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Effect of nutrient feeding on controlling leaf chlorosis, yield and physico-chemical composition of sweet orange (*Citrus sinensis* L. Osbeck) cv. Mosambi

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ABSTRACT

The present investigation was conducted in sub-tropical weather in farmer's field at Jhargram, West Bengal during 2018, to know the effect of nutrient feeding on controlling leaf chlorosis, physico-chemical composition of sweet orange (Citrus sinensis L.Osbeck) *cv. Mosambi. The investigation wascompleted in a randomized complete block design(RCBD) with seven treatments (T_1-Vermiwash @6ml/litre, T_2-Multiplex- @ 3ml/litre, T_3-Humar @ 3ml/litre, T_4-$ZnSO_4$ @ 0.4% + borax @ 0.2% +$FeSO_4$ @ 0.2% + $MnSO_4$ @ 0.2%, T_5-Nitrophoska @8g/litre, T_6-T_4 +after 07 days T_5 and T_7- Control) with four replica. Based on the results, it was concluded that the minimum leaf chlorosis (5.1%)with maximum vitamin C (41.8 mg/ 100g) were observed with treatment T_2, while the maximum number of fruits per plant (65.0), yield per plant(6.63 kg), fruit juice (43 %) and TSS content (9.4 %) were observed with treatment T_4 followed by T_6 and maximum fruit weight (108 g) and minimum acidity (0.29 %) were observed with treatment T_6. The vermiwash, an organic sources of different nutrients, hormones, etc. also showed a good results with regard to reducing leaf chlorisis, increasing fruit yield and quality fruits and is recommended for organic farming.*

Keyword: Foliar feeding, fruit yield and quality, major and micro-nutrients, Mosambi-sweet orange, organic and inorganic sources.

INTRODUCTION

Sweet orange (*Citrus sinensis*) is considered as most important fruit crop of citrus group which belonging to the family Rutaceae and is a native of Southern China. In India, it is widely grown in the subtropical zone of Andhra Pradesh, West Bengal, Karnataka, Maharashtra, Punjab, Rajasthan and Haryana. In West Bengal, the western part of the state is suitable for growing Mosambi-sweet orange and quality fruits in higher quantity have been reported (Nandi and Ghosh, 2016). Sweet orange occupies an important place in the economy of the world on the basis nutritional and antioxidant value. Fruits are a good source of vitamin C (65.69 mg/ 100g), and their daily consumption helps to prevent scurvy, a disease caused by a lack of vitamin C in the diet. Apart from this, 100 g fruit also contains protein 0.8-1.4 g, fat 0.2-0.4 g, vitamin-A 198 I.U, 0.113 mg vitamin B_1, 0.046 mg riboflavin, fiber 0.8 g, 0.2- 0.8 mg iron, potassium 192-201 mg, 0.16 mg calcium (Thorat *et al.* , 2018). As a result of growing awareness of nutritional security and the rapid development of processing companies around the world, demand of this crop has been increased tremendously.

With the rising demand of mosambi-sweet orange fruits, the area of this fruit has been increasing at a faster rate in India, even in the non-traditional citrus growing regions. Despite massive area expansion, crop production and fruit quality, but the situation in non-traditional areas has not improved to a satisfactory level. Out of many factors,the nature of the soil *i.e.*, calcareous and alkaline, which hinders the smooth uptake of micronutrients to the plants from soil, is one of the key reasons for the low yield and poor fruit quality of mosambi under non-traditional citrus growing conditions (Nandita *et al.*, 2020). Recently, foliar spraying of nutrients, has acquired a lot of attention particularly in perennial crops because of its well-recognized beneficial effect on fruit quality and crop yield (Bhanukar *et al.*, 2018; Singh *et al.*, 2017). Foliar application gives a quick effect as nutrients can be absorbed rapidly through the stomata of the leaf and in some instances through the cuticles (Fernandez *et al.*, 2013). Considering the beneficial effect of foliar feeding of nutrients, a study was made with different products, containing nutrients of organic and inorganic sources, with the view to improve the plant health and to increase production of quality fruits of sweet orange cv. Mosambi in red and laterite soils.

