E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(10): 302-305
Received: 01-07-2024
Accepted: 06-08-2024

Shahid Nadeem
Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Dharwad, Karnataka, India

Math KK
Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Dharwad, Karnataka, India

Hebsur NS
Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Dharwad, Karnataka, India

Hiremath SM
Department of Horticulture, University of Agricultural Sciences, Dharwad, Karnataka, India

Corresponding Author:
Shahid Nadeem
Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Dharwad, Karnataka, India

Effect of foliar application of water soluble fertilizer, sulphur, zinc and boron on growth, yield and economics of garlic (*Allium sativum* L.) in a vertisol

Shahid Nadeem, Math KK, Hebsur NS and Hiremath SM

DOI: https://doi.org/10.33545/2618060X.2024.v7.i10e.1762

Abstract
A field experiment was conducted to study the effect of foliar application of water soluble fertilizer, sulphur, zinc and boron on growth, yield and economics of Garlic (*Allium sativum* L.) in a Vertisol during *rabi* 2022-2023 at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. The experiment was laid out in randomized complete block design with eight treatments comprising foliar spray of 19:19:19 @ 1% at 30 days after sowing, foliar spray of zinc sulphate @ 0.50% and borax @ 0.25% both at 45 and 60 days after sowing individually and in combination replicated thrice. Results revealed that foliar spray of 19:19:19 @ 1% at 30 days after sowing + zinc sulphate @ 0.50% + borax @ 0.25% both at 45 and 60 days after sowing along with RPP significantly increased the plant height (49.50 cm), number of leaves per plant (8.22), equatorial (4.48 cm) and polar (4.17 cm) diameter of bulb, number of cloves per bulb (12.14), clove length (2.49 cm) and total bulb yield (90.60 q ha^{-1}) of garlic with higher B:C ratio (3.61).

Keywords: Water soluble, sulphur, zinc and boron

Introduction
Soil is a crucial natural asset, with its productivity reliant on the interplay of physical, chemical, and biological factors. Effective management of soil health is vital to meet the food demands of our growing global population. In India, excessive nutrient depletion due to inadequate replenishment poses a significant challenge to agricultural productivity, leading to widespread deficiencies in key nutrients-nitrogen, phosphorus, potassium, sulphur, zinc, and boron-exacerbated by the overuse of inorganic fertilizers. This situation has resulted in the erosion of 6,000 to 12,000 million tonnes of topsoil annually, causing substantial nutrient loss. Furthermore, mismanagement of soil and water resources has intensified these deficiencies, with notable deficits in sulphur (41%), zinc (49%), and boron (33%). Therefore, enhancing the availability of these nutrients is imperative for ensuring sustainable crop productivity.
Garlic (*Allium sativum* L.) a key bulbous crop in India, is valued as a spice, condiment, and pharmaceutical ingredient. With India ranking second globally in garlic production, it is cultivated over 0.43 million hectares, yielding 3.52 metric tons at an impressive productivity rate of 8.17 metric tons per hectare (Anon., 2022) [1]. The cultivation of garlic emphasizes the importance of essential macronutrients-nitrogen, phosphorus, potassium, and sulphur-while the role of micronutrients remains under investigation. Recent advancements in water-soluble foliar fertilizers, which vary in N: P: K ratios, have made foliar nutrition a viable method for enhancing plant growth during critical stages. While foliar feeding supplements rather than replaces traditional soil fertilization, it effectively addresses nutrient limitations, particularly when nutrients are immobilized in the soil, marking a significant progression in modern agricultural practices (Batra *et al*., 2002) [4].

Material and Methods
The field experiment was conducted to study the effect of foliar application of water soluble fertilizer, sulphur, zinc and boron on growth, yield and economics of Garlic (*Allium sativum* L.)

in a Vertisol during *rabi* 2022-2023 at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. The experiment was laid out in randomized complete block design with eight treatments as given in Table 1 and replicated thrice. The experimental site soil was clay in texture with low available nitrogen (174.58 kg ha^{-1}), medium in phosphorus (34.71 kg ha^{-1}) and high in potassium (472.53 kg ha^{-1}). The experimental site soil was deficient in DTPA extractable zinc and hot water soluble boron (0.56 and 0.48 mg kg^{-1}). The initial and after harvest soil samples and plant samples were analysed using the standard procedures and methods followed for the estimation of plant and soil nutrients. Sparks (1996) [9] and Tandon (2009) [10].

