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Effect of phosphorus levels and bio-fertilizers on growth parameters of garlic (*Allium sativum* L.) cv. G -282

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Abstract
A field experiment was conducted during 2016 at Horticulture Research Farm-2, BBAU, Lucknow. Studies on the "Effect of phosphorus levels and bio-fertilizers on growth parameters of garlic (*Allium sativum* L.) cv. G -282", revealed that the plant height, number of leaves per plant, length of leaves, diameter of stem was maximized when dose was done with phosphorus levels 25,50,75 kg/ha and bio-fertilizers PSB, VAM and PSB+VAM inoculation.

Keywords: Garlic, phosphorus, bio-fertilizers, PSB, VAM and growth parameter

Introduction
Garlic (*Allium sativum* L.) having diploid chromosome number 2n=2x=16 belongs to the family Amaryllidaceae (Alliaceae); known as Lahsun in Hindi, is one of the important bulb crops grown in India. It has long been recognized as a valuable spice and condiments in India. It is a frost hardy bulbous, erect annual herb with narrow flat leaves and bears small white flowers and bulbils (Janick, 1979) [4]. Garlic is a scapigerous foetid perennial medicinal herb with underground compound bulbs covered by outer white thin scales with simple smooth round stem surrounded by the bottom by tubular leaf sheath. The leaves are simple, long, flat and linear. The flowers are small and white, arranged in round umbels mixed with small bulbils. The entire umbels are enclosed in a tear-drop shaped membranous spathe. Flowers are usually sterile. The seed stalk bears terminal inflorescence, which in terms bear bulbils instead of flowers. The shoot of garlic become flat and finally aborts after the development of bulbils in the inflorescence. (Kothari and Shah, 1974) [5]. A compound bulb consists of smaller bulbils or a segment called "cloves" which are formed from auxiliary bulbs of the young foliage leaves and is surrounded by a thin white or pinkish papery sheath. Garlic is the second most important bulb crop after onion. It is an important spice crop belonging to family Alliaceae and botanically known as (*Allium sativum* L.). Garlic belongs to be central Asia and Southern Europe, especially Mediterranean region (Thompson and Kelly, 1957) [12]. The economic yield is obtained from its underground bulb, which is consisted of bulblets, popularly called as cloves. Garlic is used in flavouring foods, preparing chutneys, pickles, curry powder, tomato ketchup etc. It contains protein (6.3%), phosphorus (0.31%), potash (0.40%), calcium (0.03%), magnesium (0.025%), carbohydrates (29%) and a colourless as well as odourless water-soluble amino acid called allicin. On crushing the blub clove, an enzyme allinase acts upon allicin and breaks down to produce allicin. Garlic contains volatile oil known as diallel - disulphide which is the major flavouring component in garlic. Garlic possesses insecticidal action whereby 0.1 per cent garlic extract gives protection against mosquitoes for 8 hours. Extract of garlic along with chilli and ginger has beneficial action against soil nematodes. Beneficial use of garlic extract has been found against many fungi and bacteria (Pandey, 1997) [8]. Allicin present in aqueous extract of garlic reduce blood cholesterol concentration in human blood (Shankaracharya, 1974) [9, 11]. Garlic oil or its juice is recommended to inhale in cases of pulmonary tuberculosis, rheumatism, sterility, impotency, cough and redness of eyes (Pruthi, 1979) [7].

Material and Methods
The experimental material for the present study consisted of one genotype of garlic obtained from NHRDF, Karnal (Haryana). One genotype and different treatments with phosphorus levels and bio-fertilizers on growth parameters of garlic. The experiment was conducted using Randomized Block Design (RBD) with three replications at Horticultural Research Farm-2 of the Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow

Lucknow during the year 2016-17. Observation were recorded for plant height, number of leaves per plant, length of leaves, diameter of stem. The data so obtained were analysed statically.

Result and discussion

The results revealed that application of 75 kg/ha phosphorus had significant effect on growth attributes of garlic. All the growth parameters *viz.* plant height, number of leaves per plant, length of leaves and diameter of stem total increased linearly with the corresponding increase in levels of phosphorus up to 75 kg phosphorus per ha. However, 50 kg phosphorus per ha was found statistically at par to it. Increase in availability of phosphorus owing to its application in the soil which improved the nutrient availability status resulting increased photosynthetic and carbohydrate synthesis in garlic. Cloves inoculation with PSB + VAM significantly increased the plant height (cm), number of leaves per plant, length of leaves (cm) and diameter of stem (mm) over rest of treatments whereas, total chlorophyll content in leaves was recorded significantly higher with PSB + VAM and VAM alone over no inoculation and PSB alone. VAM inoculation plays significant and unique role in phosphate mobilization and uptake of phosphorus, zinc, sulphur and water by plant. VAM inoculation helps in uniform crop growth, increased yield of crop and also enhance resistance to root disease and improve hardiness of transplant stock. So due to its obligatory symbiotic nature and above discussed characteristics, increases its use in various crops (Yawalkar *et al.*, 1996) [13]. The combined inoculation of PSB + VAM proved significantly superior to control, PSB and VAM in terms of growth parameters *viz.*, plant height, number of leaves and diameter of stem bulb were increased in all the treatments except control. PSB + VAM provide avenues for improving P use efficiency.

