

Original Research Article

Effect of Sulphur and Micronutrients on Yield and Quality of Garlic (*Allium sativum* L.)

ABSTRACT

The field experiment was conducted at the Horticulture Farm, S.K.N. College of Agriculture, Jobner, Jaipur (Rajasthan) to find out the effect of sulphur (S) and micronutrients on yield and quality of garlic during *Rabi* seasons 2019-20 and 2020-21. The experiment was carried out in factorial randomized block design with three replications and twenty treatment combinations with four levels of sulphur-S (S₀-control, S₁-sulphur 20 kg/ha, S₂-sulphur 40 kg/ha and S₃-sulphur 60 kg/ha) and five levels of micronutrients (M₀-Control, M₁-zinc sulphate @ 0.6%, M₂-ferrous sulphate @ 0.2%, M₃-borax @ 0.5 and M₄-Ammonium molybdate @ 0.5%). The sulphur-S was applied as soil application just before sowing and micronutrients (zinc (Zn), boron-B, Fe-ferrous and Molybdenum) as foliar spray at 40 DAS. Recommended dose of inorganic fertilizers applied uniformly in whole experimental area. The results of the study have clearly indicated that among sulphur-S levels, application of sulphur-S 60 kg/ha significantly improved yield and quality parameters viz., average weight of clove, average weight of bulb, bulb yield per plot, per hectare, nitrogen (N) content, phosphorus (P) content, potassium (K) content and sulphur-S content in bulb enhanced significantly by application of sulphur-S 60 kg/ha (S₃) in both the years as well as in pooled analysis. Although, sulphur-S application at 40 kg/ha along with foliar application of zinc at 0.6 % was found at par to it. Similarly, among micronutrients foliar application of zinc-zinc sulphate @ 0.6% significantly influenced all the yield and quality parameters viz., average weight of clove, average weight of bulb, bulb yield per plot, per hectare, nitrogen-N content, phosphorus-P content, potassium-K content and sulphur-S content in bulb of garlic in both the years as well as in pooled analysis.

Keywords: *Garlic, Sulphur, Micronutrients, yield and quality of garlic.*

1. INTRODUCTION

Garlic is an important bulbous vegetable crop used throughout India primarily as a spice or condiment. Botanically it is *Allium sativum* belonging to the family Alliaceae. It is originated

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from Central Asia and later spread to Mediterranean region [1] and [2]. The bulb of garlic is compound in nature, consisting of numerous bulblets, so called as cloves, of different size and whole is surrounded by layers of white scale leaves. Alliin is the main biologically active component of freshly crushed garlic cloves, which is produced by the degradation of alliin, from results of alliinase activity [3] and [4]. Having the medicinal properties it lowers blood cholesterol level and antiplatelet aggregation, produces anti-inflammatory activity and inhibits cholesterol synthesis. Moreover, it has long been known to have antibacterial, antifungal, anticancer, antioxidant and antiviral activities [5].

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Besides, garlic also possesses insecticidal properties. Extract of garlic along with chilli and ginger has beneficial action against soil nematodes. Beneficial use of garlic extract has also been found against many fungi and bacteria [6]. Garlic oil or its juice is recommended to inhale in cases of pulmonary tuberculosis, rheumatism, sterility, impotency, cough and redness of eyes [7]. Garlic contains volatile oil known as diallel-disulphide which is the major flavouring component in garlic. Garlic has higher nutritive value as compared to other bulbous crops. It is a rich source of sugar, protein, fat, potassium (K), calcium (Ca), sulphur (S), phosphorus (P), fiber and iodine. Per 100 g of edible portion of garlic contains 59 % moisture, 6.4 g protein, 1469 k-cal energy, 0.5 g fats, 33.1 g carbohydrates, 1.5 g fiber, 181 mg Ca, 153 mg P, 1.7 mg Feferrous, 17 mg Nasodium, 401 mg K, 0.08 mg riboflavin, 0.25 mg thiamine, 0.06 mg nicotinamide and 10.8 mg ascorbic acid [8].

