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IMPACT OF ORGANIC AMENDMENTS ON BULB YIELD AND SOIL PARAMETERS OF GARLIC (*Allium sativum* L.) FIELD CROP

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ABSTRACT
An experiment on organic amendments in garlic was conducted. Among treatment, T_4 {90% RDN (Recommended doses of nutrients applied through FYM, Vermicompost, Sheep and Goat manure) + Panchagavya (5%) + Jeevamrut (5%)} was found superior in bulb yield (98.54 q / ha), OC (1.66), available N (356.33 kg/ha), available P (53.50 kg/ha) and available K (443.00 kg/ha). Therefore the developed nutrient module emphasized in T_4 may be adopted and recommended in garlic crop getting for higher productivity and as well as sustained soil health.

INTRODUCTION

Garlic (*Allium sativum* L.) is a plant of family Alliaceae, genus Allium and species sativum. It is an herbaceous annual for the bulb production and a biennial for seed production. It is the second most important bulb crop after onion. It is the native of Central Asia and Southern Europe, especially Mediterranean. It is a spice or condiment crop, widely cultivated in India for home consumption and earning foreign exchange as well. The economic yield is obtained from its underground part known as bulb. The China, Korea, India, Spain, Egypt and USA are the major garlic producing countries. The major garlic growing states in India are Gujarat, Orissa, Madhya Pradesh, Rajasthan, Uttar Pradesh and Maharashtra. Its bulbils forming a swelling somewhere within the false stem a few (cm) above the bulb. The bulb consists of 6-35 smaller bulblets called cloves and is surrounded by a thin white or pinkish papery sheath. The bulb is composed of a disk like stem, then dry scales which are the base of foliage leaves and smaller bulb or cloves which are formed from auxiliary buds of younger foliage leaves (16). Excessive hot and long days are not conducted to proper bulb formation. Therefore, the crop is usually planted in winter and harvested when the hot season sets in north India, the crop is planted in September- October in the plains and March-April in the hills. Garlic has been used in medicine. It has been used in curing infection of lungs and respiratory passage. It is also used in internally for curing chronic, externally as a febefacient in skin diseases. According to Unani and Ayurvedic system as prescribed in India, garlic is carminative gastric stimulant and thus helps in digestion and absorption of food. Allicin present in aqueous extract of garlic reduces cholesterol concentration in the human blood.

Global awareness of health and environmental issues is increasing in recent years and there is a growing demand for organically grown food products worldwide. Before the Green Revolution, cultivation was mostly by natural and traditional farming methods which involved natural methods. Later the cultivation system has been intensified by the use of high yielding and fertilizer responsive varieties which prompted the use of chemical fertilizers and pesticides. However, indiscriminate use of chemical fertilizers and pesticides led to several harmful effects on soil, water and environment causing their pollution and decline in the productivity of the soil. In spite of the intensive use of inputs for about half a century in Indian agriculture, the yield gap in various crops still remains large even after following the best practices. Threats like erosion of biodiversity and change of climate marching towards desertification and environmental, soil, air, water and food pollution. Hence, there is now a great concern to maintain soil health and protect environment by popularizing the use of eco-friendly and cost effective organic manures in agriculture. In fact, organic agriculture is a holistic way of farming with an aim of conserving the natural resources through the agronomic practices and the use of locally available low cost inputs in order to maintain soil fertility and conserve the rich bio-diversity for sustainable economic goals. Due to the prohibitive cost of chemical fertilizers, majority of Indian farmers, do not apply the recommended dose of fertilizers and instead use indigenous organic manures as sources of nutrients which organics are bulky in nature but, contain reasonable amount of nutrients. Experiences reveal that the supply of nutrients through organics alone has failed to maintain yield level in a short period. Therefore, the combined application of organics such as FYM, compost, green leaf manure, vermicompost *etc.* and liquid organics *viz.*, Jeevamrut, Beejamrut, Panchagavya, Gomutra, Angara, Vermiwash *etc.*, which contain significant microbial count and plant growth promoting regulator is advocated for better growth, yield and quality of crops. Further it helps to build soil organic matter status besides lowering the cost of cultivation. The use of organic liquid products such as Jeevamrut and Panchagavya results in better growth, yield and quality of crops. These liquid organic solutions are prepared from cow dung, urine, milk, curd, ghee, legume flour and jaggary. They contain macro nutrients, essential micro nutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Palekar 2006, Natarajan 2007, Sreenivasa *et al.*, 2010). Thus, organic manure can serve as alternative practice to mineral fertilizers for improving soil health. Keeping this in view the present investigation was carried out to verify the impact of organic manure on production of garlic and sustainability of soil health.

