www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 754-757

www.thepharmajournal.com
Received: 16-07-2021
Accepted: 28-08-2021

Veer DR
College of Agriculture Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Jagtap VS
College of Agriculture Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Wankhede SS
College of Agriculture Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Kharade MR
College of Agriculture Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Kharade MR
College of Agriculture Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Corresponding Author:
Veer DR
College of Agriculture Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Effect of sources and levels of sulphur on growth and yield of garlic (*Allium sativum* L.)

Veer DR, Jagtap VS, Wankhede SS, Kharade MR and Chavan SS

Abstract
The present investigation entitled "Effect of sources and levels of sulphur on growth, yield of garlic (*Allium sativum* L.) Cv. G-4" was undertaken at Instructional-Cum-Research Farm, Department of Horticulture, College of Agriculture, Latur. The experiment framed was intended to find out the sources and optimum level of sulphur for better vegetative growth and higher yield of garlic. The results of the present investigation indicated that, different sources and levels of sulphur produced significant effect on growth and yield attributes of garlic. The treatment of gypsum at the level of 40 kg/ha recorded the significant effect on growth and yield parameters like plant height, number of leaves/plant, days required for maturity, neck thickness, length of cloves, diameter of bulb, weight of bulb, number of cloves per bulb, yield per plot and yield per heacter.

Keywords: Sources, levels, sulphur, garlic, *Allium sativum* L.

Introduction
Garlic (*Allium sativum* L.) is a member of the Alliaceae family and one of the most aromatic herbaceous annual spices (Kurian, 1995) [10]. It is the second most widely cultivated crops, next to onion in the world (Purseglove, 1975) [16] with a characteristic pungent smell. Garlic originated in Central Asia where, it was extended to the Mediterranean region in the pre historic dates (Thompson and Kelly, 1957) [20]. Among the various species grown in country garlic (*Allium sativum* L.) has long been recognized all over the world as a valuable spice or condiment for food and a popular remedy for various ailments and disorders (Singh and Gupta, 2002).
Garlic is highly accepted for its flavour enhancing capacity (Roy and Chakraborti, 2002) [18] and has many medicinal uses also. Average yield of garlic is low, one of the reasons for such low yield is use of an inadequate and unbalanced fertilization. The balance use of all the nutrients along with sulphur is necessary for good yields and quality production of garlic. Sulphur has long been known as essential major nutrient required for growth and development of plants. Sulphur is essential for the synthesis of proteins, oils and vitamins in plant body. Quareshi and Lawande (2006) [17], reported that application of sulphur between 30 and 45 Kg/ha along with recommended NPK give maximum yield and improved the quality of garlic crop. It is necessary to estimate garlic to sulphur fertilization on sulphur deficient soils of Maharashtra. It is also necessary to identify the cheaper source of sulphur as a fertilizer. Keeping in view the situation of sulphur nutrition of garlic in Maharashtra, a field experiment entitled "Effect of sources and levels of sulphur on growth, yield and quality of garlic (*Allium sativum* L.)" is planned to find out the effect of sulphur on growth and yield of garlic.

Materials and Methods
The present investigation entitled "Effect of sources and levels of sulphur on growth and yield of garlic (*Allium sativum* L.)" was carried out during 2019-20. The experiment was conducted Instructional-Cum-Research Farm, at Department of Horticulture, College of Agriculture, Latur. The experimental site was fairly uniform with gentle slope. The soil was medium black slightly alkaline with uniform texture, colour and having good drainage. All the cultural and horticultural practices were followed as per the recommendation. The experiment consists of factorial Randomized Block Design with three replications, according three sources of sulphur (A) and four levels of sulphur (D) were tried and involving 12 treatment combinations. The three sources of sulphur were Elemental sulphur (A1), Ben sulphur (A2), and Gypsum (A3) and four levels of sulphur were 0, 20, 40 and 60 kg/ha were used in this experiment. The net plot size 2.50 m x 1.50 m.

