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Influence of Foliar Application of Micronutrients on Tree Growth and Chlorophyll Status of Mandarin Orange (*Citrus reticulata* Blanco.) Under Lower Pulney Hills

Nithin Kumar C. J.[1*], J. Rajangam[2], K. Balakrishnan[3], Sampath P. M.[4] and Kavya M. V.[5]

[1]Department of Fruit Science, College of Horticulture Bagalkot
University of Horticultural Science, Bagalakot, Karnataka -587104

[2]Department of Fruit Crops, Horticultural College and Research Institute – Periyakulam, TNAU, Tamil Nadu

[3]Department of Crop physiology, Agricultural College and Research Institute - Madurai, TNAU, Tamil Nadu

[4]Department of Fruit Science, College of Horticulture, Bengaluru, UHS- Bagalkot , Karnataka

[5]Department of Post harvest technology, College of Horticulture Bagalakot, UHS- Bagalkot , Karnataka

*Corresponding Author E-mail: kumarcjnithin@gmail.com

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ABSTRACT

To investigate the influence of foliar application of $ZnSO_4$, $FeSO_4$, H_3BO_4, $MnSO_4$ and $CuSO_4$ on tree growth and chlorophyll content of mandarin orange (Citrus reticulata Blanco.) present study was conducted under lower pulney hills, during 2015-2016. The trees sprayed with either alone or in combination with various micronutrients revealed a significant difference among the 15 treatments replicated three times in randomized block design. Among the treatment combination significant increased leaf chlorophyll contents and slightly increment in tree height and tree spread respectively by combined application of micronutrients in T_{15} ($ZnSO_4$ 0.2% + $FeSO_4$ 0.2% + H_3BO_4 0.2% + $MnSO_4$ 0.3% + $CuSO_4$ 0.4%) at flowering and fruit set stage effectively improved growth attributes of the mandarin orange.

Key words: *Mandarin orange, Micro-nutrients, Foliar application, Chlorophyll content*

INTRODUCTION

Citrus (*Citrus reticulata* Blanco.) is one of the most important fruit crops of the globe, extensively cultivated in tropical and sub-tropical climate. Citrus is primarily valued for the fruit, which is either used alone as fresh fruit, processed into juice or added to dishes and beverages. The fruits are well known for their dietary, nutritional, medicinal and cosmetic properties and are also good source of citric acid, flavonoids, phenolics, pectin, limonoids, ascorbic acid etc. in addition to potassium, folate, calcium, thiamin, niacin, vitamin B6, phosphorus, magnesium, copper, riboflavin, pantothenic acid and a variety of phytochemicals. Citrus fruits posses greater adaptability to different agro climatic condition so are grown with equal success in tropical and subtropical even in some favorable parts of the temperate of the world.

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In India, there are 26 states involved in citrus production but nine states cover more than 70% of area and 89% of total production. India is the fourth largest citrus producing country in the world contributing 6.5 percent of production. In India, citrus ranks 3rd in area and production, area of citrus fruit was about 0.98 million hectares with a production of 11.06 million tons and average productivity of 9.69 tons/ha[1]. Total mandarin production in India is 3.86 million tons with 0.35 million ha area and 9.3 tons/ha as productivity. Citrus requires 17 essential elements for the normal growth and production. Micronutrient deficiencies often tend to limit the productivity in this crop. It has been shown by several workers that low nutritional levels of micronutrients cause die-back, chlorosis, reduction in yield, quality and other ailments in mandarin orange[3,11,12]. Therefore, citrus requires judicious application of fertilizers for better growth and sustained production of high quality fruits[7,9]. Application of these micronutrients helps to increases the photosynthetic compounds inside the plant tissue which ultimately reduces the leaf drop and give strength for their persistency compare to soil application which ultimately leads to increases in production, improved fruit quality and marketability. So it need to test the foliar spraying of micronutrients to enhance the production and growth of mandarin crop.