MATERIALS AND METHODS

This experiment was conducted in a sub-tropical weather on farmer's field at Jhargram, West Bengal during 2018. Eight years old plants of sweet orange cv. Mosambi of uniform vigour were selected for the study. There was seven treatments *viz.*,T_1-Vermiwash @6ml/litre, T_2-Multiplex- @ 3m/litre, T_3-Humaur @ 3ml/litre, T_4-$ZnSO_4$ (0.4%) + borax (0.2%) +$FeSO_4$ (0.2%) + $MnSO_4$ (0.2%), T_5-Nitrophoska (19:19:19 :: N:P:K) @8g/litre, T_6-T_4+ after 07 days T_5, T_7- Control(water spray). Each treatment was replicated four times with two plants in each replication. Humaur is a bioorganic foliar nutrient which content various nutrients, vitamins and enzyme manufactured by Hindusthan Antibiotic Limited, Pune, Maharashtra, India. Vermiwash is the leached water, collected during the preparation of vermi-compost; nitrophoska- is the water soluble fertilizer, containing N, P and K at 19:19:19 ratio and multiplex- is a water soluble foliar micro-nutrient prepared by Karnataka Agro-chemicals Pvt. Ltd. and reported to have different micronutrients in soluble form. Plants were sprayed as per treatment after sunset, three times *i.e.,* on 10th March (after fruit set), 10th June and 10th August. Water soluble sticker was added for increasing the efficiency of sprayed particles on the leaves. The investigation was completed in a randomized complete block design (RCBD).

For management of the plants, each plant was fertilized three times with 40kg of FYM + urea 300 g + di-ammonium phosphate 300g +dolomite 200 g/plant on 15th March; on 15th May with urea 300 g +SSP 300 g+MOP 200g/plant and on15th July with urea 300 g +MOP 500g +mustard cake 1.0 kg. To check the fruit drops, the plants were sprayed with different bio-regulators four times *viz.,* 2,4-D at 10ppm at just after fruit set (March); GA_3 at 25 ppm on 15th May; 2,4-D at 10ppm on 15th June and GA_3 at 25ppm on 15th July. Irrigation was provided through drip during dry period (March to middle of June). Insecticides and fungicides were sprayed as per need of the plant.

For measuring leaf chlorosis, 4-shoots/ plant were tagged in four directions. Then total numbers of green and yellow leaves were counted in March, April, May, June, July, August and September, to know the plant's need of time of micro-nutrients. Before counting yellow leaves, all dry shoots from every plant were removed in February.The number of fruits/plant was counted before harvesting (20th September). Fruit weight (g) was taken with the help of a balance (average of 10 fruits/plant) and fruit yield/plant was calculated by multiplying the number of fruits per plant with average fruit weight. For juice content (%) first fruits are weighed and recorded then the percent juice contents were calculated by using the following formula; % juice contents = (juice weight ÷ fruit weight) x 100 (Jamil *et al.*, 2015). Total soluble solid content (TSS) of fruits was estimated with the help of a refractometer and calibrated at 0°Brix. The acidity (%) and ascorbic acid ((mg/100g),) content were estimated as per the methods suggested by A.O.A.C. (1990).

RESULTS AND DISCUSSION

Leaf chlorosis

It is clearly seen from the data in Table 1 that the effect of nutrient feeding on minimizing the leaf chlorosiswas significantly varied. In the different months, all the products of micronutrients were found effective in reducing the chlorosis in the leaves and they were significantly at par among themselves. Among the different sources or products of micro-nutrients, multiplex at 3ml/l was the most effective as it resulted in lowest chlorosis in June (13.2%), July (10.1%), August (7.3%) and September (5.1%) followed by T_4 [$ZnSO_4$ (0.4%) + borax (0.2%) +$FeSO_4$ (0.2%) + $MnSO_4$ (0.2%)]. The treatment T_5 which content NPK (Nitrophoska (19:19:19 :: N:P:K) @8g/litre) was ineffective in this regard which indicated that leaf chlorosis was mainly due to deficiency of micro-nutrients during May to June (fruit growth and development period). Another interesting observation was noted that the demand of micro-nutrients was more during June to August as because the control plants showed the

