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Effect of sulphur on growth, yield and quality of garlic (*Allium sativum* L.)

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Abstract
A field experiment was conducted on garlic (*Allium sativum* L.) cv. Phule Nilima during *rabi* season. The effect of sulphur application in garlic on its growth, yield and quality was studied. The experiment was conducted in Randomized Block Design with four replications. Six treatment combinations formed by combining only source of fertilizer sulphur. On the basis of response for sulphur the maximum B: C ratio (2.8), growth, yield and quality of garlic is obtained by application of 45 Kg S/ha in soil before planting the crop.

Keywords: Garlic, sulphur, growth, yield, quality

Introduction
Garlic (*Allium sativum* L.*)* belongs to family Alliaceae is the second most important cultivated *Allium* after onion. It is used as a spice flavouring agent and in pharmaceutical preparations. India ranks second in world in the total area (2, 61,000 ha) and production (14, 00,000 tones) of garlic. It has higher nutritive than other bulb crops and accepted for its flavor enhancing capacity (Roy and Chakraborti, 2002) [6]. It has many medicinal uses also. Inadequate and unbalanced use of fertilizer resulted in low yield of garlic. The balance use of all the nutrients along with sulphur is necessary for good yields and quality in garlic. In the past, need of sulphur of soil and crops was satisfied by use of seemingly incidental means, but in recent years the trend to use high analysis fertilizers and pesticides which are sulphur free, has resulted in sulphur deficient soils. Karley and Ghonsikar (1985) [2], indicated that the Maharashtra soils are deficient of sulphur. Keeping in view the situation of sulphur nutrition of garlic in Maharashtra, a field experiment was conducted to find out the effect of sulphur on growth, yield and quality of garlic.

Materials and Methods
The experiment was carried out at All India Coordinated Research Project on Vegetable Crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri during *rabi* 2015-16 in Randomized Block Design with four replications and 6 treatment combinations.*viz* T_1-No Sulphur,T_2- 15 kg S $ha^{-1,}$ T_3- 30 kg S ha^{-1}. T_4- 45 kg S $ha^{-1,}$ T_5- 60 kg S ha^{-1},T_6- 75 kg S ha^{-1}. At the time of land preparation the recommended dose of 15t FYM ha^{-1} was applied and six level of sulphur along with 50:50:50 N: P_2O5: K_2O kg ha^{-1} was applied at the time of planting. The remaining 50 kg ha^{-1} N dose was applied in two equal split during 30 and 45 days after planting as a top dressing. Healthy cloves of cv. Phule Nilima were planted at 15 x 10 cm spacing by keeping the plot size 3 x 2 m per treatment and per replication. The observations on growth, yield (q/ha), storage losses and sulphur uptake by crop were recorded. The data recorded for each observation was analyzed statistically.

Results and Discussion
Application of sulphur significantly improved the growth and yield of garlic over low levels. The data in Table 1 revealed that the recommended dose of manures and fertilizer without sulphur was produced significantly less number of leaves per plant (7.25), length of 4^{th} leaf (29.95 cm) and pseudostem length (6.63cm) at harvest, where as maximum number of leaves (8.35) was obtained in T_5 (60 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/ha) treatment but it was at par with all other recommended dose supplemented with sulphur treatment (T_2,T_3,T_4,&T_6). Similarly in case of leaf length treatment T_6 produced maximum 4^{th} leaf length

(34.35cm) and was at par with all recommended dose supplemented with Sulphur (T2, T3, T4 & T5). The treatment T_4 (45 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/ha) produced maximum pseudostem length (7.85 cm) at harvest and at par with T_3. However, the marketable yield (155.38 q/ha.) and total yield (168.87 q/ha) was produced maximum by T4 (45 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/h) and was at par with the entire recommended dose supplemented with sulphur (T2, T3, T5 & T_6) treatments. The plant height (60.80cm) and marketable bulbs (91.93%) was recorded maximum in T4 and minimum in T1. The increase in bulb yield of garlic with the application of higher levels of sulphur might be due to enhanced synthesis and translocation of photosynthates to the bulbs and the storage organs of the garlic which in turn might be caused by increased uptake of N, P, K and S by roots of crop as revealed by Tripathy *et al.* (2013) [8] in onion. Similar findings have also been reported by Losak and Kielian (2006) [3] in garlic, Fatima *et al.* (2012) [1] in onion.

The physiological loss in weight varies from 44.34 to 47.92%. Eventhough, the treatment difference was non-significant but, treatment T4 (45 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/h) recorded minimum loss in weight (44.34%) and maximum in control (47.92%) at six months of storage. This indicates that the sulphur has role in reducing storage losses in garlic bulbs. Beneficial effect of sulphur on storage quality of onion bulbs has been reported by Misra and Prasad (1966) [4], Quareshi and Lawande (2006) [5]. The available sulphur in soil before planting of the garlic crop was 8.4 mg $Kg^{-1,}$ and it was influenced by sulphur application which increased from 7.85 to 15.15 mg/Kg. The maximum available sulphur in soil after harvest (15.15 mg Kg^{-1}) was recorded in T_6 (75 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/ha) which was increased by increasing the sulphur levels (Fig.1). Similar results were found by Singh *et al.* (2008) [7]. Mean sulphur uptake in dry matter of garlic (25.95Kg ha^{-1}) was recorded maximum in treatment T_4 (45 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/ha). The graded levels of sulphur fertilizer were significantly superior with increase in every grade from 0 to 45 Kg S/ha in improving sulphur content of bulbs significantly. Uptake of sulphur was increased with every increase of the levels of sulphur. Similar finding was also reported by Quareshi and Lawande (2006) [5]. Response to elemental sulphur applied at 45 Kg S/ha was substantial because of maximum B: C ratio (2.80) was observed in T4 (45 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/ha).Further application was less beneficial resulting in diminishing return.

