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EFFECT OF FOLIAR APPLICATION OF ZINC, BORON AND COPPER ON VEGETATIVE GROWTH AND FRUIT YIELD OF MALTA (*CITRUS SINENSIS*)

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ABSTRACT

A field experiment was conducted during 2024–25 at the Maujgarh Citrus Gardening Plant, Abohar, Punjab, to evaluate the effect of zinc sulphate, boric acid, and copper sulphate on vegetative growth and fruit yield of Malta (*Citrus sinensis*) cv. ‘Red Blood’. The experiment was laid out in Randomized Block Design with eight treatments. The treatment T_7 ($ZnSO_4$ 0.7% + H_3BO_3 0.5% + $CuSO_4$ 0.5%) recorded the maximum tree spread, stem girth, fruit retention, number of fruits, fruit weight and fruit yield. The study concludes that foliar application of Zn, B and Cu, especially treatment T_7, significantly enhances growth and yield in Malta and is recommended as an effective nutrient management strategy under subtropical conditions.

Key words : Foliar spray, zinc sulphate, boric acid, copper sulphate, fruit yield, vegetative growth.

Introduction

In India, citrus ranks third in area under fruit cultivation, following mango and banana. The production and area of sweet orange Among citrus fruits, sweet orange (*Citrus sinensis*) is the economically important fruit crop grown worldwide due to its high nutritional value, pleasant flavour, and market potential. Micronutrients such as zinc (Zn), boron (B), and copper (Cu) are essential for normal physiological and biochemical functions in plants. Zinc is vital for auxin metabolism, protein synthesis, and chlorophyll formation and its deficiency often leads to reduced fruit set and lower productivity (Yadav *et al*., 2007). Boron is known for its role in sugar translocation, pollen germination, cell wall formation and fruit development (Singh *et al*., 1990; Kacar *et al*., 2020). Copper, being a part of various enzymes and proteins, supports photosynthesis and lignin biosynthesis, and enhances fruit firmness and resistance to diseases (Kumar and Verma, 2012).Foliar application of micronutrients is an efficient method of nutrient delivery, as it ensures rapid absorption and availability during critical growth stages. Several researchers have reported positive responses in citrus to foliar sprays of Zn, B and Cu either individually or in combination. Parmar *et al*. (2014) and Ilyas *et al*. (2015) found that Zn and B foliar sprays improved fruit size and yield in guava and citrus. Similarly, Rizwan *et al*. (2019) highlighted the importance of copper in improving citrus fruit quality and disease resistance.

Materials and Methods

The experimental site Maujgarh Citrus Gardening Plant, Aboharis situated at 30°15′ N latitude and 74°19′ E longitude, with an altitude of 185 meters above mean sea level under Western Plain Zone of Punjab. The soil of the experimental field was sandy loam in texture, with low to medium fertility level and the pH of soil is 7.8.

The experiment was laid out in Randomized Block Design (RBD) with eight treatments and four replications. Seven-year-old trees of *Citrus sinensis* cv. ‘Red Blood’ were used for experimental material. The experiment comprised eight treatments *viz*.; T_0 - Water spray (control), T_1 - $ZnSO_4$ (0.5%) + H_3BO_3 (0.5%) + $CuSO_4$ (0.5%), T_2 - $ZnSO_4$ (0.5%) + H_3BO_3 (0.6%) + $CuSO_4$ (0.5%), T_3 - $ZnSO_4$ (0.5%) + H_3BO_3 (0.7%) + $CuSO_4$ (0.5%), T_4 - $ZnSO_4$ (0.5%) + H_3BO_3 (0.5%) + $CuSO_4$ (0.6%), T_5 - $ZnSO_4$ (0.5%) + H_3BO_3 (0.5%) + $CuSO_4$

(0.7%), T_6 - $ZnSO_4$ (0.6%) + H_3 BO_3 (0.5%) + $CuSO_4$ (0.5%), T_7 - $ZnSO_4$ (0.7%) + H_3 BO_3 (0.5%) + $CuSO_4$ (0.5%).