Seeds of garlic (G-4) were sown on first week of November at spacing of 15 x 10 cm with full recommended dose of fertilizer i.e. 100 kg N + 50 kg + P_2O_5 + 50 kg K_2O/ha. The crop was harvested on 16 March 2020 when the plants attains maturity and showing drying up of most of the leaves and bending over.

Treatment details

Table 1: A) Factors A-Sources of sulphur

A_1	Elemental sulphur
A_2	Ben sulphur
A_3	Gypsum

Table 2: B) Factors B-levels of sulphur

D_1	No sulphur
D_2	20kg/ha
D_3	40kg/ha
D_4	60kg/ha

Table 3: Treatment combination

T_1	A_1D_1
T_2	A_1D2
T_3	A_1D_3
T_4	A_1D_4
T_5	A_2 D_1
T_6	A_2D_2
T_7	A_2D_3
T_8	A_2D_4
T_9	A_3D_1
T_{10}	A_3D_2
T_{11}	A_3D_3
T_{12}	A_3D_4

Results and Discussion

Vegetative growth parameters of garlic were influenced significantly with different sources and levels of sulphur. The maximum increase in plant height (63.44 cm), number of leaves per plant (8.83), minimum days required for maturity (108.08 days) and crop duration (131.50) was observed at gypsum and the minimum values for those parameters was recorded at elemental sulphur and ben sulphur. Maximum increase in plant height (63.47 cm) and crop duration (127.89) was observed at the level of 40 kg/ha. The minimum values was recorded at 0 kg/ha and 20 kg/ha. The interaction effect on sources and levels was found significant for vegetative growth characters. The maximum increase in plant height (64.10 cm), number of leaves per plant (8.87), days required for maturity (108.08 days) was recorded at gypsum at the level of 40 kg/ha. The minimum values for growth parameters was observed at 0 kg/ha with elemental sulphur. The interaction effect of sources and levels of sulphur was found non-significant for crop duration. The treatment of gypsum at the level of 40 kg/ha produced maximum increase in growth attributes *viz*. plant height, number of leaves per plant, days required for maturity. In general, due to graded levels of sulphur there was successive improvement in growth of garlic. This shows that sulphur deficiency prevents utilization of nitrogen and brings about accumulation of soluble nitrogen in the plant and due to increasing levels of sulphur this might be helpful for meeting higher nutritional demand for plant growth. Due to application of sulphur there might be higher production of metabolites and meristematic activity that gives better plant growth. Nasreen *et al.* (2007) [13] reported that the addition of nitrogen and sulphur fertilizers exerted significant influence on the plant height in onion. The mean number of leaves per plant increased due to recommended dose of fertilizer (NPK) application at the time of planting and after that due to maturity the growth was stopped. The number of leaves per plant was significant to various treatments. Jana and Kabir (1990) [9] suggested that the increase in number of leaves per plant with the application of sulphur might be due to its role in the synthesis of chloroplast.

The yield parameters of garlic were significantly influenced by different sources and levels of sulphur. Maximum increase in neck thickness (0.28 cm), diameter of bulb (4.33 cm), number of cloves per bulb (14.29), length of cloves ((3.20 cm), weight of bulb (10.14 g), yield per plot (1.34 kg), yield per ha (35.35 q/ha), was recorded at gypsum and the minimum values for yield parameters was recorded at ben sulphur. The maximum increase in number of cloves (14.92), diameter of cloves (2.89 mm), weight of cloves (1.53 g), and yield per plot (1.37 kg) was found significant at the level of 40 kg/ha. The interaction effect of sources and levels of sulphur was found significant. The maximum increase in neck thickness (0.34 cm), diameter of bulb (5.01 cm), diameter of cloves (3.02 mm), length of cloves (3.24 cm) was recorded in gypsum at the level of 40 kg/ha. The minimum values of yield parameters was recorded in ben sulphur at the level of 40 kg/ha. The treatment of gypsum at the level of 40 kg/ha produced maximum increase in yield parameters.

