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Effect of multi-micronutrients on growth and yield of sweet orange (*Citrus sinensis* L. Osbeck) CV. Phule Mosambi

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Abstract
A field experiment was conducted at Horticultural Research Farm, College of Horticulture, Anand Agricultural University, Anand during 2024 to evaluate the effect of multi-micronutrients on growth and yield of sweet orange (*Citrus sinensis* L. Osbeck) cv. Phule Mosambi. The experiment was laid out in Completely Randomized Design comprising nine treatments involving different combinations of government-notified multi-micronutrient grades of Gujarat (G-IV and G-V) and Maharashtra (G-II-MH) applied through soil and foliar methods and repeated thrice. Among the treatments, foliar application of G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1% combined with soil application of G-V (Fe-2.0%, Zn-5.0%, Cu-0.2%, B-0.5%, Mn-0.5%) significantly enhanced yield parameters including fruit length (7.87 cm), fruit diameter (7.83 cm), fruit weight (260.47 g), fruit volume (248.33 cc) and fruit yield (63.80 kg/tree and 17.74 t/ha). The same treatment also showed highest number of fruits at pea stage (43), number of fruits at harvest (27), reduced fruit drop percentage (38.53%) and increased number of fruits per plant (245).

Keywords: Growth, yield, sweet orange, multi-micronutrients, *Citrus sinensis*, Phule Mosambi

Introduction
Sweet orange (*Citrus sinensis* L.) is a subtropical fruit member of the rutaceae family and the aurantioideae subfamily. After mango and banana, citrus is the third-largest fruit crop cultivated in India. Both tropical and subtropical climates are often used to develop it. Different agroclimatic areas are used to cultivate sweet oranges, mandarins and acid limes for commercial purposes. Andhra Pradesh, Karnataka, Maharashtra, Punjab, Rajasthan and Haryana are the main sweet orange growing states. sweet orange needs a dry climate and arid weather with distinct summer and winter seasons, with low rainfall. It is grown on a wide range of soil, ranging from clay to light sandy and sensitive to salt. Sweet orange is well grown on medium black, red, alluvial riverbank loamy soil of Maharashtra state and sandy loam soil of Gujarat. In India, widespread deficiency of micronutrients, especially of zinc, iron and boron in horticultural crops has been reported, *i.e.*, yellowing of citrus, rosetting, little leaf, interveinal chlorosis and hard fruit have been attributed to the deficiency of zinc, ferrous and boron. (Singh and Misra, 1980; Ahlawat *et al.*, 1982; Mann and Sindhu, 1983; Yamdagni *et al.*, 1983) [13, 1, 6, 14]. Foliar feeding of micronutrients has become a commercial practice for citrus in many countries. Problems like the rapid fixation of nutrient elements in the soil, thus tending them to be relatively inaccessible to the crops by soil application, brought forth the necessity of making them available by foliar sprays of micronutrients. Due to slower response to micronutrient application and treatment in soil, their addition as a spray on the foliage offers a practical device for avoiding their deficiency and resultant crop losses before the deficiency symptom sets in or gives a clue of their emergence.

Materials and Methods
The experiment was conducted on twelve-year-old trees of sweet orange planted at Horticultural Research Farm, College of Horticulture, Anand Agricultural University, Anand during 2024. It was carried out using a Completely Randomised Design with nine treatments *viz.*, T_1: Control, T_2: G-II-MH (Fe-2.5%, Zn-3.0%, Cu-1.0%, B-0.5%, Mn-1.0%, Mo-0.1%),

T_3: G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%), T_4: G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%, T_5: G-V (Fe-2.0%, Zn-5.0%, Cu-0.2%, B-0.5%, Mn-0.5%), T_6: G-V (Fe-2.0%, Zn-5.0%, Cu-0.2%, B-0.5%, Mn-0.5%) + Mo-0.1%, T_7: G-V + T_2 {(G-II-MH (Fe-2.5%, Zn-3.0%, Cu-1.0%, B-0.5%, Mn-1.0%, Mo-0.1%)}, T_8: G-V + T_3 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) and T_9: G-V + T_4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1% repeated thrice during February to October in the year 2024. Micronutrient formulations multi-micronutrient G-II-MH and Multi-micronutrient G-IV @ 1% was applied twice as foliar spray, *i.e.* first spray in March (at flowering time) and second spray one month after the first spray and multi-micronutrient Grade-V @ 1% was given as a soil application in February. A full dose of RDF (20 kg FYM + 800:300:600 g N:P: K per plant) was given in two equal splits in the months of February and June as per the recommendation of MPKV, Rahuri.

