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Effect of different micronutrients on the quality attributes in zucchini (*Cucurbita pepo* L.) under Telangana condition

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Abstract

This study investigated the impact of foliar-applied micronutrients (boron, zinc, and manganese) on the quality attributes of zucchini. The experiment, conducted during the 2023-24 Rabi season, a randomized block design with 12 treatments and three replications. Results showed significant improvements in total soluble solids (TSS), fiber content and fruit firmness due to micronutrient application. The treatment T₁₀ - Boron (B) @ 20 ppm + Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 20 ppm yielded the highest TSS (2.95 °Brix), fiber content (0.72%) and fruit firmness (10.06 kg/cm²). These values were significantly higher than the control treatment. The study concludes that foliar application of micronutrients, particularly in combination, enhances the quality attributes of zucchini. The combined application of micronutrients promoted cell wall integrity, delayed cell wall degradation and improved nutrient concentration and highlight the importance of micronutrient management for improving fruit quality.

Keywords: Zucchini, micronutrients, total soluble solids, fiber content, fruit firmness

1. Introduction

Vegetables constitute a crucial staple in our daily nutrition, offering significant advantages in maintaining good health and preventing deficiencies. Given their indispensable role in our daily dietary intake, vegetables contribute to nutritional security and serve as a livelihood source for small-scale and subsistence farmers. They are important food and highly beneficial for the maintenance of health and the prevention of diseases. The importance of vegetables in the human diet is well known since they supply all the main components of the human diet.

Zucchini or Summer Squash (*Cucurbita pepo* L.) is an exotic vegetable that originated in Tropical America and belongs to the Cucurbitaceae family. The chromosome number is 2n = 40. They are very low in energy content (about 17 Kcal/100 g), fat, sodium and cholesterol-free. It is rich in nutrients and bioactive compounds viz., phenolics, flavonoids, Vitamins (including β-carotene, Vitamin A, Vitamin B₂, Vitamin B₆, α-tocopherol, Vitamin C and Vitamin E), lutein, zeaxanthin, protein, amino acids, carbohydrates and minerals like magnesium, especially potassium and has a large amount of fiber (Tamer *et al.*, 2010) ^[11].

Micronutrients play a crucial role in accelerating crop development, enhancing plant resistance to drought, low temperature and improving the absorption of nitrogen, phosphorus and potassium from the soil (Zaryshniak and Zherdetsky, 2007) ^[13]. Their beneficial impact on plants is attributed to their involvement in the redox processes of environmental carbohydrates. Additionally, microelements increase chlorophyll content in leaves, thereby improving the plant's photosynthetic efficiency (Bundiniene *et al.*, 2007) ^[6].

Micronutrients such as Zinc (Zn), Boron (B), Manganese (Mn), *etc.*, are well-known to act as a stimulant in regulating organic reactions that are taking place in plants and to develop plant growth (Patil *et al.*, 2013) ^[8]. They act as co-enzymes for numerous enzymes and play a vital role in enhancing quality. Their utility extends to various metabolic processes, ranging from cell wall development to functions such as respiration, photosynthesis, chlorophyll formation and enzyme activity. The demand for increasing vegetable production will require a thorough knowledge of the relationship between micronutrients and crop growth.

Inadequacy of these crucial nutrients can lead to a substantial decline in crop yield, impacting diverse physiological, morphological and biochemical aspects of crops due to deficiencies in various micronutrients.

2. Materials and Methods

The present study was conducted at PG Research Block, College of Horticulture, Sri Konda Laxman Telangana Horticultural University, Rajendranagar, Hyderabad, during Rabi season for the year 2023-24. The experiment was laid out in randomized block design with three (3) replications and twelve (12) treatment combinations i.e., T₁ - Boron (B) @ 20 ppm, T₂ - Boron (B) @ 40 ppm, T₃ - Zinc (Zn) @ 15 ppm, T₄ - Zinc (Zn) @ 30 ppm, T₅ - Manganese (Mn) @ 20 ppm, T₆ - Manganese (Mn) @ 40 ppm, T₇ - Boron (B) @ 20 ppm + Zinc (Zn) @ 30 ppm, T₈ - Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 40 ppm, T₉ - Manganese (Mn) @ 20 ppm + Boron (B) @ 40 ppm, T₁₀ - Boron (B) @ 20 ppm + Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 20 ppm, T₁₁ - Boron (B) @ 40 ppm + Zinc (Zn) @ 30 ppm + Manganese (Mn) @ 40 ppm, T₁₂ - Control. The standard recommended package of practices of SKLTGHU was followed to raise the successful crop. Periodical observation was recorded for Total soluble sugars, fiber content, fruit firmness. The data for these parameters were significantly analyzed in ANOVA are presented in Table 1. The standard procedures for estimation of the quality parameters are as followed.

