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Effect of micronutrients on growth, yield and fruit quality of mango (*Mangifera indica* L.) cv. Dashehari

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Abstract
The experiment was carried out 2015-16 in Mango orchard at Fruit Research Station Kuthulia, College of Agriculture Rewa (M.P). The study revealed that the Effect of micronutrients on growth, yield and fruit quality of mango (*Mangifera Indica* L.) cv. Dashehari with 7 treatments in Randomized Block Design with three replications, Observations were recorded on growth yield & quality parameters. The maximum plant height was recorded (9.59m) in Treatment T_4, RDF + Foliar spray of 0.4% Zinc sulphate + 0.2% copper sulphate + 0.2% Boric acid (2 Spray at just before flowering and marble stage) followed by (9.03m) treatmentT5, RDF + Zinc sulphate 100 g + Copper sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Boric acid (2 Spray at just before flowering and marble stage. The maximum plant spread was recorded (Mean of N-S 11.93m E-W 12.87) in treatment T_2, RDF + Zinc sulphate 200 g + Copper sulphate 100 g + Boric scid 100 g (soil application) in basin after harvest. The maximum number of fruits per plant was recorded (288.00) in treatment T5, RDF + Zinc sulphate 100 g + Copper sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Boric acid (2 Spray at just before flowering and marble stage) However the maximum tree volume (1100.79 m3) was recorded in treatment T_4, RDF+ Zinc sulphate 0.4%+ Copper sulphate 0.2% + Boric acid 0.2%(2 spray at just before flowering and marble stage). The maximum length and width of fruit were recorded (10.67cm), (5.97cm) in treatment T_5, RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil application) + Zinc sulphate 0.2%+ Boric acid 0.1%(2 spray at just before flowering and marble stage). The maximum fruit yield was recorded (64.04kg/tree) in treatment T_5, RDF + Zinc sulphate 100 g + Copper sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Boric acid (2 Spray at just before flowering and marble stage). The minimum fruit yield was recorded (29.55kg)in treatment T_7control RDF only. The maximumpulp percentage was recorded (79.94%) in treatment T_5, RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil application) + Zinc sulphate 0.2%+ Boric acid 0.1%(2 spray at just before flowering and marble stage) The maximum acidity was recorded (0.26%) in treatment T_4, RDF + Foliar spray of 0.4% Zinc sulphate + 0.2% copper sulphate + 0.2% Boric acid (2 Spray at just before flowering and marble stage).The maximum total soluble solids (TSS) was recorded(21.13 ^{0}Brix) T_5, RDF + Zinc Sulphate 100 g + Copper sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Boric acid (2 Spray at just before flowering and marble stage).

Keywords: Mango micronutrient growth, yield & fruit quality

Introduction
Mango (*Mangifera indica* L.) is one of the most important commercial fruits of India. Which is being grown in India more than four thousand years has been a source of inspiration of other countries and is currently being grown in over 90 countries around the world. In Madhya Pradesh region, farmers economy is better dependent on mango. However under changing climate Langra mango yield is not sure. India ranks first in mango production of total world production. It has always placed at the highest position. It is national fruit of India, which is most popular among the consumers. It has great adaptability, thrives in a wide range of climatic, and soil conditions. It's utilized at all stages of its development both in its immature and mature stages. In Madhya Pradesh region farmers economy is better dependent on mango. where it occupies an area of 2515.97 thousand hectare with total production of 18431.33 thousand million tons. In which Madhya Pradesh, occupies an area of 25.43 thousand hectare

and production is 379.73 thousand million tons (Anonymous 2013-14). In Rewa region has great potentially for mango cultivation is 7262 hectare. The success of mango cultivation largely depends on the soil, nutrient management etc. Actually soil is not an inert medium of plant growth as people often believe. The soil can influence of root growth, impact functional activities of plant and control the availability of nutrients. Nutrition consumption an important component of intensive cultivation of mango. An inadequate nutrition of mango orchard is one of the major constraints limiting the productivity. The judicious use of major or minor nutrients, have paramount importance in the production of mango. Production is usually limited by deficient nutrients and these have to be applied judiciously, harvest a proper balance between nutrients, either major or minor. Soil application of micro nutrients has less effective than foliar application although combined application of Zn (0.4%) and urea (1%), produces the highest number of fruits and yield of mango, whereas the fruit quality was improved by the application of B (0.4%) + Urea (1%) to younger plant (Banik *et al.* 1997) [2]. Dashehari is leading commercial variety of mango in the country as well as Rewa region. There is little information available on the effect of fertilization, especially in respect of micro nutrients like Zinc, Boron and Copper as basal and foliar application on growth, fruit yield and fruit quality of mango in M.P. Keeping these point in view, to study the present experiment was laid out the Effect of micronutrients on Growth, Yield and Fruit Quality cv. Dashehari of mango.

