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Effect of foliar application of micronutrients on cost of economics of mandarin orange (*Citrus reticulata* Blanco.) under lower Pulney hills

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Abstract
Field experiment was carried out to study the effect of foliar application of micronutrient on cost of economics of mandarin orange. The experiment was laid out in randomized block design with fifteen treatments replicated thrice at farmer's field (TVSN Veerna estate), Kanalkadu, Thadiyankudisai, Lower Pulney Hills during 2014-2016. The treatment comprised of $ZnSO_4$ (0.2%), $FeSO_4$ (0.2%), H_3BO_4 (0.2%), $MnSO_4$ (0.3%) and $CuSO_4$ (0.4%), sprayed at three different stages such as vegetative, flowering and fruit set. The economics suggested that foliar application of $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) + $MnSO_4$ (0.3%) + $CuSO_4$ (0.4%) registered the highest benefit cost ratio of 2.10 followed by $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) benefit cost ratio of 1.92 and lowest benefit cost ratio 1.12 was observed in $ZnSO_4$ (0.2%).

Keywords: mandarin orange, micronutrient, foliar spray and cost of economics

Introduction
Citrus is one of the commercially important fruit crops, cultivated at 40° N latitude of either side of the equator encompassing tropical to subtropical climate and is the first in area and production in the world. Citrus is an economically important fruit crop with production in more than 144 countries but commercial cultivation takes place in 53 countries only. The production of citrus fruits in the world touches an over all time high of an area of 8.64 million hectares and production of about 123.69 million tons during 2016. China emerged as largest producer of citrus fruits (22.93 million tons) followed by Brazil (22.72 million tons), USA (10.40 million tons) and Mexico accounts 6.85 million tons (Anon, 2016) [1]. The world citrus dominated by sweet orange with 61.18% contribution followed by mandarins with 22.12%, lime and lemons 11.14% and rest of 5.5% contributed by grapefruit and other citrus fruit (Ladaniya, 2017) [7]. 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 1.00 million hectares with a production of 12.51 million tons and average productivity of 9.69 tons/ha (Anon, 2017) [2]. Total mandarin production in India is 5.27 million tons with 0.48 million ha area and 9.3 tons/ha as productivity. In Tamil Nadu, the area under citrus fruits is estimated to be 10.19 thousand ha with a production of 63.96 thousand tons. The mandarin area about is 2.02 thousand ha and production 42.2 thousand tons (Anon, 2017) [3].
In our country mandarin orange is commercially cultivated in Karnataka (parts of Coorg, Hassan and Chikkamagalore), Maharashtra (Nagpur belt), West Bengal (Darjeeling), Punjab, and Assam etc. In Tamil Nadu, mandarins are grown in Lower Pulney Hills, Nilgris and Shevaroy hills (Kumar, 2014) [6]. In some North Indian states, the cultivation of mandarin orange is limited due to the acidity and puffiness of the fruit.

Material and Methods
The field experiment was conducted in farmer field at farmer's field (TVSN Veeranna estate), Kanalkadu, Thadiyankudisai, Lower Pulney Hills, Dindigul District, Tamil Nadu during the year 2014-16. 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

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 °C and 17.7 °C respectively with mean relative humidity of 66.5%. There were 15 treatment replicated thrice tested in randomized block design. The effects of $ZnSO_4$ (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 were applied as a foliar sprays 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 fruit set stages. The simple water spray was done on the tree under control treatment. In each spray treatment Tee pol was added as sticking agent in prepared solution. The number of fruits per plant was recorded at each harvest and total was calculated at last harvesting by summation of values of all pickings, yield per tree (kg) was calculated by total yield of fruits at each harvest was weighed for each tree on pan balance and yield per tree was computed by marking the summation of yield values at each harvest till the last harvest and the yield per hectare (Mt) was calculated by multiplying the value of yield/tree (kg) by total number of plants/hectare and dividing the result by 1000. Benefit: cost (B:C) ratio was worked out by using formula of gross monetary returns (' ha^{-1}) and cost of cultivation (' ha^{-1}).

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%), T_{15}: $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) + $MnSO_4$ (0.3%) + $CuSO_4$ (0.4%).

