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Influence of foliar nutrients application on growth, yield and quality of onion (*Allium cepa* L.)

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Abstract
Micronutrients play an essential role in the plant metabolic processes that helps to improve growth and quality of onion. A field experiment was conducted during spring summer, 2021-2022 at Vegetable Research Farm of Department of Agriculture, Khalsa College, Amritsar to investigate the effect of foliar application of micronutrients on growth, yield and quality attributes of onion. The experiment consisted of seven micronutrients treatments replicated thrice and evaluated in a Randomized Block Design. The mixture of micronutrients outperformed from all other treatments in terms of growth, yield and quality attributes with the maximum plant height, number of leaves, leaf length, higher bulb yield and maximum dry matter content, total soluble solids and ascorbic acid.

Keywords: Foliar application, growth, micronutrients, onion, quality growth and yield

Introduction
Onion (*Allium cepa* L.) is one of the most important bulb crop, grown all over the world. It belongs to family Alliaceae having 2n = 16 chromosome number (Griffiths *et al.* 2002) [9]. It is known as "Queen of the kitchen" due to high valued aroma, unique flavor and its rich medicinal properties. Onion contains sculpture compound in very small quantity in the form of volatile oil alkyl propyl disulphide which is responsible for its particular smell and pungency. The yellow and red colour of outer skin of onion is due to presence of quercetin and anthocyanin, respectively. Onion having anti-fungal property due to the presence of phenolic compound called as catechol. The yellow and red colour of outer skin of onion is due to the presence of the quercetin and anthocyanin, respectively. Onions with high pungency have better capacity to prevent tumor growth and also, it protects against the heart attack (Yadav *et al.* 2018) [25].

Some micronutrients such as zinc, boron and copper are essential for the cell division, carbohydrate metabolism and water relation in plant growth. It is also necessary for the protein formation that ultimately increases the bulb size and yield of onion. The manganese helps to enhance the root growth and disease resistances. The functional role of zinc includes auxin metabolism, influences on the activities of dehydrogenase, carbonic anhydrates enzymes, synthesis of cytochrome and ribosomal fractions. Boron is an essential micronutrient required for normal plant growth and development (Biswas *et al.* 2020) [6]. Copper is necessary for carbohydrates and nitrogen metabolism. Inadequate copper results in stunting of plant growth. It is also required for lignin synthesis, which is needed for cell wall strength and prevention of wilting. Hence, it plays a vital role in photosynthesis (Rashid *et al.* 2019) [21]. Foliar application of micronutrient helps to improve the yield of onion and marketability. Therefore, this experiment was conducted to find out the effect of copper, magnesium, zinc, boron and ferrous as foliar application on the growth, yield and quality traits of onion.

Material and methods
The experiment was conducted at Department of Vegetable Science of Agriculture, Khalsa College, Amritsar. The cultivar PRO 7 comprised the plant material and trail was conducted in spring-summer season. The experiment was laid out in Randomized Block Design consisting of seven treatments T_1 (1% $CuSO_4$), T_2 (1% $MgSO_4$), T_3 (0.5% $ZnSO_4$), T_4 (0.5% $FeSO_4$), T_5 (0.25% Borax), T_6 (Mixture of all micronutrients @ $CuSO_4$ - 1%, $MgSO_4$ - 1%, $ZnSO_4$ – 0.5%, $FeSO_4$ – 0.5% and B – 0.25%) and T_7 (Control) each with three replications applied through foliar application at 30, 60 and 90 days after transplanting.

The data were recorded on various growth, yield and quality parameters namely plant height (cm), number of leaves per plant, leaf length (cm), total yield (q ha^{-1}) and dry matter content (%), total soluble solids (Brix), ascorbic acid content (mg $100g^{-1}$). The mean data was statistically analyzed according to ANOVA technique of Panse and Sukhatme, 1985 [20].