Materials and Methods

The experiment was carried out in mango orchard of Fruit Research Station Kuthulia, College of Agriculture, Rewa (M.P.) The chemical analysis of the fruits was done in the laboratory of the Department of Soil Science, College of Agriculture, Rewa (M.P.).Twenty five year old plants of mango cv Dashehari spacing 10 m x 10 m apart at Fruit Research Station Kuthulia, Rewa were selected for the study during year 2015-16. Two plants pertreatment replicated three times in a randomized block design. comprising with 7 treatment *viz*, T_1, RDF + Zinc sulphate 200 g + Boric acid 100 g (soil application) in basin after harvest T_2, RDF + Zinc sulphate 200 g + Copper sulphate 100 g + Boric acid 100 g (soil application) in basin after harvest T_3, RDF + Foliar Spray of 0.4% Zinc sulphate + 0.2% Boric acid (2 Spray at just before flowering and marble stage). T_4, RDF + Foliar spray of 0.4% Zinc sulphate + 0.2% copper sulphate + 0.2% Boric acid (2 Spray at just before flowering and marble stage) T_5, RDF + Zinc sulphate 100 g + Copper Sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Boric acid (2 Spray at just before flowering and marble stage T_6, RDF + Zinc sulphate 100 g + Copper sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% copper sulphate + 0.1% Boric acid (2 Spray at just before flowering and marble stage). T_7 control RDF only. In this investigation observations were recorded on the three parameters *viz*. Growth parameter, Flowering & fruiting characters and fruit quality. The plant height from first oriented branch the tree measuring with help of bamboo. The total soluble solid (TSS) of fruit was measured with the help of portable hand refractometer of 0-32^{oB} and it was expressed in degree brix (^{0}B). Plant spread by measured in the North-South with the help of measuring tape. Randomly five mature fruits were selected and weighed and average weight was calculated and recorded in grams. Length of fruit randomly five fruits was selected and length was measured by Vernier caliper length was calculated and recorded in cm. Acidity was estimated by simple acid alkaline titration method as described in A.O.A.C. (1970) [1].

Table 1: Growth parameter of Effect of micronutrients of Mango during 2015-16

S. No.	Treatment	Plant height (m)	Canopy height (m)	Plant spread (N-S) (m)	Plant spread (E-W) (m)	Volume of tree (m^3)
T_1	RDF+ Zinc sulphate 200g + Boric acid 100g (soil application)	6.79	6.08	10.08	10.60	512.50
T_2	RDF+ Zinc sulphate 200g + Copper sulphate 100g + Boric acid 100g (soil application)	8.15	7.50	11.93	12.87	952.60
T_3	RDF+ Zinc sulphate 0.4%+ Boric acid 0.2% (2 spray at just before flowering and marble stage)	7.71	7.01	11.10	10.55	711.06
T_4	RDF+ Zinc sulphate 0.4%+ Copper sulphate 0.2% + Boric acid 0.2% (2 spray at just before flowering and marble stage)	9.59	8.56	11.79	13.07	1100.79
T_5	RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric scid 50g (soil application)+ Zinc sulphate 0.2%+ Boric acid 0.1%(2 spray at just before flowering and marble stage)	9.03	8.33	11.10	11.98	1007.99
T_6	RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil application)+ Zinc sulphate 0.2%+ Copper sulphate 0.1% +Boric acid 0.1%(2 spray at just before flowering and marble stage)	7.03	6.45	10.56	11.02	588.68
T_7	Control (as RDF)	8.58	7.58	11.72	13.38	1027.71
	S.Em ±	1.002	0.857	0.741	1.109	212.534
	C.D.at 5%	NS	NS	NS	NS	NS