MATERIALS AND METHODS

Field experiment was conducted at Experimental Farm of Department of Vegetable Science, Dr Y S Parmar university of Horticulture and Forestry, Nauni, Solan (HP). This experiment was laid out in Randomized Block Design (RBD) with ten treatments and three replications. The size of the experimental plot was 2.0 m × 2.0 m with spacing of 20 cm × 10 cm. The cultivar of garlic used for the present study was Kandaghat selection.

Treatment Details

Azotobacter and Phosphorus solubilising bacteria (PSB) @200 g each per after 100 kg FYM- Uniform application in all the treatments

RDN as per package of practices of vegetable crop:

a. FYM: 200 q/ha

b. N: 125 kg/ha

c. P_2O_5: 75 kg/ha

d. K_2O: 60 kg/ha

Recommended doses of nutrients were applied by using Vermicompost, Sheep and Goat manure in 50:50 ratio on nutrient quantity basis. The quantity of Vermicompost, Sheep and Goat Manure was quantified on the basis of Nitrogen equivalence (Sankaranarayanan 2004). Jeevamrut (5%) was applied as soil drench after 15 days of emergence of garlic cloves and will be repeated at 30 days interval and Panchagavya (5%) was applied as soil drench after 15 days of Jeevamrut application and will be repeated at 30 days interval (Sreenivasa *et al.*, 2011).

RESULTS AND DISCUSSION

The data pertaining to all the parameters have been presented in Table 1and2. The results revealed significant differences among different treatments for bulb yield, OC (%), available N, P and K except pH and EC. Maximum bulb yield (98.54 q/ha), OC (1.66), available N (356.33 kg/ha), available P (53.50 kg/ha) and available K (443.00 kg/ha) in fig 1 was recorded in T4 [90% RDN + Panchagavya (5%) + Jeevamrut (5%)] and minimum bulb yield, OC (%), available N, P and K of garlic was obtained in T1 (100% RDN). Among different years bulb

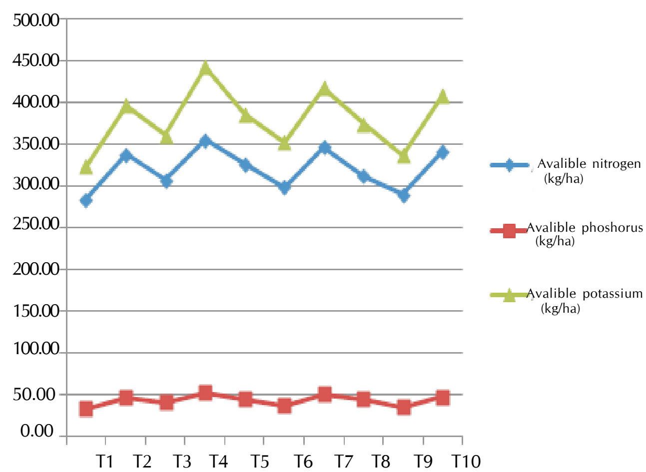

Figure 1: Effect of biofertilizers and organic amendments on available N, P and K content in soil

Table 1: Effect of biofertilizers and organic amendments on bulb yield, pH, EC and OC

	Bulb yield(q/ha)			pH			EC (dSm^{-1})			OC (%)		
Treat ment	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T1	62.71	81.25	71.98	6.63	6.67	6.65	0.17	0.16	0.17	1.23	0.94	1.09
T2	74.67	94.17	84.42	6.8	6.8	6.8	0.19	0.23	0.21	1.59	1.56	1.58
T3	70.33	87.92	79.13	6.77	6.8	6.78	0.19	0.23	0.21	1.5	1.48	1.49
T4	90.42	106.67	98.54	6.9	6.9	6.9	0.21	0.24	0.22	1.65	1.67	1.66
T5	73.83	89.58	81.71	6.77	6.8	6.78	0.19	0.23	0.21	1.57	1.54	1.55
T6	68.33	83.33	75.83	6.73	6.77	6.75	0.19	0.22	0.2	1.47	1.17	1.32
T7	81.96	103.33	92.65	6.87	6.9	6.88	0.2	0.23	0.21	1.63	1.58	1.61
T8	71.58	89.17	80.38	6.77	6.8	6.78	0.19	0.24	0.21	1.5	1.53	1.52
T9	64.83	82.92	73.88	6.67	6.7	6.68	0.19	0.21	0.2	1.42	0.98	1.2
T10	75.25	97.5	86.38	6.83	6.87	6.85	0.2	0.23	0.21	1.61	1.58	1.6
Mean	73.39	91.58	82.49	6.77	6.8	6.79	0.19	0.22	0.21	1.52	1.4	1.46
CD	13.07	12.39		NS	NS		NS	NS		NS	0.18	
Y		4.01			NS			0.01		0.09		
T		8.97			NS			NS		0.2		
Y E T		NS			NS			NS		NS		

