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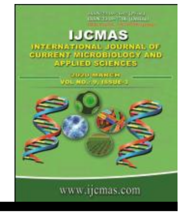

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Foliar Feeding of Micronutrients: An Essential Tool to Improve Growth, Yield and Fruit Quality of Sweet Orange (*Citrus sinensis* (L.) Osbeck) cv. Mosambi under Non-traditional Citrus Growing Track

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A B S T R A C T

Calcareous and alkaline nature of the soil under non-traditional citrus growing track is the major drawback for low yield and poor fruit quality of mosambi with increased granulation problem. Generally, these type of soil hinders the smooth up take of micronutrient to the plants from soil. Hence, the present investigation was design to evaluate the impact of foliar feeding of micronutrients on growth, yield and fruit quality of sweet orange (*Citrus sinensis* (L.) Osbeck) cv. Mosambi. The observations revealed that treatment combination of Zn @ 0.5%+ Fe @ 0.2% + B @ 0.3% + Cu @ 0.1% followed by B @ 0.3% + Fe @0.2% and Zn @ 0.5% + B @ 0.3% were most effective for improving vegetative growth of sweet orange cv. Mosambi in terms of plant height and trunk girth increment, canopy volume and growth of current season shoot. The commencement of reproductive growth in terms of 50% bloom after bud break as well as full bloom after bud break with maximum flowering and fruit setting was also obtained in in Zn @ 0.5% + Fe @ 0.2% + B @ 0.3% + Cu @ 0.1% spray followed by B @ 0.3% + Fe @0.2% and Zn @ 0.5% + B @ 0.3%. the yield was calculated maximum in the treatment consist of Zn @ 0.5% + Fe @ 0.2% + B @ 0.3% + Cu @ 0.1% (8.06 t acre^{-1}). Further, fruit quality attributes in terms of sugar:acid ratio, sucrose content, carotenoid content and edible: non-edible ratio was recorded maximum with Zn @ 0.5% + Fe @ 0.2% + B @ 0.3% + Cu @ 0.1% spray (41.88, 4.44%, 0.59 mg 100 g^{-1}).Therefore, three foliar spay of Zn @ 0.5%+ Fe @ 0.2% + B @ 0.3% + Cu @ 0.1%from May- July may be recommended to get maximum yield of better quality mosambi fruit under non-conventional citrus growing track having calcareous and alkaline nature of soil.

Introduction

The citrus, belongs to family Rutaceae, constitutes a major group of fruits; composed of citron, citrange, orange, mandarin, lime, lemon, lemonime, grapefruit, pummelo, tangelo, etc. It is one of the most economically important fruits grown worldwide. Further, itplays animportant nutritional role in our daily food requirements, being a rich source of Vitamin C. (Gregory 1993) Apart from this, citrus fruit contain phenolics compounds, protein, minerals, vitamins, pigments, volatile compounds (present in the essential oil), lipids, sugars, acids and fibre (Bampidis and Robinson 2006). These components ultimately increase the nutritional as well as antioxidant properties of the fruit (Bermejo *et al.,* 2011) and make them an important produce for human health (Barros *et al.,* 2012). Now, with increasing awareness about the nutritional security and faster development of processing industries throughout the globe, the demand of this crop has increased tremendously.

Keeping this growing demand of citrus fruits in view, the area of the crop in India has also increased at a faster rate even in non-traditional citrus growing area during the last 2-3 decades, resulting a sharp increase in total area of citrus in the country from 0.39 million hectares in 1991-92 to 1.03 million hectares in 2017-18(Anonymous 2018).

Despite of faster area expansion, the productions as well as fruit quality of the crop particularly under non-traditional area are not improved at satisfactory level. One of the main reasons behind this low yield and poor fruit quality of mosambi under non-traditional citrus growing track is the calcareous and alkaline nature of the soil which hinders the smooth up take of micronutrient to the plants from soil (Zekri and Obreza 2003) resulting acute deficiency of micronutrient to the plants.