Result and discussion

Effect of multi-micronutrients on growth parameters

The data presented to the incremental plant height, incremental plant spread [N-S] and [E-W] as influenced by foliar application of multi-micronutrients are presented in Table 1. There was no any significant difference found on growth parameters due to application of multi-micronutrients.

Table 1: Effect of multi-micronutrients on growth parameters of sweet orange

Sr. No.	Treatment Details	Incremental plant height (cm)	Incremental plant spread [N-S] (cm)	Incremental plant spread [E-W] (cm)
T_1	Control	19.33	31.50	40.07
T_2	G-II-MH (Fe-2.5%, Zn-3.0%, Cu-1.0%, B-0.5%, Mn-1.0%, Mo-0.1%)	21.93	32.47	41.23
T_3	G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%)	21.87	32.17	41.15
T_4	G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%	20.60	32.10	40.47
T_5	G-V (Fe-2.0%, Zn-5.0%, Cu-0.2%, B-0.5%, Mn-0.5%)	21.45	32.13	40.57
T_6	G-V (Fe-2.0%, Zn-5.0%, Cu-0.2%, B-0.5%, Mn-0.5%) + Mo 0.1%	20.80	31.57	40.43
T_7	G-V + T2 {(G-II-MH (Fe-2.5%, Zn-3.0%, Cu-1.0%, B-0.5%, Mn-1.0%, Mo-0.1%)}	22.00	33.53	42.13
T_8	G-V + T3 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%)}	22.20	33.60	42.40
T_9	G-V + T4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%}	23.67	34.60	42.70
	S.Em±	1.11	1.59	1.94
	CD (P=0.05)	NS	NS	NS
	CV%	8.94	8.42	8.15

Effect of multi-micronutrients on yield parameters

Fruit length (cm)

The perusal of data (Table 2) indicated that among the different treatments, T_9: G-V + T_4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%} recorded the highest fruit length (7.87 cm), followed by T_7 (7.48 cm), T_8 (7.42 cm) and T_2 (7.40 cm), whereas the minimum fruit length (6.53 cm) was observed in the control treatment T_1. The significant increase in fruit length under T_9 could be attributed to the synergistic effect of essential micronutrients such as Fe, Zn, Cu, B, Mn and Mo, which are known to enhance physiological processes like enzyme activation, cell division and cell elongation. These elements play crucial roles in improving photosynthetic efficiency and nutrient translocation to the developing fruits, thereby promoting increased fruit size. Moreover, the presence of molybdenum may have further supported nitrogen metabolism and auxin synthesis, contributing to improved fruit growth. These findings are in agreement with the earlier reports of Pawar *et al.* (2022) [8] and Nandita *et al.* (2022) [7] in sweet orange.

Fruit diameter (cm)

It was observed that among the different treatments T_9: G-V + T_4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%} resulted in the highest fruit diameter (7.83 cm), followed by T_8 (7.43 cm) and T_7 (7.42 cm), while the minimum fruit diameter (6.92 cm) was recorded under the control treatment T_1. The significant increase in fruit diameter due to improved cellular expansion and tissue differentiation, resulting from the synergistic effects of micronutrients such as Fe, Zn, Cu, B, Mn and Mo. These observations are in agreement with the findings of Sikarwar and Tomar (2019) [12] in sweet orange.

Fruit weight (g)

It was found (Table 2) that among different treatments, The highest fruit weight (260.47 g) was recorded under treatment T_9: G-V + T_4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%}, followed by T_8 (245.43 g) and T_7 (240.10 g), while the lowest fruit weight (217.57 g) was noted in the control treatment T_1. The increase in fruit weight under T_9 may be ascribed to enhanced nutrient partitioning and effective translocation of assimilates toward the developing fruits, resulting in improved sink strength. Micronutrients like Fe, Zn, Mn and Mo are known to improve photosynthetic efficiency, chlorophyll content and enzymatic activities related to sugar metabolism, which collectively enhance sugar synthesis and its accumulation in fruit tissues. These results agree with the findings of Pawar *et al.* (2022) [8] in sweet orange.