2.1 Total soluble solids (⁰brix)

Total soluble solids (TSS) in terms of percentage were obtained by using a digital refractometer. Two to three drops of juice were placed on the prism of the refractometer and reading was observed on the scale and averages were expressed in ⁰brix.

2.2 Fiber content (%)

The Fiber content of the sample was determined by boiling it with 1.25 percent dilute H₂SO₄, washing it with water, then boiling it with 1.25 percent dilute NaOH. The remaining residue after digestion was considered crude fiber, according to AOAC (1990) [2].

2.2.1 Procedure

A specific amount of moisture and fat-free powdered extrudates was weighed and placed in Fiber bags, which contained a glass spacer. The bags were loaded into the sample carousel at predetermined positions 1-6. The carousel was then carefully placed into a glass container, which was filled with 500 ml of 1.25 percent dilute H₂SO₄ and heated for 30 minutes. After this period, the bags were washed by boiling them with 500 ml of distilled water for 30 minutes. Subsequently, 500 ml of 1.25 percent NaOH was added and the mixture was heated for another 30 minutes. The bags were then boiled again with 500 ml of distilled water for an additional 30 minutes. The residue was transferred to an empty crucible and weighed (W₁), then dried at 100°C for four hours in a hot air oven. After drying, the crucible was cooled in a desiccator and weighed (W₂). Finally, the crucible was incinerated in a muffle furnace at 600°C for three hours, cooled in a desiccator and weighed again (W₃).

2.2.2 Calculation

$$\text{Fiber content (\%)} = \frac{(W_2 - W_1) - (W_3 - W_1)}{W_1} \times 100$$

2.3 Fruit firmness (kg/cm²)

A penetrometer was used to record the unconfined strength of fruits and direct readings were obtained in terms of kg/cm².

3. Results and Discussion

The Present investigation on “Effect of different micronutrients on the quality attributes in zucchini (*Cucurbita pepo* L.) Under Telangana condition” during Rabi season 2023-24 is discussed and presented below (Table 1.).

3.1 Total soluble solids (⁰brix)

The data pertaining to total soluble solids (⁰Brix) was found significant among the treatments is presented in Table-1 and Fig -1. Among the different treatments, highest total soluble solids were recorded in treatment T₁₀ - Boron (B) @ 20 ppm + Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 40 ppm (2.95 ⁰Brix) which was statistically on par with T₁₁ - Boron (B) @ 40 ppm + Zinc (Zn) @ 30 ppm + Manganese (Mn) @ 40 ppm (2.80 ⁰Brix) and followed by T₇ - Boron (B) @ 20 ppm + Zinc (Zn) @ 30 ppm (2.68 ⁰Brix). The lowest value was recorded in T₁₂ - Control (1.76 ⁰Brix).

The total soluble solids (TSS) content increased with the addition of zinc and manganese. Zinc supplementation also enhances the crude protein content, likely due to higher fruit nitrogen levels. Meanwhile, boron application aids in maintaining carbohydrate balance. As a result, the inclusion of micronutrients leads to higher TSS content. Additionally, elevated atmospheric CO₂ levels have been shown to enhance fruit quality by increasing TSS. The results were similar with Akshata *et al.* (2023) [1] in cucumber, Ashraf *et al.* (2020) [14] and Yadav *et al.* (2020) [12] in bitter gourd, Ashraf *et al.* (2019) [15] in sponge gourd.

3.2 Fiber Content (%)

The data recorded on fiber content (%) as influenced by the different levels of micronutrients is illustrated in Table-1 and Fig-2. All the different levels of micronutrient concentration treatments significantly influenced fiber content. Maximum fiber content is recorded in treatment T₁₀ - Boron (B) @ 20 ppm + Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 40 ppm (0.72%) which was on par with treatment T₁₁ - Boron (B) @ 40 ppm + Zinc (Zn) @ 30 ppm + Manganese (Mn) @ 40 ppm (0.69%) followed by T₇ - Boron (B) @ 20 ppm + Zinc (Zn) @ 30 ppm (0.67%) and minimum fiber content was recorded in T₁₂ - Control (0.45%).

This might be due to the production of dry matter and other energy-dense compounds. By improving nutrient intake, zinc, boron and manganese also control photosynthesis, carbon adsorption, and plant development. It improves cation exchange capacity (CEC), which facilitates the nutrient uptake from soil and supports the production of chlorophyll, the regulation of auxin, and other physiological processes, ultimately leading to an increase in nutrient concentration. The results were in conformity with Sharma *et al.* (2018) [10] in okra and Yadav *et al.* (2020) [12] in bitter gourd, Bhattacharjee *et al.* (2023) [5] in zucchini.

