International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2020; 8(1): 1370-1373

Received: 19-11-2019
Accepted: 21-12-2019

Satyavir Singh Solanki
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Ankur Chaurasiya
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Amit Mudgal
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Anushka Mishra
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Ashish Kumar Singh
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Corresponding Author:
Satyavir Singh Solanki
Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Effect of soil application of sulphur, farm yard manure and vermicompost on soil fertility, growth and yield of garlic *(Allium sativum* L.)

Satyavir Singh Solanki, Ankur Chaurasiya, Amit Mudgal, Anushka Mishra and Ashish Kumar Singh

DOI: https://doi.org/10.22271/chemi.2020.v8.i1s.8445

Abstract
A field experiment was conducted at Karguwanji Agricultural Research Farm, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (UP) to find out the suitable doses of sulphur, FYM and vermicompost for garlic crop. The experiment was laid out in randomized block design with three replications having fifteen treatments *viz.*, T_1 - Control, T_2 – FYM @ 10t ha^{-1}, T_3 - FYM @ 20 t ha^{-1}, T_4 – Vermicompost @ 2.5 t ha^{-1}, T_5 - Vermicompost @ 5 t ha^{-1}, T_6 – Sulphur @ 20 kg ha^{-1}, T_7 - FYM @ 10 t ha^{-1} + Sulphur @ 20 kg ha^{-1}, T_8 - FYM @ 20 t ha^{-1} + Sulphur @ 20 kg ha^{-1}, T_9 - Vermicompost @ 2.5 t ha^{-1} + Sulphur @ 20 kg ha^{-1}, T_{10} - Vermicompost @ 5 t ha^{-1} + Sulphur @ 20 kg ha^{-1}, T_{11} - Sulphur @ 40 kg ha^{-1}, T_{12} - FYM @ 10 t ha^{-1} + Sulphur @ 40 kg ha^{-1}, T_{13} - FYM @ 20 t ha^{-1} + Sulphur @ 40 kg ha^{-1}, T_{14} - Vermicompost @ 2.5 t ha^{-1} + Sulphur @ 40 kg ha^{-1} and T_{15} - Vermicompost @ 5 t ha^{-1} + Sulphur @ 40 kg ha^{-1}. Result revealed that the growth and yield parameters *viz.*, plant height, number of leaves per plant, number of cloves per bulb, bulb diameter, clove weight, bulb weight and bulb yield increased significantly with increasing levels of sulphur, FYM and vemicompost. Application of vermicompost @ 5 t ha^{-1} + sulphur @ 40 kg ha^{-1} (T_{15}) was recorded maximum plant height (48.8 cm), number of leaves per plant (8.1), number of cloves per bulb (20.6), bulb diameter (17.8 cm), bulb weight (29.3 g) and bulb yield (69.2 q ha^{-1}) while maximum number of cloves per bulb (21.0) was observed with T_{12}. Application of sulphur along with different doses of FYM or vermicompost improved the soil health and increased availability of nutrients in the soil.

Keywords: Garlic, sulphur, farm yard manure, vermicompost, bulb yield, soil property

Introduction
Among the bulb crops, garlic (*AIlium sativum* L.) is an important cash crop of India belongs from the family alliaceae and second most widely cultivated bulbous crop after onion. India ranks second in area and production of garlic in the world. In India, Madhya Pradesh first rank in the area and production. Uttar Pradesh has third rank in area and production. The main constraints of low productivity of garlic are imbalance use of fertilizers and decline soil productivity. Balanced application of nutrition is a prerequisite for harnessing higher yield. The continuous application of chemical fertilizers alone without use of organic manures has deteriorated soil health in terms of chemical, physical and biological characters resulting in decline in crop yield. On the other hand, organic manures such as farmyard manure and vermicompost are known to have beneficial effect on soil health but their limited nutrient content and their availability in large amount is a constraint for their wider usage. This indicates that sole application of inorganic fertilizers is in no way a suitable solution for maintaining soil health and enhancing crop productivity. So the solution lies in the integrated use of chemical fertilizers and organic manures for obtaining sustainable crop production, better nutrient availability and efficient nutrient. Like other bulbous crops, garlic also requires adequate sulphur which is an essential nutrient for growth and development of plants and if soil is deficient in sulphur declined the full potential of garlic by decline productivity of the crop. Keeping above facts in view, present experiment was carried out to evaluate the effect of soil application of sulphur, FYM and vermicompost on soil properties, growth and yield of garlic.

