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Response of micronutrient on the quality yield of mango cv. Alphonso under Konkan agro-climatic conditions

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Abstract
The present study was aimed to determine the effect of micronutrients (Cu, B and Zn) on the quality of mango (*Mangifera indica* L.) cv. Alphonso plants. For this purpose, full bearing and mature (10 years old) trees were selected for micronutrient application of different combinations of $CuSO_4$, borax, boric acid and $ZnSO_4$ before flowering and at marble stage of fruit. Results revealed that the application of all micronutrients significantly increased the quality of fruit than the control. Results reported that the treatment T_5 (RDF + foliar spray of 0.4% zinc sulphate + copper sulphate (0.2%) + Borax (0.2%), spraying at just before flowering and marble stage of fruit growth recorded the highest number of fruits/tree (173.32) and fruit yield (4.14 t./ha). Further, the treatment T_4 (RDF + foliar spray of 0.4% zinc sulphate + boric acid (0.2%) spraying at just before flowering and marble stage of fruit growth recorded the highest T.S.S (18.80 ^{0}B) and lowest acidity (0.20%).

Keywords: Mango, micronutrients, quality, yield

Introduction
Mango (*Mangifera indica* L.) the king of fruits" the main fruit of Asia and possessing own importance all over the world has been cultivating in the Indian sub-continent for well over 4000 years (De Candolle, 1904) [6]. The king of fruits is nutritionally very rich, unique in flavor and smell thus account for approximately half of all tropical fruits produced globally.
Alphonso is one of the most popular varieties of India. The fruits are very attractive, large in size having a prominent ventral shoulder and attractive pinkish flush toward the basal end. The taste is superb with an excellent sugar: acid blend and captivating flavour besides being a Table cultivar, much in demand it is a favoured fruits of the processing industry because it remains its characteristics flavour even during processing. But Alphonso has a problem of alternate bearing which is considered as one of the long standing unresolved problems, directly and substantially contributing to poor production. It was observed that unbalanced fertilization, micronutrients deficiencies, poor tree management and inadequate cultural practices are mainly responsible for orchard related quality issues (Ahmad and Rashid, 2003) [1].
These micronutrients also play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzymatic activity, hormone synthesis, nitrogen fixation and reduction etc., (Das, 2003) [4]. Therefore food supplements, multivitamins and mineral supplements are necessary for the healthy crops. According to horticulturists, only application of primary nutrients could not prove successful to produce high quality fruit in mango trees, the application of micronutrients is compulsory as well. Major elements/ macronutrients are quickly taken up and utilized by the tissues of the plants by the catalyzing effect of micronutrients/minor elements (Phillips, 2004) [16].
The sufficient amount of micronutrients necessary for better plant growth which resulted in higher yield due to increased growth, better flowering and higher fruit set (Ram and Bose, 2000) [16]. The improvement in quality of fruit might be due to the catalytic action of micronutrients particularly at higher concentrations. Hence the foliar application of micronutrients quickly increased the uptake of macronutrients in the tissues and organs and improves fruit quality (Anees *et al.*, 2011) [2]. Nowadays, micronutrients are gradually gaining momentum among the fruit growers because of their beneficial nutritional support and at the same time ensure better harvest and returns.

Materials and Methods
The investigation was carried out at the Regional Fruit Research Centre, Vengurla of the University. The experiment was conducted on 30 year old trees of mango cv.

Alphonso planted at 10 m spacing in square system and maintained under uniform cultural practices. The trees were almost uniform in growth and vigour. The experiment was laid out in Randomized Block Design with eight treatments combinations and replicated thrice. The treatment details are as follows.

T. No.	Treatment details
T_1	Control as per RDF (after harvest) in basin after harvest
T_2	RDF + 200 g Zinc sulphate + 100 g Boric acid (Soil application) in basin after harvest
T_3	RDF + 200 g Zinc sulphate + 100 g Copper sulphate + 100 g Borax (Soil application) in basin after harvest
T_4	RDF + Foliar spray of 0.4% Zinc sulphate + Boric acid (0.2%) [2 sprays at just before flowering and marble stage]
T_5	RDF + Foliar spray of 0.4% Zinc sulphate + Copper sulphate (0.2%) + Borax (0.2%) [2 sprays at just before flowering and marble stage]
T_6	RDF + 100 g Zinc sulphate + 50 g Copper sulphate + 50 g Boric acid (Soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Boric acid [2 sprays at just before flowering and marble stage]
T_7	RDF + 100 g Zinc sulphate + 50 g Copper sulphate + 50 g Boric acid (Soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Copper sulphate + 0.1% Boric acid [2 sprays at just before flowering and marble stage]
T_8	Mango special (IIHR) + RDF [2 months before flowering and fruits of 2-4 cm diameter stage]
T_9	RDF + Amrashakti 3 sprays [at pea nut, marble and egg stage]

Recommended dose of fertilizer (RDF): N – 1500g, P_2O_5 – 500g and K_2O – 1000g.

