



Studies On Different Grades And Time Of Application Of Micronutrient Mixture On Growth, Yield And Quality Of Sweet Orange (*Citrus sinensis* L. Osbeck) cv. Sathgudi

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ABSTRACT

The experiment was conducted on ten years old sweet orange (Sathgudi). The experiment was laid out in factorial randomized block design with two factors i.e. micronutrient mixture (Grades) and time of application. These factors consist of four and three levels respectively, twelve treatment combination and three replications. Among the different treatment combination the treatment T10 i.e. G4T1 (Grade-2 sulphate by foliar application monthly) noted the highest plant growth and yield in respect to, no. of leaves per plant (38000), days to initiate flowering (28.43days) and final fruit set (68.00%), number of fruits per plant (320), weight of fruit (200.00g), volume of fruit (216.00g), breadth of fruit (6.53cm), length of fruit (6.33cm), juice of fruit (45.03%), peel of fruit (21.00%), rag of fruit (26.50%), number of fruits per plant (320.00), yield per tree (70.00kg). The physico-chemical parameters also recorded maximum viz. T.S.S. (11.00%), ascorbic acid (55.00mg) and total sugar of fruit 8.05% (reducing sugar 5.20% and non-reducing sugar 2.85%) with reduction in acidity (0.85%). In this experiment the treatment G4T1 (Grade-2 chelated by foliar application monthly) also performed well in respect of vegetative and reproductive growth which showed results viz. reduction in days required for initiation of new flush (16.03days) and days for first harvesting (232.00 days), leaf area (60.25cm²) and number of flowers per plant (375.18). Therefore, amongst all the treatment combinations Grade-2 chelated by foliar application monthly can be considered as most beneficial in terms of yield, vegetative and reproductive growth.

Key words: Micronutrient mixture, yield & quality of sweet orange

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INTRODUCTION

Sweet orange (*Citrus sinensis* L. Osbeck) is one of the important sub-tropical fruit crop belonging to family Rutaceae. Sweet orange is a best source of 100 g fruit contains 60-80 % fruit juice, protein 0.8-1.4 g, fat 0.2-0.4 g, fiber 0.8 g, vitamin-A 198 I.U, vitamin B1 0.113 mg, riboflavin 0.046 mg, vitamin C 65.69 mg, iron 0.2-0.8 mg, calcium 0.16 mg and potassium 192-201 mg. The major sweet orange producing states in India are Andhra Pradesh, Maharashtra, Tamil Nadu, Karnataka, Madhya Pradesh, Assam, Bihar, Gujarat, Himachal Pradesh, Uttar Pradesh, Punjab and Haryana. In India, about 27.47 lakh ha. area is under sweet orange cultivation with production of 424.82 lakh tones of fruits with 15.5 MT productivity. (Anonymous, 2016). In Maharashtra, sweet orange is grown in Jalna, Aurangabad, Parbhani, Nanded, Nagpur, Amravati and Ahmednagar districts. It is cultivated on area of 61.8 thousand ha. with the production of 543.0 thousand MT of fruits and productivity is 8.8 MT/ha. (Anonymous, 2015). Micronutrients play important major role in crop production due to their essentiality in plant metabolism and adverse effects that manifest due to their deficiency. Besides affecting plant growth, micronutrients also play a major role in disease resistance in cultivated crop species. Micronutrients can tremendously boost horticultural crop yield and improve quality and post harvest life of horticultural produce (Raja, 2009). Foliar spray of micronutrients is the common practice to overcome the micronutrients deficiency in order to improve the fruit quality. Nutrients are generally quickly available to plant by the foliar application than the soil application (Lal Bahadur *et al.* 1998).

It is necessary to use of micronutrients in fruit crops to increase quality of fruits and yield with maintain soil fertility and productivity for further years production.