Materials and Methods

The field experiment was conducted at Karguwanji Agricultural Research Farm, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (U.P.). The experimental soil was red loam with slightly alkaline in nature. The experimental field was low to organic matter content, available nitrogen, phosphorus and potassium as well as medium to availability of sulphur. The experiment was laid out in Randomized Block Design with three replications. There was fifteen treatments *viz.*, T_1 - Control, T_2 – FYM @ 10t ha^{-1}, T_3 - FYM @ 20 t ha^{-1}, T_4 – Vermicompost @ 2.5 t ha^{-1}, T_5 - Vermicompost @ 5 t ha^{-1}, T_6 – Sulphur @ 20 kg ha^{-1}, T_7 - FYM @ 10 t ha^{-1} + Sulphur @ 20 kg ha^{-1}, T_8 - FYM @ 20 t ha^{-1} + Sulphur @ 20 kg ha^{-1}, T_9 - Vermicompost @ 2.5 t ha^{-1} + Sulphur @ 20 kg ha^{-1}, T_{10} - Vermicompost @ 5 t ha^{-1} + Sulphur @ 20 kg ha^{-1}, T_{11} - Sulphur @ 40 kg ha^{-1}, T_{12} - FYM @ 10 t ha^{-1} + Sulphur @ 40 kg ha^{-1}, T_{13} - FYM @ 20 t ha^{-1} + Sulphur @ 40 kg ha^{-1}, T_{14} - Vermicompost @ 2.5 t ha^{-1} + Sulphur @ 40 kg ha^{-1} and T_{15} - Vermicompost @ 5 t ha^{-1} + Sulphur @ 40 kg ha^{-1} comprised to evaluate their effect on soil properties, growth and yield of garlic. The recommended doses of fertilizers (60:90:60 kg NPK ha^{-1}) were applied in the form of Urea, DAP and MOP. The sulphur was applied in the form of elemental sulphur. The half quantity of nitrogen, whole quantity of phosphorus, potassium and sulphur was applied as basal dose and rest half quantity of nitrogen is applied as top dressing. Garlic variety "Yamuna safed" was used for experiment and planted with spacing of 15×10 cm. The observations on plant height (cm), number of leaves per plant, number of cloves per bulb, bulb diameter (cm), clove weight (g), bulb weight (g) and bulb yield (q ha^{-1}). Pre and post experimental physic-chemical properties of soil was also determined.