Further, the competitions for water and nutrient; application of major nutrients through straight or mixed fertilizers leads to the depletion of micronutrients resulting less availability of the same to the plant.However, micronutrients are required in small amount but play a great role in plant metabolism (Katyal 2004; Kazi *et al.,* 2012). Among different micronutrients, zinc, iron, boron and copper plays the vital role in plant metabolism of citrus (Sohrab *et al.,* 2013; Stenico *et al.,* 2009; Khurshid *et al.,* 2008; Zekri and Obreza 2003).These are involved in the synthesis of many compounds essential for plant growth and development. Further, by acting as the activators for various other enzymes, micronutrients can tremendously boost the crop yield and post-harvest life of horticultural produce (Raja 2009) while their deficiency can turn healthy orchard unproductive with poor yield and quality.

Hence, micronutrient management is one of the key technologies to enhance the production of quality fruits not only in citrus but in all the perennial fruit crops (Sikarwarand Tomar2018; Abhijith *et al.,* 2018; Guvvali *et al.,* 2017).Few experiments have been conducted earlier on the application of micronutrient on different fruit crops and shown significant improvement in yield and quality (Kumar and Verma 2004) through improved growth, better flowering and higher fruit set (Ram and Bose 2000).

Therefore, application of micro-nutrients along with primary and secondary nutrients becomes very pertinent to avert the emerging nutrient deficiencies and to evolve sustainable production technology with increased productivity of citrus crops particularly under non-conventional citrus growing track.

However, soil application of micronutrients is not very effective to recover these deficiencies in calcareous and alkaline soils. Hence, application of these micronutrient through any other alternate but effective methods could be one of the productive options.

Foliar feeding of micronutrients, particularly in perennial crops has gained considerable attention in recent time due to its highly recognized effect on yield and quality of crop (Bhanukar *et al.,* 2018; Singh *et al.,* 2017). Foliar feeding gives quick response as the application is directly on leaves. In addition, foliar feeding avoids soil interactions and can be used in combination with existing spray programs.

Hence, the present investigation was carried out to investigate the effect of foliar feeding of micronutrients on granulation and fruit quality of sweet orange (*Citrus sinensis*(L.) Osbeck) cv. Mosambi under non-conventional area of the crop.

Materials and Methods

Ten years old sweet orange (*Citrus sinensis* (L.) Osbeck) cv. Mosambi was selected as the experimental plant. All the plants were in uniform growth and free from any injuries and pest and disease infestation.

Treatment details

The trail was continued with the following treatment combinations- T_1: Control (treated with distilled water); T_2:Zn @ 0.5%; T_3:Cu @ 0.1%; T_4:B @ 0.3%; T_5:Cu @ 0.1%+ Fe @ 0.2%; T_6:B @ 0.3% + Fe @0.2%; T_7:Zn @ 0.5% + B @ 0.3%; T_8:Cu @ 0.1% + B @ 0.3%; T_9:Zn @ 0.5%+ (Fe @ 0.2% + B @ 0.3% + Cu @ 0.1%). Working solutions were sprayed though foot sprayer to the entire canopy of the selected mosambi plants during the morning hours.

Three foliar spray at one month interval was done on each experimental plant starting from the month of May. Among the selected micronutrient, application of zinc solution was done fifteen days before the application of other micronutrients at each interval to avoid any antagonistic effect among these micronutrients. Zn-EDTA (chelated), Cu-EDTA (chelated), Fe-EDTA (chelated)and Solubor were used as the source of Zn, Cu, Fe and B respectively.

Vegetative, physiologicaland reproductive growth of the plants was observed under field condition. After harvesting, yield was calculated and biochemicalanalyses of fruit were carried out.

Vegetative and physiological growth of the plant

To measure the increment in plant height, trunk girth and canopy volume as influenced by the foliar spray of micronutrients, the height of the plant, trunk girth and canopy volume was measured before foliar application of micronutrients and again after harvesting of fruits from the entire experimental orchard. Thereafter, net increment was calculated by subtracting the value of initial observation from the final one after harvesting.

However, growth of current season shoot was measured after all the foliar application. Further, chlorophyll content (chlorophyll a, and b) of the leaves was analysed at vegetative stage and again at fruiting stage following the method of Barnes *et al.*, (1992) and the ratio of chlorophyll a: b was calculated thereafter.

Period of 50% flowering after bud break as well as full bloom after bud break was measured by counting the days taken to come 50% flowering and full bloom after bud break respectively.