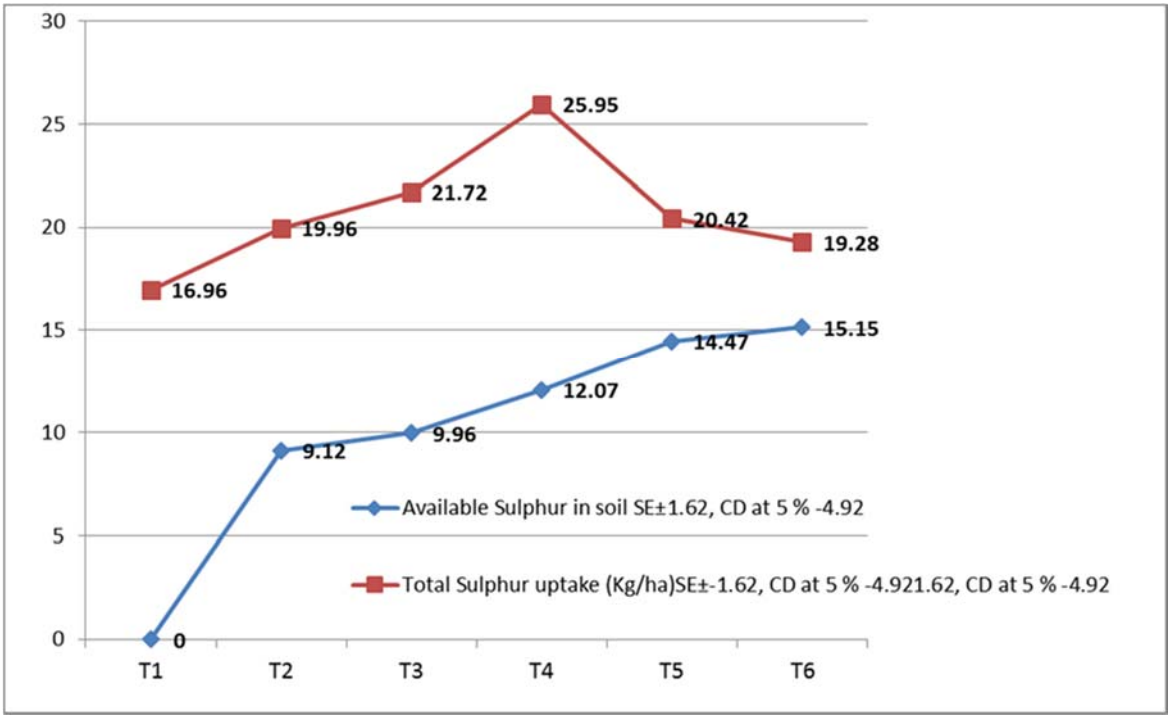

Fig 1: The available sulphur in soil and total uptake influenced by sulphur application

Table 1: Effect of sulphur application on growth, yield and quality of garlic

Sr. No.	Treatment details	Plant height (cm) at harvest	Number of leaves/ plant at harvest	Leaf length (cm) (4th leaf) at harvest	Leaf width (cm) (4th leaf) at harvest	Pseudo stem length (cm) at harvest	% Marketable bulbs	Marketable yield (q/ha)	Total yield (q ha-1)	Physiological loss in weight (%)	B:C Ratio
1	No sulphur + 15t FYM + 100:50:50 NPK Kg/ha	58.67	7.25	29.95	1.49	6.63	91.56	126.93	138.60	47.92	2.54
2	15 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/ha	60.30	7.85	32.90	1.54	7.43	90.14	136.67	151.29	46.24	2.66
3	30 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/ha	60.55	8.00	32.85	1.55	7.58	91.81	150.10	163.54	47.35	2.77
4	45 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/ha	60.80	8.23	31.45	1.51	7.85	91.93	155.38	168.87	44.34	2.8
5	60 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/ha	60.45	8.35	33.30	1.53	7.55	91.33	141.26	154.61	45.65	2.67
6	75 Kg S/ha + 15t FYM + 100:50:50 NPK Kg/ha	60.55	7.95	34.35	1.54	7.39	90.53	135.57	149.62	45.14	2.61
	SE±	1.58	0.24	1.42	0.03	0.09	1.18	7.46	7.07	1.74	-
	CD at 5%	N.S.	0.75	4.28	N.S.	0.29	N.S.	22.51	21.32	N.S.	-

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