Table 1: Effect of foliar application of micronutrients on Cost of expenditure

Sl. No.	Particular	Unit cost	Quantity for one time	Total cost (Rs)
1.	Spraying of chemical 3 times (Labor cost)	210 Rs/ day	10 labors	6,300
2.	Spraying equipment fuel cost 3 times	60 Rs/lit	16 lit	2,880
3.	Intercultural operation i) weeding 4 times ii) harvesting 3 times	210 Rs/ day	10 labors	14,700
4.	Transportation	1,260	1 time	1,260
5.	Subtotal			25,140

Table 2: Effect of foliar application of micronutrients on Chemical spray quantity

Sl. No.	Chemical spray quantity	Total cost (Rs.)
1.	Single micronutrient spray (chemical and machinery cost)	1,200
2.	Two micronutrients combined spray (chemical and machinery cost)	2,400
3.	Three micronutrients combined spray (chemical and machinery cost)	3,600
4.	Combined spray (chemical and machinery cost)	4,600

Result and Discussion

From the (Table-3) effectiveness of zinc, iron, boron, manganese and copper was found to be significant in increasing the yield characters of mandarin orange. The foliar application of these $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) + $MnSO_4$ (0.3%) + $CuSO_4$ (0.4%) in T_{15} significantly increased the yield 7.82 Kg/tree and 3.02 t/ha followed by T_{11}: $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) of 6.92 Kg/tree and 2.76 t/ha and lowest was found in $T_{1:}$ Control of 3.00Kg/tree and 0.90t/ha. The possible reason may be due to micro-element ascribed to better photosynthesis, lesser fruit drop, improve fruit size and quality characters. The beneficial role of boron in pollination, zinc in growth promoting substance, iron in electron transport chain system and copper in carbohydrate similar results was also observed by Shivanandam *et al.* (2007) [11] in mango and Yadav *et al.* (2013) [12] in peach *cv.* Sharbati. Similar findings, Ramesh and Singh (2015) [9] obtained that in *cv.* NA-7 aonla the combination of micronutrients has significant increase in fruit set and number of fruits per tree due to direct or indirect involvement in setting, retention, reduction in fruit drop as well as growth and development of fruits. Kachave and Bhosale (2007) [5] combined application of micronutrients increased the yield parameters because the rate of translocation of nutrients from source leaf to sink fruits is increased with enhancement in photosynthesis rate observed in Kagzi lime.

Economics of different treatments were worked out in order to compare the efficacy of different treatments in table 3. The treatment comprised of $ZnSO_4$ (0.2%), $FeSO_4$ (0.2%), H_3BO_4 (0.2%), $MnSO_4$ (0.3%) and $CuSO_4$ (0.4%), sprayed at three different stages such as vegetative, flowering and fruit set. The economics suggested that foliar application of $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) + $MnSO_4$ (0.3%) + $CuSO_4$ (0.4%) registered the highest benefit cost ratio of 2.10 followed by $ZnSO_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_4 (0.2%) benefit cost ratio of 1.92 and lowest benefit cost ratio 1.12 was observed in $ZnSO_4$ (0.2%). The present results are in conformity with the findings of Sayan *et al.* (2018) [10] Dutta and Mahaveer *et al.* (2016) [8] in guava.

Table 3: Effect of foliar application of micronutrients on Economics of different treatments

Treatments	Yield (Kg/tree)	Yield (t/ha)	Cost of cultivation (Rs)	Gross return (Rs)	B : C ratio
T_1	3.00	0.90	15,960	18,000	1.12
T_2	4.02	1.60	26,340	32,160	1.22
T_3	4.17	1.66	26,340	33,260	1.26
T_4	4.66	1.86	26,340	37,280	1.41
T_5	4.27	1.70	26,340	34,160	1.29
T_6	4.47	1.78	26,340	35,750	1.35
T_7	4.95	1.98	27,540	39,600	1.43
T_8	5.27	2.18	27,540	42,160	1.53
T_9	5.08	2.03	27,540	41,280	1.49
T_{10}	5.66	2.38	27,540	47,680	1.73
T_{11}	6.92	2.76	28,740	55,360	1.92
T_{12}	5.96	2.38	28,740	47,680	1.54
T_{13}	6.24	2.49	28,740	49,920	1.73
T_{14}	6.49	2.59	28,740	51,920	1.80
T_{15}	7.82	3.02	29,540	60,560	2.10

Mandarin orange marketing rate at Rs 20/kg.

Conclusion

All the treatments resulted positively with respect to yield. Yield maximization should be the prime objective from the farmers point of view. Under such conditions, the treatment T_{15} ($ZnSo_4$ (0.2%) + $FeSO_4$ (0.2%) + H_3BO_3 (0.2%) + $CuSO_4$ (0.4%) + $MnSO_4$ (0.3%)) with combined micronutrients spray exhibited a superior performance regarding yield and other yield contributing characters and also gross return and B: C ratio was found maximum in T_{15}.

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