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Effect of foliar application of micronutrients on growth, yield and quality of garlic

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Abstract
The present investigation entitled "Effect of foliar application of micronutrients on growth, yield and quality of garlic" was undertaken at Instructional Farm, Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during Rabi season of 2021-2022. The experiment was laid out in Randomized Block Design with three replications and nine treatments *viz.,* T_1: $ZnSO_4$ -0.25%, T_2: $ZnSO_4$ -0.50%, T_3: $FeSO_4$ -0.25%, T_4: $FeSO_4$ -0.50%, T_5: Borax-0.2%, T_6: Borax-0.3%, T_7: PDKV Micrograde-II (1%), T_8: PDKV Micrograde-II (2%), T_9: Control. Among all the treatments T_8 treatment: PDKV Micrograde-II (2%) was recorded significantly maximum growth parameters *viz.,* plant height (cm), length of leaves (cm), number of leaves per plant, neck thickness (cm) at 90 days DAS and the yield and yield contributing characters *viz.,* fresh weight of bulb (g), cured weight of bulb (g), number of cloves per bulb, length of cloves, bulb girth (cm), yield per plot (kg), yield per hectare (q), fruit quality observation viz., total soluble solids i.e. TSS content (%). Minimum growth was recorded under T_9 control treatment.

Keywords: Garlic, micronutrients, $ZnSO_4$, $FeSO_4$, borax, PDKV micrograde-II

Introduction
Garlic is the second most widely used cultivated Allium after onion. It has long been recognized all over the world as a valuable spice for foods and a popular remedy for various ailments and physiological disorders. Garlic (*Allium sativum* L.) belongs to family Alliaceae. Garlic is one of the most important commercial bulb vegetable crop and is next to onion in importance. The plant is native to central Asia but grows wild in Italy and Southern France and is classic ingredient in many national cuisines. The land area used for growing garlic in India 401 thousand hectares with 3.1 metric tons (FAO, 2022) [7]. Madhya Pradesh recorded highest production of garlic across India. It is commonly used as spice and also for medicinal purpose. Allicin is formed enzymatically from the precursor allin, it is responsible for the characteristic odour and flavour of fresh garlic. (Ceceillia and Nunes, 2004) [5]. Garlic is also a good source of minerals and vitamin C (31 mg/ 100 g fresh weight) and other vitamins in lower amount. The chief constituents of garlic oil are diallyl disulfide (60%), diallyl trisulphide (6%). Garlic has been using as antibiotic, cholesterol lowering, carminative and gastric stimulant properties. The inhalation of garlic oil or garlic juice has generally been recommended by doctors against the cases of pulmonary tuberculosis, rheumatism, sterility, impotency, cough, lung diseases and a specific remedy for sour eyes and ear ache.

Foliar application of micronutrients improves the effectiveness of macronutrients under high soil pH, solubility of most micronutrients in soil decreased causing plant physiological disorders (Srivastava and Gupta, 1996) [14]. Although the requirement of micronutrients like Zn, Fe, B, Cu, Mn, and Mo are relatively less but their role in normal crop production is indispensable because of their active role in the plant metabolic process from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity, nitrogen fixation etc. (Ballabh and Rana, 2013) [4]. Foliar application of micronutrients during crop growth was successfully used for correcting their deficits and improving the mineral status of plant as well as increasing the crop yield and quality.

Material and Methods
The current investigation was undertaken at Instructional Farm, Department of Vegetable Science, Dr. PDKV, Akola during *Rabi* season of 2021-2022. The experiment was laid out in Randomized Block Design with 9 treatments and 3 replications. T_1, T_2 $ZnSO_4$ -0.25% and 0.50% respectively, T_3, T_4 $FeSO_4$ -0.25% and 0.50% respectively, T_5, T_6 Borax-0.2 and 0.3%, T_7, T_8 PDKV Micrograde-II (1%) and PDKV Micrograde-II (2%) respectively, and T_9: Control.

