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Impact of micronutrient foliar application on *Cucurbita pepo* (Summer squash) on growth and yield

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Abstract
Data for this analysis were collected in 2021-2022 at the Agricultural Farm of the School of Agriculture at Lovely Professional University in Phagwara, Punjab, to assess the efficacy of a foliar spray containing micronutrients on the development and production of *Cucurbita pepo* (summer squash). In this study, a random block design was used for the experimental design with seven treatments and a control group, with three replicates of each. The majority of micronutrients are incorporated into plant enzyme systems. Micronutrients are crucial to photosynthesis. Micronutrients are crucial in processes like protein synthesis and the fixation of nitrogen. According to the findings, treatment T4 SA (5 ppm) + Zn (50 ppm) and treatment T5 SA (5 ppm) + Mn (50 ppm) showed the greatest increase in plant length (25.32 cm) and plant height (20.94 cm) respectively, while treatment T5 SA (5 ppm) + Mn (50 ppm) produced the greatest increase in leaf count (24.44), flower count (8). Hence, T5SA (5 ppm) + Mn (50 ppm) treated plants had the highest total yield, while T0 plants produced the lowest (control). Using biofertilizers in combination with micronutrient foliar sprays has been found to have a significant effect on plant development and harvest yield. So, it is concluded that, for increased sustainable production of *Cucurbita pepo* (summer squash), primarily under organic farming system, the combined application of micronutrients and biofertilizers must be done.

Keywords: Micronutrients, foliar application, zinc, manganese, boron, iron

Introduction

Often known as "summer squash," *Cucurbita pepo* is a member of the gourd family, Cucurbitaceae (2n=40), and is a member of the genus Cucurbita. The term "squash" is a plural form of a Native American word that means "young" or "unfinished." Many different names have been used to refer to the various types of *C. pepo*, however these names are rarely utilized according to their intended definitions (Paris, 1996) [11]. With numerous species of edible plants, the family is one of the biggest in the plant kingdom. Originally from the Americas and northeastern Mexico, this annual cucurbit is unique among Bush varieties in being a nutritious food source. A variety of soil types can be used for cultivation, although fertile sandy loam with good drainage is ideally suited (Bielinski *et al*., 2006) [2]. They thrive well on loamy sand with a pH range of 5.5 to 6.5 with a high concentration of organic matter.

In addition to their medicinal value, squash fruits are good for dieters due to their low-calorie content and properties as a diuretic, laxative, and inhibitor of excess fluid in the body (Khadem and Hussein, 2015) [8]. In addition to having a significant amount of vitamins and minerals, it also has a lot of carbs (10%), proteins (34%), fibers (2.8%), and oils (46%) (Whitaker and Davis, 1962) [13]. Also include a portion of acids as well, including 12.8% and 60.4% of linoleic acid, respectively. Potassium and magnesium are plentiful in the seeds (Idouraine *et al*. 1996) [7]. Micronutrient application strengthens plant defenses against a variety of stressors. Because of the low rates and lack of direct contact with the soil, foliar fertilization is an efficient approach for the delivery of several micronutrients.

Applying micronutrients to a plant's leaves before anthesis and during seed filling will improve crop nutrition and, perhaps, seed production. The formation of lignin, a key component of the cell wall, requires salicylic acid and other phenolic chemicals, including phytoalexin, which is crucial to the plant's chemical defenses against pathogens, insects, and herbivores. Zinc is an essential element for plant growth and development; it is found in trace amounts in the bark, where it helps produce important enzymes like transferase, oxidoreductase, hydrolase, ligase, and isomerase and promotes the metabolism of carbohydrates, proteins, and the stability of nucleic acids and cellular membranes.

