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Research Paper

Impact of Nutrient and Bio-fertilizers on Soil Nutrient Status and Quality Attributes of Garlic (*Allium sativum* L.)

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ABSTRACT

An experiment was conducted during the year 2015-2016, at the Instructional Farm, Department of Horticulture, SKN, College of Agriculture, Jobner for the study the impact of nutrient and bio-fertilizers on Soil Nutrient Status and Quality attributes of garlic. The experiment was laid out in factorial randomized block design with 16 treatment combinations, four phosphorous levels viz. control, 25 kg P ha^{-1}, 50 kg P ha^{-1} and 75 kg P ha^{-1} as first factor and four seed inoculation with bio-fertilizer as second factor viz. control, PSB, VAM and PSB + VAM. The results of phosphorous levels revealed significantly higher soil nutrient status and quality were recorded due to application of 75 kg P ha^{-1}. However, application of 75 kg P ha^{-1} was statistically at par with 50 kg ha^{-1} for all quality characters, Sulphur content (%), N content in bulb (%), P content in bulb (%), K content in bulb (%), Total soluble solids (%) and P content in soil Among the bio-fertilizers, inoculation with PSB + VAM recorded higher values of soil nutrients and quality characters of garlic.

HIGHLIGHTS

- Garlic (*Allium sativum* L.) is a plant with a major economic importance and usually recognized all over the world as a valuable spice for foods.
- Study recommends that to obtain higher Soil Nutrient Status and Quality attributes of garlic crop under different agro-climatic conditions of Rajasthan, then it should be grown with application of 75 kg p ha^{-1} along with inoculation of PSB + VAM.

Keywords: Bio-fertilizers, TSS %, inoculation, phosphorous and VAM

Garlic (*Allium sativum* L), a member of the Alliaceae family, is one of the most aromatic herbaceous annual spices (Kurian, 1995). It is the second most important spice crop of the cultivated *Allium* crops, next to onion in the world (Purseglove, 1975) with a characteristic pungent smell. Garlic is originated in central Asia where it was extended to the Mediterranean region in the pre-historic dates (Thompson and Kelly, 1957). China, South Korea, Egypt, India, Spain, USA, Thailand and Turkey are the major garlic producing countries of the world.

Garlic is popular in all over the world as a valuable spice for cooking of different dishes. Besides, it is also used for preparing pickles, chutneys, curry powder, vegetables, tomato ketchup etc. According to the Unani and Ayurvedic medicines it is used in the treatments of disease like chronic infection of the stomach and

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intestine, dysentery, typhoid, cholera and lung problems (Chopra *et al.* 1958). Moreover, the aqueous extract of garlic cloves (containing allicin and related disulphides) reduces cholesterol level in human beings (Augusti, 1977). It also helps in eliminating waste materials and dangerous free radicals from the human body (Durak *et al.* 2004).

Phosphorus acts as a structural component of membrane system of cells, chloroplasts and mitochondria. It is a constituent of energy phosphates like ADP and ATP, nucleic acid, nucleo proteins, purines, pyrimidine, nucleotides and several coenzymes. It involved in the basic reaction of photosynthesis and plays an important role in cell division, breakdown of carbohydrate, transfer of inherited characteristics and hastening the maturity of plants. It is also an essential constituent of various enzymes which are important in the transformation of energy in carbohydrate and fat metabolism and also in respiration of plants.

Symbiosis between plant root and certain soil fungi *e.g.* Vesicular Arbuscular Mycorrhiza (VAM) play an important role in phosphorus cycling and uptake of phosphorus by plants (Biswas *et al.* 2001). VAM belongs to endomycorrhiza group which penetrate in the cell wall of roots. These fungi enter in root cells and form hyphal masses within the cells. This group is most common and widespread. VAM as symbiotic association with plant roots helps in mobilization of 'phosphorus', which increase the growth and yield of most crop plants through improved phosphorus uptake. It also increases tolerance to biotic and abiotic stresses. These micro-organisms have extensive mycelial network and can increase the transport of other mineral elements such as zinc and copper. VAM can also play an important role in enhancing phosphorus availability to the plants particularly in phosphorus deficient soils. VAM fungi can save phosphorus fertilizer by 25-30% (Somani *et al.* 1990).

