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

Dharmraj Meena, RB Ram, RS Verma and Bhag Chand Shivran

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 yield and quality parameters of garlic (*Allium sativum* L.) cv. G -282", revealed that the Neck thickness of bulb, Bulb diameter, Number of cloves per bulb, length of clove, Average weight, Number of bulb, Bulb yield, Total soluble solids 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 yield and quality 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) [5]. 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) [6]. 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) [19]. 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) [9]. Allicin present in aqueous extract of garlic reduce blood cholesterol concentration in human blood (Shankaracharya, 1974) [14]. Garlic oil or its juice is recommended to inhale in cases of pulmonary tuberculosis, rheumatism, sterility, impotency, cough and redness of eyes (Pruthi, 1979) [8].

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 during the year 2016-17. Observation were recorded for Neck thickness of bulb, Bulb diameter, Number of cloves per bulb, Length of clove, Average weight, Number of bulbs, Bulb yield, Total soluble solids.

Result and discussion

The results revealed that application of 75 kg/ha phosphorus had significant effect on yield and quality attributes of garlic. All the yield and quality parameters *viz.* Neck thickness of bulb, Bulb diameter, Number of cloves per bulb, Length of clove, Average weight, Number of bulbs, Bulb yield, Total soluble solids 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. These findings corroborate the results of Ram *et al*. (2007) [11]. In chickpea, Tarafdar and Rao (2001) [18]. in cluster bean. Application of 75 kg phosphorus per ha recorded the maximum TSS content in bulb recorded significantly higher up to 50 kg phosphorus per ha over rest of treatments. Singh and Paliwal (2003) [15] in cowpea, Rathore *et al.* (2007) [13]. In cluster bean, Rathore *et al.* (2010) [12]. In urd bean and Puniya (2011) [10] in moth bean.

Cloves inoculation with PSB + VAM significantly increased the Neck thickness of bulb, Bulb diameter, Number of cloves per bulb, Length of clove, Average weight, Number of bulbs, Bulb yield, Total soluble solids 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 yield and quality, 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) [20]. The combined inoculation of PSB + VAM proved significantly superior to control, PSB and VAM in terms of yield and quality parameters *viz.*, Neck thickness of bulb, Bulb diameter, Number of cloves per bulb, Length of clove, Average weight, Number of bulbs, Bulb yield, Total soluble solids were increased in all the treatments except control. PSB + VAM provide avenues for improving P use efficiency. PSB + VAM significantly increased TSS. Content in bulb as compared to others whereas, the N and P content in bulb were increased in all the treatments except control. These results corroborate the findings of Bahadur *et al*. (2006) [4]. in pea and Kahlon and Sharanappa in (2006) in cowpea. Yogita and Ram (2012) [21] in onion reported similar kind of results.

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

Treatment		Neck thickness of bulb (mm)	Bulb diameter (mm)	No. of cloves per bulb	Length of clove	Average weight (gm.)	No. of bulb/ kg	Bulb yield (q ha^{-1})	Total soluble Solids (%)
Phosphorus Levels									
Control	P_0	6.50	41.81	15.67	3.59	30.58	32.48	124.03	33.47
25 kg/ha	P_1	7.46	43.65	16.38	3.97	32.69	30.55	135.77	36.49
50 kg/ha	P_2	7.65	44.44	16.69	4.11	34.82	29.68	138.32	37.65
75 kg/ha	P_3	8.12	47.17	17.71	4.53	36.52	28.58	145.84	38.76
SEm±		0.180	0.883	0.458	0.112	0.558	0.853	2.804	1.149
CD(P=0.05)		0.521	2.561	1.330	0.324	1.705	2.475	8.139	3.335
Bio-fertilizers									
Control	B_0	6.12	39.78	14.55	3.36	28.74	35.86	122.57	32.28
PSB inoculation	B_1	7.24	43.72	16.75	3.79	33.36	30.18	131.74	36.22
VAM inoculation	B_2	7.70	45.45	17.35	4.22	35.20	28.54	140.59	37.36
PSB+VAM inoculation	B_3	8.65	48.11	17.82	4.82	28.74	26.71	149.06	40.50
SEm±		0.180	0.883	0.458	0.112	0.558	0.853	2.804	1.149
CD(P=0.05)		0.521	2.561	1.330	0.324	1.705	2.475	8.139	3.335

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 Neck thickness of bulb, Bulb diameter, Number of cloves per bulb, Length of clove, Average weight, Number of bulbs, Bulb yield, Total soluble solids over control and 50 and 25 kg Phosphorus ha^{-1}. Among different bio-fertilizers the inoculation of PSB + VAM leads to maximum Neck thickness of bulb, Bulb diameter, Number of cloves per bulb, Length of clove, Average weight, Number of bulbs, Bulb yield, Total soluble solids 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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