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Influence of biofertilizers on quality and yield of Garlic (*Allium sativum* L.)

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Abstract
A field experiment entitled 'Influence of biofertilizers on quality and yield of Garlic (*Allium sativum* L.) was conducted during the rabi season in 2018-19 at the Research Farm-I of the Department of Horticulture, School of agriculture Science, Career Point University Kota, Rajasthan. The experiment was laid out in Randomized Block Design with ten treatments and three replications. The maximum number of cloves per bulb (27.160), diameter of bulb (4.537cm), thickness of necks (7.967 mm), length of clove (4.903 cm), bulb yield (78.513 q), T.S.S. of bulb (40.353), weight of bulb / plant (31.117g), dry matter content in bulb (34.633%) was recorded under T_9 (PAB + VAM + 50 kg/ha P_2O_5) treatment.

Keywords: Garlic, bio-fertilizers, yield, quality

Introduction
Garlic (*Allium sativum* L.) belongs to the family Amaryllidaceae. It is commonly used as a spice or in the medicinal purposes. It is grown throughout the plains of India and consumed by most of the people. It is used practically all over the world for flavoring various dishes (Pruthi, 1979) [6]. The major garlic producing states of India are Maharashtra, Madhya Pradesh, Orissa, Rajasthan, Karnataka, U. P. and Gujarat.

Bio-fertilizer secretes certain growth promoting substances. Further, they are harmless, eco-friendly and low cost agro- input supplementary to chemical fertilizers. They increase the soil fertility, improve soil structure, porosity and water holding capacity and also enhance seed germination. Under certain conditions they exhibit anti- fungal activities and thereby protect the plants from pathogenic fungi. The phosphate solubilizing bacteria are aerobic and heterotrophic in nature. Large numbers of microorganism have been tested and inoculants of *Bacillus megaterium*, *Pseudomonas striata*, *Bacillus polymyxa* are found suitable and available for seed inoculation. These bacteria solubilize phosphate in excess quantities for their own requirements and thus make it available to plants for their healthy growth. 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. 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.*, 2004) [7]. 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.

Materials and methods
The experiment was conducted during Rabi 2001- 2002 at the experimental fields of the Research Farm-I of the Department of Horticulture, School of agriculture Science, Career Point University Kota, Rajasthan. Experimental soil was sandy loam and slightly alkaline in nature pH less than 8.2, Electrical conductivity more then 4.0 and Sodium exchangeable% less than 15.0. The field was thoroughly prepared. The experiment was laid out in randomized block design (RBD) with ten treatments and replicated thrice. Treatment combination T_1- Control, T_2- RDF 100%, T_3- RDF 90%, T_4- RDF 80%, T_5- VAM + 40 kg/ha P_2O_5, T_6- VAM + 50 kg/ha P_2O_5, T_7- VAM + 75 kg/ha P_2O_5, T_8- PSB + VAM+ 40 kg/ha P_2O_5, T_9- PAB + VAM + 50 kg/ha P_2O_5, T_{10}- PAB + VAM + 50 kg/ha P_2O_5. The observation will be recorded number of cloves per bulb, diameter of bulb (cm), Thickness of necks (mm), length of clove (cm), bulb yield ha. (q), T.S.S. of bulb, fresh weight of bulb / plant (g), dry matter content in

bulb (%). The recorded data were analysed through statistical software for observation the parameter was statically significant (0.05%) statically difference (RBD) as described by Cochran and Cox (1992) [2].

Results and discussion

The maximum number of cloves per bulb (27.160) was recorded under T_9 (PAB + VAM + 50 kg/ha P_2O_5) followed by T_8 (PSB + VAM+ 40 kg/ha P_2O_5) and the minimum number of cloves per bulb (21.173) was observed under T_1(Control).The increase in uptake was more pronounced with respect to PSB and VAM or their combinations. This may be ascribed to solubilization and mineralization of organic phosphorus, containing substances by production of aliphatic, aromatic acids, phytasis, phosphatic lipases by VAM and PSB (Chadha and Prabhakar, 1997) [1]. These results are in conformity with the findings of Vimala and Natarajan (2000) [8] in pea.

The maximum diameter of bulb (4.537cm) was recorded under T_9 (PAB + VAM + 50 kg/ha P_2O_5) followed by T_{10} (PSB + VAM + 75 kg/ha P_2O_5) while the minimum diameter of bulb (2.450 cm) was observed under T_1(Control). The maximum thickness of necks (7.967 mm) was recorded under T_9 (PAB + VAM + 50 kg/ha P_2O_5) followed by T_8 (PSB + VAM+ 40 kg/ha P_2O_5) and the minimum thickness of necks (4.340 mm) was observed under T_1(Control). Microorganisms such as *Azotobacter, Azospirillum and Kelbsiella*; can secrete growth promoting substance similar to gibberellic acid and indole acetic acid, cytokinins and auxins which could stimulate plant growth, increased the surface area/ plant unit root length and were responsible for root hair branching with an eventual increase in absorption of nutrients and improving plant growth. The present findings are also in agreement with the results of Khandelwal and Pareek (2007) [4] in onion.