MATERIAL AND METHODS

The field experiment was conducted in farmer field under lower Pulney hills of Kaanalkadu (Thadiyankudisai), Tamilnadu during the year 2015-16. For conducting this study six-year-old uniform trees of mandarin orange were selected. Soils of pulney hill region are red laterite having brown to dark brown colour. They are deep well drained and possess sandy clay loam structure which is appropriate for citrus cultivation. An altitude of 1098 m above MSL and the annual rainfall is around 1400 mm. The mean maximum and minimum temperature were 32.6 ºC and 17.7 ºC respectively with mean relative humidity of 66.5 %.

There were 15 treatments with 3 replication tested in randomized block design. The effects of ZnSO4 (0.2%), $FeSO_4$ (0.2%), H_3BO_4 (0.2%), $MnSO_4$ (0.3%) and $CuSO_4$ (0.4%) alone or in combination was studied. The micronutrient was applied as a foliar spray thrice at monthly interval from July to October 2015 and spray was given in the evening hours between 3.00-5.00 pm by using a hand sprayer**.** The required quantities of micronutrients were dissolved in water separately and then pH of these nutrient solutions was adjusted by lime and sprayed in vegetative, flowering and fruitset stages. The simple water spray was done on the tree under control treatment. In each spray treatment Teepol was added as sticking agent in prepared solution.

Treatment details:

T_1: Control (Water spray), T_2: $ZnSO_4$ (0.2%), T_3: $FeSO_4$ (0.2%), T_4: H_3BO_4 (0.2%), T_5: $MnSO_4$ (0.3%), T_6: $CuSO_4$ (0.4%), T_7: $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%), T_8: $ZnSO_4$ (0.2%) + H_3BO_4 (0.2%), T_9: $ZnSO_4$ (0.2%) + $MnSO_4$ (0.3%), T_{10}: $ZnSO_4$ (0.2%) + $CuSO_4$ (0.4%), T_{11}: $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_4 (0.2%), T_{12}: $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) + $CuSO_4$ (0.4%), T_{13}: $ZnSO_4$ (0.2%) + $MnSO_4$ (0.3%) + $CuSO_4$ (0.4%), T_{14}: $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) + $MnSO_4$ (0.3%) and T_{15}: $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) + $MnSO_4$ (0.3%) + $CuSO_4$ (0.4%).

RESULT AND DISCUSSION

Growth parameters

The data on plant height was recorded in the three stages *viz.*, vegetative, flowering and fruit set are presented in (Table 1). During vegetative stage the treatment combination had no influence on plant height. At later stages among the treatments, T_{15} had significant influence on the plant height with 3.82 and 3.90 m at flowering and fruit set stage. Whereas in control (T_1) it was recorded the lowest value of plant height (3.21 and 3.30 m). The tree spread was also recorded in three stages (Table 1) where as application of micronutrients as foliar spray in vegetative stage were not influenced any significant results. Later at flowering and fruit set stage, the treatment T_{15} recorded the highest spread of 2.67 and 2.80 m in N-S and 2.34 and 2.48 m in E-W. The minimum tree spread of 2.20 and 2.33m in N-S and 2.00 m and 2.12m in E-W was registered in control (T_1). This is due to the application of micronutrients, like Zn, Fe and B which influence on growth attributes and improves the photosynthetic efficiency and respiration of plant. The zinc sulphate on enhancing the vegetative growth may be ascribed for role of zinc in synthesis of tryptophan, which is the precursor of auxin as conformed by Singh *et al*[13]. The combinations of boron and zinc increased the metabolites activities, which lead to increase plant metabolites responsible for cell division, cell elongation and plant growth. The result was in agreement with the findings of Bhaleroa and Patel[2] in Papaya var. Taiwan Red lady. Fe is also necessary for vital plant metabolic functions such as chlorophyll synthesis, enzymatic reactions, respiration and photosynthesis. In addition, boron regulates metabolism involved in translocation of carbohydrates, cell wall development and RNA synthesis. The result is in close conformity with the findings of Ram and Bose[10].