Table 1: Treatment details

T_1	Absolute control
T_2	Control (RPP)
T_3	T_2 + Foliar spray of 19:19:19 @ 1% at 30 DAS
T_4	T_2 + Foliar spray of $ZnSO_4$ @ 0.50% at 45 and 60 DAS
T_5	T_2 + Foliar spray of borax @ 0.25% at 45 and 60 DAS
T_6	T_2 + Foliar spray of 19:19:19 @ 1% at 30 DAS + $ZnSO_4$ @ 0.50% at 45 and 60 DAS
T_7	T_2 + Foliar spray of 19:19:19 @ 1% at 30 DAS + borax @ 0.25% at 45 and 60 DAS
T_8	T_2 + Foliar spray of 19:19:19 @ 1% at 30 DAS + $ZnSO_4$ @ 0.50% + borax @ 0.25% both at 45 and 60 DAS

Note: RPP (FYM @ 30 t ha^{-1} + 125:62.5:62.5 N: P_2O_5: K_2O kg ha^{-1})
DAS- Days after sowing

Results and Discussion

Growth attributes

Foliar applications of 19:19:19, zinc sulphate, and borax improved plant height, number of leaves per plant, and SPAD value significantly at all the growth stages of the crop (Table 2). These supply raw resources for plant growth and development leading to increased bulb yield. Treatment T_8 (T_2 + Foliar spray of 19:19:19 @ 1% at 30 DAS + $ZnSO_4$ @ 0.50% + borax @ 0.25% both at 45 and 60 DAS) recorded significantly taller plants (49.50 cm) compared to rest of the treatments and RPP (T_2) but was on par with T_7 (44.67 cm) and T_6 (45.38 cm). Among the different treatments, significantly higher number of leaves (8.22) were recorded with the foliar application of 19:19:19 @ 1% at 30 DAS + $ZnSO_4$ @ 0.50% + borax @ 0.25% both at 45 and 60 DAS along with recommended package of practice (T_8) compared to rest of the treatments and the same treatment registered significantly higher SPAD value (61.82) in leaves of garlic. The improvement in growth parameters with the application of 19:19:19, zinc sulphate, and borax could be attributed to their role in chlorophyll synthesis. The improvement in growth parameters with foliar application of water soluble fertilizer (19:19:19) might be due to increased translocation and assimilation of nutrients in the plant. Application of zinc and boron had a beneficial effect on the growth attributes of garlic at different growth stages as zinc is a component of enzymes involved in protein synthesis and plays a vital role in many biochemical processes such as hormone production and leaf elongation. Similar findings were made by Khan (2013) [5] and Alam *et al*. (2019) [2] in garlic.

Yield attributes and bulb yield

Yield, as a complex property, is the total of various morphological and biochemical events that occur throughout crop growth and development. Garlic yield parameters and total bulb yield are influenced indirectly by crop growth characteristics. Yield attributes such as equatorial and polar diameter of bulb, number of cloves per bulb and clove length of garlic were significantly influenced by the foliar application of 19:19:19, zinc sulphate and borax (Table 3 and Fig. 1). Foliar application of 19:19:19 @ 1% at 30 days after sowing + $ZnSO_4$ @ 0.50% + borax @ 0.25% both at 45 and 60 days after sowing along with the recommended package of practice (T_8) recorded significantly higher equatorial (4.48 cm) and polar diameter of bulb (4.17 cm) and number of cloves per bulb (12.14) and clove length (2.49 cm) in garlic over rest of the treatments including recommended package of practice (RPP) and the same treatment recorded significantly higher bulb yield (90.60 q ha^{-1}) of garlic over the rest other treatments (Fig 2). The probable reasons for higher equatorial and polar bulb diameter, number of cloves per bulb, clove length and clove diameter under foliar application of water soluble fertilizer (19:19:19) along with zinc sulphate and borax might be due to adequate availability of easily soluble nutrients. This attributes to an optimum level of synthesis of cytokinin at higher levels of nitrogen and phosphorus which results in a favourable sink to supply more nutrients during critical crop growth stages. Increase in availability of N from foliar spray hastens the photosynthetic activity. Increase in bulb growth was attributed to the better utilization of photosynthates and increased allocation of photosynthates and accumulation of carbohydrates towards the economically useful parts in plant which in turn positively related with the increase in the bulb yield of garlic. These present findings are in conformity with the results of Zakiullah *et al*. (2019) [11] and Kulthe *et al*. (2022) [6] in garlic and by More *et al*. (2017) [8] in onion.