Result and Discussion

Soil application of sulphur, Farm Yard Manure and vermicompost showed significant effect on growth and yield attributes of garlic (Table 2). The plant height varied significantly among the treatments and maximum plant height (48.8 cm) was recorded under T_{15} followed by T_{14} (45.4 cm), T_{13} (45.4 cm), T_{12} (45.3 cm) and T_{10} (44.7 cm) however, all the follower treatments were at par with each other. The maximum number of leaves per plant (8.12) was recorded under T_{15} which was found statistically at par with T_{13} (7.91) and T_{13} was found statistically at par with T_{14}, T_{12} and T_{10}. Organic sources of nutrients provide all essential nutrients to plants resulted in rapid cell division, multiplication and cell elongation in meristematic region of the plant which promoted vegetative growth of the plant (Patil *et al.*, 2007) [10]. The maximum number of cloves per bulb (21.03) was recorded with T_{12} followed by T_{15}, T_{13}, T_{14}, T_9 and T_{10} however these were statistically at par with each other. Significantly higher bulb diameter (17.81 cm) was recorded under T_{15} followed by T_{13}, T_8 and T_{14} while there was no significant difference was found between all the follower treatments. The maximum clove weight (1.69 g) which was found statistically at par with T_{15}, T_{13}, T_{10}, T_{12}, T_9, T_6, T_5 and T_4. The significantly higher bulb weight (29.25 g) and yield (69.23 q ha^{-1}) was recorded under T_{15} over all the treatments except T_{14} which was found statistically at par with T_{15} for bulb weight (28.82 g) and yield (68.21 q ha^{-1}). It was further observed that there was no significant difference found between T_{14} and T_{13} for bulb weight and between T_{14}, T_{13}, T_{12}, T_{11}, T_{10} and T_5 for bulb yield. These results are in line with the findings of Gowdual *et al.* (2007) [4], Suthar (2008) [16] and Patidar *et al.* (2017) [9]. Chatterjee (2010) [1] revealed that higher amount of organic manures (10 and 20 t ha^{-1} FYM and 2.5 and 5 t ha^{-1} vermicompost) and inorganic fertilizers significantly influenced growth and yield attributes as compared to sole application of recommended inorganic fertilizers and vermicompost emerged as better organic nutrient source over farm yard manure. Soil application of sulphur along with farm yard manure or vermicompost may improve the physical, chemical, and biological properties of soil increase the root and plant growth and development in yield characters which was result in high garlic yield Suthar, 2009 [16]; Rodriguez *et al.*, 2012 [11] and Verma *et al.*, 2013 [19].

Soil Properties

Addition of sulphur, FYM and vermicompost in different doses had a positive effect on soil pH, electrical conductivity, organic carbon, available nitrogen, phosphorus, potassium and sulphur (Table 3). The pH value was decreased with increase level of sulphur, FYM and vermicompost however, there was no significant difference observed between different treatments. The EC value was also decreased with increase level of sulphur, FYM and vermicompost. Significantly lower value of EC (0.31 dsm^{-1}) was recorded with T_{15} followed by T_{13} and T_{10} however these were at par with each other while higher value observed with control. The value of organic carbon (0.27%) was highest under treatment T_{13} followed by T_{15} and T_{12} whereas lowest (0.17%) under T_1 (control). Organic carbon in soil increased significantly with the increase level of FYM and Vermicompost. Choudhary *et al.* (2005) [2] reported that the incorporation of FYM and vermicompost with inorganic fertilizers significantly improved the organic carbon content of the soil in tomato. The available N in different treatments ranged from 98.70 kg ha^{-1} to 118.52 kg ha^{-1} which falls in lower range from the availability point of view. Maximum available N (118.52 kg ha^{-1}) was recorded with T_{15} which was statistically at par with T_{13} and T_{10}. The increased available N due to incorporation of organic material is attributed to the enhanced mineralization. Swain *et al.* (2013) [17] also noted maximum available nitrogen in the plots supplied with 100% chemical fertilizers along with inorganic fertilizers, mineralization process was faster and thereby has shown immediate release of N and its availability in the soil. The highest available P (18.21 kg ha^{-1}) was recorded under treatment T_{13} which was statistically at par with T_{15} and lowest under T_1. Addition of organic manure like FYM and vermicompost along with inorganic fertilizer had a beneficial effect in increasing the phosphate availability, which was also observed by Upadhyay *et al.* (2012) [18]. Data revealed that the effect of different treatments was significant and highest potassium (218.76 kg ha^{-1}) was recorded under T_{13} however it was statistically at par with T_{15} and lowest was noted in T_1. The beneficial effect of vermicompost and FYM on available K may be ascribed to the direct potassium addition to the Potassium pool of the soil besides the reduction in potassium fixation and its release due to interaction of organic matter with clay particles. The beneficial effects of integration of organic manures + chemical fertilizers in promoting inherent fertility status of soil was earlier reported by Parmar *et al.* (2006) [8] in cauliflower. Significantly higher sulphur (15.11 ppm) was recorded for T_{15} and it was statistically at with T_{13}, T_{14}, T_{12}, T_{10} and T_8 whereas lower was with T_1. The application of FYM and vermicompost along with inorganic sulphur generally resulted in buildup of available S status of the soil.