Deficiency of micronutrients during the last three decades has become a major constraint to production and productivity of vegetables in general and garlic in particular. Thus, there is an urgent need for correction of individual nutrient deficiency and for arresting its further spread. The lower productivity of Indian garlic is primarily due to cultivation of low yield potential varieties, susceptibility to both biotic and abiotic factors. Therefore, imbalanced nutrition is treated as one of the major abiotic factors which adversely affects growth and yield of garlic. Keeping these points in view, foliar application of boron, zinc, iron and molybdenum as micronutrients and basal doses of sulphur-S as a macronutrient were used in the experimental crop to study the impact on growth, yield and storage of garlic. The foliar application of micronutrients reduces the cost of owing to the lesser requirement of nutrients and better absorption through the foliage. It has been observed that application of micronutrients are is important in-for enhancing the translocation of carbohydrates from the site of synthesis to the storage organ. Among the macronutrients, sulphur-S is one of a major plant nutrient essential for building up sulphur-S containing amino acids namely cystine,

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cysteine & methionine ~~and~~. Surfer is also involved in synthesis of protein and ~~sulphur~~-S containing vitamins like biotin, thiamine and some coenzymes.

2. MATERIALS AND METHODS

2.1 Location of experimental site

The experiment was laid out at Horticulture farm, S.K.N. College of Agriculture, Jobner, District Jaipur (Rajasthan) during *Rabi* season 2019-20 and 2020-21. Geographically, Jobner is situated 45 km in West of Jaipur at 26°5' North latitude, 75°20' East longitude and at an altitude of 427 meters above mean sea level. This region falls under Agro-Climatic Zone-III A (Semi- Arid Eastern Plain Zone) of Rajasthan.

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2.2 Climate and weather

The climate of Jobner region is typically semi-arid characterized by extremes of temperature both in summer and winter, low rainfall and moderate relative humidity. The annual average rainfall varies between 250 to 500 mm, most of which is received in rainy season fall during July to early September, sporadic showers also received in winters. The maximum temperature ranges from 30 to 46°C during month of May and June, while in December and January, it falls down below -1°C and evaporation ranges from 1.2-6.9 mm per day.

2.3 Soil characteristics of experimental field

To know the fertility status and other physical constraints of soil, samples were taken and analyzed in the department of Soil Science and Agricultural Chemistry, S.K.N. College of Agriculture, Jobner to evaluate physico-chemical characteristics of the soil before experimentation. The soil samples from 0-15 cm depth were collected from different locations of the experimental field before application of manures and fertilizers. A representative composite sample was prepared by processing and mixing them together and analysed for physical and chemical properties. The results of analysis presented in Table 3 showed that the soil of experimental site was loamy sand in texture, slightly alkaline in reaction, poor in organic carbon with low available nitrogen, phosphorus ~~&-and~~ sulphur ~~and~~ as well as medium in potassium content. The underground water used for irrigation is partially saline in nature.

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2.4 Quality of irrigation water

The irrigation water sample was taken from tube well of horticulture farm, SKN COA, Jobner and analysed in the department of soil science of S.K.N. College of Agriculture,

Jobner. The irrigation water falls under class C₃S₁ to USDA Hand Book No. 60. The pH and EC were found to be 7.75 and 7.68 and 1.01 and 1.02 ds/m in the year 2019-20 and 2020-21 respectively. Water of Jobner area is little but saline in nature.

2.5 Treatments and design

A field experiment was carried out during *Rabi* season of 2019-20 and 2020-21 in factorial randomized block design with ~~twenty~~ 20 treatment combinations viz., (S₀-control, S₁-sulphur 20 kg/ha, S₂-sulphur 40 kg/ha and S₃-sulphur 60 kg/ha, M₀-Control, M₁-zinc sulphate @ 0.6%, M₂-ferrous sulphate @ 0.2%, M₃-borax @ 0.5 and M₄-Ammonium molybdate @ 0.5%) and three replications. The sulphur-S was applied as a basal dose before sowing and micronutrients (Zn, B, Fe and Mo) as foliar spray. Recommended dose of inorganic fertilizers applied uniformly in whole experimental area.