Treatments were applied three times at monthly intervals starting in April. Observations were recorded on vegetative parameters of tree spreading is measured by a measuring tape and the stem girth was measured 30 cm above ground level by a meter scale. Among the yield attributes fruit retention is calculated by using following formula Retention (%) = (Final Fruit Count / Initial Fruit Set Count) × 100, fruit number is recorded after harvesting of full mature fruits, The diameter of five randomly selected fruits was measured using a vernier calliper and the average fruit diameter was calculated in centimetres. The picked fruits under each experimental tree were weighed separately for yield per plant.

Results and Discussion

Effect on Vegetative Growth

The application of Zn, B and Cu significantly improved vegetative parameters. The annual increase in tree spread and stem girth of Malta showed notable differences across the treatments. As shown in Table 1, the maximum East–West (61.50 cm) and North–South (38.75 cm) tree spread, along with the greatest stem girth increment, were achieved with the foliar application of $ZnSO_4$ 0.7% + H_3 BO_3 0.5% + $CuSO_4$ 0.5% (T_7), closely followed by $ZnSO_4$ 0.6% + H_3 BO_3 0.5% + $CuSO_4$ 0.5% (T_6). These two treatments were statistically at par. Treatments T_1 and T_5 showed comparable performance and were statistically similar to T_4 and T_6 and all significantly improved tree spread and stem girth over the control (T_0). The lowest tree spread in both directions and the least stem girth increment were recorded in the control treatment (T_0). These results align with the findings of Swietlik (2002), Singh *et al*. (2018) and Kacar *et al.* (2020).

Effect on Yield attributes and Fruit yield

The fruit retention percentage in Malta varied significantly across the micronutrient treatments. The highest fruit retention was observed in T_7 ($ZnSO_4$ 0.7% + H_3BO_3 0.5% + $CuSO_4$ 0.5%), followed closely by T_6 ($ZnSO_4$ 0.6% + H_3BO_3 0.5% + $CuSO_4$ 0.5%), which recorded 69.00% retention. This indicates that increasing zinc levels contribute to better fruit retention, likely due to reduced fruit drop influenced by micronutrient supplementation. The lowest fruit retention was recorded in the control treatment (T_0). The number of fruits per plant also showed significant variation among treatments. The highest fruit count (477.50 fruits/plant) was recorded

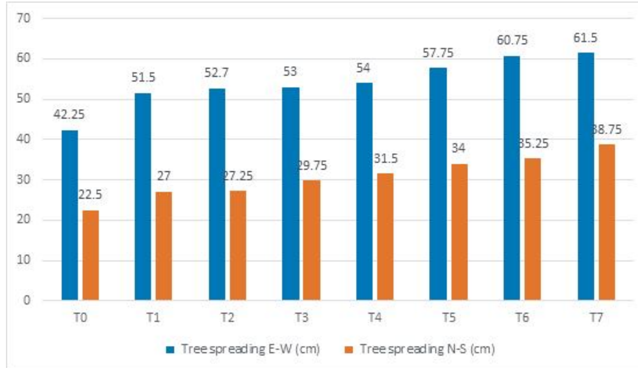

Fig. 1 : Effect of Foliar application of Zinc, Boron and copper on tree spread.

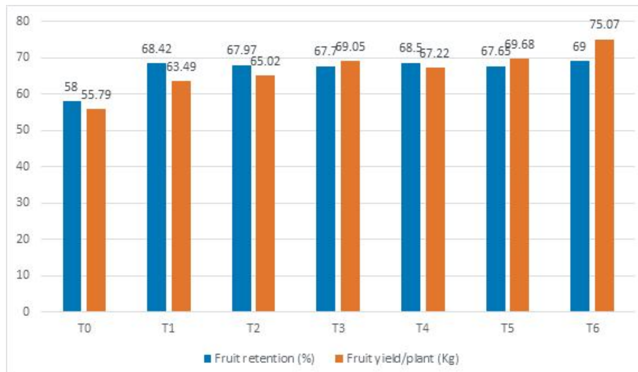

Fig. 2 : Effect of Foliar application of Zinc, Boron and copper on fruit retention and fruit yield.