3.3 Fruit firmness (kg/cm²)

It was evident from Table - 1 and Fig - 3 that a significant difference was observed due to micronutrient concentration on Fruit firmness (kg/cm²). Significantly the highest fruit firmness was observed in the micronutrient concentration on the

treatment T₁₀ - Boron (B) @ 20 ppm + Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 40 ppm (10.06 kg/cm²) which was on par with treatment T₁₁ - Boron (B) @ 40 ppm + Zinc (Zn) @ 30 ppm + Manganese (Mn) @ 40 ppm (9.61 kg/cm²), T₇ - Boron (B) @ 20 ppm + Zinc (Zn) @ 30 ppm (9.49 kg/cm²) and followed by T₈ - Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 40 ppm (9.36 kg/cm²). Significantly the lowest value T₁₂ - Control (8.78 kg/cm²).

The data from the recent study concluded that higher

concentrations of macro and micronutrients in the leaves and fruits, resulted in better accumulation of assimilates and improved quality parameters. It could be linked to the combined application of micronutrients enhancing fruit firmness and promoting cell wall integrity but delaying cell wall degradation which results in higher firmness of the fruit. The results were in accordance with Rab and Haq (2012) [9] and Kazemi (2013) [7] in Tomato.

Table 1: Effect of different micronutrient concentrations on TSS (⁰Brix), Fruit fiber Content (%) and Fruit firmness (kg/cm²) in Zucchini.

Treatments	TSS (⁰ Brix)	Fiber Content (%)	Fruit Firmness (kg/cm ²)
T ₁ : Boron (B) @ 20 ppm	1.83 ^{de}	0.46 ^f	8.97 ^{bc}
T ₂ : Boron (B) @ 40 ppm	1.80 ^e	0.47 ^f	9.06 ^{bc}
T ₃ : Zinc (Zn) @ 15 ppm	1.97 ^d	0.52 ^e	9.17 ^{bc}
T ₄ : Zinc (Zn) @ 30 ppm	2.38 ^c	0.60 ^d	9.25 ^{bc}
T ₅ : Manganese (Mn) @ 20 ppm	1.89 ^{de}	0.49 ^{ef}	9.09 ^{bc}
T ₆ : Manganese (Mn) @ 40 ppm	1.95 ^d	0.51 ^e	9.12 ^{bc}
T ₇ : Boron (B) @ 20 ppm + Zinc (Zn) @ 30 ppm	2.68 ^b	0.67 ^b	9.49 ^{ab}
T ₈ : Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 40 ppm	2.52 ^c	0.65 ^{bc}	9.36 ^{bc}
T ₉ : Manganese (Mn) @ 20 ppm + Boron (B) @ 40 ppm	2.50 ^c	0.63 ^{cd}	9.29 ^{bc}
T ₁₀ : Boron (B) @ 20 ppm + Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 20 ppm	2.95 ^a	0.72 ^a	10.06 ^a
T ₁₁ : Boron (B) @ 40 ppm + Zinc (Zn) @ 30 ppm + Manganese (Mn) @ 40 ppm	2.80 ^{ab}	0.69 ^b	9.61 ^{ab}
T ₁₂ : Control	1.76 ^e	0.45 ^f	8.78 ^c
S.E (m) ±	0.05	0.01	0.22
CD @ 5%	0.15	0.04	0.65
C.V. (%)	3.81	3.91	4.10

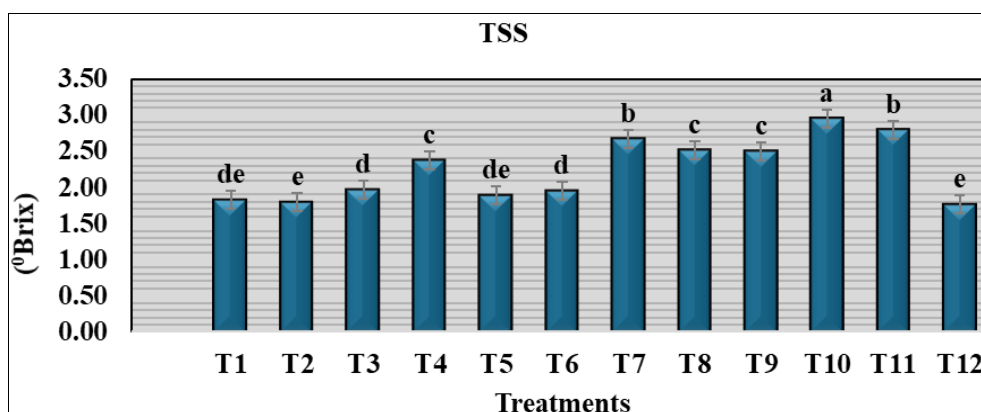


Fig 1: Effect of different micronutrient concentrations on TSS (⁰Brix) in Zucchini