Table 1: Effect of nutrient feeding on leaf chlorosis (%) in Mosambi

	May	June	July	August	September
Treatment	**Yellow leaf**	**Yellow leaf**	**Yellow leaf**	**Yellow leaf**	**Yellow leaf**
T_1 Varmiwash	4.2	17.7	23.2	17.3	16.3
T_2 Multiplex	4.7	13.2	10.1	7.3	5.1
T_3 Humaur	5.7	15.9	22.4	18.1	13.9
T_4 (Zn, B, Fe, Mn)	7.2	13.8	14.3	8.4	5.4
T_5 Nitrophoska(NPK)	32.6	30.4	41.0	25.1	24.6
T_6 (T4, after 07 days T5)	9.5	17.5	15.6	8.7	6.7
T_7 (Control)	12.8	29.4	40.4	35.9	25.3
SE(m) ± **C.D. at 5%**	**2.502** **7.434**	**1.803** **5.358**	**3.103** **9.220**	**2.631** **7.819**	**2.175** **6.461**

T_1-Vermiwash @6ml/litre, T_2-Multiplex- @ 3m/litre, T_3-Humaur @ 3ml/litre, T_4-$ZnSO_4$ (0.4%) + borax (0.2%) +$FeSO_4$ (0.2%) + $MnSO_4$ (0.2%), T_5-Nitrophoska (19:19:19 :: N:P:K) @8g/litre, T_6-T_4 + after 07 days T_5, T_7- Control (water spray)

Table 2: Effect of nutrient feeding on fruit yield and physico-chemical composition of Mosambi.

Treatment	Fruits plant^{-1}	Weight of fruit (g)	Yield plant^{-1}(kg)	Juice (%)	TSS (%)	Acidity (%)	Vitamin C (mg/ 100g)
T_1	39.3	105	4.13	41	8.3	0.30	36.2
T_2	38.8	103	4.00	40	9.3	0.32	41.8
T_3	36.7	101	3.71	42	9.0	0.35	37.4
T_4	65.0	102	6.63	43	9.4	0.32	41.7
T_5	33.0	104	3.43	42	9.3	0.30	40.6
T_6	47.5	108	5.13	42	8.9	0.29	41.0
T_7	32.5	99	3.22	40	8.1	0.38	36.0
SE(m) ± **C.D. at 5%**	**2.8892** **8.5842**	**1.2263** **3.6436**	**0.3023** **0.8981**	**0.4914** **1.4602**	**0.1543** **0.4585**	**0.0086** **0.0256**	**0.7541** **2.2406**

T_1-Vermiwash @6ml/litre, T_2-Multiplex- @ 3m/litre, T_3-Humaur @ 3ml/litre, T_4-$ZnSO_4$ (0.4%) + borax (0.2%) +$FeSO_4$ (0.2%) + $MnSO_4$ (0.2%), T_5-Nitrophoska (19:19:19 :: N:P:K) @8g/litre, T_6-T_4 + after 07 days T_5, T_7- Control (water spray)

maximum chlorosis in these months. The reason of high demand of micronutrients during these months was due to fruit growth and development. It was noted that varmiwash, organic source of micronutrients, was also effective in reducing leaf chlorosis in different months as compared to the control plants. In sweet oranges leaf chlorosis due to deficiency of major and minor nutrients is well known but the study indicated that the demand of micro-nutrients is more during fruit growth period as compared to other periods. The result is near to Devi *et al.*(1997) in Sathqudi orange in their experiment where lowest chlorosis (2.5%) was observed with soil application of 50 g/plant each of $FeSO_4$, $ZnSO_4$ and $MnSO_4$ combined with foliar application of 0.5 % each of the above three micronutrients.