2.6 Crop Management

The experimental land was prepared by ploughing and double harrowing to bring it to the fine tilth. Farm yard manure was applied at the rate of 25 t/ha before final harrowing and incorporated into the soil one week before sowing. The plots of required size were prepared. Bunds, irrigation channels and roads were laid out as per the plan. The seeds of cv. G -282 procured from NHRDF, Karnal (Haryana). The seeds (cloves) of garlic were first treated with Carbendazim @ 2 g/kg seed to control seed borne diseases. The seeds were sown on 16th October, 2019 and 22th October, 2020 manually with a seed rate of 500 kg /ha in row at 15 cm apart.

2.7 Statistical analysis

The experimental data recorded for growth, yield, quality and storage characters were subjected to statistical analysis in accordance with the 'Analysis of variance' technique suggested by Fisher. The critical difference (CD) was calculated wherever the difference was found significant. Assuming homogeneity in the experimental data of two years, pooled analysis was done. The analysis of variance of different components for all parameters discussed is given in the annexures at the end.

3. RESULTS AND DISCUSSION

3.1 Effect of Sulphur on yield parameters

The perusal of data in the [Tables](#) (1, 2 and 3) reveals that all the sulphur ([S](#)) levels (20, 40 and 60 kg ha⁻¹) significantly increased the average weight of clove, average weight of bulb, bulb yield per plot and per hectare as compared to control during both the years and in pooled mean. The maximum average weight of clove (1.49, 1.46 and 1.47g), average weight of bulb (26.65, 24.84 and 25.75g), bulb yield per plot (3.20, 2.98 and 3.09 kg/plot) and per hectare (177.68, 165.62 and 171.65 q/ha) was recorded with 60 kg S ha⁻¹ that was at par with 40 kg S ha⁻¹. Where as the minimum average weight of clove (1.29, 1.27 and 1.28 g), average weight of bulb (21.17, 19.78 and 20.48 g), bulb yield per plot (2.54, 2.37 and 2.46 kg/plot) and per hectare (141.15, 131.86 and 136.51 q/ha) was recorded with control.

The yield attributing characters namely average weight of clove, average weight of bulb and bulb yield per plot and per hectare increased significantly with the application of sulphur (S₃) sulphur @ 60 kg/ha over control. Pooled mean basis, the maximum values of yield and yield attributes *i.e.*, average weight of clove (1.47 g), average weight of bulb (25.75 g), bulb yield per plot (3.09 kg/plot) and bulb yield per hectare (171.65 q/ha) were recorded with application of 60 kg S/ha (S₃) which at par with 40 kg S/ha (S₂) and minimum under control (S₀). Further, [sulphur-S](#) being an integral constituent of certain amino acids of which nitrogen ([N](#)) is also essential constituent, might have helped in increasing net assimilation rate of [nitrogen-N](#) along with other nutrients. Thus, it might have resulted in increased yield attributes. Increase in yield of garlic due to [sulphur-S](#) application may be due to low initial available [sulphur-S](#) content in experimental soil and better development and thickening of xylem and collenchyma fibers because of higher rate of protein synthesis and enhanced photosynthetic activity of the plant with increased chlorophyll synthesis due to fertilization with [sulphur-S](#) which in turn resulted in more yield attributes and yield of plant. These results are agreement with findings of [9] in onion and garlic, [10] in onion, [11], [12] in garlic, [13] and [14] in onion.