Neck thickness of the plant increased due to nutrient uptake capacity of roots and availability of phosphorus. Nitrogen play important role in cell division and resulted in continued growth of leaves that keeps the neck wide (Lemma and Shimeles, 2003) [11]. Sulphur application has created significant impact on bulb diameter of garlic. The sulphur application at level of 40 to 60 kg/ha favoured plant growth and development for producing large sized bulb. The application of N, P, K and S this might have synergistic role in providing balanced supply of nutrients to the crop for increasing in bulb diameter (Amin *et al.* 2007 and Diribi-shiferaw *et al.* 2015) [5, 8]. The increase in diameter of cloves was mainly influenced by sulphur application due to enhanced rate of photosynthates and carbohydrates metabolism. Sulphur application has created significant impact on length of cloves. This might be due to synergistic effect of sulphur on yield characters of garlic. The mean weight of cloves should be increased due to levels of sulphur. Availability of sulphur shows effect on development of lateral roots and fibrous rootlets which are responsible for nutrient uptake form soil. Greater nutrient uptake by garlic plant increases weight of cloves that gives increased in total bulb yield. Similar result has been found by Diriba-shiferase *et al.* (2015) [8] and Babaleshwar *et al.* (2017) [6] in garlic.

Sulphur application shows significant effect on weight of bulb. Sulphur is essential element for growth to build up protoplasm and proteins, which also induce cell division and meristematic activity this shows more plant cells in number and size which completely increases in bulb fresh weight (Devlin, 1979). Adequate supply of nutrients favoured in enlarging the bulb. This shows synergistic effect of sulphur with other nutrient for increasing weight of bulb. These results were reported by Ahmad H. Al-Fraihat (2009) [3] in onion and Diriba-shiferase *et al.* (2015) [8], Babaleshwar *et al.* (2017) [6] in garlic. Availability of sulphur shows effect on development of lateral roots and fibrous rootlets which are responsible for nutrient uptake form soil. Greater nutrient

uptake by garlic plant increases weight of cloves that gives increased in total bulb yield. Similar result has been found by Diriba-shiferase *et al.* (2015) [8] and Babaleshwar *et al.* (2017) [6] in garlic. Sulphur application shows significant effect on total yield (kg/plot). Application of sulphur along with nutrients like nitrogen and phosphorus significantly increases yield. Sulphur contains certain amino acids which might help for increasing net assimilation of nitrogen along with other nutrients this resulted in increased projected yield. Sulphur is useful for various enzymatic actions, chlorophyll formation which might be helpful for good vegetative growth for higher yield (Tisdale and Nelson, 1985). These results are reported by Farooqui *et al.* (2009), Diriba-shiferaw *et al.* (2015) [8], Babaleshwar *et al.* (2017) [6], Choudhary and Choudhary (2018) [7] in garlic. The sources of sulphur has significant effect on yield characters of garlic. Application of different sources of sulphur resulted in increased bulb yield this might be due to enhanced synthesis and translocation of photosynthates to the bulbs and storage organs of garlic. Due to higher photosynthesis accumulation in the bulbs gives higher individual bulb weight and large bulb diameter which responsible for increasing bulb yield of garlic. These results were reported by Pradhan *et al.* (2015) and Meher *et al.* (2016) [12] in onion.

Table 4: Growth characters of garlic as influenced by different sources and levels of sulphur at different growth stages of garlic