Yield and physico-chemical composition

Number of fruits/ plant and yield/ plant (kg) varied significantly due to various nutrient feeding (Table 2). Highest number of fruits/plant (65.0) and yield/plant (6.63 kg) was noted in treatment of $ZnSO_4$ @0.4% + borax @ 0.2% +$FeSO_4$ @ 0.2%

+ $MnSO_4$ @ 0.2% (T_4) wherein lowest fruit number and yield/plant (32.5 and 3.22 kg respectively) was observed in control plants (T_7). The combined use of Fe, Zn, B and Mn prolonged the photosynthetic activities which resulted in more production of carbohydrates that resulted in fruit production in mosambi sweet orange. The findings are supported with the results of Singh *et al.* (2018) and Nandita *et al*. (2020) in sweet orange. Fruit production in terms of number of fruits (47.5) and yield/plant (5.13kg) was also higher in T_6 (combination of micronutrients and NPK).

Foliar application of nutrients helped to improve fruit weight (Table 2) significantly and highest fruit weight (108g) was recorded fromT_6 (combination of micronutrients and NPK) as compared to control (99 g). Highest fruit weight in T_6 may be explained from the fact NPK (readily available form) in combination with micronutrients, helped to increase more synthesis of carbohydrate and other photosynthates. Similar type result was found by Reetika *et al.* (2018) in Kinnow Mandarin when the plants were sprayed with a combination of urea 1.0% + $ZnSO_4$ 0.5% + K_2SO_4 1.0% + H_3BO_3 0.2% + $FeSO_4$ 0.5%. In another research, Kazi *et al*. (2012) found a similar result in sweet orange and they recorded that fruit weight/tree improved with the application of NPK and multi micronutrients.

Table 2 cue that the application of nutrients significantly increased juice content and TSS. The highest juice content (43 %) was found in T_4 whereas the lowest (40 %) was in control. The study made by Rama and Bose (2000) and Kaur *et al.* (2015) in mandarin orange indicated that the highest juice content was associated with the application of Zn, B, Fe. TSS was highest (9.4º brix) in T_4 and the lowest (8.1º brix) in control. This finding was confirmed by Ghosh and Basra (2000), who observed that the application of zinc +boron in sweet orange increase TSS.

The acidity content was maximum in control fruits (0.38%) and lowest in T_6 (o.29%) (Table 2). Lower fruit acidity in nutrients treated plants may be due to the transformation of organic acid into sugar. These results are supported by Kazi *et al.* (2012) who found the application of NPK and micronutrients minimize acidity in sweet orange.

The ascorbic acid content in the fruits was significantly increased with the application of nutrients (Table 2). The highest vitamin C (41.8 mg/100ml) was measured from the plants in T_2 closely followed by T_4 (41.7mg/100ml) and the lowest (36.0 mg/100ml) in T_7 (control). Application of micronutrient increased the sugar level and vitamin C synthesized from sugar which may be a possible reason and zinc also plays a major role in the creation of auxin, which is also boost vitamin C content (Alloway, 2008; Nawaz *et al.,* 2008). Similar observations were also documented by Tariq *et al.* (2007) in Sweet orange.

CONCLUSION

The conclusion of the experiment that, the application of micronutrients $ZnSO_4$ (0.4%) + borax (0.2%) +$FeSO_4$ (0.2%) + $MnSO_4$ (0.2%) in soluble form during fruit set, growth and development period (March to August) helped to minimize the leaf chlorosis, fruit drop and increased fruit yield and physico-chemical composition in Mosambi. Foliar feeding with soluble N, P and K like nitrophoska may have synergistic effect on increasing more sizeable fruits of quality fruits. Vermiwash, an organic sources of different nutrients, hormones, etc. showed good results with regard to reducing leaf chlorisis, increasing fruit yield and quality fruits as compared to control plants. Multiplex, commercial products of micronutrients, is also helpful in reducing leaf chlorosis and improving production of quality Mosambi fruits.

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