Table 1: Effect of phosphorus levels and bio-fertilizers on growth parameters of garlic (*Allium sativum* L.)

Treatment		Plant Height (cm)			
		30 DAP	60 DAP	90 DAP	120 DAP
Phosphorus Levels					
Control	P_0	25.58	35.58	64.35	65.38
25 kg/ha	P_1	26.64	37.56	69.65	70.25
50 kg/ha	P_2	27.56	37.86	72.78	73.76
75 kg/ha	P_3	28.23	39.16	74.23	78.58
SEm±		0.436	0.302	0.883	1.252
CD(P=0.05)		1.267	0.876	2.562	3.633
Bio-fertilizers					
Control	B_0	24.33	35.66	67.11	67.41
PSB inoculation	B_1	26.83	37.11	69.55	70.68
VAM inoculation	B_2	27.70	37.94	71.02	73.06
PSB+VAM inoculation	B_3	29.17	39.39	73.33	76.81
SEm±		0.436	0.302	0.883	1.252
CD(P=0.05)		1.267	0.876	2.562	3.663

Table 2: Effect of phosphorus levels and bio-fertilizers on growth parameters of garlic (*Allium sativum* L.)

Treatment		Number of leaves			
		30 DAP	60 DAP	90 DAP	120 DAP
Phosphorus Levels					
Control	P_0	5.18	5.61	6.62	7.17
25 kg/ha	P_1	5.41	5.79	6.95	7.65
50 kg/ha	P_2	5.43	5.84	6.90	7.98
75 kg/ha	P_3	5.38	6.05	7.08	8.03
SEm±		0.055	0.099	0.082	0.209
CD(P=0.05)		0.160	0.288	0.239	0.606
Bio-fertilizers					
Control	B_0	5.11	5.57	6.65	7.01
PSB inoculation	B_1	5.51	5.95	6.95	7.73
VAM inoculation	B_2	5.35	5.81	6.78	7.72
PSB+VAM inoculation	B_3	5.43	5.95	7.17	8.83
SEm±		0.055	0.099	0.082	0.209
CD(P=0.05)		0.160	0.288	0.239	0.606

Table 3: Effect of phosphorus levels and bio-fertilizers on growth parameters of garlic (*Allium sativum* L.)

Treatment		Length of leaves (cm)			
		30 DAP	60 DAP	90 DAP	120 DAP
Phosphorus Levels					
Control	P_0	24.15	35.05	43.44	46.47
25 kg/ha	P_1	24.63	36.43	46.60	48.55
50 kg/ha	P_2	25.89	36.38	47.93	51.14
75 kg/ha	P_3	26.14	37.05	49.55	53.92
SEm±		0.356	0.473	0.565	0.896
CD(P=0.05)		1.034	1.373	1.639	2.601
Bio-fertilizers					
Control	B_0	23.20	35.34	45.64	47.61
PSB inoculation	B_1	25.67	36.07	46.50	49.46
VAM inoculation	B_2	25.80	36.17	47.05	50.32
PSB+VAM inoculation	B_3	26.14	37.34	48.34	52.69
SEm±		0.356	0.473	0.565	0.896
CD(P=0.05)		1.034	1.373	1.639	2.601

Table 4: Effect of phosphorus levels and bio-fertilizers on growth parameters of garlic (*Allium sativum* L.)

Treatment		Diameter of stem (mm)			
		30 DAP	60 DAP	90 DAP	120 DAP
Phosphorus Levels					
Control	P_0	4.89	6.58	11.12	11.86
25 kg/ha	P_1	5.223	7.15	12.38	13.25
50 kg/ha	P_2	5.33	7.47	12.84	13.62
75 kg/ha	P_3	5.47	7.71	13.56	14.42
SEm±		0.086	0.072	0.233	0.330
CD(P=0.05)		0.248	0.208	0.677	0.958
Bio-fertilizers					
Control	B_0	5.02	6.84	11.42	12.19
PSB inoculation	B_1	5.27	7.15	12.42	13.29
VAM inoculation	B_2	5.21	7.34	12.64	13.36
PSB+VAM inoculation	B_3	5.40	7.58	13.40	14.32
SEm±		0.086	0.072	0.233	0.330
CD(P=0.05)		0.248	0.208	0.677	0.958

Conclusion

On the basis of the results obtained in the present investigation, it may be concluded that application of different phosphorus levels and bio-fertilizers enhanced the growth of garlic except days take bulb initiation in comparison to control.

The application of 75 kg Phosphorus ha^{-1} significantly increased the plant height, number of leaves per plant, length of leaves, diameter of stem at 30, 60, 90 and 120 DAP, over control and 25 and 50 kg Phosphorus ha^{-1}. Among different bio-fertilizers the inoculation of PSB + VAM leads to maximum plant height, number of leaves per plant, length of leaves, diameter of stem at 30, 60, 90 and 120 DAP while minimum under control.

Application of 75 kg P_2O_5 and inoculation with PSB + VAM may be considered as best treatment in terms of garlic bulb production (145.84 q/ha and 149.06 q/ha). It is recommended for higher production of garlic under Lucknow conditions.

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