MATERIAL AND METHODS:

The experiment was conducted on ten years old sweet orange (Sathgudi). The experiment was laid out in factorial randomized block design with two factors i.e. micronutrient mixture (Grades) and time of application. These factors consist of four and three levels respectively, twelve treatment combination and three replications. The micronutrient mixtures i.e. Grade-1 (sulphate & chelated) and Grade-2 (sulphate & chelated) were applied monthly, bimonthly and six monthly by soil and foliar application method respectively. The treatment details are given below:

Treatment details:

Factor	Sr. No.	Symbol	Treatment
Factor:1 Micronutrient mixture	1	G1	Soil application of Grade-1 sulphate @ 250 g/tree
	2	G2	Soil application of Grade-1 chelated @ 25 g/tree
	3	G3	Foliar application of Grade-2 sulphate @30 g/tree
	4	G4	Foliar application of Grade-2 chelated @ 7 g/tree
Factor:2 Time of application	1	T1	Monthly application
	2	T2	Bimonthly application
	3	T3	Six monthly application

The growth, yield and quality observations like days required for initiation of new flush, days to initiation of flowering number of leaves per plant, leaf area, number of flowers per plant, number of fruits per plant, days required for first harvesting, initial fruit set percentage, final fruit set percentage, fruit drop percentage, weight of fruit, volume of fruit, breadth of fruit, length of fruit, juice of fruit, peel of fruit, rag of fruit, yield per tree, yield per hectare, total soluble solids, acidity, ascorbic acid, total sugar, reducing sugar and non-reducing sugar were recorded.

RESULTS AND DISCUSSION

The days required for initiation of new flush were minimum in the treatment T10 (G4T1) i.e. 16.03 days followed by treatment T7 (G3T1) i.e. 17.00 days. The treatment T10 (G4T1) recorded minimum days to initiation of flowering (28.43). The present findings are in agreement with the Ghumare *et al.*, (2014) in sapota and Gurjar *et al.*, (2015) in mango. The treatment T10 (G4T1) recorded maximum number of leaves per plant (38000). The results obtained are in agreement with the findings reported by Balakrishnan (2000) and Bagali *et al.* (1993) in guava. The treatment T10 (G4T1) recorded the maximum leaf area i.e. 60.25 cm². The present findings are in agreement with supriya *et al.*, (1993) in citrus. Application of treatment T10 (G4T1) recorded more number of flowers per plant (375.18), followed by T7 (G3T1) i.e. (373.30). It similar with the result of Ghumare *et al.*, (2014) in sapota and Balakrishnan (2000) in guava.

The treatment T10 (G4T1) maximum initial fruit set (78.50 %) and maximum final fruit set recorded (68.00%). Dixit *et al.*, (1977) in kinnow mandarin, Ghumare *et al.* (2014) in sapota, Balakrishnan (2000) in guava and Eiada *et al.* (2013) in pomegranate observed similar result for increase in fruit set. The minimum fruit drop was recorded in treatment T10 (G4T1) 14.20%. The present finding are in agreement with Sajid *et al.*, (2010) in sweet orange and Babu and Yadav (2005) in khashi mandarin. The treatment T10 (G4T1) recorded maximum number of fruits per tree (320.00), followed by T7 (G3T1) 316.00. Tariq *et al.*, (2007) these result are in agreement with in sweet orange and kinnow. The fruit came to harvest earlier with the application of T10 (G4T1) 232.00 days, followed by T7 (G3T1) 234.00 days. Singh and Rajput (1976) in banana, Arora and Singh (1971) in guava observed similar results for hastening fruit maturity.

The treatment T7 (G3T1) recorded maximum weight of fruit 224.00 g and maximum volume of fruit 248.00 ml. It is in accordance with the findings of Eiada *et al.*, (2013) who revealed that highest fruit weight (188.88 g) in pomegranate, Dinesh Babu and Yadav (2005) and Sourour *et al.*, (2011). The treatment T7 (G3T1) recorded maximum breadth and length of fruit 8.03 cm and 7.43 cm. Result are agreement with Gurjar *et al.*, (2015) in mandarin. The treatment T10 (G4T1) recorded maximum juice percentage i.e. 45.03%, the treatment T12 (G4T3) recorded highest peel percentage i.e. 23.10% and the treatment T7 (G3T1) recorded highest rag percentage i.e. 27.93%. The present finding are in agreement with Ghosh and Basara (2000) in sweet orange and Srivastava (2011) in Nagpur mandarin. The maximum yield per tree was recorded in treatment T10 (G4T1) 70.00 kg, Similar results were found by Ghumare *et al.*, (2014) in sapota, Balakrishnan (2000) in guava, Gurjar *et al.*, (2015) in mango.