Similar report was observed by Khan *et al*[7]., in Feutrell' s Early mandarin, Gurjar *et al*[5]., and Ullah *et al*[15]., in Kinnow mandarin. Foliar application of zinc and boron significantly affected the vegetative growth parameter. This might be due to the favorable influence of applied micronutrient (zinc + boron) on vegetative characteristics because of their catalytic or stimulatory effect on most of the physiological and metabolic process of plant. Zinc and boron are essential component of enzymes responsible for nitrogen and carbohydrates metabolism respectively, there by resulting in increased uptake of nitrogen by the plant. Further, involvement of zinc in the synthesis of tryptophan which is a precursor of indole acetic acid synthesis, consequently increased tissue growth and development. Boron increases the phenolic compounds which regulate polar auxin transport. The increased auxin activity results in increased vegetative growth characters.

The results of the present finding revealed that plant spread was influenced by the foliar application of micronutrient. During initial vegetative stage spraying micronutrient had no significant influence but on later stages (flowering and fruit set) the plant spread N-S and E-W was influenced significantly. The plant spread recorded the highest value in T_{15} . Possible reason for the increment of plant spread at later stage may be because of increased photosynthetic rate and carbohydrate accumulation as a result of sufficient level of micronutrient in plant system which helped for better plant growth reported by Gautam *et al*[4]., and Krishnamorthy and Noorjehan[8] in mango by application of zinc, iron, boron, magnesium and copper.

Physiological parameters

The perusal of the data regarding leaf chlorophyll 'a', chlorophyll 'b' and total chlorophyll content showed significant differences between the treatments at subsequent different stages. The chlorophyll 'a'content in leaf significantly differed among the treatment at all the stages **(Table 2).** Maximum chlorophyll 'a' was registered in all stages. But in the treatment T_{15} at vegetative stage (1.690 mg /g), flowering stage (1.845 mg/ g) and fruit set stage (1.965 mg g^{-1}) the chlorophyll content was recorded the highest value. The minimum content of chlorophyll 'a' was recorded in T_1 at vegetative stage (1.63 mg /g), flowering stage (1.083 mg/ g) and fruit set stage (1.098 mg /g) respectively. Similar trend was also observed in content of chlorophyll 'b' in leaves at all the three stages**.** The highest content was reported in T_{15}, at vegetative stage (0.700 mg /g), flowering stage (0.730 mg /g) and fruit set stage (0.770 mg /g), respectively. The lowest chlorophyll 'b' content was registered in control T_1 at vegetative stage (0.318 mg /g), flowering stage (0.380 mg /g) and fruit set stage (0.415 mg /g). The total chlorophyll content was observed higher in vegetative stage (2.390 mg /g), flowering stage (2.575 mg /g) and fruit set stage (2.735 mg /g) in T_{15}. The lower values of total chlorophyll content was recorded in T_1 vegetative stage (1.381 mg /g), flowering stage (1.463 mg /g) and fruit set stage (1.513 mg /g) respectively. The micronutrient application plays an important role in the representation of crucial auxin that increases the chlorophyll content of leaf. Zinc, copper and boron take part in chlorophyll synthesis and imparts dark green colour in plant by Ilyas *et al*[6]., in Kinnow mandarin. The findings are also coinciding with Singh *et al*[14]., he observed increased chlorophyll content in Kagzi lime was due to the application of zinc and copper resulted in enhanced conversion of phylloxanthin to chlorophyllin.