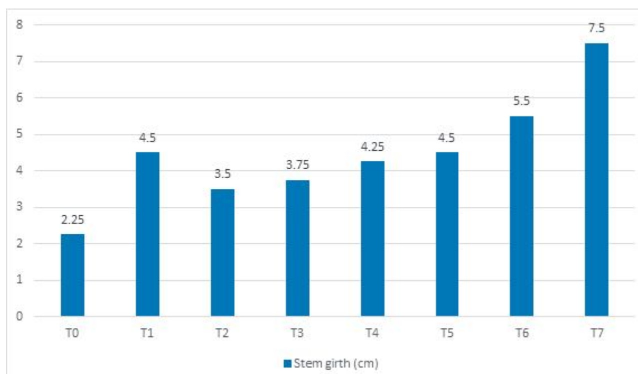

Fig. 3 : Effect of Foliar application of Zinc, Boron and copper on stem girth.

under T_7, indicating that a higher zinc concentration positively affected fruit set and development. In contrast, the lowest fruit count (413.66 fruits/plant) was recorded in the control (T_0), where only water was applied. Fruit diameter was significantly influenced by foliar application of zinc, boron, and copper. The maximum equatorial (7.96 cm) and polar (6.37 cm) diameters were recorded under T_7, followed by T_6 and T_5. This increase in fruit size may be attributed to enhanced cell division, sugar translocation, and hormonal balance facilitated by these micronutrients.

Fruit yield per plant also varied significantly among the treatments. The highest yield (81.23 kg/tree) was

Table 1 : Effect of Foliar application of Zinc, Boron and copper on tree spread and stem girth.

Treatments	Tree Spread		Annual increment of stem girth (cm)
	Annual increment of E - W spreading (cm)	Annual increment of N - S spreading (cm)	
T_0	42.25	22.50	2.25
T_1	51.50	27.00	4.50
T_2	52.70	27.25	3.50
T_3	53.00	29.75	3.75
T_4	54.00	31.50	4.25
T_5	57.75	34.00	4.50
T_6	60.75	35.25	5.50
T_7	61.50	38.75	7.50
CD at 5 %	4.565	3.703	3.36

Table 2 : Effect of Foliar application of Zinc, Boron and copper on fruit retention (%), fruit/ plant and fruit yield/ plant.

Treatments	Fruit Retention (%)	Fruits/Plant	Fruit yield/Plant (kg)
T_0	58.00	413.66	55.79
T_1	68.42	454.00	63.49
T_2	67.97	452.29	65.02
T_3	67.70	457.77	69.05
T_4	68.50	453.25	67.22
T_5	67.65	459.00	69.68
T_6	69.00	469.76	75.07
T_7	69.74	477.50	81.23
CD at 5%	4.91	4.06	3.62

recorded under T_7, likely due to the cumulative effect of improved fruit retention, size, and number. Treatments T_5 (69.68 kg), T_3 (69.05 kg), and T_4 (67.22 kg) were statistically at par, showing comparable performance despite slight differences in boric acid and copper sulphate concentrations. The lowest yield (55.79 kg/tree) was observed in the control (T_0), which received no micronutrient application. These results are consistent with the findings of Khan *et al.* (2021) and Kacar *et al.* (2020), who reported enhanced fruit retention and fruit yield by foliar application of micronutrients.

Conclusion

Foliar application of zinc, boron, and copper significantly enhanced vegetative growth, yield attributes, and overall fruit yield in Malta. Among all treatments, the foliar application of $ZnSO_4$ 0.7% + H_3BO_3 0.5% + $CuSO_4$ 0.5% (T_7) was found to be the most effective.

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