PDKV micrograde II was developed by Dr. P. D. K. V, Akola University and its composition includes B – 0.5%, Mn – 1.0%, Fe – 2.5%, Zn – 3.0%, Cu – 1.0%, and Mo – 0.1%. The soil of experimental field was slightly alkaline (pH-7.97) and available N (226 kg ha^{-1}), available P (15.83 kg ha^{-1}), available K (320.40 kg ha^{-1}). The experiment was laid out in 2 m X 2 m plot size with 10 cm X15 cm spacing. The garlic cultivar *Bhima Purple* was used for experiment. Garlic bulbs are procured from Director of Onion and Garlic Research Institute, Rajgurunagar, Maharashtra. These garlic cloves are sown on the broad bed furrow and the optimum plant population was maintained. Recommended fertilizer dose of 100:50:50 N, P and K kg ha^{-1}, full dose of P and K as basal dose and half dose of N and remaining N 30 days after sowing of cloves were applied. The solution of micronutrients i.e. zinc sulphate, iron sulphate and borax were prepared by weighing the micronutrients of required quantity with few drops of HCL were added to iron sulphate solution for complete solubility and the lime was added to neutralize the acidity. The sticking agent 'Tepol' was added as adhesive. Schedule for spraying of micronutrients include at 45, 60 and 75 days after sowing of garlic cloves. The observation was recorded for growth, yield and quality parameters. For growth and yield parameters, five plants from each plot were selected randomly and tagged. The growth parameters *viz.,* plant height (cm), length of leaves (cm), number of leaves per plant, neck thickness (cm) was recorded by using vernier caliper, yield and yield contributing characters *viz.*, fresh weight of bulb (g), cured weight of bulb (g), number of cloves per bulb, length of cloves, bulb girth (cm), yield per plot (kg), yield per hectare (q) was recorded at 90 days after sowing, fruit quality observation *viz*., total soluble solids i.e. TSS content (^{o}Brix) was recorded using hand refractometer after the harvest. The data obtained on various observations were analyzed as per the method advocated for Randomized Block Design (RBD) by Panse and Sukhatme (1985) [10]. Treatment means were compared by using critical difference at 5% level of significance.

Result and Discussion

Growth parameters

Data pertaining to plant height is presented in table no. 1. The maximum plant height was observed in treatment T_8 PDKV Micrograde-II (2%) i.e., 58.72 cm at 90 DAS, which was found to be at par with T_7 and T_2. The increase in plant height in treatment T_8 might be due to the involvement of zinc in chlorophyll formation, which might have helped to influence cell division, meristematic activity in apical tissue, expansion of cell and formation of cell wall. The similar results of present investigation have also been reported by Choudary *et al.*, (2015) [16] in garlic crop. The data on length of leaves is presented in table no.1. The maximum length of leaves was observed in T_8 treatment PDKV Micrograde-II (2%) i.e., 35.85 cm which was found to be at par with T_7 and T_2 treatments. These findings are in agreement with Alam *et al.*, (2019) [2] in garlic crop. The data pertaining leaves per plant was finally recorded at 90 DAS is presented in table no.1. Treatment T_8 PDKV Micrograde-II (2%) recorded maximum leaves per plant (15.50), which was statistically found to be at par with treatment T_7 and T_2 treatments. The increase in the number of leaves per plant might be due to role of micronutrients in the in the physiology of the plants and due to their involvement in the fundamental processes such as cellular mechanism and respiration. The results are in confirmatory with the findings of Shukla *et al.,* (2018) [13]. The maximum neck thickness was recorded in treatment T_8 PDKV Micrograde-II (2%) i.e., 0.92 cm which was at par with the T_7 and T_2 treatments. The basic reason for increase in the neck thickness might be due to mineral components zinc and iron are the key components of many enzymatic and protein synthesis and also micronutrients involved in various biochemical processes which helps in chlorophyll production as well as harmone production. The results are in accordance with Rohidas *et al.,* (2011) [12] in garlic crop.

Quality parameters

Data pertaining to TSS content is presented in table no.1. Maximum TSS was recorded in treatment T_8 PDKV Micrograde-II (2%) i.e, (37.05) which was at par with the T_7 treatment (36.84) followed by T_2 (36.50). The increase in TSS of bulb might be due to increased carbohydrates production during photosynthesis. Zn and B play a very important role in photosynthetic activities of the plant. Boron involved in regulation of carbohydrate balance and helped to increase the TSS content. The results endorse with the findings of Abd-Elkader *et al.,* (2016) [1].

