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Effect of sulphur and micronutrients on growth attributes of garlic (*Allium sativum* L.)

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Abstract

The field experiment was conducted at the Horticulture Farm, S.K.N. College of Agriculture, Jobner, Jaipur (Rajasthan) during *Rabi* seasons 2019-20 and 2020-21. The result showed that soil application of sulphur 60 kg/ha and foliar application Zinc sulphate @ 0.6% was recorded maximum plant height, number of leaves and chlorophyll content of leaves in both the years as well as in pooled analysis. Although, sulphur application at 40 kg/ha along with foliar application of zinc sulphate at 0.6% was found at par to it.

Keywords: Garlic, plant height, number of leaves and pooled analysis

Introduction

Garlic is an important bulbous plant and used throughout India primarily as a spice or condiment. It is botanically known as *Allium sativum* L. is member of the genus *Allium*, which comprises approximately 750 species belonging to the family Alliaceae. It is one of the most important bulbous vegetable crops and is next to onion (Hamma *et al.*, 2013) [4]. It is originated from Central Asia and later spread to Mediterranean region (Simon, 2001 and Kigori *et al.*, 2005) [8, 5]. Garlic has higher nutritive value as compared to other bulbous crops. It is a rich source of sugar, protein, fat, potassium, calcium, sulphur, phosphorus, fiber and iodine. Per 100 g of edible portion of garlic contains 59% moisture, 6.4 g protein, 1469 kcal energy, 0.5 g fats, 33.1 g carbohydrates, 1.5 g fiber, 181 mg Ca, 153 mg P, 1.7 mg Fe, 17 mg Na, 401 mg K, 0.08 mg riboflavin, 0.25 mg thiamine, 0.06 mg nicotinamide and 10.8 mg ascorbic acid (Lorenz and Maynard, 1988) [6].

Nutrient are the product of the magnitude of impacts crop yield per unit area. Plant requires essential nutrients for normal functioning and growth. A plant's sufficiency range is the range of nutrient amount necessary to meet the plant's nutritional need and maximize growth. Boron, Zinc, Iron and Molybdenum as micronutrients and sulphur as a macronutrient are to be applied and in the experimental crop to study the impact on growth, yield and storage. Boron is one of the most important micronutrients, although it is required in very small quantity and regulates the carbohydrate metabolism and water relation in plant growth (Brady, 1990) [2]. Zinc is also an important micronutrient concerned in metabolic processes, enzymatic system, seed production and rate of maturity in plants. It is essential for synthesis of tryptophan, which is originator of indoleacetic acid. It also plays an important role in starch metabolism in plants (Alloway, 2008) [1]. Iron is indispensable for chlorophyll synthesis. It acts as an oxygen carrier and is a constituent of certain enzymes and proteins. Iron is an essential micronutrient for almost all living organisms because it plays critical role in metabolic processes such as DNA synthesis, respiration and photosynthesis. Molybdenum is also an important micronutrient for plants, which plays a vital role in enzymes activity as nitrogenase, catalase and peroxidase (Marschner, 1995 and Campbell, 1999) [7, 3].

Among the macronutrients, sulphur is one of a major plant nutrient essential for building up sulphur containing amino acids namely cystine, cysteine & methionine and is involved in synthesis of protein and sulphur containing vitamins like biotin, thiamine and some coenzymes. Pungency in garlic is attributed to presence of an alkaloid "Di allyl disulphide" in which sulphur is prime component.

Materials and Methods

The experiment will be carried out at Horticulture farm, S.K.N. College of Agriculture, Jobner, District Jaipur (Rajasthan) during *Rabi* season 2019-20 and 2020-21. The experiment was laid out in factorial randomized block design consisting 20 treatment combinations with four sulphur levels and five micronutrient levels. Each treatment replicated thrice. The treatments were allotted randomly to different plots using random number tables of Fishers and Yates (1963). Five competitive plants were selected at randomly tagged from each plot to record observation on various characters *viz.*, plant height, number of leaves etc.

Results

The effect of different treatments on growth of garlic were analyzed statistically to test their significance whenever necessary, the data recorded for important characters have also been presented graphically for elucidation of the important trends. The results obtained have been presented in succeeding pages and table 1 to 3 under following heads.

1 Plant height (cm)

Sulphur: The data presented in the Table 1, showed that different sulphur levels significantly increased the plant height (cm) at 60 and 90 DAS. The maximum plant height was obtained with the treatment S₃- sulphur @ 40 kg/ha (38.97, 36.98 and 37.98 cm at 60 DAS and 59.35, 57.46 and 58.41 cm at 90 DAS) in both the years as well as under pooled analysis, which was statistically at par with the treatment S₂ (Sulphur @ 60 kg/ha) in 2019-20, 2020-21 and pooled analysis.