Economic analysis

The Benefit cost ratio of a treatment is the vital factor in order to judge its suitability and to recommend the same to the farming community in order to get higher returns with the minimum investment for cultivation of crop. From the data it is evident that foliar application of 19:19:19 at 1% at 30 DAS along with foliar application of $ZnSO_4$ @ 0.50% + borax @ 0.25% both at 45 and 60 DAS (T_8) recorded higher gross (724800 Rs. ha^{-1}) and net (524103 Rs. ha^{-1}) returns with higher B:C ratio (3.61) over RPP (T_2) (Table 4). This might be attributed to the higher total bulb yield of garlic in the said treatment over the others. These results are in confirmity with the reports of Mehta *et al*. (2017) [7] and Ashokbhai (2021) [3] in garlic.

Table 2: Effect of foliar application of water soluble fertilizer, sulphur, zinc and boron on plant height, number of leaves per plant and SPAD value of garlic at different stages of growth

Treatments	Plant height (cm)			Number of leaves per plant			SPAD value	
	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest	60 DAS	75 DAS
T_1	23.76	29.16	30.26	4.02	4.93	4.87	35.87	40.50
T_2	30.58	37.45	39.45	4.91	6.21	5.99	43.51	48.89
T_3	32.05	38.08	40.19	5.03	6.49	6.21	45.98	50.91
T_4	33.92	42.01	44.26	5.72	7.08	6.97	49.75	55.70
T_5	32.81	40.12	42.96	5.51	6.96	6.53	46.77	53.81
T_6	35.30	43.39	45.38	6.02	7.52	7.20	51.03	57.01
T_7	34.10	42.85	44.67	5.99	7.33	7.04	49.24	54.64
T_8	38.72	47.87	49.50	6.75	8.22	8.07	55.75	61.82
S.Em. ±	1.55	1.91	1.84	0.23	0.28	0.31	2.21	2.23
CD @ 5%	4.72	5.81	5.58	0.70	0.87	0.95	6.44	6.78

DAS - Days after sowing

Table 3: Effect of foliar application of water soluble fertilizer, sulphur, zinc and boron on yield attributes and total bulb yield of garlic

Treatments	Equatorial diameter (cm)	Polar diameter (cm)	Number of cloves per bulb	Clove length (cm)	Total bulb yield (q ha^{-1})
T_1	3.02	2.86	6.20	1.48	44.44
T_2	3.47	3.35	9.43	1.86	72.20
T_3	3.59	3.41	9.72	1.98	74.72
T_4	3.81	3.54	10.30	2.09	77.60
T_5	3.78	3.49	10.16	2.01	75.80
T_6	3.92	3.66	10.81	2.15	80.20
T_7	3.84	3.59	10.64	2.11	79.90
T_8	4.48	4.17	12.14	2.49	90.60
S.Em. ±	0.17	0.15	0.42	0.10	3.41
CD at 5%	0.52	0.46	1.29	0.32	10.36

Table 4: Economics of garlic production as influenced by foliar application of water soluble fertilizer, sulphur, zinc and boron

Treatments	Gross returns (Rs. Ha^{-1})	Net returns (Rs. Ha^{-1})	Cost of cultivation (Rs. Ha^{-1})	B: C ratio
T_1	355520	209705	145815	2.43
T_2	577600	382467	195133	2.96
T_3	597760	400527	197233	3.03
T_4	620800	423003	197797	3.13
T_5	606400	408267	198133	3.06
T_6	641600	441703	199897	3.20
T_7	639200	438967	200233	3.19
T_8	724800	524103	200697	3.61