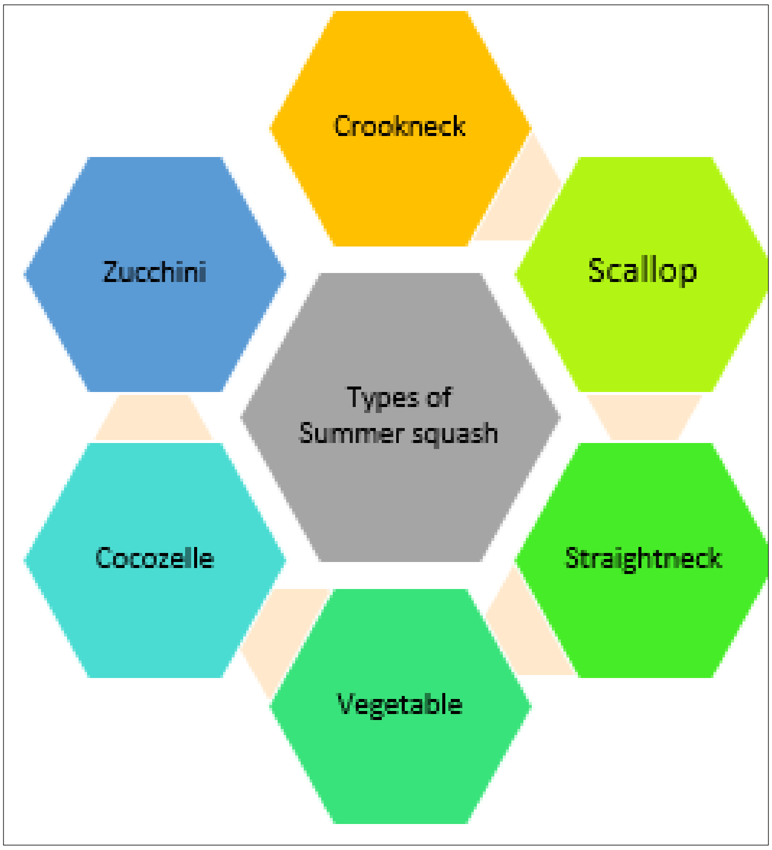

Fig 1: Different types of summer squash (Paris, 1986) [11].

Methodology

Experimental Site and Material

Research was conducted in Agricultural Farm, School of Agriculture, Lovely Professional University, Phagwara, Punjab, during the year 2021-2022. The seeds of summer squash plant (*Cucurbita pepo*) used in the experiment were acquired from Good Grow Crop Care, Phagwara (Punjab). The fertilizers NPK, Vermicompost and micronutrients Boron, Manganese, Zinc and Salicylic acid for treatments were supplied by university. The summer squash seeds were sown on 27th April 2022, in a plot area of 105 x 45m^2 with spacing of 1m with surface irrigation system. The plot was divided into three equal segments, each of 5 X 3m^2 in area. In this experiment, each plant was placed at a distance of 75 × 75 cm^2.

Table 1: Layout model

R1	R2	R3
T0	T2	T6
T1	T3	T5
T2	T6	T4
T3	T1	T3
T4	T0	T2
T5	T4	T1
T6	T5	T0

*T0-T6: treatments; R1, R2, R3: Replications

Treatments

Foliar spray of micronutrients and soil application of organic manure was used on the plants in the experiment. Organic manure (vermicompost) and a combination of boron, manganese, zinc, and salicylic acid was used in our experiment. The experiment was designed with a completely randomized block design (Table 1), with seven treatments and a control group, and three replicates of each treatment group. Table 2 displays information on current treatments.

Table 2: Treatment details

Treatments	Combination of micronutrients
T0	Control
T1	Zn (50 ppm) + B (50 ppm)
T2	Mn (50 ppm) + B (50 ppm)
T3	SA (5 ppm) + B (50 ppm)
T4	SA (5 ppm) + Zn (50 ppm)
T5	SA (5 ppm) + Mn (50 ppm)
T6	SA (5 ppm) + Zn (50 ppm) + B (50 ppm)

*Zn-Zinc; B-Boron; Mn- Manganese; SA-Salicylic acid

Results and Discussion

According to the results of the study, the growth parameters (plant length, plant height, number of leaves per plant, number of flowers per plant) and yield of *Cucurbita pepo* (Summer squash) are profoundly affected by the foliar administration of micronutrients.

Effect of micronutrients on growth and yield of *Cucurbita pepo*

Table 3 shows that 90 days following establishment, plants in treatment T5 {(SA 5 ppm) + Mn (50 ppm)} had the highest average height (20.94 cm), followed by T2 (19.16 cm), T4 (19.14 cm), and T6 (19.05 cm). The lowest average height was observed in T1 (SA 5 ppm) (18.52 cm). T4 {SA (5 ppm) + Zn (50 ppm)} treated plants had the longest overall length (25.32 cm), followed by T6 (24.98 cm), T2 (24.89 cm), T3 (24.22 cm), T5 (24.09 cm), and T0 plants (22.34 cm).