Fruit volume (cc)

The perusal data (Table 2) showed that among different treatments. The maximum fruit volume (248.33 cc) was recorded under treatment T_9: G-V + T_4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%}, followed by T_8 (233.33 cc) and T_7 (230.00 cc), while the minimum fruit volume (208.33 cc) was observed in the control treatment T_1. The notable increase in fruit volume under T_9 may be attributed to enhanced cellular expansion and internal fruit development supported by the balanced and synergistic effect of micronutrients. These results are in agreement with the findings of Meena *et al.* (2016) in mandarin; Salve *et al.* (2022) [10] and Kavinprashanth *et al.* (2021) [4] in acid lime; Kumari *et al.* (2022) [5] in lemon.

Number of fruits at pea stage per branch

It can be seen (Table 2) that among different treatments, The highest number of fruits at pea stage (43) was recorded under treatment T_9: G-V + T_4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%}), followed by T_7 (42), T_8 (41), T_6 (41), T_5 (40) and T_2 (40), whereas the minimum fruit retention (38) was observed in the control treatment T_1. The enhanced fruit retention at the pea stage may be attributed to the crucial role played by micronutrients in improving reproductive success. Boron (B) facilitates pollen germination and pollen tube elongation, ensuring effective fertilization; zinc (Zn) is involved in auxin synthesis and flower organ development; while molybdenum (Mo) aids in nitrogen metabolism and energy production during the critical phases of fruit initiation. The combined and balanced supply of these nutrients likely improved early fruit set and minimized fruit drop. These results are in line with the findings of Sikarwar and Tomar (2019) [12] in sweet orange and Salve *et al.* (2022) [10] in acid lime.

Number of fruits at harvest per branch

The perusal of data (Table 2) revealed that the number of fruits at harvest per branch found maximum number of fruits at harvest (27) was recorded under treatment T_9: G-V + T_4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%}, followed by T_8 (25), T_7 (25) and T_5 (24), while the minimum number of fruits (19) was observed in the control treatment T_1. The increased fruit retention up to harvest may be ascribed to the synergistic effect of essential micronutrients such as Fe, Zn, Mn, Cu, B and Mo, which play pivotal roles in various physiological processes. The results are in close agreement with the findings of Sheikh *et al.* (2021) [11] in lemon.

Fruit drop (%)

It was found (Table 2) that among different treatments, minimum fruit drop (37.20%) was recorded under treatment T_9: G-V + T_4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%}, which was statistically at par with T_8 (39.42%), T_7 (40.92%), T_2 (41.44%) and T_5 (42.56%). In contrast, the highest fruit drop (50.46%) was observed in the control treatment T_1. The substantial reduction in fruit drop under T_9 may be attributed to the synergistic effect of a balanced micronutrient combination including Fe, Zn, Cu, B, Mn and Mo. These elements contribute significantly to the synthesis of growth hormones such as auxins and cytokinins, enhance photosynthetic activity and promote efficient nutrient translocation—all of which are vital in strengthening fruit at harvest mechanisms. These findings are in agreement with the reports of Davinder *et al.* (2017) [3] in kinnow mandarin.

Number of fruits per plant

The perusal of data (Table 2) revealed that the number of fruits per plant in sweet orange was significantly influenced by various multi-micronutrient treatments. The highest fruit count per plant (245) was recorded under treatment T_9: G-V + T_4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%}, followed by T_8 (242), T_7 (240) and T_4 (222), while the lowest fruit number (212) was noted in the control treatment T_1. The increased fruit count under T_9 may be attributed to the synergistic effect of essential micronutrients such as Fe, Zn, Mn, Cu, B and Mo, which play critical roles in reproductive development and physiological processes. These findings are in line with the earlier reports of Pawar *et al.* (2022) [8], Sikarwar and Tomar (2019) [12] and Saha *et al.* (2020) [9] in sweet orange.