Singh *et al.* (2012) [14] in an incubation study observed an increase in the soil microorganism population apparently utilize organically bound S and convert it into cystine and methionine, which are further converted in to inorganic sulphate by microorganisms. The buildup of available S in soil with the addition of FYM and vermicompost after the harvest of the crop has also been reported by Nambiar and Ghosh (1984) [6].

Table 1: Physico-chemical properties of experimental soil

Parameter	Pre experiment	Method adopted
pH	8.50	1. Blackman's Glass Electrode pH meter (Muhur *et al.* 1965) [5]
EC ($dsm^{-1)}$	0.70	2. Solubridge method (Richard, 1954) [12]
Organic carbon (%)	0.19	Walkley and Black's Rapid Titration method (1934) [20]
Available N (kg/ha)	98.00	3. Alkaline potassium permanganate method (Subbiah and Asiza, 1956) [15]
Available P (kg/ha)	14.50	4. Olsen's method (Olsen *et al.*, 1954) [7]
Available K (kg/ha)	208.00	5. Flame Photometer (Muhur *et al.*, 1965) [5]
Available S (ppm)	11.31	0.15% CaCl2 extractant and turbidimetric determination (Chesnin and Yien, 1950) [3]

Table 2: Effect of soil application of sulphur, FYM and vermicompost on growth and yield of garlic

Treatments	Plant height (cm)	Number of leaves $plant^{-1}$	Number of cloves $bulb^{-1}$	Bulb Diameter (cm)	Clove weight (g)	Bulb weight (g)	Bulb yield (q ha^{-1})
T_1 - Control	39.41	6.32	14.00	14.30	1.45	25.31	65.13
T_2 – FYM @ 10t ha^{-1}	40.72	6.71	14.61	15.20	1.44	26.42	65.41
T_3 - FYM @ 20 t ha^{-1}	42.83	6.90	15.63	16.14	1.55	27.64	66.20
T_4 – Vermicompost @ 2.5 t ha^{-1}	42.02	7.13	15.64	15.41	1.57	26.73	66.31
T_5 - Vermicompost @ 5 t ha^{-1}	42.81	7.40	17.35	15.83	1.57	27.75	67.32
T_6 – Sulphur @ 20 kg ha^{-1}	40.30	6.81	16.30	14.72	1.58	27.71	66.21
T_7 - FYM @ 10 t ha^{-1} + Sulphur @ 20 kg ha^{-1}	43.21	6.90	16.61	16.30	1.42	27.62	66.33
T_8 - FYM @ 20 t ha^{-1} + Sulphur @ 20 kg ha^{-1}	43.62	7.21	17.62	16.61	1.48	27.82	66.62
T_9 - Vermicompost @ 2.5 t ha^{-1} + Sulphur @ 20 kg ha^{-1}	43.90	7.32	19.30	15.80	1.58	27.71	66.91
T_{10} - Vermicompost @ 5 t ha^{-1} + Sulphur @ 20 kg ha^{-1}	44.73	7.71	19.08	16.03	1.60	28.05	67.40
T_{11} - Sulphur @ 40 kg ha^{-1}	42.20	7.61	18.02	15.10	1.54	28.01	67.41
T_{12} - FYM @ 10 t ha^{-1} + Sulphur @ 40 kg ha^{-1}	45.32	7.79	21.03	16.42	1.59	27.92	67.50
T_{13} - FYM @ 20 t ha^{-1} + Sulphur @ 40 kg ha^{-1}	45.44	7.91	20.05	16.81	1.68	28.63	67.70
T_{14} - Vermicompost @ 2.5 t ha^{-1} + Sulphur @ 40 kg ha^{-1}	45.45	7.80	19.32	16.60	1.69	28.82	68.21
T_{15} - Vermicompost @ 5 t ha^{-1} + Sulphur @ 40 kg ha^{-1}	48.81	8.12	20.61	17.81	1.68	29.25	69.23
SEM±	0.35	0.09	0.83	0.22	0.05	0.16	0.38
$CD_{5\%}$	1.00	0.27	2.42	0.27	0.14	0.46	1.11