Micronutrients: Data further indicated that application of different micronutrients also significantly enhanced the plant height during experimentation. Application of zinc sulphate @ 0.6% (M₁) significantly affected the plant height over rest of the treatments except borax @ 0.5% (M₃) which was statistically at par to it during experimentation.

2 Number of leaves

Sulphur: The data presented in table 2 revealed that application of different sulphur levels significantly influenced the number of leaves per plant of garlic. The maximum number of leaves (6.37, 5.83 and 6.10 at 60 DAS and 8.06, 7.14 and 7.60 at 90 DAS) were observed in treatment S₂ (Sulphur @ 40 kg/ha) which is significantly superior than rest of the treatments except treatment S₃ (sulphur @ 60 kg/ha) and minimum (5.52, 4.92 and 5.22 at 60 DAS and 7.03, 6.17 and 6.60 at 90 DAS) found under control during both years as well as in pooled mean.

Micronutrients: Similarly, the application of various micronutrients also significantly influenced the number of leaves per plant during both the years as well as pooled analysis. The maximum number of leaves per plant at 60 and 90 DAS was recorded with application of Zinc sulphate @ 0.6% (M₁), which was found significantly higher over control. Application of Zinc sulphate @ 0.6% registered 17.75, 18.20 and 17.87 per cent at 60 DAS and 16.31, 16.94 and 16.44 per cent at 90 DAS number of leaves per plant than control, respectively during both the years and in pooled analysis.

3 Chlorophyll content in leaves (mg/g)

Sulphur: It is evident from data (Table 3) that application of sulphur levels had significant effect on chlorophyll

content in leaves was observed. The maximum chlorophyll content (38.97, 36.98 and 37.98 mg/g) was recorded with application of treatment S₃ (Sulphur @ 60 kg/ha) which was found statistically at par with treatment S₂ (Sulphur @ 40 kg/ha) during both the years as well as in pooled mean, respectively. However, minimum chlorophyll content in leaves (32.86, 30.89 and 31.88 mg/g) noted under control which was 14.30 and 16.41 and 15.31 per cent lesser than treatment S₂ (Sulphur @ 40 kg/ha) during individual year and in pooled analysis, respectively.

Micronutrients: A further reference to data (Table 3) showed that application of micronutrients significantly increased chlorophyll content in leaves of garlic during both the years as well as pooled analysis. The maximum chlorophyll content (38.38, 36.54 and 37.46 mg/g) was registered under treatment M₁ (Zinc sulphate @ 0.6%) which was at par with the treatment M₃ (borax @ 0.5%) whereas minimum (33.00, 31.10 and 32.05 mg/g) in treatment M₀ (control).

Discussion

Effect of sulphur

1 Growth attributes

The result of present study clearly indicate that plant height, number of leaves per plant, and chlorophyll content of leaves increased significantly due to application of S₃-sulphur @ 60 kg/ha. Pooled mean basis, the maximum value of growth parameters *i.e.* plant height both at 60 and 90 DAS (37.98 and 58.41 cm), number of leaves per plant both at 60 and 90 DAS (6.25 and 7.78), and chlorophyll content at 60 DAS (1.24 mg/g in leaves), was recorded with treatment S₃ (Sulphur @ 60 kg/ha) and the minimum value of growth parameters *i.e.* plant height both at 60 and 90 DAS (31.88 and 49.05 cm), number of leaves per plant both at 60 and 90 DAS (5.22 and 6.60), and chlorophyll content at 60 DAS (31.88 mg/g in leaves) were recorded under control, respectively which were at par with S₂ (Sulphur @ 40 kg/ha). Similar results were recorded by Chattoo *et al.* (2018) ^[14], Choudhary *et al.* (2018) ^[26] in garlic, Hariyappa (2003) ^[18], Jaggi (2005) ^[19], Singh *et al.* (2019) ^[25] and Raghavendra *et al.* (2020) ^[22] in onion, respectively.

Effect of micronutrients

1 Growth attributes

The results of present investigation showed that foliar application of micronutrients significantly increased the plant height, number of leaves per plant, and chlorophyll content of leaves as compared to control (water spray). Pooled mean basis, the maximum value of growth parameters *i.e.* plant height both at 60 and 90 DAS (37.43 and 59.33 cm), number of leaves per plant both at 60 and 90 DAS (6.20 and 7.72), and chlorophyll content at 60 DAS (1.18 mg/g in leaves) was recorded under foliar application of zinc sulphate @ 0.6% (M₁) which was found statistically at par with foliar application of borax @ 0.5% (M₃) and the minimum value of growth parameters *i.e.* plant height both at 60 and 90 DAS (32.05 and 50.69 cm), number of leaves per plant both at 60 and 90 DAS (5.26 and 6.63), neck thickness (50.69 cm) and chlorophyll content at 60 DAS (32.05 mg/g in leaves) were recorded under control, respectively. The same trends were also recorded by various scientists El-Tohamy *et al.* (2009) ^[16] in onion, Rohidas *et al.* (2010) ^[23] in garlic, Abd-El-Samad *et al.* (2011) ^[9] in

onion, Abedin *et al.* (2012)^[10] in onion and Gurmani *et al.* (2012)^[17] in tomato. Acharya *et al.* (2013)^[12] in onion, Manna and Maity (2016)^[21] in onion, Aske *et al.* (2017)^[11]

in garlic, Sethupathi (2019)^[24], Biswas *et al.* (2020)^[13] in onion and Jaiswal *et al.* (2020)^[20] in garlic.