MATERIALS AND METHODS

The field experiment entitled "Effect of Nutrient and Bio-fertilizers on Quality attributes of Garlic (*Allium sativum* L.)" was conducted at the Horticulture farm and quality observations were recorded at Laboratory, Department of Horticulture, S.K.N. College of Agriculture, Jobner during the *Rabi* season, 2015-16. Garlic cv. G- 282. The experiment was laid out in RBD and replicated 3 times. The treatments were randomly allotted to different plots using random number table of Fisher and Yates (1963). The treatments were applied during first week of November, 2015-16 after recording initial (base) growth, yield, quality and plants as well as soil parameters. Sulphur content (%): Sulphur was estimated by turbidometric method (Tabatabi and Bremner, 1970). Plant samples were digested with tri-acid mixture (Nitric acid, per chloric acid and hydrochloric acid) using gelatin barium chloride solution for development of turbidity. The resultant turbidity was measured by colorimeter and sulphur content was expressed in percentage on dry weight basis. N content in bulb (%): The samples of bulb drawn at the time of harvesting and were dried in oven before grinding by electrical grinder. The samples were digested with sulphuric acid using hydrogen peroxide to remove black colour. Estimation of nitrogen was done by colorimetric method using Nessler's reagent to develop colour (Snell and Snell, 1949) and expressed as per cent nitrogen content P content in soil Extraction of soil with 0.5 m $NaHCO_3$ at pH 8.5 and development of colour with $SnCl_2$ (Olsen *et al.* 1954).

RESULTS AND DISCUSSION

Effect on Quality attributes

Application of phosphorous and inoculation with bio-fertilizers caused significant effect on quality characters of garlic at after harvest (Table 1). Application of 75 kg P ha^{-1} exerted significantly higher nitrogen content (0.866%), application of 50 kg significantly higher P content in bulb (0.342 %), K content in bulb (0.057), S content in bulb (1.46%) and TSS content in bulb (42.31%) which was statistically at par with application of 50 kg and 25 kg P ha^{-1}. This may be due to phosphorus influences photosynthesis, biosynthesis of proteins and phospholipids, nucleic acid synthesis, membrane transport and cytoplasmic streaming. Increase in availability of phosphorus owing to its application

in the soil which was otherwise low in its content improved the nutrient availability status resulting increased photosynthetic and carbohydrate synthesis in garlic. The energy obtained from photosynthesis and metabolisms of carbohydrates was stored in storage compound (ADP and ATP) and then translocated to different parts for promoting meristemic development in potential apical buds and inter calary meristems which ultimately increased in quality of garlic. In line with the above-said facts, the experimental findings of Mandal *et al.* (2013); Diriba-Shiferaw G. *et al.* (2014) in garlic are also in agreement.

Table 1: Effect of phosphorus and bio-fertilizers on N, P and K content in bulb

Treatments	N content (%)	P content (%)	K content (%)
Phosphorus Levels			
Control (P_0)	0.764	0.275	0.040
25 kg/ha (P_1)	0.822	0.320	0.049
50 kg/ha (P_2)	0.844	0.342	0.054
75 kg/ha (P_3)	0.866	0.357	0.057
SEm±	0.018	0.007	0.001
CD (P = 0.05)	0.052	0.020	0.002
Bio-fertilizer			
Control (B_0)	0.782	0.286	0.042
PSB inoculation (B_1)	0.816	0.316	0.050
VAM inoculation (B_2)	0.842	0.340	0.051
PSB + VAM inoculation (B_3)	0.856	0.352	0.057
SEm±	0.018	0.007	0.001
CD (P = 0.05)	0.052	0.020	0.002
Interaction	NS	NS	NS

Among the bio-fertilizers (Table 1), inoculation with PSB + VAM observed nitrogen content (0.856%) application of 50 kg significantly higher P content in bulb (0. 0.352%), K content in bulb (0.057), S content in bulb (1.52 %) and TSS content in bulb ((43.18 %) and superior over rest of the treatments. This was due to the fact that PSB produce organic acids like gluconic, guccinic, lactic, oxalic, citric and a-ketogluconic acid which convert the insoluble phosphate to soluble one and synthesize growth promoting substances which augment plant growth (Gaind and Guar, 1992). The PSB increases the availability of phosphorus in root zone which in turn resulted in better growth and development of roots and shoots and also helped in better nodulation. The overall development of plant might have absorbed more nutrients and enhanced photosynthesis and production of assimilates, which in turn increased the plant height and chlorophyll content in garlic leaves.