Treatment	Plant height				No of leaves per plant				Days required for maturity	Crop duration (days)
	30	60	90	At harvest	30	60	90	At harvest		
Sources (A)										
Elemental sulphur	28.35	40.22	61.32	62.43	4.01	5.81	8.34	8.54	111.97	130.62
Ben sulphur	28.63	40.25	61.32	63.03	4.13	5.84	8.38	8.69	114.25	122.85
Gypsum	28.99	40.44	62.29	63.44	4.18	5.98	8.42	8.79	108.08	131.50
SE (m) ±	0.225	0.144	0.297	0.276	0.054	0.070	0.026	0.016	1.933	2.333
CD at 5%	0.659	NS	0.871	NS	0.158	0.204	0.075	0.048	5.668	6.842
Levels (D)										
D_1 (control)	28.02	39.99	60.83	62.29	4.02	5.71	8.25	8.42	111.12	125.02
D_2 (20 kg S ha^{-1})	28.68	40.26	61.89	63.01	4.10	5.87	8.37	8.74	115.44	125.56
D_3 (40 kg S ha^{-1})	29.28	40.73	62.84	63.47	4.20	6.04	8.40	8.77	109.37	127.89
D_4 (60 kg S ha^{-1})	28.64	40.21	61.02	61.76	4.09	5.88	8.27	8.76	109.81	125.50
SE (m) ±	0.195	0.125	0.257	0.239	0.047	0.060	0.022	0.014	1.674	2.021
CD at 5%	NS	0.366	NS	0.700	0.137	NS	NS	NS	NS	5.926
Interaction (AxD)										
SE (m) ±	0.389	0.250	0.515	0.477	0.094	0.121	0.044	0.028	3.348	4.041
CD at 5%	1.14	0.733	1.509	1.399	NS	0.354	0.130	0.083	9.817	NS
General mean	28.61	40.3	61.64	62.63	5.69	5.87	8.33	8.68	110.74	124.99

Table 5: Yield characters of garlic influenced by different sources and levels of Sulphur

Treatment	Neck thickness (cm)	Diameter of bulb (cm)	Number of cloves /bulbs	Diameter of cloves (mm)
Sources (A)				
Elemental Sulphur	0.28	4.32	14.01	2.65
Ben Sulphur	0.22	4.12	14.16	2.75
Gypsum	0.26	4.33	14.29	2.77
SE (m) ±	0.016	0.116	0.119	0.064
CD at 5%	0.046	0.340	NS	NS
Levels (D)				
D_1 (control)	0.25	3.86	13.72	2.46
D_2 (20 kg S ha^{-1})	0.25	4.34	13.70	2.75
D_3 (40 kg S ha^{-1})	0.27	4.46	14.92	2.89
D_4 (60 kg S ha^{-1})	0.23	4.36	14.26	2.78
SE (m) ±	0.013	0.100	0.103	0.055
CD at 5%	NS	NS	S	0.162
Interaction (AxD)				
SE (m) ±	0.027	0.201	0.206	0.111
CD at 5%	0.079	0.589	NS	0.325
General mean	0.25	4.42	14.15	2.75

Table 6: Treatment Length of cloves (cm) Weight of cloves (g) Weight of bulb (g) Yield / plot (kg) Yield per ha (q)

Treatment	Length of cloves (cm)	Weight of cloves (g)	Weight of bulb (g)	Yield / plot (kg)	Yield per ha (q)
Sources (A)					
Elemental Sulphur	3.09	1.12	9.94	1.32	35.19
Ben Sulphur	3.11	1.22	9.89	1.25	35.33
Gypsum	3.20	1.32	10.14	1.34	35.35
SE (m) ±	0.068	0.095	0.100	0.035	0.130
CD at 5%	0.199	S	NS	0.103	0.381
Levels (D)					
D_1 (control)	3.04	0.96	9.74	1.24	34.81
D_2 (20 kg S ha^{-1})	3.13	1.28	10.16	1.32	35.18
D_3 (40 kg S ha^{-1})	3.20	1.53	10.24	1.37	35.76

D_4 (60 kg S ha^{-1})	3.16	1.15	9.82	1.28	35.40
SE (m) ±	0.059	0.082	0.086	0.031	0.112
CD at 5%	NS	NS	S	0.090	NS
Interaction (AxD)					
SE (m) ±	0.117	0.164	0.173	0.061	0.225
CD at 5%	0.344	NS	NS	NS	NS
General mean	3.12	1.23	9.99	1.3	35.28

Conclusion

It is concluded that the among sources of sulphur, the gypsum was found superior over to both sources of sulphur as compared to various characters. Regarding the levels of sulphur, the application of 40 kg per ha was observed beneficial for growth and yield characters of garlic. The source of gypsum at the level of 40 kg /ha was found better for increasing growth and yield of garlic under Marathwada conditions. Hence the application of gypsum at the level of 40 kg/ha is suitable for obtaining higher growth and yield of garlic.