Table 3: Effect of soil application of sulphur, FYM and vermicompost on soil properties after harvest of garlic

Treatments	pH	EC ($dsm^{-1)}$	Organic carbon (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})	Available S (ppm)
T_1 - Control	8.49	0.54	0.17	98.70	11.70	207.11	9.81
T_2 – FYM @ 10t ha^{-1}	8.41	0.46	0.21	107.12	12.82	211.33	10.24
T_3 - FYM @ 20 t ha^{-1}	8.35	0.40	0.25	114.11	13.51	216.07	11.52
T_4 – Vermicompost @ 2.5 t ha^{-1}	8.38	0.44	0.19	108.61	12.22	212.11	10.54
T_5 - Vermicompost @ 5 t ha^{-1}	8.35	0.39	0.22	115.32	13.86	215.55	11.67
T_6 – Sulphur @ 20 kg ha^{-1}	8.43	0.50	0.18	100.20	14.11	208.31	11.94
T_7 - FYM @ 10 t ha^{-1} + Sulphur @ 20 kg ha^{-1}	8.31	0.43	0.22	108.61	14.87	212.53	13.27
T_8 - FYM @ 20 t ha^{-1} + Sulphur @ 20 kg ha^{-1}	8.27	0.32	0.26	115.82	16.11	217.42	13.98
T_9 - Vermicompost @ 2.5 t ha^{-1} + Sulphur @ 20 kg ha^{-1}	8.28	0.42	0.19	110.33	14.90	212.77	13.37
T_{10} - Vermicompost @ 5 t ha^{-1} + Sulphur @ 20 kg ha^{-1}	8.23	0.32	0.23	117.42	16.05	216.00	14.03
T_{11} - Sulphur @ 40 kg ha^{-1}	8.39	0.49	0.19	101.31	15.97	208.97	13.52
T_{12} - FYM @ 10 t ha^{-1} + Sulphur @ 40 kg ha^{-1}	8.30	0.42	0.24	109.33	16.15	214.87	14.22
T_{13} - FYM @ 20 t ha^{-1} + Sulphur @ 40 kg ha^{-1}	8.17	0.32	0.27	117.44	18.21	218.76	14.84
T_{14} - Vermicompost @ 2.5 t ha^{-1} + Sulphur @ 40 kg ha^{-1}	8.28	0.39	0.20	112.00	16.45	213.97	14.43
T_{15} - Vermicompost @ 5 t ha^{-1} + Sulphur @ 40 kg ha^{-1}	8.15	0.31	0.24	118.52	17.82	218.08	15.11
SEM±	0.10	0.01	0.01	0.78	0.46	0.96	0.40
$CD_{5\%}$	NS	0.03	0.02	2.27	1.35	2.81	1.18

Conclusion

On the basis of the present study, it may be concluded that application of vermicompost @ 5 t ha^{-1} + sulphur @ 40 kg ha^{-1} (T_{15}) registered maximum values of growth and yield attributes as well as improve the soil properties also. Hence application of vemicompost @ 5 t ha^{-1} + sulphur @ 40 kg ha^{-1} along with 100% RDF can be suggested as an effective nutrient management module for getting higher yield in garlic cultivation on sustainable basis.