Table 2: Effect of phosphorus and bio-fertilizers on sulphur content and TSS of bulb

Treatments	S content (%)	TSS (%)
Phosphorus Levels		
Control (P_0)	1.31	38.00
25 kg/ha (P_1)	1.39	40.21
50 kg/ha (P_2)	1.46	42.31
75 kg/ha (P_3)	1.48	42.71
SEm±	0.03	0.68
CD (P = 0.05)	0.08	1.95
Bio-fertilizer		
Control (B_0)	1.30	38.33
PSB inoculation (B_1)	1.40	40.52
VAM inoculation (B_2)	1.43	41.20
PSB + VAM inoculation (B_3)	1.52	43.18
SEm±	0.03	0.68
CD (P = 0.05)	0.08	1.95
Interaction	NS	NS

Table 3: Effect of phosphorus and bio-fertilizers on available phosphorus in soil at harvest

Treatments	Available phosphorus (kg/ha)
Phosphorus Levels	
Control (P_0)	12.55
25 kg/ha (P_1)	15.20
50 kg/ha (P_2)	17.04
75 kg/ha (P_3)	18.04
SEm±	0.35
CD (P = 0.05)	1.00
Bio-fertilizer	
Control (B_0)	14.72
PSB inoculation (B_1)	15.17
VAM inoculation (B_2)	16.20
PSB + VAM inoculation (B_3)	16.73
SEm±	0.35
CD (P = 0.05)	1.00
Interaction	NS

However, VAM inoculation helps in uniform crop growth and also enhances resistance to root disease and improve hardiness of transplant stock. So due to its obligatory symbiont nature and above discussed characteristics, increases its use in various crops. Application of phosphorus at 75 kg/ha gave the maximum bulb yield and N content in the onion bulbs. However, the quality of onion in respect of TSS and P contents remained unaffected by P application (Vachhani and Patel, 1993); Mandal *et al.* (2013) reported that the application of 50% vermicompost + 50% NPK recorded maximum plant height, neck diameter, bulb polar and equatorial diameter, average bulb weight and bulb yield of onion over other treatments. Diriba-Shiferaw G. *et al.* (2014) reported that the application of phosphorus at 40 kg/ha led to the attainment of optimum bulb quality attributes on andosol and vertisols of garlic. Meena *et al.* (2015) effect of organic manures and bio-fertilisers on growth and quality attributes of *kharif* onion (*Allium cepa* L.) in semi-arid region and found that growth attributes, TSS and nitrogen content in bulb increased significantly with the combined application of FYM @ 5 t /ha + vermicompost @ 2.5 t /ha. While, phosphorus and sulphur content of bulb significantly increased with application of FYM @ 5 t/ ha + poultry manure @ 2.5 t /ha. Bulb inoculation with azospirillium + PSB also significantly increased both growth and quality attributes over other treatments. Going through the above reviews, it may be concluded that application of different phosphorus levels (control, 25, 50 and 75 kg/ha) and bio-fertilizers (control, PSB, VAM and PSB + VAM) serves many purposes. It can enhance the growth, yield and improve the quality attributes of garlic. Hence, needs more work on this aspect of garlic particularly on cv. G-282 under semi-arid conditions of Rajasthan.

Interaction effect of phosphorous levels and inoculation with bio-fertilizers failed to show any significant effect on quality characters of garlic.

Effect of nutrients status in soil

Application of different levels of phosphorus up to 50 kg phosphorus per ha. to garlic crop significantly increased the phosphorus content in soil after harvest. Application of 50 kg phosphorus per ha significantly increased the phosphorus content in soil after harvest indicating an increase of 43.75 and 18.68 per cent over control and 25 kg phosphorus per ha, respectively and remained statistically at par with application of 75 kg phosphorus per ha. Data represent that inoculation with bio-fertilizers significantly increased the available P_2O_5 content in soil after harvest. Inoculation with PSB + VAM exhibited maximum (16.73 kg/ha) available P_2O_5 in the soil followed by VAM only (16.20 kg/ha), being at par with each other. Inoculation with PSB + VAM and VAM alone were indicating an increase of 13.65 and 10.05 per cent available P_2O_5 in the soil over control, respectively.

CONCLUSION

On the basis of results obtained, it may be concluded that it is recommended that to obtain higher quality characters and soil nutrients status of garlic should be grown by application of 75 kg p ha^{-1} along with inoculation of PSB + VAM under ago-climatic conditions of Jaipur region of Rajasthan.

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