References

1. Anonymous. Indian Horticultural Database, National Board, Govt. of India 2018a.
2. Anonymous. Krishi dianandini V.N.M.K.V, Parbhani 2018b.
3. Ahmad H, Al-Fraihat. Effect of different Nitrogen and sulphur fertilizer levels on growth, yield and quality of onion (*Aillum cepa*, L.). Jourdan J agric. Sci 2009;5(2):2/2009.
4. Ahmed MEM, Derbala A, El-Kader NA. Effect of irrigation frequency and potassium source on the productivity, quality and storability of garlic (*Allium sativum* L.). Misr. J Agri. Eng 2009;26(3):1245-1262.
5. Amin MR, Hasan MK, Naher Q, Hossain MA, Noor ZV. Response of onion to NPKS fertilizers in low Ganges river flood plain soil. Int. Jr. of sus. crop pro 2007;2(1):11-14.
6. Babaleshwar SB, Koppad SR, Math KK, Dharmatti R. Influence of sulphur on growth and yield of garlic (*Allium sativum* L.). J Pharmacogn. and Phyochem 2017;6(5):450-452.
7. Choudhary K, Choudhary MR. Response of sowing date and sulphur levels on growth and yield of garlic (*Allium sativum* L.). Int. J Agric. Sci 2018;(10):5791-5793.
8. Diriba–Shiferaw G, Nigussie–Dechassa R, Kebede–Woldetsadik, Getachew Tabor, Sharma JJ. Effect of nitrogen, phosphorus and sulphur fertilization on growth, yield and economic returns of garlic (*Allium sativum* L.). Sci. Technol. Arts Res. J 2015;4(2):10-22.
9. Jana BK, Kabir J. Effect of sulphur on growth and yield of onion cultivar (Nasik red). Crop Res 1990;3(2):241-243.
10. Kurian JC. Plant that Heal (1st edn.). OrientaI Watchman Publishing House, Pune, India 1995, 31.
11. Lemma D, Shimeles A. Research experience in onion production. Research report No. 55, EARO 2003, 8-29.
12. Meher R, Mandal J, Saha D, Mohanta S. Effects of sulphur application in onion (*Aillum cepa* L.) J crop and weed 2016;12(3):86-90.
13. Nasreen S, Imamual Haq SM, Hossain MA. Sulphur effects on growth and yield of onion. Asian J plant Sci 2007;2(12):897-902.
14. Nasreen S, Haque MM, Hossain MA, Farid ATM. Nutrient uptake and yield of onion influenced by nitrogen and sulphur fertilization. Bangladesh J Agric. Res 2007;32(3):413-420.
15. Pradhan R, Pattnaik AK, Tripathy P, Mallikarjunrao K, Sahoo BB, Lenka J. Influence of sulphur fertilization on nutrient uptake of onion (*Aillum cepa* L.). J crop and weed 2013;11:134-138.
16. Purseglove JW. *Tropical Crops*: Monocotyledons, ELBS Longman London 1975, 52-56.
17. Quareshi A, Lawande KE. Response of onion (*Allium cepa* L.) to Sulphur application for yield, quality and its storability in S-deficient soils. Ind. J Agric. Sci 2006;76(9):535537.
18. Roy SK, Chakraborti AK. Postaharvest management and processing of onion and garlic souvenir consultative meeting on accelerated production and Export of onion and garlic, April 19-20. New Delhi 2002, 44.
19. Singh DK, Gupta RP. Screening of garlic collection for dehydration N.H.R.D.F. Newsletter 1998;XVIII(3):1.
20. Thompson HC, Kelly WC. *Vegetable crops*. Mc Grew Hill Book Co., New York 1957, 368-370.