Result and Discussion

Plant height (cm)

Height is one of the imperative factors determining yield and harvest duration of onion plants. Taller plants are considered to be more required since they lead to a greater number of leaves which ultimately increased photosynthesis efficiency. Significant variations in plant height throughout the crop growth period were found in the treatments at 30, 60 and 90 days after transplanting, as shown in Table 1. Treatment T_6 had the maximum plant height at 30 and 90 DAT which was significantly higher from all other treatments. Plant height was highest in treatment T_6 at 60 days after transplanting which was statistically at par with the treatment T_3 - Treatment T_7 was recorded minimum plant height at 30, 60 and 90 DAT. The increased plant height by application of micronutrient might be due to their role in cell division and other physiological processes like cell enlargement in a coincident enlargement of the protoplast through water uptake. The results are significant with the findings of Bose *et al.* (2009) [5], Alam *et al.* (2010) [1] and Lal *et al.* (2017) [13] indicates that mixture of micronutrients had the maximum plant height (61.63, 61.30, 56.80cm), respectively.

Number of leaves per plant

The onion leaves are either erect or oblique with bluish-green colour. The maximum number of leaves ultimately increases photosynthetic rate that helps to produces maximum bulb production due to high nutrient accumulation. The number of leaves was significantly highest in treatment T_6 which was statistically at par with treatment T_3. At 60 and 90 days after transplanting, the number of leaves had maximum in treatment T_6 which has determined to be statistically superior from all other treatments. Treatment T_7 had the lowest number of leaves at 30, 60 and 90 DAT (Table 1). This could be attributed to increased photosynthetic rate, increased plant height and maximum dry matter production. This may be because of better growth and development of foliage under high nutritive environment. This investigation similar result was supported by Paul *et al.* (2007) [17], Ballabh & Rana *et al.* (2013) [4], Rizk *et al.* (2014) [22] and Biswas *et al.* (2020) [6] who observed the similar results finding that the micronutrient mixture had maximum number of leaves (6.76, 14.1, 10.67 and 12.71), respectively.

Leaf length (cm)

The leaf length of plant is one of the critical parameter helps to improve cell wall expansion of the plant that improve bulb growth. The leaf length was significantly highest in treatment T_6 which was statistically at par with the treatment T_3 at 30 DAT. The treatment T_6 recorded significantly maximum leaf length at 60 and 90 DAT. Treatment T_7 had the minimum leaf length at 30, 60 and 90 DAT (Table 1). This could be due to increases turgidity of plant cells, which results in cell wall expansion and increases lateral and linear dimension of the leaf. These findings related to the length of leaves are in agreement with the findings Ballabh *et al.* (2013) [4], Shukla *et al.* (2015) [4] Goyal *et al.* (2017) [8] and Lal *et al.* (2017) [13] observed the maximum leaf length (48.1, 62.32, 41.36, 42.50 and 48.80cm), respectively with the application of micronutrient mixture.

Bulb yield (kg ha^{-1})

Yield per plant is one of the critical parameters achieving utmost consideration in crop. This particular trait depends upon bulb yield per plot and plant population. Treatment T_6 had the highest overall bulb yield which was considerably higher than all other treatments. The lowest bulb yield was found in treatment T_7 (Table 2). The improvement of bulb yield was observed due to the better vegetative growth of onion plants and higher photosynthetic accumulation in bulbs would ensure higher individual bulb weight and large bulb diameter which collectively increases the bulb yield in onion. Similar report of increased bulb yield was observed by several workers Pramanik *et al.* (2017) [18], Maurya *et al.* (2017) [15] and Khatemenla *et al.* (2021) [10] also observed the maximum bulb yield (268.28, 126.59, 276.08qha^{-1}), respectively in combination of micronutrients.

Dry matter content (%)

Dry matter content is one of the critical parameter depends upon the dry weight of bulb. Treatment T_6 had the maximum dry matter content which was statistically at par with treatment T_3 and lowest dry matter content was found in treatment T_7 (Table 2). It might be due to reverse relationship between percent dry matter and soil nutrients. The available soil nutrients supported proper vegetative growth by producing succulent bulb with more protoplasm in the cells comparison to less available nutrients in onion. On the other hand when the nutrients availability become reduced in the soil, plant growth decreased with thicken walls and less protoplasm containing cells resulting higher percent of dry matter in onion bulb. This result is similar to the finding Rashid *et al.* (2019) [21] and Pramanik *et al.* (2020) [19] who reported that the micronutrient mixture had maximum dry matter content (13.33 and 15.23%), respectively.