Table 2: Effect of micronutrients on Yield attributes during 2015-16

S. No.	Treatment	Fruit length(cm)	Fruit width(cm)	Fruit Wt. (g)	Num. of fruits/ plant	Fruit yield kg/plant
T_1	RDF+ Zinc sulphate 200g +Boric acid 100g (soil application)	9.67	5.82	208.33	169.00	35.47
T_2	RDF+ Zinc sulphate 200g + Copper sulphate 100g + Boric acid 100g (soil application)	9.87	5.72	200.00	234.33	46.83
T_3	RDF+ Zinc sulphate 0.4%+ Boric acid 0.2%(2 spray at just before flowering and marble stage)	9.33	5.52	196.67	184.83	36.41
T_4	RDF+ Zinc sulphate 0.4%+ Copper sulphate 0.2% + Boric Acid 0.2%(2 spray at just before flowering and marble stage)	9.73	5.67	186.67	266.00	49.65
T_5	RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil	10.67	5.97	220.00	288.00	64.04

	application)+Zinc sulphate 0.2%+ Boric acid 0.1%(2 spray at just before flowering and marble stage)					
T_6	RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric Acid 50g (soil application)+ Zinc sulphate 0.2%+ Copper sulphate 0.1% +Boric acid 0.1%(2 spray at just before flowering and marble stage)	10.33	5.77	210.00	281.17	58.98
T_7	Control (as RDF)	8.66	5.43	180.00	160.83	29.55
	S.Em ±	0.538	0.070	6.810	34.638	7.888
	C.D.at 5%	1.668	0.218	21.103	107.341	24.446

Table 3: Effect of micronutrients on fruit quality parameters of Mango during 2015-16

S. No.	Treatment	Peel (%)	Pulp (%)	Stone (%)	Acidity (%)	TSS (º B)
T_1	RDF+ Zinc sulphate 200g +Boric acid 100g (soil application)	12.21	78.02	9.77	0.25	20.47
T_2	RDF+ Zinc sulphate 200g + Copper sulphate 100g + Boric acid 100g (soil application)	11.01	79.72	9.27	0.24	20.33
T_3	RDF+ Zinc sulphate 0.4%+ Boric acid 0.2%(2 spray at just before flowering and marble stage)	12.34	79.34	8.32	0.25	20.53
T_4	RDF+ Zinc sulphate 0.4%+ Copper sulphate 0.2% + Boric acid 0.2%(2 spray at just before flowering and marble stage)	12.20	78.50	9.30	0.26	20.53
T_5	RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil application)+ Zinc sulphate 0.2%+ Boric acid 0.1%(2 spray at just before flowering and marble stage)	11.75	79.94	8.31	0.24	21.13
T_6	RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil application)+ Zinc sulphate 0.2%+ Copper sulphate 0.1% +Boric acid 0.1%(2 spray at just before flowering and marble stage)	12.16	78.65	9.19	0.25	20.67
T_7	Control (as RDF)	11.57	78.39	10.04	0.27	20.07
	S.Em ±	0.788	1.115	0.591	0.013	0.530
	C.D.at 5%	NS	NS	NS	NS	NS