Table 3: Impact of micronutrients on growth and yield of *Cucurbita pepo*

Treatments	Plant height (cm)	Plant Length (cm)	No. of Leaves per plant	No. of Flowers per plant	No. of Fruits per plant	Yield per plant (kg)
T0	18.94	22.34	22.11	6.28	5.11	1.87
T1	18.52	23.15	24.44	7.54	6.83	2.40
T2	19.16	24.89	22.28	7.81	6.16	2.32
T3	18.99	24.22	20.61	7.66	6.50	2.41
T4	19.14	25.32	22.78	7.64	6.50	2.40
T5	20.94	24.09	23.78	8.43	7.39	2.76
T6	19.05	24.98	21.78	7.53	6.39	2.36
CD (0.5%)	0.385	0.486	0.968	1.034	1.049	0.198
S.Em (±)	0.121	0.148	0.302	0.364	0.329	0.062

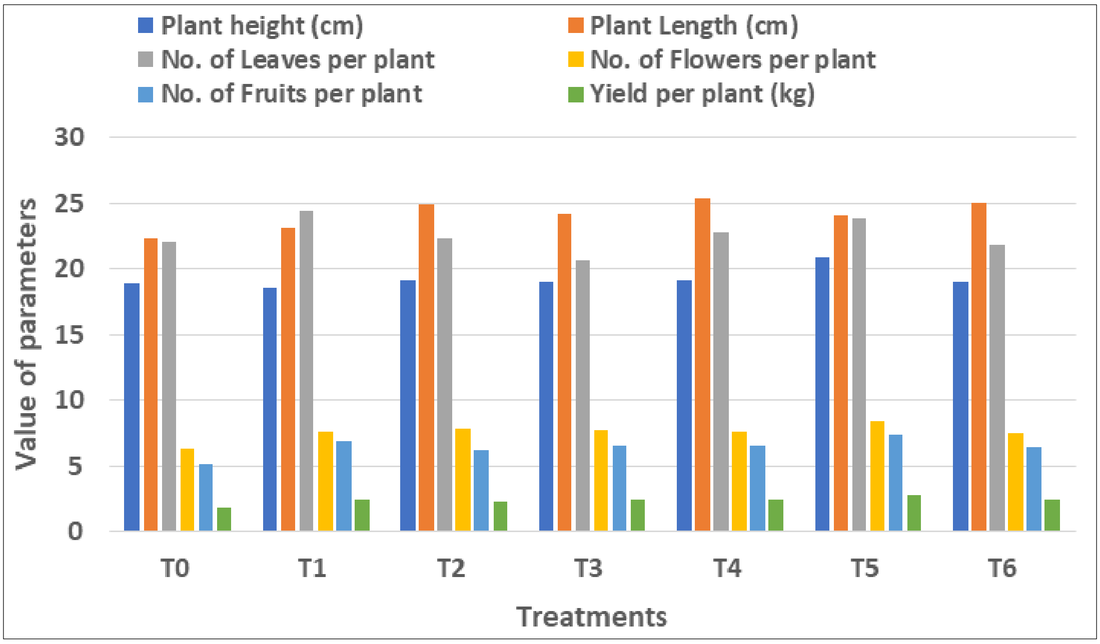

Fig 2: Impact of micronutrients foliar spray on growth and yield of *Cucurbita pepo*.

In addition, plants exposed to T1 concentrations of Zn (50 ppm) and B (50 ppm) had the highest average number of leaves per plant (24.44), followed by T5 concentrations (23.78), T4 concentrations (22.78), T2 concentrations (22.28), and T6 concentrations (21.78). Treatment T5 {SA (5 ppm) + Mn (50 ppm)} yielded the highest number of flowers per plant (8.43), followed by T2 (7.81), T3 (7.66), T4 (7.64), and T0 (6.28). In terms of average fruit yield, treatment T5 {SA (5 ppm) + Mn (50 ppm)} produced the highest at 7.39 fruits per plant, followed by T1 (6.83), T3 & T4 (6.50), T6 (6.39), and T0 (5.11). Also, T5 {SA (5 ppm) + Mn (50 ppm)} treated plants recorded the highest overall yield per plant (2.76 kg/ plant), followed by T3 (2.41 kg/ plant), T1&T4 (2.40 kg/ plant), T6 (2.36 kg/ plant) and the lowest in T0 (1.87kg/ plant).

Treatment 5 (Fig.2) had the highest yields; the reason might be due to the fact that more nutrients and organic matter were made available in the soil as a result of the foliar spray of micronutrients and the soil application of organic manures. Plants develop additional leaves because they are able to take in more minerals and nutrients. The plant's ability to store carbohydrates gained from increased photosynthetic activity, as a result of a higher leaf count, is put to use in the formation of fruit. A high total yield is a direct result of a increased leaves number, which in turn increases the number of blooms and fruits. This research agrees with previous findings by El-Shoura A.M., (2020) [4] and Baqer and Emad (2017) [1].

Conclusion

Increased nutrient availability on the host plant's leaves is likely responsible for the positive effects observed after foliar spray of micronutrients on the growth and yield of *Cucurbita pepo* plants. As a result, it could be useful for increasing fruit yields of *Cucurbita pepo* in a sustainable manner. In addition, this might be a useful resource for fostering the growth of environmentally friendly farming practices, that is experiencing a sudden and unexpected surge in demand.

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