Maximum TSS (11.00%) was observed in treatment T10 (G4T1) followed by treatment T11 (G4T2) 10.60 %. The minimum acidity was recorded in treatment T10 (G4T1) 0.85 %. Ghosh and Basara (2000) in kinnow mandarin and Rajput *et al.*, (1991) in sweet orange had observed similar results. The treatment T10 (G4T1) recorded highest ascorbic acid i.e. 55.00 mg. Devi *et al.*, (1997), Ghosh and Basra (2000) in sweet orange. The treatment T10 (G4T1) recorded highest reducing sugar 5.20%, followed by T7 (G3T1) i.e. 5.00%. The treatment combination T10 (G4T1) Grade-2 chelated monthly foliar application recorded highest non-reducing sugar which was 2.85%. Babu and Yadav (2005) and Ghumare *et al.*, (2014) reported that total sugars, reducing sugar and non-reducing sugar were significantly influenced by foliar spray of micronutrients in khasi mandarin and sapota.

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Result Table: Effect of different grades and time of application of micronutrient mixture on growth, yield and quality of sweet orange.

Tr. No.	Factor/Treatment	Days for initiation of new flush	Days for flower initiation	Number of leaves per plant	Leaf area (cm ²)	Number of flower per plant	Number of fruits per plant
Factor G: Micronutrient mixture Grade							
1	G1	21.63	33.71	33567	45.00	336.59	270.00
2	G2	21.07	33.16	33933	47.42	343.52	281.67
3	G3	18.91	31.42	35667	51.13	356.54	293.67
4	G4	19.01	30.86	36167	53.67	356.59	292.67
SE_±		0.38	0.05	197.31	0.62	13.63	0.81
CD at 5%		1.10	0.15	577.83	1.82	NS	2.62
Factor T: Time of Application							
1	T1	17.90	30.52	36575	55.24	362.90	306.50
2	T2	19.33	31.96	35425	50.97	352.80	293.25
3	T3	23.23	34.38	32500	41.86	329.24	253.75
SE_±		0.33	0.04	170.88	0.54	11.80	0.78
CD at 5%		0.95	0.13	500.42	1.58	NS	2.27
Interaction (G x T)							
T1	G1T1	19.57	32.83	35000	50.25	346.02	290.00
T2	G1T2	20.67	33.30	33500	45.50	338.50	270.00
T3	G1T3	24.67	35.00	35200	39.26	325.26	250.00
T4	G2T1	19.00	31.87	35700	53.15	357.08	300.00
T5	G2T2	20.17	33.23	34300	48.75	342.34	285.00
T6	G2T3	24.03	34.37	32100	40.38	331.15	260.00
T7	G3T1	17.00	28.93	37600	57.30	373.30	316.00
T8	G3T2	18.50	31.10	36400	54.38	362.21	310.00
T9	G3T3	21.23	34.23	33000	42.31	334.10	255.00
T10	G4T1	16.03	28.43	38000	60.25	375.18	320.00
T11	G4T2	18.00	30.20	37800	55.25	368.15	308.00
T12	G4T3	23.00	33.93	32700	45.50	326.45	250.00
Mean		20.16	32.29	34833	49.36	348.31	284.00
SE_±		0.65	0.09	341.76	1.08	23.59	1.55
CD at 5%		1.90	0.25	100.08	NS	NS	4.54
G: G1- Grade-1 Sulphate (Soil) G2- Grade-1 Chelated (Soil) G3- Grade-2 Sulphate (Foliar) G4- Grade-2 Chelated (Foliar)				T: T1- Monthly T2- Bimonthly T3- Six monthly			

Contd....