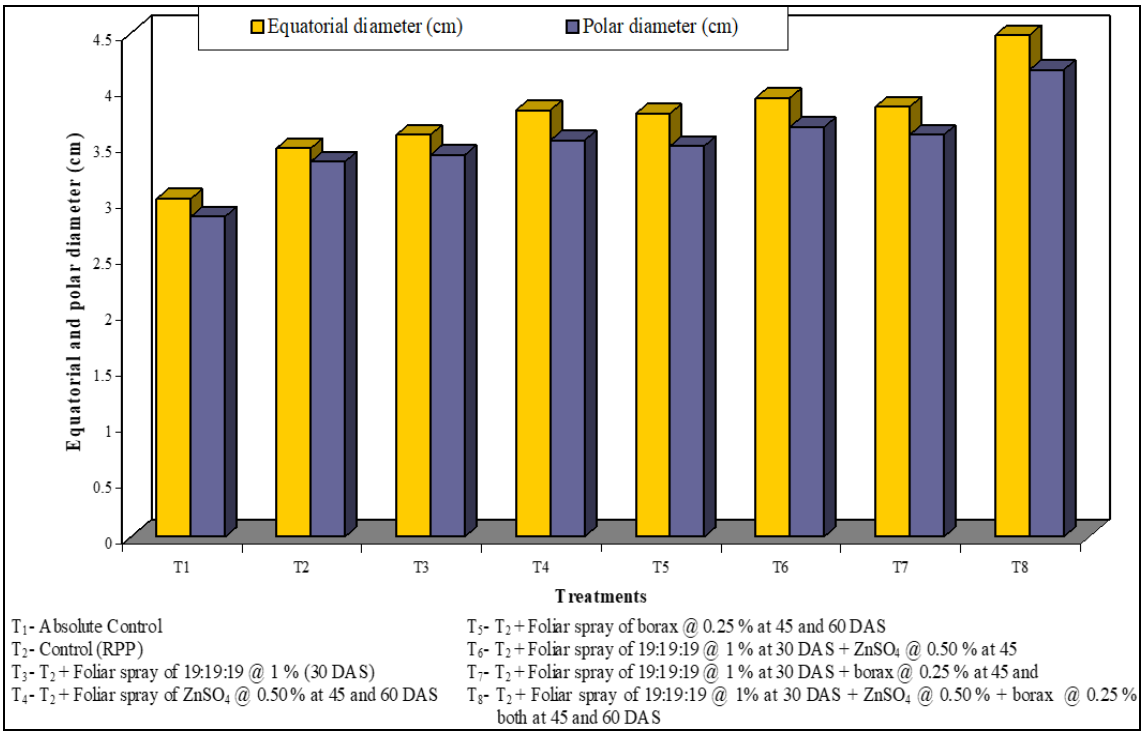

Fig 1: Effect of foliar application of water soluble fertilizer, sulphur, zinc and boron on equatorial and polar diameter of garlic bulb at harvest