3.2 Effect of [sSulphur](#) on quality parameters

Data (Table 2) indicated that the [nitrogen-N](#) content was significantly increased by the application of increasing levels of [sulphur-S](#) fertilization during both the years as well as pooled mean. The maximum [nitrogen-N](#) content (0.821, 0.850 and 0.836 per cent), phosphorus ([P](#)) content (0.302, 0.339 and 0.321 per cent) and potassium ([K](#)) content (0.522, 0.542 and 0.532 per cent) was recorded under treatment S₃ ([Sulphur](#) @ 60 kg/ha) and minimum [nitrogen-N](#) content (0.942, 1.020 and 0.981 %), [phosphorus-P](#) content (0.260, 0.292

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and 0.276 per cent) and potassium-K content (0.439, 0.461 and 0.450 per cent) under control during 2019-20, 2020-2021 and in pooled mean. The treatment S₃ where Sulphur @ 60 kg/ha was applied observed as significantly superior over control but remained statistically at par with treatment S₂ (Sulphur @ 40 kg/ha).

Application of sulphur-S resulted in significant increase in chlorophyll content of leaves, which might have enhanced the rate of photosynthesis which further increased vegetative growth and provided more site for translocation of photosynthates which might have resulted in increased accumulation of carbohydrate, thus increased TSS content in garlic bulb. These results are in accordance with the findings of [15] in onion and [16] in onion, [17] in onion, [18] in garlic, [19] in garlic, [20] in garlic and [21] in onion.

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3.3 Effect of mMicronutrients on yield parameters

Data (Table 3) also showed that significant improvement in average weight of clove (1.45, 1.44 and 1.44 g), average weight of bulb (25.70, 24.84 and 25.75 g), bulb yield per plot (3.08, 2.92 and 3.00 kg/plot) and bulb yield per hectare (171.34, 162.14 and 166.74 q/ha) of garlic was recorded with foliar application of micronutrients wherein zinc sulphate @ 0.6% produced significantly maximum average weight of clove, average weight of bulb, bulb yield per plot and bulb yield per hectare compared to control (M₀). While, micronutrient treatments viz., zinc sulphate @ 0.6%, ferrous sulphate @ 0.2%, borax @ 0.5% and ammonium molybdate @ 0.5% remaining at par with each other also proved significantly superior to control.

The average weight of clove, average weight of bulb, bulb yield per plot and bulb yield per hectare increased significantly with foliar application of micronutrients (zinc sulphate @ 0.6%) over control. Pooled mean basis, the maximum values of yield and yield attributes *i.e.*, average weight of clove (1.44 g), average weight of bulb (25.01 g), bulb yield per plot (3.00 kg/plot) and yield per hectare (166.74 q/ha) was recorded with the foliar application of zinc sulphate @ 0.6% (M₁) and minimum under control. These results are in conformity with the findings of [22] -in garlic, [23] in garlic, [24] in garlic, and [25] in onion.

The increase in yield and yield attributes by the application of micronutrient (Zn) might have influenced the formation of some growth hormones in the plant as it is associated with water relation in the plants and also involved in auxins metabolism like tryptophane synthetase, tryptomine metabolism, influence the activity of dehydrogenase enzymes Pyridine nucleotide, glucose-6 phosphate and triose phosphate and also synthesis of

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tryptophane, a compound of proteins and needed for the production of growth hormones such as IAA and GA. -Similar findings were recorded by [26] in tomato, [27] in okra, [28] in garlic and [29] in onion.