Tr. No.	Factor/Treatment	Days for first harvesting	Initial fruit set (%)	Final fruit set (%)	Fruit drop (%)	Weight of fruit (g)	Volume of fruit (ml)
Factor G: Micronutrient mixture Grade							
1	G1	247.34	65.24	61.17	25.67	205.34	221.34
2	G2	245.00	66.83	60.74	24.35	206.67	223.67
3	G3	239.00	71.07	62.93	20.44	218.67	238.67
4	G4	238.67	72.07	64.40	19.57	206.00	227.34
SE_±		0.01	0.01	0.01	0.01	0.01	0.01
CD at 5%		0.03	0.04	0.02	0.02	0.03	0.04
Factor T: Time of Application							
1	T1	237.25	74.18	64.93	18.62	211.00	228.75

2	T2	241.00	70.30	62.30	21.03	212.00	231.00
3	T3	249.25	61.93	59.70	27.88	204.50	223.50
SE±		0.01	0.01	0.01	0.01	0.01	0.01
CD at 5%		0.02	0.03	0.02	0.02	0.03	0.03
Interaction (G x T)							
T1	G1T1	243.00	70.01	62.00	22.80	210.00	225.00
T2	G1T2	248.00	65.51	59.00	24.00	206.00	221.00
T3	G1T3	251.00	60.21	62.50	30.20	200.00	218.00
T4	G2T1	240.00	72.00	63.20	21.25	210.00	226.00
T5	G2T2	245.00	67.50	61.00	23.80	208.00	227.00
T6	G2T3	250.00	61.00	58.00	28.00	202.00	218.00
T7	G3T1	234.00	76.21	66.50	16.20	224.00	248.00
T8	G3T2	236.00	73.20	64.00	19.10	214.00	232.00
T9	G3T3	247.00	63.80	58.30	26.00	218.00	236.00
T10	G4T1	232.00	78.50	68.00	14.20	200.00	216.00
T11	G4T2	235.00	75.01	65.20	17.20	220.00	244.00
T12	G4T3	249.00	62.70	60.00	27.30	198.00	222.00
Mean		242.50	68.80	62.31	22.51	209.17	227.75
SE±		0.02	0.02	0.01	0.01	0.02	0.02
CD at 5%		0.05	0.07	0.03	0.04	0.06	0.06
G: G1- Grade-1 Sulphate (Soil) G2- Grade-1 Chelated (Soil) G3- Grade-2 Sulphate (Foliar) G4- Grade-2 Chelated (Foliar)				T: T1- Monthly T2- Bimonthly T3- Six monthly			

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Tr. No.	Factor/ Treatment	Breadth of fruit (cm)	Length of fruit (cm)	Juice of fruit (%)	Peel of fruit (%)	Rag of fruit (%)	Yield per tree (kg)
Factor G: Micronutrient mixture Grade							
1	G1	6.96	6.77	40.03	22.67	25.87	57.67
2	G2	6.93	6.72	39.46	22.48	26.50	59.67
3	G3	7.32	7.11	41.46	22.12	23.93	62.00
4	G4	6.99	6.76	41.70	21.90	24.50	62.00
SE±		0.05	0.05	0.05	0.05	0.06	0.87
CD at 5%		0.15	0.15	0.15	0.16	0.18	2.55
Factor T: Time of Application							
1	T1	7.13	6.83	42.28	21.73	26.67	65.50
2	T2	7.15	6.87	40.78	22.17	24.47	63.00
3	T3	6.88	6.82	38.93	22.98	24.47	52.50
SE±		0.04	0.04	0.04	0.04	0.05	0.75
CD at 5%		0.13	NS	0.14	0.14	0.16	2.21
Interaction (G x T)							
T1	G1T1	6.90	6.73	41.03	22.33	26.23	63.00
T2	G1T2	6.73	6.53	40.53	22.63	27.23	58.00
T3	G1T3	7.23	7.03	38.53	23.03	24.13	52.00
T4	G2T1	7.03	6.83	40.03	22.23	26.00	60.00
T5	G2T2	7.13	6.63	39.03	22.30	26.50	63.00
T6	G2T3	6.63	6.70	39.30	22.90	27.00	56.00
T7	G3T1	8.03	7.43	43.00	21.33	27.93	69.00
T8	G3T2	6.90	6.90	41.53	22.13	21.13	65.00
T9	G3T3	7.03	7.00	39.83	22.90	22.73	52.00
T10	G4T1	6.53	6.33	45.03	21.00	26.50	70.00
T11	G4T2	7.83	7.40	42.03	21.60	23.00	66.00