References

1. Chatterjee R. Physiological attributes of cabbage (*Brassica oleracea*) as influenced by different sources of nutrients under eastern Himalayan region Research. Journal of Agricultural Sciences. 2010; 1(4):318-321.
2. Chaudhary RS, Das A, Patnaik US. Organic farming for vegetable production using vermicompost and FYM in Kokriguda watershed of Orissa. Indian Journal of Soil Conservation. 2005; 31(2):203-206.
3. Chesnin L, Yien CH. Turbidimetric determination of available sulphates. Soil Science Society of America Proceedings. 1950; 15:149-151.
4. Gowdual MC, Vijayakumar M, Gowda APM. Influence of integrated nutrient management on growth, yield and quality of garlic (*Allium sativum* L.) cv. G-282. Crop Research. 2007; 33(1-3):144-147.
5. Mahur RN, Datta NP, Subramoney Sankar H, Leley VK, Donaline LV. Soil testing in India. U.S. Agency for International Development Mission to India. 1965, 39-45.
6. Nambiar KKM, Ghosh AB. All India Co-ordinated Research Project on long term fertilizer experiments and its research achievements. Fertilizer News. 1984; 30(4):56-77.
7. Olsen SR, Cole CV, Watanable FS, Dean LA. Estimation of available phosphorous in soil by extraction with sodium bicarbonate. USDA Circular. 1954; 939:1-19.
8. Parmar DK, Verma TS, Deor BS, Mishra A, Vermani A. Enhancing yield and profitability of a Western Himalayan vegetable production system by balancing nutrient inputs through farmyard manure and synthetic fertilizer applications. Journal of Sustainable Agriculture. 2006; 29:89-99.
9. Patidar M, Shaktawat RPS, Naruka IS. Effect of Sulphur and Vermicompost on Growth, Yield and Quality of Garlic. Journal of Krishi Vigyan. 2017; 5(2):54-56.
10. Patil MB, Shitole DS, Shinde SB, Purandare ND. Response of garlic to organic and inorganic fertilizers. Journal of Horticulture Sciences. 2007; 2(2):130-133.
11. Rodriguez RA, Miglierina AM, Ayastuy ME, Lobartini JC, Dagna N, Greco N *et al*. The effect of different organic fertilization on garlic (*Allium sativum* L.) in Balia Blanca, Argentina. Acta Horticulture. 2012; 933:187-194.
12. Richard LAE. Diagnosis and Improvement of Saline and Alkaline Soil. USDA, Washington, Hand book, 1954, 50.
13. Shashidhar TR, Mannikeri IM, Chavan ML. Influnce of different organic manures on growth and yield of garlic (*Allium sativum* L.). Journal of Economics and Business. 2009; 25(3):235-239.
14. Singh PC, Saravanan R, Singh SR. Effect of NPK with different doses of organic manures on growth and yield of garlic (*Allium sativum* L.).var Yamuna Safed (G-50). Environment and Ecology. 2012; 30(2):329-331.
15. Subbiah BV, Asija GL. Rapid procedure for the estimation of the available nitrogen in soils. Current Science. 1956; 25:259-260.
16. Suthar S. Impact of vermicompost and composted farmyard manure on growth and yield of garlic (*Allium sativum* L.) field crop. International Journal of Plant Production. 2009; 3:27-38.
17. Swain DK, Murmu K, Ghosh BC. Comparative assessment of conventional and organic nutrient management on crop growth and yield and soil fertility in tomato-sweet corn production system. Australian Journal of Crop Science. 2013; 7(11):1617-1626.
18. Upadhyay AK, Bahadur A, Singh J. Effect of organic manures and biofertilizers on yield, dry matter partitioning and quality traits of cabbage (Brassica oleracea var. capitata). Indian Journal of Agricultural Sciences. 2012; 82(1):31-34.
19. Verma S, Choudhary MR, Yadav BL, Jakhar ML. Influence of venicompost and sulphur on growth and yield of garlic (*Allium sativum* L.) under semi arid climate. Journal of spices Aromatic Crop. 2013; 22(1):20-23.
20. Walkley A, Black TA. An estimation of soil organic matter and proposed modification of the chromic acid titration method. Soil Science. 1934; 37:29-38.