Yield parameters

The data recorded fresh weight of the garlic bulb as influenced by the different treatments is presented in table no.2. Among different treatments treatment T_8 PDKV Micrograde-II (2%) was recorded significantly maximum fresh weight of bulb (39.66 g) which was at par with the treatment T_7 treatment (38.89 g), The increase in the fresh weight of the garlic bulb might be due to application of micronutrients at different growth stages, which might have resulted in increased metabolic process which in turn increases the translocation of food material into bulb finally leading to increase in the weight of the bulb. Similar results are have also been recorded by Hore *et al.,* (2013) [9] in garlic crop. Maximum cured weight of the garlic bulb was recorded in T_8 treatment (36.14 g), which was found to be at par with the treatments T_7 (35.43 g), These findings are in confirmatory with Choudary *et al.*, (2015) [16]. Maximum number of cloves per bulb was recorded in T_8 treatment (26.05) which was found to be at par with T_7 treatment (25.91). The maximum number of cloves might be due to role of micronutrients in chlorophyll production, enzyme activation and in protein synthesis which helps in rapid translocation and storage of food material in the bulbs which ultimately increases the number of cloves per bulb These results are in consonance of the findings of Gallani *et al.*, (2017) [8] Maximum length of the cloves was recorded in T_8 treatment (4.46 cm) which was found to be at par with the T_7 treatment (4.37 cm). The results are in accordance with the findings of Panghal *et al.,* (2018) [11]. Treatment T_8 (5.33 cm) was recorded significantly maximum bulb diameter which was found to be at par with T_7 treatment (5.26 cm) The results of the present study are in accordance with the findings Vekaria *et al.,* (2018) [15] in garlic crop. The significantly maximum yield per plot was recorded in T_8 treatment (4.25 kg) which was found to be at par with T_7 treatment (4.19 kg) The results endorse with the findings of Shukla *et al.,* (2018) [13] in garlic crop. The maximum yield per hectare was recorded in T_8 treatment (106.63 q) which was found to be at par with T_7 treatment (104.54 q). The increase in the yield per

hectare might be due to micronutrients application may be attributed to enhance photosynthesis activity and increased in production and accumulation of carbohydrates and favorable effect on vegetative growth, and their allocation to the bulbs. The results of the present study are in agreement with the Bayat *et al.*, (2014) [3].

Table 1: Effect of foliar application of micronutrients on plant height (cm), length of leaves(cm), number of leaves per plant, neck thickness(cm) and TSS content.

Sr. No.	Treatment details	Plant height (cm)	length of leaves	No. of leaves/plant	Neck thickness (cm)	TSS (^{0}Brix)
		90 DAS	90 DAS	90 DAS	90 DAS	At harvest
T_1	$ZnSO_4$-0.25%	56.36	34.29	13.58	0.83	35.65
T_2	$ZnSO_4$-0.50%	56.71	34.84	14.22	0.86	36.50
T_3	$FeSO_4$-0.2%	54.72	33.84	13.30	0.81	34.65
T_4	$FeSO_4$-0.3%	56.06	34.13	13.45	0.85	35.38
T_5	Borax-0.2%	52.82	32.69	11.87	0.77	33.91
T_6	Borax-0.3%	53.96	33.63	12.74	0.79	34.66
T_7	PDKV Microgarde-II (1%)	57.81	35.47	14.95	0.89	36.84
T_8	PDKV Microgarde-II (2%)	58.72	35.85	15.50	0.92	37.05
T_9	Control	49.16	28.07	11.04	0.72	32.33
S.E.(m)±		0.37	0.48	0.35	0.01	0.53
C.D at5%		1.12	1.44	1.05	0.03	1.59

Table 2: Effect of foliar application of micronutrients on yield and yield contributing parameters

Sr. No.	Treatment details	Yield parameters						
		Fresh weight of bulb (g)	Cured weight of bulb (g)	No. of cloves per bulb	Length of cloves (cm)	Bulb girth (cm)	Yield/plot (kg)	Yield/hectare (q)
T_1	$ZnSO_4$-0.25%	36.64	32.82	24.60	4.22	5.06	4.06	101.43
T_2	$ZnSO_4$-0.50%	37.82	34.92	25.61	4.26	5.13	4.15	103.29
T_3	$FeSO_4$-0.2%	35.87	32.35	23.69	4.06	4.93	3.92	96.11
T_4	$FeSO_4$-0.3%	36.11	33.01	24.74	4.12	4.96	3.96	98.57
T_5	Borax-0.2%	34.06	31.24	21.80	3.93	4.83	3.82	94.32
T_6	Borax-0.3%	35.29	32.12	22.84	3.98	4.86	3.85	97.07
T_7	PDKV Microgarde-II (1%)	38.89	35.43	25.91	4.37	5.26	4.19	104.54
T_8	PDKV Microgarde-II (2%)	39.66	36.14	26.05	4.46	5.33	4.25	106.63
T_9	Control	32.54	29.28	18.70	3.02	4.21	3.43	84.51
S.E.(m)±		0.13	0.19	0.39	0.01	0.02	0.01	0.84
C.D at5%		0.39	0.57	1.18	0.05	0.06	0.04	2.53

Conclusion

In this present investigation, it was found that treatment T_8 PDKV Microgarde II (2%) recorded positive effect on growth, yield and quality characters of garlic crop.

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