T12	G4T3	6.60	6.53	38.03	23.10	24.00	50.00
Mean		7.05	6.84	40.66	22.29	25.20	60.33
SE±		0.09	0.08	0.09	0.09	0.11	1.51
CD at 5%		0.27	0.26	0.27	0.27	0.32	4.41
G: G1- Grade-1 Sulphate (Soil) G2- Grade-1 Chelated (Soil) G3- Grade-2 Sulphate (Foliar) G4- Grade-2 Chelated (Foliar)				T: T1- Monthly T2- Bimonthly T3- Six monthly			

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Tr. No.	Factor/Treatment	T.S.S (%)	Acidity (%)	Ascorbic acid (mg/100g juice)	Reducing sugar (%)	Non-Reducing sugar (%)	Total Sugar (%)
Factor G: Micronutrient mixture Grade							
1	G1	9.05	0.97	47.00	3.85	2.23	6.18
2	G2	9.62	0.96	48.17	4.15	2.58	6.73
3	G3	9.97	0.92	50.83	4.70	2.39	7.15
4	G4	10.15	0.92	51.33	4.72	2.56	7.34
SE±		0.01	0.01	0.01	0.07	0.04	0.01
CD at 5%		0.02	0.02	0.03	0.21	0.12	0.03
Factor T: Time of Application							
1	T1	10.48	0.90	52.25	4.72	2.58	7.43
2	T2	9.93	0.93	49.88	4.43	2.50	6.99
3	T3	8.68	1.00	45.88	3.90	2.24	6.15
SE±		0.01	0.01	0.01	0.06	0.03	0.01
CD at 5%		0.02	0.02	0.03	0.18	0.11	0.03
Interaction (G x T)							
T1	G1T1	9.65	0.94	49.00	4.20	2.60	7.10
T2	G1T2	9.00	0.96	47.00	3.85	2.10	5.95
T3	G1T3	8.50	1.02	45.00	3.50	2.00	5.50
T4	G2T1	10.60	0.93	50.50	4.50	2.70	7.20
T5	G2T2	9.60	0.95	48.50	4.35	2.60	6.95
T6	G2T3	8.65	1.00	45.50	3.60	2.45	6.05
T7	G3T1	10.65	0.87	54.50	5.00	2.16	7.36
T8	G3T2	10.50	0.92	51.00	4.75	2.65	7.40
T9	G3T3	8.75	0.96	47.00	4.35	2.35	6.70
T10	G4T1	11.00	0.85	55.00	5.20	2.85	8.05
T11	G4T2	10.60	0.90	53.00	4.80	2.65	7.65
T12	G4T3	8.85	1.01	46.00	4.16	2.17	6.33
Mean		9.70	0.94	49.33	4.35	2.44	6.85
SE±		0.01	0.01	0.01	0.13	0.07	0.02
CD at 5%		0.03	NS	0.05	NS	0.23	NS
G: G1- Grade-1 Sulphate (Soil) G2- Grade-1 Chelated (Soil) G3- Grade-2 Sulphate (Foliar) G4- Grade-2 Chelated (Foliar)				T: T1- Monthly T2- Bimonthly T3- Six monthly			

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