Results and Discussion

The present investigation Effect of micronutrients on growth, yield and fruit quality of mango cv. Dashehari was conducted Under AICRP on Fruits, Fruit Research Station, Kuthulia College of Agriculture Rewa (M.P.) during the year 2015-2016. The maximum plant height was recorded (9.59 m) in treatment T_4, RDF + Foliar spray of 0.4% Zinc sulphate + 0.2% copper sulphate + 0.2% Boric acid (2 Spray at just before flowering and marble stage)followed by (9.03m). in treatment T_5,RDF + Zinc sulphate 100 g + Copper sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Boric acid (2 Spray at just before flowering and marble stage).Which is lowest (6.79m) in treatment T_1. RDF+ Zinc sulphate 200g +Boric acid 100g (soil application) The maximum canopy height was recorded (8.56 m) in treatment T_4, RDF + Foliar spray of 0.4% Zinc sulphate + 0.2% copper sulphate + 0.2% Boric acid (2 Spray at just before flowering and marble stage)followed by (8.33m) in treatment T_5, RDF + Zinc sulphate 100 g + Copper sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Boric acid (2 spray at just before flowering and marble stage).The maximum plant spreadwas recorded (Mean N-S11.72m&E-W 13.38m) in treatment T_7 control RDF only followed by (N-S 11.93m &E-W 12.87m) in treatment T_2, RDF + Zinc Sulphate 200 g + Copper sulphate 100 g + Boric acid 100 g (soil application) in basin after harvest. The maximum tree volume was recorded (1100.79 m^3) in treatment T_4,RDF+ Zinc sulphate 0.4%+ Copper sulphate 0.2% + Boric Acid 0.2% (2 spray at just before flowering and marble stage) followed by (1027.71 m^3) in treatment T_7controlRDF only. The maximum fruit weight was recorded in (220 g)treatment T_5, RDF + Zinc sulphate 100 g + Copper sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% Boric acid (2 Spray at just before flowering and marble stage followed by (210 g.) RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric Acid 50g (soil application) + Zinc sulphate 0.2%+ Copper Sulphate 0.1% +Boric Acid 0.1% (2 spray at just before flowering and marble stage). The minimum fruit weight was recorded (180g) in treatment T_7 control RDF only. Bacha *et al*. (1995) [3] they application of Fe, Zn and Mn was most effective found that the foliar application and pronounced on the yield and spraying vines with Fe, Zn and Mn gave obvious increased in the weight of fruit in grape. The maximum number of fruits per plant was recorded in (288.00) treatment T_5, RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric Acid 50g (soil application) + Zinc sulphate 0.2%+ Boric acid 0.1%(2 spray at just before flowering and marble stage) followed by (281.17) fruits per plant in treatmentT_6,, RDF + Zinc sulphate 100 g + Copper sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% copper sulphate + 0.1% Boric acid (2 Spray at just before flowering and marble stage).Whereas the minimum number of fruit (160.83) per plant were recorded in treatment T_7, control RDF only. The maximum length & fruit width was recorded (10.67cm& 5.97cm)in treatment T_5, RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil application) + Zinc sulphate 0.2% + Boric acid 0.1%(2 spray at just before flowering and marble stage) followed by (10.33cm& 5.77cm) in treatment T_6, RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil application) + Zinc sulphate 0.2% + Copper sulphate 0.1% + Boric acid 0.1%(2 spray at just before flowering and marble stage). The results partially agreed with the finding of Dutta and Dhua (2002) [5] also reported that 0.2% spray of Zn at flowering + pea stage of mango recorded highest fruit diameter & length. The maximum fruit yield (64.04kg/tree) was recorded in treatment T_5, RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil application) + Zinc sulphate 0.2% + Boric acid 0.1%(2 spray at just before flowering and marble stage) followed by (58.98kg) in treatment T_6, RDF + Zinc sulphate 100 g + Copper sulphate 50 g + Boric acid 50 g (soil application) in basin after harvest + Foliar spray of 0.2% Zinc sulphate + 0.1% copper sulphate + 0.1% Boric acid (2 Spray at just before flowering and marble stage).which is minimum was recorded (29.55kg/tree) inT_7, control RDF only. These findings are also in confirmation with findings of Balakrishnan *et al*. (1996) [4]

reported that foliar spray of 0.25% each of ZnSO4, FeSO4 and MnSO4 combined with the 0.15% boric acid on pomegranate significantly increased the weight and yield. The maximum peel percentage (12.34%) was recorded in treatment T3, RDF + Foliar spray of 0.4% Zinc sulphate + 0.2% Boric acid (2 Spray at just before flowering and marble stage) followed by (12.21%) in treatment T_1,RDF + Zinc sulphate 200 g + Boric acid 100 g (soil application) in basin after harvest. The results revealed that maximum pulp percentage was recorded(79.94%) in treatment T_5, RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric Acid 50g (soil application) + Zinc sulphate 0.2%+ Boric acid 0.1%(2 spray at just before flowering and marble stage). followed by (79.72%) in treatment T_2RDF + Zinc sulphate 200 g + Coppersulphate 100 g + Boric acid 100 g (soil application) in basin after harvest. The minimum pulp (78.02%) in treatment T_1RDF+ Zinc Sulphate 200g +Boric acid 100g (soil application). The maximum total soluble solids(TSS)was recorded (21.13 ^{0}B) in treatment T_5, RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil application) + Zinc sulphate 0.2%+ Boric acid 0.1%(2 spray at just before flowering and marble stage) followed by (20.67^{0}B) treatment T_6, RDF+ Zinc sulphate 100g + Copper sulphate 50g + Boric acid 50g (soil application) + Zinc Sulphate 0.2%+ copper sulphate + Boric acid 0.1% (2 spray at just before flowering and marble stage). The minimum TSS was recorded (20.07^{0}B) in treatment T_7, control RDF only. The maximum acidity content was recorded (0.27%) in treatment T_7control RDF only. (Banik *et al*. 1997) [2]. These findings are in accordance with the reports of Sarkar *et al*. (1984) [10] in Litchi and Rath *et al*. (1980) [8] in mango. Kundu and Matra (1999) [6] reported that the spray of Cu + B + Zn was most effective in increasing the fruit weight & yield of mango.

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