Table 1: Effect of sulphur and micronutrients on plant height of garlic

Treatments	Plant height (cm)					
	60 DAS			90 DAS		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
A. Sulphur						
S ₀ (Control)	32.86	30.89	31.88	50.08	48.01	49.05
S ₁ (Sulphur 20 kg/ha)	35.24	33.49	34.37	54.10	52.16	53.13
S ₂ (Sulphur 40 kg/ha)	37.56	35.96	36.76	57.95	56.17	57.06
S ₃ (Sulphur 60 kg/ha)	38.97	36.98	37.98	59.35	57.46	58.41
S.Em±	0.76	0.82	0.56	1.31	1.39	0.96
CD (P=0.05)	2.18	2.34	1.58	3.75	3.99	2.69
B. Micronutrients						
M ₀ (Control water spray)	33.00	31.10	32.05	51.78	49.60	50.69
M ₁ (Zinc sulphate @ 0.6%)	38.38	36.54	37.46	60.21	58.45	59.33
M ₂ (Ferrous sulphate @ 0.2%)	35.77	34.13	34.95	54.22	52.64	53.43
M ₃ (Borax @ 0.5%)	38.05	36.23	37.14	57.69	55.75	56.72
M ₄ (Ammonium molybdate @ 0.5%)	35.59	33.65	34.62	52.95	50.82	51.88
S.Em±	0.85	0.92	0.63	1.47	1.56	1.07
CD (P=0.05)	2.44	2.62	1.76	4.20	4.46	3.01

Table 2: Effect of sulphur and micronutrients on number of leaves of garlic

Treatments	Number of leaves					
	60 DAS			90 DAS		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
A. Sulphur						
S ₀ (Control)	5.52	4.92	5.22	7.03	6.17	6.60
S ₁ (Sulphur 20 kg/ha)	5.96	5.39	5.68	7.55	6.67	7.11
S ₂ (Sulphur 40 kg/ha)	6.37	5.83	6.10	8.06	7.14	7.60
S ₃ (Sulphur 60 kg/ha)	6.53	5.96	6.25	8.26	7.29	7.78
S.Em±	0.12	0.12	0.09	0.17	0.15	0.11
CD (P=0.05)	0.35	0.36	0.25	0.48	0.44	0.32
B. Micronutrients						
M ₀ (Control water spray)	5.52	5.00	5.26	7.05	6.20	6.63
M ₁ (Zinc sulphate @ 0.6%)	6.50	5.91	6.20	8.20	7.25	7.72
M ₂ (Ferrous sulphate @ 0.2%)	6.04	5.45	5.74	7.64	6.78	7.21
M ₃ (Borax @ 0.5%)	6.46	5.85	6.15	8.14	7.17	7.65
M ₄ (Ammonium molybdate @ 0.5%)	5.96	5.42	5.69	7.60	6.69	7.14
S.Em±	0.14	0.14	0.10	0.19	0.17	0.13
CD (P=0.05)	0.40	0.40	0.28	0.53	0.49	0.36

Table 3: Effect of sulphur and micronutrients on chlorophyll content of leaves

Treatments	Chlorophyll content (mg/g)		
	60 DAS		
	2019-20	2020-21	Pooled
A. Sulphur			
S ₀ (Control)	0.82	0.88	0.85
S ₁ (Sulphur 20 kg/ha)	1.11	1.15	1.13
S ₂ (Sulphur 40 kg/ha)	1.19	1.23	1.21
S ₃ (Sulphur 60 kg/ha)	1.21	1.27	1.24
S.Em±	0.022	0.023	0.016
CD (P=0.05)	0.063	0.066	0.045
B. Micronutrients			
M ₀ (Control water spray)	0.87	0.90	0.88
M ₁ (Zinc sulphate @ 0.6%)	1.18	1.25	1.22
M ₂ (Ferrous sulphate @ 0.2%)	1.15	1.20	1.18
M ₃ (Borax @ 0.5%)	1.12	1.19	1.16
M ₄ (Ammonium molybdate @ 0.5%)	1.09	1.12	1.11
S.Em±	0.024	0.026	0.018
CD (P=0.05)	0.070	0.074	0.050

Conclusion

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. Although, sulphur application at 40 kg/ha along with foliar application of zinc sulphate at 0.6% was found at par to it.

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