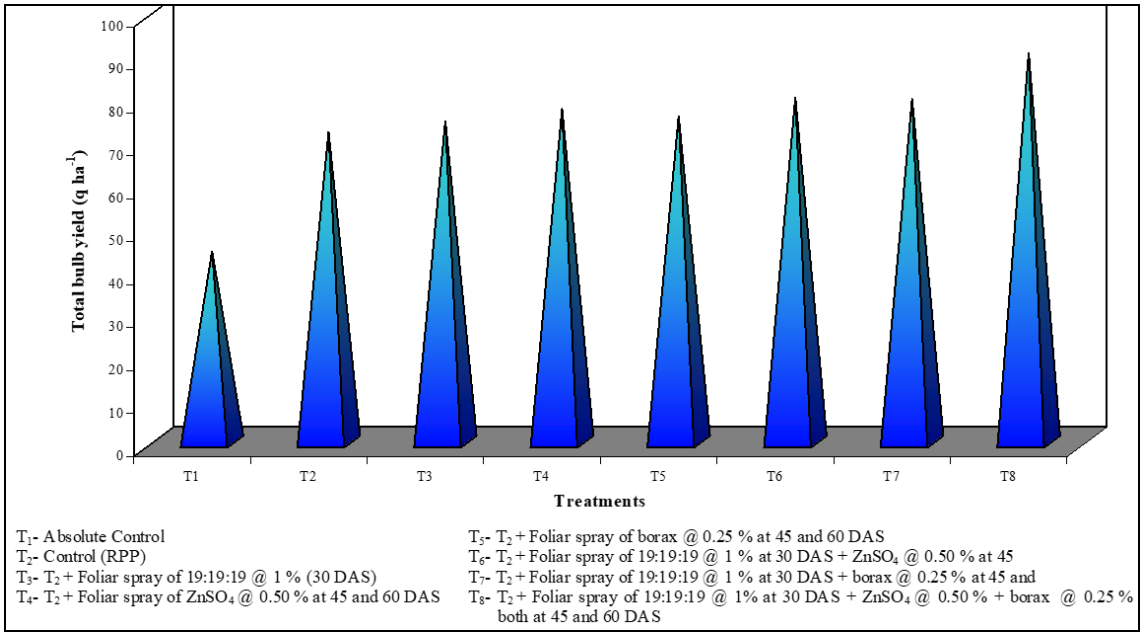

Fig 2: Effect of foliar application of water soluble fertilizer, sulphur, zinc and boron on total bulb yield of garlic

Conclusion

From the experimental study it is evident that foliar application of 19:19:19 @ 1% at 30 DAS + $ZnSO_4$ @ 0.50% + borax @ 0.25% both at 45 and 60 DAS along with RPP significantly improved growth and yield attributes and hence total bulb yield in garlic over RPP and the same treatment recorded higher gross (724800 Rs. ha^{-1}) and net (524103 Rs. ha^{-1}) returns with higher B: C ratio (3.61).

References

1. Anonymous. Indiastat, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi. 2022.
2. Alam MS, Mahmood AI, Ullah AM, Naseeb T, Nawab NN, Haider IA. Growth and yield of garlic influenced by zinc and iron application. Food Biol. 2019;8:13-15.
3. Ashokbhai VH. Effect of micronutrients on yield and quality of garlic (*Allium sativum* L.). M.Sc. (Agri.) Thesis, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India; 2021.
4. Batra VK, Birender S, Virendare S. Response of brinjal to foliar feeding of water soluble fertilizer. In: Proceedings of the International Conference on Vegetable for Sustainable Food and Nutrition Security in the New Millennium; Bangalore; 2002 Nov 11-14. p. 176.
5. Khan MA. Effect of zinc and boron on the growth and yield of garlic. Annual Research Report, Bangladesh Agricultural Research Institute, Spices Research Sub-station, BARI, Lalmonirhat; 2013.
6. Kulthe SD, Pawar GS, Thombre PR, Pawar VS. Effects of micronutrients on growth, yield and storage of garlic (*Allium sativum* L.). The Pharma Innovation J. 2022;11(12):2045-2048.
7. Mehta VS, Padhiar BV, Vikas K. Influence of foliar application of water soluble fertilizers on growth, yield and quality attributes of garlic (*Allium sativum* L.) var. Gujarat Garlic-3 in Southern Gujarat (India). Int J Curr Microbiol Appl Sci. 2017;6(10):3211-3225.
8. More S, Varma L, Joshi H, Verma P, Vadodariya J, Thakur D. Effect of iron, zinc and boron on quality parameters of onion (*Allium cepa* L.) cv. Agrifound Light Red. Bull Environ Pharmacol Life Sci. 2017;6(3):553-557.
9. Sparks D. Methods of soil analysis Part-3: Chemical methods. The Soil Science Society of America Journal, USA; 1996.
10. Tandon HLS. Methods of analysis of soils, plants, water and fertilizers. 4th ed. Fertilizer Development and Consultation Organization, New Delhi, India; 2009. p. 144.
11. Zakiullah, Muhammad M, Irfanullah, Faheemullah, Abdul K, Tahsin R, *et al*. Effect of zinc and boron on the growth and yield of Gulabi variety of garlic (*Allium sativum* L.) under agro-climatic condition of Peshawar. Int J Agron Agric Res. 2019;14(1):11-15.