Reproductive growth, yield and fruit quality attributes

Total numbers of flowers per shoot was recorded by counting the flowers on each shoot at full bloom. Thereafter, total number of fruit setting was also counted similarly. Further, Total number of harvestable fruits retained on each experimental plant was counted manually and fruit yield per plant was measured by weighing all the harvested fruits from individual plant using digital weighing balance. Thereafter, yield per acre area was calculated by using following formula-

$$\text{Yield/acre} = \text{Yield/plant} \times \text{No. of plants accomodated in one acre (540)}$$

Peel of individual mosambi fruit was separated manually and juice content was extracted. Thereafter edible: non-edible ratio was measured. Sugar:acid ratio was determined by dividing the total sugar content in the juice with titratable acidity for ten individual fruits under each replication and average value was calculated thereafter Sugar content in the ripe fruit was estimated by Lane and Eynone (1923) method.

Total carotenoids content of fruit juice was determined by the method of Roy (1973) with some modifications. In which 5 g of juicy vessiclas was crushed in acetone till the tissue became colourless. Then the extracted solution was poured into a separating funnel. To it, petroleum ether and small amount of sodium sulphate solution was added and shaken rigorously.

Then the separating funnel was kept undisturbed to separate the carotenoids from acetone to petroleum ether layer. After that, coloured solution was separated in a 50 ml volumetric flask and the volume was adjusted with petroleum ether. Finally, the sample absorbance was measured at 452 nm in a (HALO DB-20S UV-VIS double beam) spectrophotometer, using petroleum ether as blank. The results was expressed as mg/100 g fresh weight.

Statistical analysis

The experiment was laid out in randomized block design with three replications. The observations were analysed by using OPSTAT software (OPSTAT, CSS HAU, Hisar India).

Results and Discussion

Vegetative and physiological growth of the plant

A perusal of data pertaining to plant height increment differed significantly due to the effect of various micronutrient treatments (Table 1). As compared to control, plant height has increased in each and every treatment and it was observed maximum in the treatment consist of foliar feeding of Zn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9) (99.71% higher than the control). Similarly, increment of trunk girth was measured maximum in the treatment consist of foliar feeding of Zn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9) flowed by B @ 0.3% + Fe @ 0.2% (T_6) (4.84 cm and 4.63 cm, respectively) with minimum in control (4.05 cm) (Table 1).

Among all the treatments, increment in canopy volume was recorded maximum in the plant treated with Zn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9) followed by B @ 0.3% + Fe @ 0.2% (T_6) (12.37 cm^3 and 12.08 cm^3, respectively) with minimum in control (9.98 cm^3). On the other hand, growth of current season shoot was also varied significantly over control in all the micronutrient treatment with maximum in Zn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9) with at par result in B @ 0.3% + Fe @ 0.2% (T_6)(9.57 cm and 9.50 cm, respectively).

On the other hand, ratio of chlorophyll A:B at vegetative stage was recorded maximum in B @ 0.3% + Fe @ 0.2% (T_6)with statistically at par result inZn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9) (3.10 and 3.06, respectively) while minimum in control (1.94) (Table 2). However, at fruiting stage, it was increased drastically in control and reach to maximum level as compared to other treatment (2.49) with minimum in Cu @ 0.1% + B @ 0.3% (T_8).

Reproductive growth, yield and fruit quality attributes

The perusal of data regarding period of 50% flowering as well as full bloom after bud break indicates a significant variation among the treatments as influenced by micronutrient application (Table 2). The commencement of 50% flowering as well as full bloom after bud break was earliest in the treatment consist of Zn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9) (6.0 day s and 15.33 days, respectively after bud break) with at par result in B @ 0.3% + Fe @ 0.2% (T_6) (6.33 days and 15.67 days, respectively).

Apart from these two treatment it was also earlier in all the treatments as compared to control. However the plants under control took maximum time to come into 50% flowering as well as in full blooming condition (11.00 days and 20.00 days after bud break, respectively).

On the other hand, total number of flower per shoot as well as total number of fruit setting per shoot was estimated maximum (63.00 and 27.67, respectively) in the plant treated with Zn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9) followed by B @ 0.3% + Fe @ 0.2% (T_6) (Table 3). Apart from these fruit setting was also increased significantly over control in all the treatment combinations. Similar pattern was also observed for fruit yield.

