% 1 MAP)
T5: 100 % RDN inorganic (two splits basal and 1 ½ MAP) + borax (foliar 2% 1 MAP)
T6: 100 % RDN inorganic (two splits basal and 1 ½ MAP) + $ZnSO_4$+ borax (foliar 2% & 1% 1 MAP)
T7:100 % RDN organic (three splits, basal, 1 and 2 MAP)
T8:100 % RDN inorganic (two splits basal and 1 ½ MAP)

The sources included inorganic fertilizers (urea, rajphos, muriate of potash @ 2.6 g, 6 g and 2 g per plant respectively) and organic sources (vermicompost 100g, poultry manure 50 g, ash 25 g, farm yard manure 100g, neem cake 50 g and fermented oilcake slurry 250 ml). In all treatments the entire quantity of phosphorus (rajphos 20% P_2O_5) was applied basally. Nitrogen and potassium were given in two splits with urea (46% N) and muriate of potash (60% K_2O) in the inorganic nutrition treatments and organic manures in three splits. Application of fertilizers was followed by earthing up. The crop was ready for harvest in December. Observations on plant height, leaf number, number of tillers and per plant yields at harvest were recorded. Statistical analysis of data was done as per the procedure of Gomez and Gomez (1991).

Results and Discussion

The data on the growth parameters, plant height, leaf and tiller numbers at 2, 4, 5 and 7 MAP are presented in Table 1. The effect was non significant in all stages except at 5 months after planting. Significantly higher values were recorded for plant height in the treatment in which Zn and / B were applied along with inorganic NPK sources. Leaf number was greater for the organic manure treated plants without Zn and / B. Lower values of leaf number 7 MAP compared to that at 5 MAP may be attributed to the senescence of the older leaves as the plant matured. Tiller number also recorded higher values for inorganic combination with Zn and B, and sole organic nutrition.

Table 1. Effect of different nutrient sources on the growth in mango ginger

Treatm-ents	Plant height (cm)				Leaf number				Tiller number			
	2MAP	4MAP	5MAP	7MAP	2MAP	4MAP	5MAP	7MAP	2MAP	4MAP	5MAP	7MAP
T1	39.40	62.33	63.4	76.80	8.67	17.33	18.67	16.67	2.33	3.00	4.33	4.00
T2	48.10	61.50	67.27	64.17	14.67	23.67	22.00	18.67	3.67	3.00	4.00	4.67
T3	45.60	64.03	70.47	70.77	10.67	21.67	21.67	18.67	3.00	4.33	4.67	5.33
T4	50.87	65.47	75.43	74.40	11.67	22.00	17.67	16.00	3.33	3.33	4.00	4.67
T5	54.50	75.37	84.83	89.20	12.00	22.33	17.33	20.33	3.00	3.33	4.67	5.33
T6	49.83	72.90	90.50	85.40	9.00	21.67	23.67	22.33	3.33	3.67	4.67	6.33
T7	45.17	63.20	73.83	76.90	12.33	27.00	28.67	23.00	4.00	4.00	6.33	5.00
T8	43.13	63.53	78.50	76.00	15.00	27.00	25.00	21.67	4.67	4.33	6.00	4.67
CD	ns	ns	14.53	ns	ns	ns	5.53	ns	ns	ns	Ns	ns

Increased vegetative growth is indicative of higher photosynthetic efficiency and higher yields. The rhizome yields recorded followed similar trends. Per plant yields of mango ginger varied significantly with the nutrient sources (Table 2). Maximum yields were recorded in the treatments of inorganic sources combined with boron (673.33g) closely followed by inorganic +Zn and B (648.17g) and sole organic treatment (611g). Significant effects of mineral nutrition in mango ginger have been reported [11]. Zinc and boron are critical plant nutrients required in small quantities. Zinc besides being a constituent of enzymes influences translocation and transport of phosphorus in plants and plays a major role in many metabolic activities. Boron plays a vital role in the physiology of plants and is responsible for cell wall formation, stabilization, lignifications and xylem differentiation. The micronutrient requirements rhizomatous crops have been well documented [3]. Soil application of zinc sulphate (25 kg ha^{-1}), borax (10 kg ha^{-1}) and two foliar sprays of ferrous sulphate (1.0%) significantly increased the yield and yield attributing in ginger [12-13]. Reports on combined applications of NPK and micronutrients resulting in increased rhizome yields have been documented [14-15].

Although application of zinc and boron had stimulatory effects when applied with the inorganic sources, the effect of boron was more marked compared to Zn alone. Better yields with combined application might be due to the synergistic effects of the two micronutrients. Similar findings on the effect of boron being more pronounced than Zn in ginger and in cauliflower were recorded earlier [16-17]. The significant role of boron over copper in turmeric nutrition has also been documented [18]. It is interpreted that mango ginger responds well to boron and zinc nutrition when chemical sources of NPK are used. Yields were 41 and 45 % greater with Zn + B and sole boron application respectively compared to inorganic NPK alone.

Yield attributes varied significantly with treatments, maximum values being recorded for boron application along with inorganic sources followed by combined application and organic management.

Table. 2. Yield and economics of mango ginger as influenced by nutrient management methods

Treatments	Rhizome yield (g/plant)	Rhizome spread (cm)	Total no. of fingers/hill	Benefit- cost
T1	442.00	17.50	42.00	1.28
T2	457.00	15.00	32.33	1.32
T3	435.33	17.37	39.00	1.18
T4	467.67	17.17	43.00	2.78
T5	673.33	20.43	65.00	4.00
T6	648.17	18.17	44.00	3. 40
T7	611.00	17.83	51.67	1.89
T8	396.25	15.57	27.67	3.96
CD	265.56	2.06	14.11	-

A similar trend in yield was not observed when organic sources were combined with Zn and / B application. The assumption is that the micronutrient requirements are satisfied from the organic source itself and hence the response to the additional application was not promising as in inorganic nutrition treatments. It is well illustrated that mango ginger yields were significantly higher when organic sources alone were used, nearly 34.8 to 39.7 percent greater than when combined with Zn and /boron. Organic manures are good sources of micronutrients [19]. According to the results of the study, an additional application is not required when adequate quantum of organic manures are given to meet the NPK requirement of the crop.

Economic analysis of the cultivation with the different sources of nutrients showed inorganic nutrition to be the most profitable (B:C >2.5) while 100 per cent organic treatment, despite the higher yield, recorded lower values for net returns, and hence benefit: cost ratio, as cost of the organic inputs were considered as purchased inputs. However, if these inputs are produced *in situ*, as possible in a homestead system, organic nutrition would be profitable and the disadvantages associated with chemical use can be contained effectively. The suitability of mango ginger as component crop in homestead systems has earlier been documented [20].

Conclusion: The study has brought to light the significance of organic nutrient management in mango ginger. Boron application as foliar spray significantly increased yields in plants fertilized with inorganic NPK fertilizers while organic manures alone were sufficient to meet the nutrient requirements of the crop including that of micronutrients. Hence, in homesteads an organic package of 100g FYM, 100 g vermicompost, 50g neem cake, 25g ash and 50 g poultry manure per plant in three splits at monthly intervals and a foliar spray of fermented oil cake slurry can be recommended for grow bag cultivation of mango ginger.

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