



P-ISSN: 2349-8528

E-ISSN: 2321-4902

www.chemijournal.com

IJCS 2020; 8(4): 958-960

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Received: 01-05-2020

Accepted: 04-06-2020

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Effect of soil and foliar feeding of nutrients through organic and inorganic sources on yield and quality of sweet orange (*Citrus Sinensis L. Osbeck*)

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DOI: <https://doi.org/10.22271/chemi.2020.v8.i4g.9724>

Abstract

A field experiment was conducted during 2014-15 at Water management farm, Vasantnao Naik Marathwada Krishi Vidyapeeth, Parbhani on 10 year old sweet orange orchard to assess the effect of soil and foliar feeding of nutrient application through organic and inorganic sources on yield and quality of sweet orange (*Citrus sinensis L. osbeck*). The study indicates that treatment T₁₂ with application of NPK in 8 splits with drip irrigation + vermicompost @ 3 tonne ha⁻¹ and biofertilizers i.e *Azotobacter* and PSB @ 2000 ml per ha and trichoderma @ 1 kg ha⁻¹ + 8 spraying of Zn (0.5%), Fe (0.5%) and B (0.2%) found to be most effective to producing number of fruits, weight of fruits, and yield and fruit quality parameters like ascorbic acid, TSS, acidity and total sugar percentage.

Keywords: Sweet orange, yield, ascorbic acid, TSS etc.

Introduction

In India 2013-14 citrus fruit are grown in an area of 1078 thousand ha, with a production of 11147.1 thousand million tones and productivity 10.3 (Mt ha⁻¹). In Maharashtra 2013-14 sweet orange fruit was cultivated on an area of 95 thousand ha, with a production of 712.5 thousand million tones and productivity 7.5 (Mt ha⁻¹). Marathwada is a mother of sweet orange (*Citrus sinensis osbec.*) which is concentrated in Aurangabad, Jalna, Parbhani and Nanded districts of south part of Maharashtra. The average productivity of 'Mosambi' i.e. sweet orange is 14.9 t/ha which comparatively lower. One of the main reasons for low sweet orange orchard productivity in the soils of Marathwada region is due to multiple nutrient deficiencies. The soils of this region are mostly derived from basaltic parent material and are commonly deficient in multiple nutrients, including N, P, Fe and Zn (Srivastava and Singh, 2004 and Patil, 1997)^{[1], [6]}.

Soil reaction may be a problem in micronutrient deficiencies, necessitating application of foliar micronutrient sprays. In recent years, much importance is given for correction of nutritional disorders through foliar sprays of nutrients. Works carried out from different parts of country appear to be inadequate. Therefore, evaluation of the effect of soil and foliar treatments of micronutrients in sweet orange on quality and yield of fruits is important. (Kausadikar, 2005)^[2].

To stabilize fruit production and quality, it is necessary to supply adequate irrigation in the dry season, and proper drainage during the wet season. It is important to provide the right amount of water and fertilizers at different growth stages not only enhances the growth of citrus trees, but also improves yield and fruit quality (Shirgure *et al.*, 2000a)^[9].

Materials and Methods

The field experiments were carried out using sweet orange orchard in *Ambia* bahar at Water management farm, Vasantnao Naik Marathwada Krishi Vidyapeeth, Parbhani, during years 2014-15. The experiment was laid out in Randomized Block Design comprising thirteen (13) treatments, T₁ – RDF+ 4 spraying of (Zn+B+Fe), T₂ - RDF+ 6 spraying of (Zn+B+Fe), T₃- RDF+ 8 spraying of (Zn+B+Fe), T₄- RDF+ Vermicompost+ biofertilizer + 4 spraying of (Zn+B+Fe),

T₅- RDF+ Vermicompost+ biofertilizer + 6 spraying of (Zn+B+Fe), T₆- RDF+ Vermicompost+ biofertilizer + 8 spraying of (Zn+B+Fe), T₇- Vermicompost+ biofertilizer + 4 spraying of (Zn+B+Fe), T₈- Vermicompost+ biofertilizer + 6 spraying of (Zn+B+Fe), T₉- Vermicompost+ biofertilizer + 8 spraying of (Zn+B+Fe), T₁₀- RDF through fertigation + Vermicompost+ biofertilizer + 4 spraying of (Zn+B+Fe), T₁₁- RDF through fertigation + Vermicompost+ biofertilizer + 6 spraying of (Zn+B+Fe), T₁₂- RDF through fertigation + Vermicompost+ biofertilizer + 8 spraying of (Zn+B+Fe) and T₁₃- control, replicated four times in sweet orange orchard. Recommended fertilizer dose NPK is 800:400:400 gm/tree, As per the treatment half dose of nitrogen and full dose of phosphorus, potassium were applied in the form of Urea, Single Super phosphate and Murate of potash respectively near the feeding root zone and mixed thoroughly in soil after release of water stress. Remaining half dose of nitrogen was given one to one and half month thereafter when fruit set. Zn+B+Fe: [Chelated zinc (0.5%) + Borax (0.2%) + Chelated Fe (0.5%)] applied in foliar spraying, and Vermicompost (3tonne/ha), Azotobactor (800ml/acre), PSB (800ml/acre), and Trichoderma(1kg/ha) were applied.