Fruit yield

It was observed that among different treatments, the highest fruit yield (63.80 kg/plant and 17.74 t/ha) was recorded under treatment T_9 G-V + T_4 {(G-IV (Fe-4.0%, Zn-6.0%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo-0.1%}, which was found to be significantly superior to all other treatments. It was followed by T_8 (59.42 kg/plant and 16.52 t/ha) and T_7 (57.73 kg/plant and 16.05 t/ha), while the lowest yield was recorded in the control treatment T_1 (46.10 kg/plant and 12.82 t/ha). The significant increase in fruit yield under T_9 could be attributed to the balanced supply of essential micronutrients such as Fe, Zn, Cu, B, Mn and Mo, which play vital roles in enhancing enzymatic activity, chlorophyll biosynthesis, reproductive development and overall plant vigour. These results are consistent with the findings of Pawar *et al.* (2022) [8] and Nandita *et al.* (2022) [7] in sweet orange; Salve *et al.* (2022) [10] and Bastakoti *et al.* (2022) [2] in acid lime.

Table 2: Effect of multi-micronutrients on yield parameters of sweet orange

Sr. No.	Fruit Length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit volume (cc)	Number of fruits at pea stage per branch	Number of fruits at harvest per branch	Fruit drop (%)	Number of fruits per plant	Yield (kg/plant)	Yield (t/ha)
T1	6.53	6.92	217.57	208.33	38	19	50.46	212	46.10	12.82
T2	7.40	7.27	230.87	219.33	40	23	41.44	219	50.51	14.04
T3	6.68	7.18	219.97	209.33	37	19	47.24	216	47.66	13.25
T4	7.12	7.07	227.37	216.67	39	21	45.63	222	50.58	14.06
T5	7.02	7.00	223.33	214.00	40	24	42.56	215	47.87	13.25
T6	6.93	7.22	228.27	217.33	41	22	45.12	216	48.68	13.53
T7	7.48	7.42	240.10	230.00	42	25	40.92	240	57.73	16.05
T8	7.42	7.43	245.43	233.33	41	25	39.42	242	59.42	16.52
T9	7.87	7.83	260.47	248.33	43	27	37.20	245	63.80	17.74
S.Em±	0.16	0.14	8.25	6.92	1.19	0.94	2.16	7.91	2.18	0.61
CD (P=0.05)	0.48	0.43	24.50	20.55	3.52	2.78	6.44	23.50	6.49	1.80
CV%	3.93	3.44	6.14	5.40	5.11	7.08	8.67	6.08	7.21	7.21