Fruit yield was recorded maximum in combined application of Zn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9) treatment with statistically at par result in Zn @0.5% + B @0.3% (T_7) and B @ 0.3% + Fe @ 0.2% (T_6) treatment (79.91%, 74.33% and 71.79% higher than the control) (Table 3).

Apart from these, fruit yield was also increased significantly over control in the plants sprayed with Cu @ 0.1% + B @ 0.3% (T_8), Cu @ 0.1% + Fe @ 0.2% (T_5), B alone @ 0.3% (T_4) and Zn alone @ 0.5% (T_2) treatment (55.24%, 40.14%, 39.42% and, 18.08%higher than control). However, it was computed minimum in control (4.48 tonnesacre^{-1}) with par value in Cu spray alone @ 0.1% (T_3) (4.52tonnesacre^{-1}).

Perusal of data pertaining to edible to non-edible ratio of ripped mosambi fruits(table 3) indicates that the control had minimum ratio(0.640) while it was increased significantly in all the micronutrient treatment with maximum in Zn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9)which was statistically at par with combined spray of Zn @0.5% + B @0.3% (T_7) (0.840).

Among biochemical attributes, sucrose%, Sugar: Acid ratio and carotenoid content in ripped mosambi fruits was recorded maximum in the treatment consist of foliar spray of Zn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9) (4.44%, 41.88 and 0.59 mg 100 g^{-1}, respectively) with at par result in Zn @0.5% + B @0.3% (T_7). However, all these biochemical attributes of ripped mosambi fruit also enhanced significantly in all the micronutrient treatments as compared to control (3.31%, 17.45 and 0.37 mg 100 g^{-1}, respectively) (Table 3).

Physiological growth of the plant

Generally foliar application of micronutrients increased all the photosynthetic compounds significantly within the plant system resulting improved vegetative and physiological growth of the plant with reduced leaf drop. Zn helps to increase the rate of cell division and elongation (Cakmak 2008) and also accelerates the rate of metabolites translocation (Hatwar *et al.,* 2003). Further, Zn also increases the rate of photosynthesis in the plant system by increasing the activity of carbonic anhydrase (Qiao *et al.,* 2009).

Boron indirectly increased the rate of photosynthesis by involving in the carbohydrate metabolism. On the other hand, Fe helps in the formation of chlorophyll and activation of several enzymes including those involved in the oxidation or reduction processes of photosynthesis and respiration and being a good synthesizer of carbohydrate in the plant system, Fe acts as a strong sink (Sohrab *et al.,* 2013) resulting improved physiological growth before the start of reproductive phase.

However, Cu influenced the metabolic activity in the plant system by involving in different metabolic pathways (including ATP synthesis) as cofactor for various enzymes (Sharma and Agrawal 2005). Further, Cu helps in the carbohydrate and nitrogen metabolism in citrus (Stenico *et al.,* 2009) resulting improved physiological growthin sweet orange cv. Mosambi.

Hence, combined application of all these four micronutrients (Fe, Zn, Cu and B) ultimately enhanced the physiological activities in the plant system significantly resulting improved vegetative growth in term of increment of plant height, trunk girth, canopy volume and current season shoot.

Reproductive growth, yield and fruit quality attributes

Zn and B plays significant role on reproductive growth of the plants. Foliar spray of boron increases the level of sugar in the stigma resulting improved pollen germination. Further, it promotes the pollen tube growth which ultimately helps in early flowering and fruit setting (Singh *et al.,* 2003).

In addition, it regulates carbohydrate metabolism in the plants and accelerate the carbohydrate supply to the reproductive buds resulting improved flower and fruit setting with decreased flower and fruit abscission (Smit and Combrink 2005). However, foliar feeding of Zn enhanced the photosynthates translocation at faster rate to the developing fruits and decreased the flower and fruit abscission by increasing IAA synthesis (Shnain *et al.,* 2014; Singh and Tawari 2013; Graham *et al.,* 2000; Ruby *et al.,* 2001).

Hence, the combined application of Zn, Fe, B and Cu enhanced the photosynthetic activities significantly in the plant system resulting improved carbohydrate translocation from source to sink. Therefore, treatment T_9 had maximum yield followed by treatment T_7.

These results confirm the earlier findings of Singh and Tiwari (2013), Ashraf *et al.,* (2012) and Tariq *et al.,* (2007) who reported that the increased production of photosynthatesunder these treatmentswas utilized by the developing fruits resulting increased fruit yield.