3.4 Effect of mMicronutrients on quality parameters

The data regarding the foliar application of micronutrients on nitrogen-N content, phosphorus P and potassium-K content presented in the table 2. The perusal of data revealed that the nitrogen-N was significantly increased by foliar application of micronutrients during both the years as well as pooled mean. The nitrogen-N content (0.922, 0.986 and 0.954 per cent), phosphorus-P content (0.295, 0.335 and 0.315 per cent) and potassium-K content (0.505, 0.531 and 0.518 per cent) was recorded maximum under treatment M₁ (zinc sulphate @ 0.6%) whereas, the minimum nitrogen-N content (0.825, 0.865 and 0.845 per cent), phosphorus-P content (0.267, 0.293 and 0.280 per cent) and potassium-K content (0.453, 0.470 and 0.462 per cent) was recorded under the treatment M₀ (control). The treatment M₁ was observed as significantly superior over control and remained statistically at par with treatment M₂ (ferrous sulphate @ 0.2%), M₃ (borax @ 0.5%), M₄ (ammonium molybdate @ 0.5%) during both the years and in pooled mean. It might be due to adequate nutrient availability in the feeding zone which ultimately increased the uptake of nutrients, photosynthetic rate and finally the greater growth of plant by enhancing the quality of bulb. Zinc plays an important role in metal activator of different enzymes and essential trace elements in various function of the plant like increases the rate of chlorophyll, antioxidant enzymes and essential components of many proteins and improving the mineral status (TSS, ascorbic acid, protein and sugar content) as well as increasing crop yield and quality. Similar results were also recorded by [30] in cauliflower, [31] in garlic, [32] and [33] in onion, [34] in onion, [35] in tomato and [36] in tomato, [37] in onion, [38] in garlic.

4. CONCLUSIONS

Based on the results of two years experiments, it may be concluded that soil application of sulphur at 60 kg/ha combined with foliar spray of zinc sulphate at 0.6% proved the most superior treatment combination in garlic fetching the significantly higher yield. Although, sulphur application at 40 kg/ha along with foliar application of zinc at 0.6 % was found at par to it.

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REFERENCES

1. Simon, W. 2001. The origin and distribution of garlic. USDA Vegetable Crops Research Unit, USA, 1-3.
2. Kigori, J.M., Magaji, M.D. and Yakudu, A.I. 2005. Productivity of two garlic (*Allium sativum* L.) cultivars as affected by different levels of nitrogenous and phosphorus fertilizers in Sokoto, Nigeria. Proceeding of 41st Annual Conference on Bulletin of the Science Association of Nigeria, Usmanu Danfodiyo University, Sokoto.
3. Bocchini, P., Andalò, C., Pozzi, R., Galletti, G.C. and Antonelli, A. 2001. Determination of diallyl thiosulfinate (allicin) in garlic (*Allium sativum* L.) by high performance liquid chromatography with a post column photochemical reactor. *Analytica Chimica Acta*, 441: 37–43.
4. Rahman, M.M., Fazlic, V., and Saad, N.W. 2012. Antioxidant properties of raw garlic (*Allium sativum* L.) extract. *International Food Research Journal*, 19: 589–591.
5. Lawrence, R. and Lawrence, K. 2011. Antioxidant activity of garlic essential oil (*Allium sativum* L.) grown in north Indian plains. *Asian Pacific Journal of Tropical Biomedicine*, 1: 51–54.
6. Pandey, U.B. 1997. Garlic cultivation in India. National Horticulture Research and Development Foundation, (NHRDF) Nasik, Maharashtra. Technological Bulletin, 7: 8-9.
7. Pruthi, J.S. 1979. Spices and condiments, National Book Trust, India, New Delhi, 25-132.
8. Lorenz, O.A. and D.N. Maynard. 1988. Knott's handbook for vegetable growers. A Wiley International Science Publication of John Wiley and Sons, 3: 456.
9. Srinidhi, N. 2000. Studies on sulphur nutrition on onion and garlic in sulphur deficient, research report, University of Agricultural Sciences, Dharwad.
10. Channagoudra, R.F. and Janawade, A.D. 2006. Effect of different levels of irrigation and sulphur on growth, yield and quality of onion (*Allium cepa* L.). *Karnataka Journal of Agricultural Sciences*, 19(3): 489-492.
11. Jaggi, R.C. 2005. Sulphur levels and sources affecting yield and yield attributes in onion (*Allium cepa* L.). *Indian Journal of Agricultural Sciences*, 75(3): 154-156.
12. Verma, D. and Singh, H. 2012. Response of varying levels of potassium and sulphur on yield and uptake of nutrients by onion. *Annals of Plant and Soil Research*, 14(2): 143-146.