Total Soluble Solid (°Brix)

The total soluble solids are a necessary quality attribute for onion in processing as well as fresh consumption. Treatment T_6 had the highest total soluble solid which was statistically at par with treatment T_3. Treatment T_7 had lowest total soluble solid (Table 2). The improvement of TSS content in onion bulbs with the foliar application of micronutrients might be attributed to enhanced metabolic processes involved in biosynthesis of total soluble solid, such as carbohydrates, amino acids, organic acid and other inorganic constitutes. This might be due to increased carbohydrates production in onion crop during the photosynthesis process. The results are significant with the findings of Ballabh *et al.* (2013) [4], Aske *et al.* (2017) [2] and More *et al.* (2017) [16] who reported maximum total soluble solids (14.2, 14.33 and 11.92ºBrix), respectively in combination of micronutrients.

Ascorbic acid content (mg 100 g^{-1})

Ascorbic acid content (Vitamin C) is one of the chief quality components in onion as it improves the nutritional quality of bulb. Treatment T_6 had the highest ascorbic acid concentration which was significantly higher from all other treatments. Treatment T_7 exhibited the lowest levels of ascorbic acid (Table 2). The rise in ascorbic acid might be attributed to an increase in ascorbic acid oxidase enzyme activity, which increases ascorbic acid content in bulbs and also as micronutrients that involved in carbohydrate metabolism and have a favorable and tight association with ascorbic acid production. These findings are assisted by Sethupathi *et al.* (2019) [23], Kumar *et al.* (2021) [13] and Chandan *et al.* (2021) [7] who observed the maximum ascorbic acid content (13.95, 12.19 and 14.35mg $100g^{-1}$), respectively.

Table 1: Effect of foliar application of micronutrients on growth attributes of onion

Treatments	Plant Height (cm)			Number of leaves per plant			Leaf length plant (cm)		
	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days
T_1- 1% Copper sulphate	29.07	49.73	53.57	3.43	6.67	9.37	25.23	44.43	46.63
T_2- 1% Magnesium sulphate	30.03	51.63	57.00	3.87	7.03	10.30	26.70	46.53	50.33
T_3- 0.5% Zinc sulphate	31.17	54.43	60.37	4.20	7.60	11.23	27.30	49.23	53.13
T_4- 0.5% Ferrous sulphate	29.53	50.80	56.67	3.60	6.90	9.90	25.50	45.70	49.40
T_5- 0.25% Borax	30.63	52.27	59.20	4.07	7.23	10.50	26.77	47.77	52.57
*T_6- Mixture of all the micronutrients	32.13	55.47	63.07	4.53	8.07	12.20	28.47	50.50	56.07
T_7- Control	28.90	48.50	51.50	3.07	6.27	8.90	23.67	43.57	44.57
Mean	30.2	51.8	57.3	3.82	7.10	10.34	26.2	46.81	50.4
CD ($p \leq 0.05$)	0.88	1.16	1.73	0.37	0.35	0.56	0.92	1.07	1.39

(*Treatment 6- mixture of all the micronutrients @ $CuSO_4$ - 1%, $MgSO_4$ - 1%, $ZnSO_4$ - 0.5%, $FeSO_4$ -0.5% and B - 0.25%)

Table 2: Effect of foliar application of micronutrients on yield and quality attributes of onion

Treatments	Bulb yield (q ha^{-1})	Dry matter content %	Total Soluble Solids (ºBrix)	Ascorbic Acid (mg $100g^{-1}$)
T_1-1% Copper sulphate	340.03	13.59	12.40	9.97
T_2-1%Magnesium sulphate -	360.33	14.21	13.10	10.13
T_3-0.5% Zinc sulphate	387.77	15.76	13.97	11.27
T_4-0.5% Ferrous sulphate	354.44	14.47	12.87	10.03
T_5-0.25% Borax	376.66	15.34	13.30	10.50
*T_6- Mixture of all the micronutrients	397.77	16.16	14.43	12.37
T_7- Control	311.11	11.72	12.23	9.83
Mean	360.68	14.5	13.2	10.6
CD ($p \leq 0.05$)	5.32	0.80	0.59	0.67

Conclusion

It is recommended that combine application of micronutrients @ $CuSO_4$ - 1%, $MgSO_4$ - 1%, $ZnSO_4$ - 0.5%, $FeSO_4$ -0.5% and B - 0.25%) is the most suitable dose for maximum growth, yield and quality of onions.

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