Table 1: Effect of foliar application of micronutrients on plant height and plant spread N-S and E-W (m)

Treatments	Plant height (m)			Plant spread (m)					
	S-I	S-II	S-III	S-I		S-II		S-III	
				N-S	E-W	N-S	E-W	N-S	E-W
T1	3.10	3.21	3.30	2.10	1.83	2.20	2.00	2.33	2.12
T2	3.15	3.44	3.54	2.12	1.85	2.36	2.09	2.42	2.24
T3	3.18	3.43	3.53	2.15	1.85	2.33	2.08	2.38	2.23
T4	3.18	3.41	3.52	2.15	1.85	2.30	2.05	2.40	2.22
T5	3.16	3.40	3.51	2.15	1.80	2.32	2.06	2.38	2.20
T6	3.16	3.38	3.47	2.12	1.82	2.28	2.06	2.36	2.19
T7	3.18	3.47	3.57	2.17	1.87	2.46	2.12	2.55	2.33
T8	3.17	3.44	3.54	2.12	1.88	2.44	2.10	2.53	2.31
T9	3.15	3.41	3.52	2.17	1.89	2.40	2.18	2.51	2.29
T10	3.15	3.41	3.52	2.13	1.88	2.42	2.19	2.50	2.31
T11	3.17	3.65	3.74	2.18	1.90	2.58	2.28	2.70	2.42
T12	3.17	3.55	3.67	2.17	1.90	2.56	2.25	2.67	2.39
T13	3.15	3.52	3.62	2.17	1.90	2.56	2.25	2.65	2.38
T14	3.17	3.54	3.63	2.18	1.88	2.50	2.24	2.60	2.35
T15	3.22	3.82	3.90	2.22	1.92	2.67	2.34	2.80	2.48
S Ed±	0.074	0.053	0.059	0.506	0.062	0.009	0.008	0.009	0.007
CD(0.05)	NS	0.108	0.120	NS	NS	0.018	0.015	0.019	0.014

Note: NS- Not significant; S-I: Vegetative stage, S-II: Flowering stage, S-III: Fruit set stage

Table 2: Effect of foliar application of micronutrients on chlorophyll a, b and total chlorophyll (mg/ g)

Treatments	Chlorophyll a			Chlorophyll b			Total chlorophyll		
	S-I	S-II	S-III	S-I	S-II	S-III	S-I	S-II	S-III
T1	1.063	1.083	1.098	0.318	0.380	0.415	1.381	1.463	1.513
T2	1.475	1.478	1.535	0.493	0.523	0.563	1.968	2.001	2.098
T3	1.468	1.420	1.500	0.470	0.503	0.555	1.938	1.923	2.055
T4	1.320	1.400	1.480	0.468	0.480	0.550	1.788	1.88	2.030
T5	1.275	1.313	1.345	0.450	0.475	0.515	1.725	1.788	1.860
T6	1.203	1.238	1.255	0.365	0.420	0.428	1.568	1.658	1.683
T7	1.535	1.543	1.590	0.613	0.618	0.645	2.148	2.161	2.235
T8	1.525	1.540	1.573	0.588	0.593	0.640	2.113	2.133	2.213
T9	1.505	1.532	1.565	0.583	0.588	0.630	2.088	2.120	2.195
T10	1.495	1.515	1.540	0.568	0.585	0.593	2.063	2.100	2.133
T11	1.643	1.658	1.855	0.685	0.718	0.755	2.328	2.376	2.610
T12	1.603	1.620	1.695	0.678	0.685	0.733	2.281	2.305	2.428
T13	1.570	1.605	1.630	0.670	0.685	0.715	2.240	2.290	2.345
T14	1.545	1.585	1.605	0.623	0.625	0.670	2.168	2.210	2.275
T15	1.690	1.845	1.965	0.700	0.730	0.770	2.390	2.575	2.735
S Ed±	0.012	0.013	0.014	0.008	0.008	0.008	0.019	0.020	0.022
CD(0.05)	0.024	0.026	0.028	0.017	0.016	0.017	0.039	0.041	0.045

Note: NS- Not significant; S-I: Vegetative stage, S-II: Flowering stage, S-III: Fruit set stage

CONCLUSION

The foliar application of micronutrients T_{15}: $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) + $MnSO_4$ (0.3%) + $CuSO_4$ (0.4%). in mandarin orange significantly increased the leaf chlorophyll content and slightly increment in tree height and tree spread respectively at flowering and fruit set stage effectively and improved growth attributes of the mandarin orange.

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