Fruit quality in terms of edible to non-edible ratio, sucrose content, sugar:acid ratio and carotenoid content in the ripped mosambi fruit has increased significantly in all the micronutrient treated plants as compared to control. However, all the fruit quality attributes were estimated maximum in combined application of Zn @0.5% + Fe @0.2% + B @0.3% + Cu @0.1% (T_9) followed by Zn @0.5% + B @0.3% (T_7).

Table.1 Effect of foliar feeding of micronutrients on vegetative growthof sweet orange (*Citrus sinensis* (L.) Osbeck) cv. Mosambi

Treatment	Plant height increment (cm)	Trunk girth increment (cm)	Canopy Volume (cm^3)	Growth of current season shoot (cm)
T_1- Control	17.57±0.02	4.05±0.02	9.98±0.05	6.95±0.04
T_2- Zn @ 0.5%	21.07±0.50	4.14±0.02	10.46±0.04	7.65±0.06
T_3 -Cu @ 0.1%	21.28±0.57	4.17±0.02	10.72±0.07	8.46±0.05
T_4- B @ 0.3%	25.12±0.69	4.22±0.05	11.34±0.05	8.92±0.03
T_5- Cu @ 0.1%+ Fe @ 0.2%	23.82±0.94	4.20±0.03	11.15±0.06	8.74±0.10
T_6- B @ 0.3% + Fe @0.2%	32.77±1.13	4.63±0.06	12.08±0.03	9.50±0.03
T_7- Zn @ 0.5% + B @ 0.3%	30.03±0.97	4.44±0.04	11.93±0.03	9.37±0.07
T_8-Cu @ 0.1% + B @ 0.3%	28.15±0.79	4.35±0.04	11.66±0.05	9.16±0.05
T_9- Zn @ 0.5%+ (Fe @ 0.2% + B @ 0.3% + Cu @ 0.1%)	35.09±0.45	4.84±0.10	12.37±0.08	9.57±0.06
CD (≤0.05)	2.59	0.13	0.17	0.18
CV (%)	5.68	1.65	0.85	1.17

Value indicates mean of three replicates. Different letters in the same column indicate significant differences at P ≤ 0.05 (Duncan's Multiple Range Test).

Table.2 Effect of foliar feeding of micronutrients on physiological and reproductive growth of sweet orange (*Citrus sinensis* (L.) Osbeck) cv. Mosambi

Treatment	Chlorophyll A:B ratio in leaf		Duration to 50% flowering after bud break (days)	Duration to full bloom after bud break (days)
	Vegetative stage	Fruiting stage		
T_1- Control	1.94±0.06	2.49±0.11	11.00±0.58	20.00±0.58
T_2- Zn @ 0.5%	2.43±0.21	1.66±0.15	9.67±0.67	19.33±0.33
T_3 -Cu @ 0.1%	2.47±0.20	1.95±0.04	9.00±0.58	19.33±0.82
T_4- B @ 0.3%	2.94±0.20	1.46±0.07	8.00±0.58	17.67±0.33
T_5- Cu @ 0.1%+ Fe @ 0.2%	2.73±0.22	1.26±0.09	8.33±0.33	18.00±0.25
T_6- B @ 0.3% + Fe @0.2%	2.69±0.15	1.40±0.05	6.33±0.33	15.67±0.33
T_7- Zn @ 0.5% + B @ 0.3%	3.10±0.19	1.64±0.06	6.67±0.67	16.33±0.33
T_8-Cu @ 0.1% + B @ 0.3%	2.69±0.09	1.25±0.06	7.33±0.33	17.67±0.67
T_9- Zn @ 0.5%+ (Fe @ 0.2% + B @ 0.3% + Cu @ 0.1%)	3.06±0.18	1.41±0.03	6.00±0.58	15.33±0.33
CD (≤0.05)	0.58	0.26	1.23	1.38
CV (%)	11.93	9.14	8.76	4.45

Value indicates mean of three replicates. Different letters in the same column indicate significant differences at P ≤ 0.05 (Duncan's Multiple Range Test).