The maximum length of clove (4.903 cm) was recorded under T_9 (PAB + VAM + 50 kg/ha P_2O_5) followed by T_6 (VAM + 50 kg/ha P_2O_5) and the minimum length of clove (3.163 cm) was observed under T_1(Control). The present findings are also in agreement with the results of Meena (2019) in garlic. The highest bulb yield (78.513 q) was recorded under T_9 (PAB + VAM + 50 kg/ha P_2O_5) followed by T_{10} (PSB + VAM + 75 kg/ha P2O5) while the lowest bulb yield (65.033 q) was recorded under T_1(Control). The combined inoculation with PSB + VAM was more beneficial in enhancing all the above parameters due to increase solubilization and mineralization of organic phosphorus and availability of nitrogen and phosphorus. These results corroborate the findings of Yogita & Ram (2012) [9] in onion.

The maximum T.S.S. of bulb (40.353) observed under T_9 (PAB + VAM + 50 kg/ha P_2O_5) followed by T_8 (PSB + VAM+ 40 kg/ha P_2O_5) and the minimum T.S.S. of bulb (31.807) was recorded under T_1(Control). VAM inoculation plays significant and unique role in phosphate mobilization and uptake of phosphorus, zinc, sulphur and water by plant. Many investigators reported that Bio-fertilizers application increased growth of garlic plants (El-Morsy *et al*., 2009) [3].

The maximum weight of bulb / plant (31.117g) was recorded under T_9 (PAB + VAM + 50 kg/ha P2O5) followed by T_8 (PSB + VAM+ 40 kg/ha P2O5) and the minimum weight of bulb / plant (25.280 g) was recorded under T_1 (Control). This might be due to the fact that under adequate availability of nutrients, more nutrients might have taken up by the plants for greater photosynthesis and excess assimilates stored in the leaves and later translocated into parts at the time of senescence, ultimately led to higher bulb yield. These findings corroborate the results of Vimala and Natarajan (2000) [8] in pea.

The maximum dry matter content in bulb (34.633%) was recorded under T_9 (PAB + VAM + 50 kg/ha P2O5) followed by T_1(Control). and the minimum dry matter content in bulb (31.500g) was recorded under T_6 (VAM + 50 kg/ha P_2O_5). PSB + VAM provide avenues for improving P use efficiency. The increase in uptake was more pronounced with respect to PSB and VAM or their combinations. This may be ascribed to solubilization and mineralization of organic phosphorus, containing substances by production of aliphatic, aromatic acids, phytasis, phosphatic lipases by VAM and PSB (Chadha and Prabhakar, 1997) [1]. These findings are in close conformity with of Khandelwal and Pareek (2007) [4] in onion.

Table 1: Effect of bio-fertilizers on yield and quality of garlic

Treatments		Number of cloves per bulb	Diameter of bulb (cm)	Thickness of necks (mm)	Length of clove (cm)	Bulb yield ha. (q)	T.S.S. brix	Fresh weight of bulb / plant (g)	Dry matter content in bulb (%)
T1	Control	21.173	2.450	4.340	3.163	65.033	31.807	25.280	33.523
T2	RDF 100%	22.120	3.180	5.583	3.620	68.217	32.967	28.573	31.783
T3	RDF 90%	23.583	4.113	5.753	3.680	75.097	35.447	28.880	32.413
T4	RDF 80%	23.633	3.150	6.650	4.047	75.477	35.433	27.633	32.817
T5	VAM + 40 kg/ha P_2O_5	24.523	3.333	7.080	3.923	76.177	36.787	28.030	31.840
T6	VAM + 50 kg/ha P_2O_5	24.173	3.220	6.320	4.537	75.693	38.047	27.733	31.500
T7	VAM + 75 kg/ha P_2O_5	25.380	4.423	6.807	4.183	77.000	37.547	29.300	33.633
T8	PSB + VAM+ 40 kg/ha P_2O_5	26.457	4.040	7.420	4.337	77.720	38.087	29.183	31.967
T9	PAB + VAM + 50 kg/ha P_2O_5	27.160	4.537	7.967	4.903	78.513	40.353	31.117	34.633
T10	PSB + VAM + 75 kg/ha P_2O_5	25.900	4.097	7.637	4.407	78.287	37.907	30.300	32.600
SEm±		0.321	0.098	0.177	0.199	0.215	0.367	0.344	0.618
CD(P=0.05)		0.960	0.294	0.531	0.596	0.645	1.098	1.029	1.851

Conclusion

The present investigation clearly revealed that the application of (PAB + VAM + 50 kg/ha P_2O_5) under the treatment T_9 has obtained better response of garlic over the all other treatment combinations.

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