13. Singh, S.K., Kumar, M., Seema, Singh, P.K. and Yadav, L.M. 2019. Effect of sulphur sources and levels on growth, yield and quality of onion. *Current Journal of Applied Science and Technology*, 33(2): 1-4.
14. Raghavendra, B.H., Umamaheswarappa, P., Srinivasa, V., Salimath, S. and Hanumantappa, M. 2020. Effect of different sources and levels of sulphur on yield and yield attributes in onion under central dry zone of Karnataka. *International Journal of Ecology and Environmental Sciences*, 2(4): 766-768.
15. Quareshi, A. and Lawande, K.E. 2006. Response of onion (*Allium cepa* L.) to sulphur application for yield, quality and its storability in S- deficient soil. *Indian Journal of Agricultural Sciences*, 76(6): 535-537.
16. Channagoudra, R.F. and Janawade, A.D. 2006. Effect of different levels of irrigation and sulphur on growth, yield and quality of onion (*Allium cepa* L.). *Karnataka Journal of Agricultural Sciences*, 19(3): 489-492.
17. Pradhan, K., Pattnaik, A.K., Tripathy, P., Mallikarjunrao, K., Sahoo, B.B. and Lenka, J. 2015. Influence of sulphur fertilization on nutrient uptake of onion (*Allium cepa* L.). *Journal Crop and Weed*, 11 (special issue): 134-138.
18. Patidar, M., Shaktawat., S.P.R. and Naruka, S.I. 2017. Effect of sulphur and vermicompost on growth, yield and quality of garlic (*Allium sativum* L.). *Journal of Krishi Vigyan*, 5(2): 54-56.
19. Chattoo, M.A., Magray, M.M., Parray, A.H.F., Shah, M.D. and Bhat, A.T. 2018. Effect of sulphur on growth, yield and quality of garlic (*Allium sativum* L.). *Journal of Pharmacognosy and Phytochemistry*, 7(5): 2894-2896.
20. Singh, C.V., Gupta, P. and Kasana, B.S. 2018. Response of garlic to sulphur and boron application in terms of biochemical parameters. *International Journal of Current Microbiology and Applied Sciences*, 7(9): 2677-2687.
21. Singh, S.K., Kumar, M., Seema, Singh, P.K. and Yadav, L.M. 2019. Effect of sulphur sources and levels on growth, yield and quality of onion. *Current Journal of Applied Science and Technology*, 33(2): 1-4.
22. Sharangi, A. B. Pariari, A. Datta, S. and Chatterjee, R. 2003. Effect of boron and zinc on growth and yield of garlic in new alluvial zone of West Bengal. *Crop Research Hisar*, 25(1): 83-85.
23. Srivastava, R., Agarwal, A., Tiwari, R.S. and Kumar, S. 2005. Effect of micronutrients, zinc and boron on yield, quality and storability of garlic (*Allium sativum* L.). *Indian Journal of Agricultural Sciences*, 75(3): 157-159.