Harvesting was carried out at once. Yield in respects of number of fruit per tree, weight of fruit (kg/tree) and yield (kg ha⁻¹) was recorded. Observations on fruit size, fruit weight were based on random five fruit samples. Fruit quality parameters, viz., Total soluble solids were recorded with the help of hand refractometer (Erma Tokkyo A 300C), total sugars (reducing and non reducing sugar), acidity with titrable acidity and ascorbic acid with titrimetic method were determined as per standard procedures given by AOAC (1965).

Results and Discussion

Effect of different nutrient management practices on yield parameters in sweet orange: The data on number of fruits per tree, weight of fruit, volume of fruit and yield per tree presented in Table 1.

Yield Attributes of sweet orange

The data pertaining to number of fruits per tree was observed statistically significant by the different management practices are given in Table 1. The number of fruits per tree increased from 48.25 to 206.50 at harvest. The treatment T₁₂ was RDF plus vermicompost plus biofertilizers along with 8 spraying of zinc, boron and iron was at par with treatment T₁₁ which is RDF plus vermicompost plus biofertilizers along with 6 spraying of zinc, boron and iron and significantly superior over rest of treatments.

The production of more number of fruits in the treatments of application of bio-fertilizers with chemical fertilizers at different combination could be a result of the improvement in soil physical and chemical properties which in turn provided required nutrition for the conversion of flowers to fruits resulting in higher fruit set ultimately, increasing the number of fruits per tree. The data presented in Table 1, the maximum weight of fruit 225.57 g in treatment T₆ and minimum weight of fruit 170.95 g in treatment T₁₃ were recorded. The perusal of the data presented in the Table 1 shows the different combinations of organic and inorganic fertilizers treatments significantly improved the yield. The fruit yield was increased from 21.27 to 46.15 kg/tree. Treatment T₁₂ was application of RDF through fertigation plus vermicompost plus biofertilizers with 8 numbers of spraying of zinc, boron and iron found significantly superior over rest of the treatment except T₁₀, T₈ and T₄.

Table 1: Effect of different nutrient management practices on yield attributes of sweet orange

Treat. No.	Treatment	No. of fruits / tree	Wt. of fruits (g)	Yield kg tree ⁻¹	Vol. of fruit (cm ³)
T ₁	RDF+ 4 spraying of (Zn+B+Fe)	105.50	196.15	21.24	200.00
T ₂	RDF+ 6 spraying of (Zn+B+Fe)	119.25	201.35	21.27	188.75
T ₃	RDF+ 8 spraying of (Zn+B+Fe)	162.25	214.25	31.83	186.00
T ₄	RDF+ Vermicompost+ biofertilizers + 4 spraying of (Zn+B+Fe)	149.75	202.40	33.79	192.00
T ₅	RDF+ Vermicompost+ biofertilizers + 6 spraying of (Zn+B+Fe)	128.00	202.85	25.97	217.00
T ₆	RDF+ Vermicompost+ biofertilizers + 8 spraying of (Zn+B+Fe)	143.00	225.57	28.94	K8189.50
T ₇	Vermicompost + biofertilizers +4 spraying of (Zn+B+Fe)	133.25	187.58	21.25	177.75
T ₈	Vermicompost + biofertilizers +6 spraying of (Zn+B+Fe)	145.00	199.15	34.92	188.75
T ₉	Vermicompost + biofertilizers +8 spraying of (Zn+B+Fe)	172.25	202.74	28.88	189.50
T ₁₀	RDF through fertigation + Vermicompost + biofertilizers + 4 spraying of (Zn+B+Fe)	164.25	220.85	36.27	219.00
T ₁₁	RDF through fertigation + Vermicompost + biofertilizers + 6 spraying of (Zn+B+Fe)	172.50	215.50	31.17	204.25
T ₁₂	RDF through fertigation + Vermicompost + biofertilizers + 8 spraying of (Zn+B+Fe)	206.50	223.50	46.15	222.50
T ₁₃	Control	48.25	170.95	21.27	151.00
	S.Em.±	19.25	9.35	4.70	6.22
	C.D. at 5%	55.78	27.11	13.63	18.33
	Mean	142.29	204.83	29.46	194.31