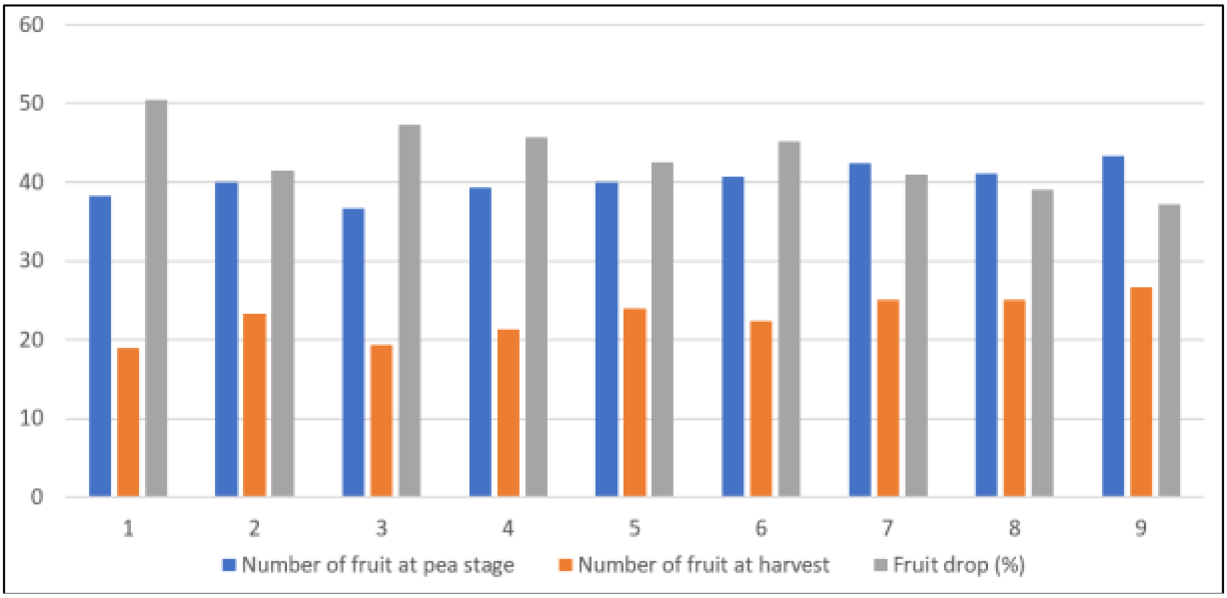

Fig 1: Effect of multi-micronutrients on yield parameters

Conclusion

From the foregoing investigation, it can be concluded that the application of multi-micronutrient Gujarat government notified grade-V (Fe-2.0%, Zn-5.0%, Cu-0.2%, B-0.5%, Mn-0.5%) @ 1% soil application in February and spraying of grade-IV (Fe-4.0%, Zn-6%, Cu-0.5%, B-0.5%, Mn-1.0%) + Mo 0.1% @ 1% at pea stage and one month after first spray along with RDF (20 kg FYM + 800:300:600 g N:P:K per plant) was found effective in increasing yield parameters.

Reference

1. Ahlawat VP, Sharma RC, Singh J. Micronutrient status of citrus orchards in Haryana. Haryana Journal of Horticultural Sciences. 1982;11(1-2):25-30.
2. Bastakoti S, Nepal S, Sharma D, Shrestha AK. Effect of foliar application of micronutrients on growth, fruit retention and yield parameters of acid lime (*Citrus aurantifolia* Swingle). Cogent Food & Agriculture. 2022;8(1):2112421.
3. Davinder AM, Kumar A, Singh R, Pratap S, Singh B. Impact of zinc and boron on growth, yield and quality of Kinnow (*Citrus deliciosa* × *Citrus nobilis*) in sub-tropical conditions of Punjab. Journal of Pure and Applied Microbiology. 2017;11(2):1135-1139.
4. Kavinprashanth R, Paramaguru P, Aneesa Rani MS, Sujatha KB. Impact of foliar application of growth regulators and micronutrients on yield and quality of acid lime (*Citrus aurantifolia* Swingle). Journal of Pharmacognosy and Phytochemistry. 2021;10(1):2091-2093.
5. Kumari B, Kumar L, Soni AK. Effect of micro-nutrients on growth, yield and quality of lemon (*Citrus limon* L.) in rainy season. The Pharma Innovation Journal. 2022;11(2):1958-1962.
6. Mann SS, Sindhu SS. Zinc deficiency in citrus and its correction. Journal of Research, Punjab Agricultural University. 1983;20(2):150-155.
7. Nandita K, Kundu M, Rakshit R, Nahakpam S. Effects of foliar application of micronutrients on growth, yield and quality of sweet orange (*Citrus sinensis* L. Osbeck). Bangladesh Journal of Botany. 2022;51(1):57-63.
8. Pawar PS, Rukadikar MV, Bhite BR. Studies on use of micronutrients in sweet orange (*Citrus sinensis* Osbeck) cv. Mosambi. The Pharma Innovation Journal. 2022;11(6):601-603.
9. Saha T, Das A, Ghosh B, Kundu S, Bhattacharya S. Effect of micronutrient on fruit set, yield and quality of sweet orange (*Citrus sinensis* Osbeck) cv. Mosambi in the Gangetic alluvial region of West Bengal. Journal of Pharmacognosy and Phytochemistry. 2020;9(3):1793-1795.
10. Salve PS, Patil SG, Girase LA. Studies on different grades and methods of application of micronutrient mixture on yield and quality of acid lime (*Citrus aurantifolia* Swingle) cv. Sai Sharbati. Multilogic in Science. 2022;12(42):1-13.
11. Sheikh KHA, Singh B, Haokip SW, Kripa S, Debbarma R, Athokpam GD, Nengparmoi TH. Response of yield and fruit quality to foliar application of micronutrients in lemon [*Citrus limon* (L.) Burm.] cv. Assam Lemon. Journal of Horticultural Sciences. 2021;16(2):144-151.
12. Sikarwar PS, Tomar KS. Effect of micronutrients on growth, yield and quality parameters of sweet orange (*Citrus sinensis* L.) cv. Mosambi. International Journal of Current Microbiology and Applied Sciences. 2019;8(11):2524-2531.
13. Singh D, Misra RL. Influence of micronutrient sprays on citrus fruit quality. Indian Journal of Agricultural Sciences. 1980;50(3):210-213.
14. Yamdagni R, Singh D, Kaur J. Micronutrient deficiencies in citrus orchards of Himachal Pradesh. Himachal Journal of Agricultural Research. 1983;9(1):60-65.