During harvest, ten disease and insect-free, fruits were taken, out of these five fruits were separated and were weighed and remaining five fruits wrapped in paper and stored at room temperature in a basket up to ripening. For biochemical analysis, fruits were peeled and flesh was homogenized in a blender. Biochemical analysis of the fresh fruit juice was carried out. Atago hand refractometer was used to determine the total soluble solids percentage. Total acidity (%) was determined by the method given by Hortwitz (1960) [11].

Results and Discussion

Number of fruits per tree

Data presented in Table 1 revealed that, the treatment T5 (RDF + Foliar spray of 0.4% zinc sulphate + copper sulphate (0.2%) + Borax (0.2%)), spraying at just before flowering and marble stage of fruit growth recorded the highest number of fruits/tree (240.67). The micronutrients when sprayed alone or in combination involved directly in various physiological processes and enzymatic activities. This might have resulted into better photosynthesis, greater accumulation of starch in fruits. The involvement of Zinc in auxin synthesis and Boron in translocation of starch to fruits. The balance of auxin in plant regulates the fruit drop or retention in plants, which altered the control of fruit drop and increased the total number of fruits per tree. Similar results were observed by Singh *et al*. (2003) [20] and Dutta (2004) [8] in mango and Jeyabaskaran and Pandey (2008) [12] in banana, Kavitha *et al*. (2000) [13] in papaya, Sarolia *et al*. (2007) [19] in guava, Kaur *et al*. (2016) [14] in Kinnow Mandarin and Asad *et al*. (2013) [3] in Pear supported the present findings.

Weight of fruit (g)

Data presented in Table 1 revealed that, the treatment T_6 (RDF + 100 g Zinc sulphate + 50 g Copper sulphate + 50 g Boric acid (Soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Boric acid), spraying at just before flowering and marble stage of fruit growth recorded the highest weight of fruit/fruit (270.50 g). The enhancement in quality of fruit could be due to the catalytic action of micronutrients particularly at higher concentration. Hence, the foliar application of micronutrients quickly increased the uptake of macronutrients in the tissues and organs of the mango plants, decreased the nutritional deficiencies and improved the fruit weight. These observations supported by Dhakar *et al*. (2013) [7] in Bael and Asad *et al*. (2013) [3] in pear.

Table 1: Effect of micronutrient on yield and quality of mango cv. Alphonso.

Treatments	No. of fruits/tree	Weight of fruit (g)	Fruit yield (kg/tree)	Fruit Yield (t/ha)	T.S.S. (^{0}B)	Acidity (%)
T_1	86.73	230.60	20.00	2.00	17.70	0.26
T_2	99.98	228.17	22.80	2.28	17.30	0.21
T_3	104.93	223.80	23.40	2.34	17.52	0.21
T_4	110.36	228.33	25.20	2.52	18.80	0.20
T_5	173.32	239.00	41.40	4.14	17.60	0.22
T_6	118.85	275.80	32.70	3.27	17.20	0.21
T_7	118.87	251.00	29.80	2.98	18.15	0.21
T_8	112.23	217.40	24.20	2.42	17.80	0.22
T_9	102.10	240.00	24.50	2.45	18.10	0.21
SEm+	5.37	8.39	1.43	0.13	0.26	0.006
CD at 5%	16.30	25.45	4.36	0.42	0.80	NS

Yield (kg/tree)

Significantly the maximum yield (64.04 kg/tree) was obtained from the trees treated with combination of RDF + Foliar spray of 0.4% zinc sulphate + copper sulphate (0.2%) + Borax (0.2%)), spraying at just before flowering and marble stage compared to other treatments. The significant increase in fruit yield (kg/tree) is a cumulative effect of increase in number of fruits because of reduction in fruit drop vis-a-vis higher fruit weight by the direct and indirect effect of foliar spray of micronutrients in mango cv. Alphonso. Promotion of starch formation followed by rapid transportation of carbohydrates in plants activated by micronutrients like Zn and B are well established. In the present experiment, foliar spray of micronutrient might have affected the physiological processes resulting into higher production of mango cv. Alphonso. This indicated that single chemical or combination of low dose of chemical nutrient did not influence on fruit yield. The increase in yield by boron application may be accredited to the positive effect of boron on increasing the rates of carbohydrate and RNA metabolism (Parr and Loughman,

1983) [15]. The results are in conformity with those of Dutta and Dhua (2002) [9] and Singh *et al*. (2003) [20] in mango, Sarolia *et al*. (2007) [19] and Gaur *et al*. (2014) [10] in guava and Kavitha *et al*. (2000) [13] in papaya.

TSS and Acidity (%)

Amongst the different treatments, the maximum total soluble solids (19.35°) and low acidity (0.13%) were found in T4 (RDF + foliar spray of 0.4% zinc sulphate + boric acid (0.2%) (2 sprays at just before flowering and marble stage) in comparison to rest of treatments and control. These observations were supported by the previous findings by various eminent workers (Rath *et al*., 1980; Syamal and Mishra, 1989; Asad *et al* 2013 and Daulta *et al*. 1981) [18, 21, 3, 5]. The enhancement in quality of fruit could be due to the catalytic action of micronutrients particularly at higher concentration. Hence, the foliar application of micronutrients quickly increased the uptake of macronutrients in the tissues and organs of the mango plants, decreased the nutritional deficiencies and improved the fruit quality.

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