Effect of different nutrient management practices on volume of fruits (cm³) per tree in sweet orange. The data regarding effect of organic and inorganic fertilizers on volume of fruits are presented in Table.1 The application of organic and inorganic fertilizers significantly influenced the volume of fruits. The volume of fruits were ranged from 151.00 to 222.50 cm³, the results on similar lines were also reported by

Patel *et al.* (2012) [7] and (Verma and Rao, 2013) [12] who studied that increased in fruit yield and its parameters may be due to increased in the number of leaves which worked as an efficient photosynthesis structure and produce high amount of carbohydrates in the plant system. These findings are in agreement with the findings of (Nazir *et al.* 2015) [5].

Effect of different nutrient management practices on quality parameters in sweet orange.**Table 2:** Effect of different nutrient management practices on quality parameters of sweet orange.

Treat. No.	Treatment	Ascorbic acid (mg/100 ml juice)	TSS (Brix ⁰)	Acidity (%)	Total sugars (%)
T ₁	RDF+ 4 spraying of (Zn+B+Fe)	51.24	9.20	0.81	7.62
T ₂	RDF+ 6 spraying of (Zn+B+Fe)	54.72	10.10	0.78	8.01
T ₃	RDF+ 8 spraying of (Zn+B+Fe)	54.21	9.35	0.76	7.71
T ₄	RDF+ Vermicompost+ biofertilizers + 4 spraying of (Zn+B+Fe)	55.64	9.90	0.79	7.96
T ₅	RDF+ Vermicompost+ biofertilizers + 6 spraying of (Zn+B+Fe)	53.21	10.20	0.78	8.18
T ₆	RDF+ Vermicompost+ biofertilizers + 8 spraying of (Zn+B+Fe)	57.22	10.40	0.75	8.2
T ₇	Vermicompost + biofertilizers +4 spraying of (Zn+B+Fe)	55.32	9.80	0.74	7.89
T ₈	Vermicompost + biofertilizers +6 spraying of (Zn+B+Fe)	56.62	9.60	0.72	7.91
T ₉	Vermicompost + biofertilizers +8 spraying of (Zn+B+Fe)	54.04	10.15	0.74	7.93
T ₁₀	RDF through fertigation + Vermicompost + biofertilizers + 4 spraying of (Zn+B+Fe)	56.67	10.25	0.79	8.12
T ₁₁	RDF through fertigation + Vermicompost + biofertilizers + 6 spraying of (Zn+B+Fe)	58.76	10.30	0.75	8.22
T ₁₂	RDF through fertigation + Vermicompost + biofertilizers + 8 spraying of (Zn+B+Fe)	62.16	10.60	0.74	8.31
T ₁₃	Control	52.04	9.10	0.73	7.05
	S.Em.±	1.27	0.14	0.007	0.06
	C.D. at 5%	3.69	0.40	NS	0.17
	Mean	55.53	9.92	0.76	7.93

The data presented in Table 2 revealed that ascorbic acid, TSS content and Total sugar percentage was significantly highest in treatment T₁₂ followed by T₁₁ and T₆ treatments. Treatments with combine application of inorganic and organic sources recorded highest ascorbic acid while inorganic fertilizers recorded lower ascorbic acid content; it is lowest with the application of RDF with 4 numbers of spraying of Zn, Fe and B. These results are in line with the findings of Seshadri and Madhavi (2001) [8] in sweet orange. The acidity percentage was ranged from 0.72 to 0.81. (Table 2) The acidity of fruits was recorded lowest in treatments involving individual application of organic manures compared to inorganic fertilizer treatments. Marathe (2005) [3] reported increase in acidity of fruit juice of sweet orange with increasing dose of N, P and K application reduced acidity. Improved fruit quality may be attributed to better vegetative growth of the treated plants, which resulted in higher quantities of photosynthates (starch, carbohydrate etc.) and translocation to the fruits thus increasing the contents of various fruits quality parameters (Dutta *et al.* 2014 and Mir *et al.* 2015) [1, 4].

Conclusion

There was improvement in yield, yield attributes quality parameters of sweet orange due to application of RDF with vermicompost and biofertilizers (*Azotobacter*, PSB and trichoderma) with or without drip irrigation along with Zn, Fe and B micronutrients spraying with an interval of 1 and 1.5 month.

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