24. Rohidas, S.B., Bharadia, P.S., Jature, S.D. and Ghate, K.B. 2010. Effect of micronutrient on growth and yield of garlic (*Allium sativum* L.) var. G-41. *Asian Journal of Horticulture*, 5(2): 517-519.
25. Abedin, M.J., Alam, M.N., Hossain, M.J., Ara, N.A., and Haque, K.M.F. 2012. Effect of micronutrients on growth and yield of onion under calcareous soil environment. *International Journal of Biosciences*, 2(8): 95-101.
26. Patnaik, M.C.; Raj, G.B. and Reddy, I.P. 2001. Response of tomato (*Lycopersicon esculentum* L.) to zinc and iron, *Vegetable Science*, 28(1): 78-79.
27. Kumar, M. and Sen, N.L. 2005. Effect of zinc, boron and GA₃ on yield of okra (*Abelmoschus esculentus* L.). *Indian Journal of Horticulture*, 62(3): 308-309.
28. Vekaria, L.C., Sakarvadia, H.L., Asodaria, K.B., Ponkia, H.P., Polara, K.B. and Parkhia, D.M. 2018. Response of garlic to micronutrients application in medium black calcareous soil of saurashtra region of Gujrat. *International Journal of Chemical Studies*, 6(4): 2178-2182.
29. Khatemenla, Singh, V.B., Sangma, T.T.A. and Maiti, C.S. 2018. Effect of zinc and boron on growth, yield and quality of onion (*Allium cepa* L.) cv. Agrifound dark red. *International Journal of Current Microbiology and Applied Sciences*, 7(4): 3673-3685.
30. Chhipa, B.G. 2005. Effect of different levels of sulphur and zinc on growth and yield of cauliflower (*Brassica oleracea* var. *botrytis* L.), M.Sc. (Ag.) Thesis, S.K.N. College of Agriculture, Jobner, RAU, Bikaner.
31. Srivastava, R., Agarwal, A., Tiwari, R.S. and Kumar, S. 2005. Effect of micronutrients, zinc and boron on yield, quality and storability of garlic (*Allium sativum* L.). *Indian Journal of Agricultural Sciences*, 75(3): 157-159.
32. El-Tohamy, W.A., Khalid, A.KH., El-Abagy, H.M. and Abou-Hussein, S.D. 2009. Essential oil, growth and yield of onion (*Allium Cepa* L.) in response to foliar application of some micronutrients. *Australian Journal of Basic and Applied Sciences*, 3(1): 201-205.
33. Alam, M.N., Abedin, M.J. and Azad, M. 2010. Effect of micronutrients on growth and yield of onion (*Allium cepa* L.) under calcareous soil environment. *International Research Journal of Plant Science*, 1(3): 56 - 61.
34. Abd El-Samad, E.H., Khalifa, R.K.H.M. Lashine, Z.A. and Shafeek, M.R. 2011. Influence of urea fertilization and foliar application of some micronutrients on

growth, yield and bulb quality of onion. *Australian Journal of Basic and Applied Sciences*, 5(5): 96-103.

35. Gurmani, A.R., Din, J.U., Khan, S.U., Andaleep, R., Waseem, K., Khan, A. and Ullah, H. 2012. Soil Application of zinc improves growth and yield of tomato. *International Journal of Agriculture and Biology*, 14: 91–96.
36. Singh, H.M and Tiwari, J.K. 2013. Impact of micronutrients spray on growth, yield and quality of tomato (*Lycopersicon esculantum* Mill). *Hortflora Research spectrum*, 2(1): 87-89.
37. Pramanik, K., Tripathy, P., Mandal, P., Pradhan, M. and Biswal, M. 2018. Effect of micronutrients on quality of onion (*Allium cepa* L.). *International Journal of Chemical Studies*, 6(6): 1324-1327.
38. Sethupathi, S. 2019. Effect of zinc and boron on yield and quality of onion (*Allium cepa* L.) in alfisols of tamirabarni tract. *Madras Agricultural Journal*, 106(4-6): 293-296.

UNDER PEER REVIEW

Table 1 Effect of sulphur and micronutrient on average weight of clove and average weight of bulb

Treatments	Average weight of clove			Average weight of bulb		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Sulphur levels						
S ₀	1.29	1.27	1.28	21.17	19.78	20.48
S ₁	1.40	1.36	1.38	24.31	22.46	23.38
S ₂	1.47	1.45	1.46	26.22	24.51	25.36
S ₃	1.49	1.46	1.47	26.65	24.84	25.75
SEm ±	0.03	0.03	0.02	0.46	0.46	0.32
CD (P = 0.05)	0.07	0.08	0.05	1.32	1.31	0.91
Micronutrients						
M ₀	1.33	1.29	1.31	21.81	20.04	20.93
M ₁	1.45	1.44	1.44	25.70	24.32	25.01
M ₂	1.43	1.40	1.42	25.19	23.34	24.27
M ₃	1.45	1.42	1.43	25.58	23.97	24.77
M ₄	1.41	1.38	1.39	24.66	22.81	23.73
SEm ±	0.03	0.03	0.02	0.52	0.51	0.36
CD (P = 0.05)	0.08	0.09	0.06	1.48	1.46	1.02