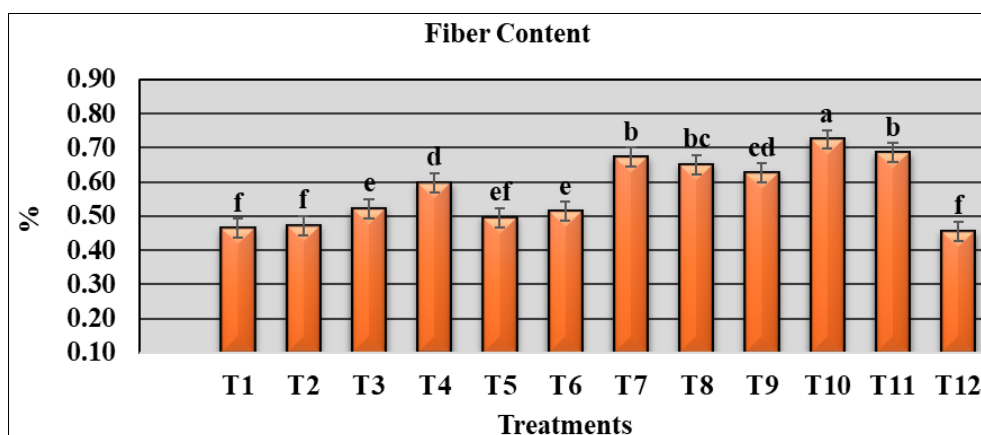


Fig 2: Effect of different micronutrient concentrations on Fruit fiber content (%) in Zucchini

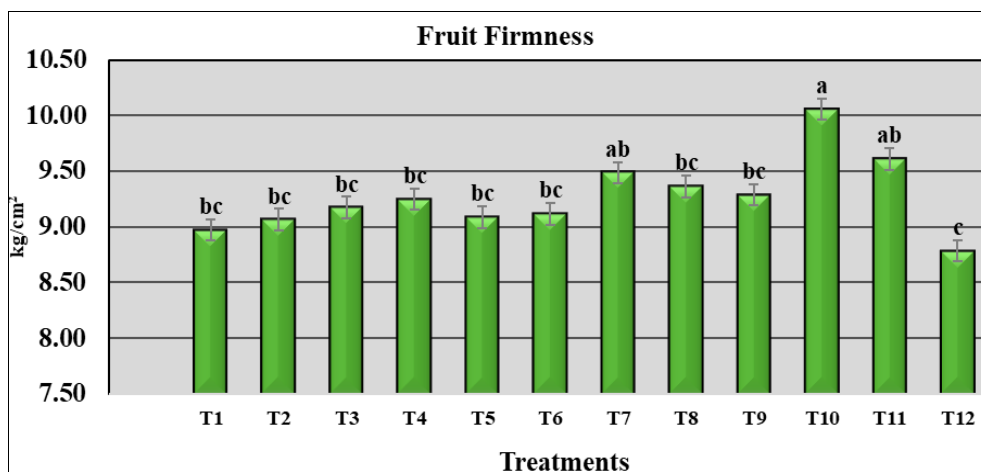


Fig 3: Effect of different micronutrient concentrations on Fruit firmness (kg/cm²) in Zucchini

Treatment details

T ₁ - Boron (B) @ 20 ppm	T ₂ - Boron (B) @ 40 ppm	T ₃ - Zinc (Zn) @ 15 ppm
T ₄ - Zinc (Zn) @ 30 ppm	T ₅ - Manganese (Mn) @ 20 ppm	T ₆ - Manganese (Mn) @ 40 ppm
T ₇ - Boron (B) @ 20 ppm + Zinc (Zn) @ 30 ppm	T ₈ - Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 40 ppm	T ₉ - Manganese (Mn) @ 20 ppm + Boron (B) @ 40 ppm
T ₁₀ - Boron (B) @ 20 ppm + Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 20 ppm	T ₁₁ - Boron (B) @ 40 ppm + Zinc (Zn) @ 30 ppm + Manganese (Mn) @ 40 ppm	T ₁₂ - Control

4. Conclusion

The maximum Total soluble sugars (2.95 °Brix), fiber content (0.72%), Fruit firmness (10.06 kg/cm²) is recorded in treatment T₁₀ - Boron (B) @ 20 ppm + Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 40 ppm. However, minimum Total soluble sugars (1.76 °Brix), Fiber content (0.45%) and Fruit firmness (8.78 kg/cm²) was recorded in T₁₂ - control. Among the different treatments, application of treatment T₁₀ - Boron (B) @ 20 ppm + Zinc (Zn) @ 15 ppm + Manganese (Mn) @ 40 ppm (2.95 °Brix) was found to be best for the quality of zucchini compared to other treatments.

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