Table.3 Effect of foliar feeding of micronutrients on yield and fruit quality of sweet orange (*Citrus sinensis* (L.)Osbeck) cv. Mosambi

Treatment	Total number of flowers shoot^{-1}	Total number of fruit setting shoot^{-1}	Yield (t acre^{-1})	Fruit quality attributes			
				Edible: non-edible ratio	Sucrose content (%)	Sugar: Acid ratio	Carotenoid content (mg 100 g^{-1} FW)
T_1- Control	41.33±0.88	15.67±0.33	4.48±0.07	0.640±0.017	3.31±0.02	17.45±0.23	0.37±0.003
T_2- Zn @ 0.5%	46.00±0.58	17.33±0.33	5.29±0.04	0.730±0.015	4.03±0.11	22.53±0.69	0.40±0.004
T_3 -Cu @ 0.1%	44.67±1.76	17.33±0.33	4.52±0.05	0.743±0.032	4.04±0.07	20.98±1.27	0.43±0.003
T_4- B @ 0.3%	48.33±0.88	19.67±0.33	6.25±0.10	0.743±0.026	3.70±0.18	25.17±1.28	0.49±0.002
T_5- Cu @ 0.1%+ Fe @ 0.2%	48.00±0.58	19.33±0.67	6.28±1.04	0.743±0.007	3.65±0.20	25.64±0.82	0.48±0.004
T_6- B @ 0.3% + Fe @0.2%	59.00±1.16	25.00±0.58	7.70±0.28	0.770±0.017	4.20±0.12	36.88±1.40	0.55±0.002
T_7- Zn @ 0.5% + B @ 0.3%	57.33±1.20	22.67±0.88	7.81±0.09	0.840±0.015	4.53±0.15	39.96±1.35	0.54±0.004
T_8-Cu @ 0.1% + B @ 0.3%	52.67±1.20	21.00±0.58	6.95±0.13	0.797±0.027	3.51±0.14	31.72±1.05	0.52±0.006
T_9- Zn @ 0.5%+ (Fe @ 0.2% + B @ 0.3% + Cu @ 0.1%)	63.00±1.53	27.67±1.45	8.06±0.12	0.853±0.049	4.44±0.08	41.88±1.40	0.59±0.006
CD (≤0.05)	3.36	2.20	0.39	0.079	0.40	3.54	0.01
CV (%)	3.76	6.12	3.53	5.92	5.86	6.96	1.20

Value indicates mean of three replicates. Different letters in the same column indicate significant differences at P ≤ 0.05 (Duncan's Multiple Range Test).

In both the treatment, the improvement of fruit quality is mainly associated with the role of Zn and B. Zn play important role for the synthesis of different enzymes during fruit developmental stages which accelerate the formation of higher amount of protein, acids and sugars (Srivastava and Gupta 1996) resulting increased TSS: acid ratio.

Further, Zn specifically accelerates the activity of aldolase enzyme which in turn helps in more accumulation of sugar in the fruits. On the other hand, boron helps to increase sugar translocation from source to sink by forming B complex with the sugar element (furanosecis-diol structure). In addition, Fe helps in the synthesis carbohydrate in the plant system and act as a strong sink (Sohrab *et al.*, 2013) which ultimately helps to enhance the sugar content and TSS in ripped mosambi fruits (Ram and Bose, 2000) while copper has positive impact on improving fruit quality particularly TSS and sugar content in ripe fruits (Khurshid *et al.*, 2008).

Hence the combined application of Zn, Fe, Cu and B together as well as Zn and B together ultimately improved the overall fruit quality attributes significantly as compared to other treatment which confirm the earlier findings of Alloway (2008); Tariq *et al.*, (2007) and Babu and Yadav (2005).

In addition, due to maximum translocation of food reserves from source to sink under these two treatments (T_9 and T_7), the rag percent was recorded minimum in T_9 and T_7treatments. The result of the present investigation showed that the treatment combination of Zn @ 0.5%+ (Fe @ 0.2% + B @ 0.3% + Cu @ 0.1%) was most effective for improving growth, yield and quality attributes of sweet orange (*Citrus sinensis* (L.) Osbeck) cv. Mosambi. Hence, three foliar application of Zn @ 0.5%+ (Fe @ 0.2% + B @ 0.3% + Cu @ 0.1%) during the month of May, June and July may be recommended for getting maximum profit from mosambi orchard having calcareous and alkalinenature of soil.

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