[SEm: Standard error of the mean](#)

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Table 2 Effects of sulphur and micronutrient on average weight of bulb per plot and yield of bulb per hectare of garlic

Treatments	Bulb yield (kg/plot)			Bulb yield (q/ha)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Sulphur levels						
S ₀	2.54	2.37	2.46	141.15	131.86	136.51
S ₁	2.92	2.70	2.81	162.05	149.73	155.89
S ₂	3.15	2.94	3.04	174.79	163.39	169.09
S ₃	3.20	2.98	3.09	177.68	165.62	171.65
SEm ±	0.05	0.05	0.04	3.07	3.22	2.23
CD (P = 0.05)	0.16	0.15	0.11	8.80	9.22	6.27
Micronutrients						
M ₀	2.62	2.41	2.51	145.39	133.63	139.51
M ₁	3.08	2.92	3.00	171.34	162.14	166.74
M ₂	3.02	2.80	2.91	167.94	155.62	161.78
M ₃	3.07	2.88	2.97	170.54	159.78	165.16
M ₄	2.96	2.74	2.85	164.37	152.07	158.22
SEm ±	0.06	0.06	0.04	3.44	3.60	2.49
CD (P = 0.05)	0.18	0.17	0.12	9.84	10.31	7.01

SEm: Standard error of the mean

Comment [S17]: Please use SI unit.

Comment [S18]: ?

Table 3 Effects of sulphur and micronutrient on number of cloves per plant of garlic

Treatments	N content (%)		
	2019-20	2020-21	Pooled
Sulphur levels			
S ₀	0.821	0.850	0.836
S ₁	0.870	0.920	0.895
S ₂	0.912	0.980	0.946
S ₃	0.942	1.020	0.981
SEm ±	0.013	0.018	0.011
CD (P = 0.05)	0.037	0.050	0.031
Micronutrients			
M ₀	0.825	0.865	0.845
M ₁	0.922	0.986	0.954
M ₂	0.895	0.955	0.925
M ₃	0.905	0.970	0.937
M ₄	0.885	0.937	0.911
SEm ±	0.014	0.020	0.012
CD (P = 0.05)	0.041	0.056	0.034

SEm: Standard error of the mean

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Table 4 Effects of sulphur and micronutrient on phosphorus and potassium content in garlic bulb

Treatments	Phosphorus content (%)			Potassium content (%)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
Sulphur levels						
S ₀	0.260	0.292	0.276	0.439	0.461	0.450
S ₁	0.282	0.312	0.297	0.481	0.502	0.492
S ₂	0.295	0.331	0.313	0.511	0.533	0.522
S ₃	0.302	0.339	0.321	0.522	0.542	0.532
SEm ±	0.004	0.006	0.004	0.007	0.008	0.005
CD (P = 0.05)	0.013	0.018	0.011	0.021	0.023	0.015
Micronutrients						
M ₀	0.267	0.293	0.280	0.453	0.470	0.462
M ₁	0.295	0.335	0.315	0.505	0.531	0.518
M ₂	0.287	0.320	0.303	0.495	0.516	0.506
M ₃	0.292	0.329	0.311	0.503	0.524	0.514
M ₄	0.283	0.316	0.299	0.485	0.506	0.496
SEm ±	0.005	0.007	0.004	0.008	0.009	0.006
CD (P = 0.05)	0.014	0.020	0.012	0.023	0.026	0.017

[SEm: Standard error of the mean](#)

Comment [S21]: ?

UNDER PEER REVIEW