Table 2: Effect of biofertilizers and organic amendments on available NPK content in soil (kg/ha)

	Available Nitrogen (kg /ha)			Available Phosphorus (kg/ha)			Available Potassium (kg/ha)		
Treatment	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
T1	280.67	288	284.33	33.33	34.67	34	321.67	327.67	324.67
T2	332.33	344	338.17	44	50.33	47.17	387.33	406.67	397
T3	301	314.33	307.67	40.33	43.33	41.83	351.67	371	361.33
T4	353.33	359.33	356.33	51.67	55.33	53.5	433.33	452.67	443
T5	319.33	334.67	327	42.67	48.33	45.5	377.33	396.67	387
T6	293	304.67	298.83	37.33	39	38.17	343	362.33	352.67
T7	338.67	355.67	347.17	48	53.67	50.83	408.67	428	418.33
T8	302.33	323	312.67	44	47	45.5	365.67	385	375.33
T9	289.33	291.33	290.33	36	36.67	36.33	328	347.33	337.67
T10	333	352.67	342.83	45.67	52	48.83	399.67	419	409.33
Mean	314.3	326.77	320.53	42.3	46.03	44.17	371.63	389.63	380.63
CD	21.32	38.32		NS	5.23		15.1	13.59	
Y		9.5			2.91			4.26	
T		21.23			6.51			9.53	
Y E T		NS			NS			NS	

yield, OC (%), available N, P and K was recorded in 2017-18 which was statistically different from 2016-17. Interaction between treatments x years established significant effects with bulb yield except all the parameters.

The highest yield parameters in vermi compost treated plot can be attributed to the supply of both macro and micro nutrients as well as some growth promoting substances like cytokinin and GA throughout growing period and these organic supplement the nutrient requirement of crops apart from conservation of more rain water and its supply (Lokesh *et al*., 2008 and Raut and Mehetre 2008). Ghosh and Kanzaria (1964) reported that organics seem to act directly in increasing crop yield either by acceleration of respiratory processes by increasing cell permeability, by hormone growth action or by combination of all these processes. These organics provide nitrogen, phosphorus and sulphur in available forms to the plants through biological decomposition and also improves the physical properties of soil such as aggregation, aeration, permeability and water holding capacity. The higher concentration of soil enzymes, soil organic matter and soil microorganisms in worm casts creates suitable microclimatic conditions in soils for rapid mineralization and transformation of plant nutrients in soil (Suthar, 2009). This might be due to the fact that organic manures supply balanced nutrition to the crop, improves soil conditions and result in better growth and development leading to higher yield (Damse *et al*., 2014; Naik *et al*., 2014). Improvement in yield and quality parameters due to the application of vermi compost can be attributed to improved nutrient availability and improvement in physical conditions of the soil which in turn provides a balanced nutritional environment both in the soil rhizosphere and plant system (Reddy *et al*., 1998).The present results are supported by the findings of Thanunathan *et al*. (1997) who indicated that the use of vermi compost on onions increased growth and yield. Similarly, Gezachew (2006) also reported that increased application of compost significantly increased the average tuber weight.

Nileema *et al*. (2011) reported that there was a significant improvement in the growth and yield with the combined application of liquid organic manures as compared to RDF alone. The plant nutrient concentrations (N, P and K) were the highest with the application of liquid organic manures + RDF followed by Beejamrut + Jeevamrut + Panchagavya.

According to Lal and Kanaujia (2013), application of 50 % NPK + 50 % FYM + biofertilizers recorded significantly higher soil organic carbon (2.19 %) with statistically similar OC by 50 % NPK + 50 % pigmanure + biofertilizers and 50 % NPK + 50 % vermicompost + biofertilizers over other treatments after the harvest of capsicum. This may be due to increased microbial activities in the root zone which decomposed organic manures and also fixed unavailable form of mineral nutrients into available forms in soil thereby substantiated crop requirements and improved organic carbon level and stabilized soil pH. Similar results were also reported by Chaudhary *et al*. (2005), who had observed significant improvement in the organic carbon content (2.19 %) in the treatment comprising of 50 % NPK + 50 % FYM + biofertilizers after harvesting of tomato crop. Chumyani *et al*. (2012) in tomato and Vimera *et al*. (2012) in king chilli had also drawn similar conclusions in their respective studies.

The increase in available N status due to biofertilizers application may be due to the multiplication of soil microbes leading to enhanced conversion of organically bound N into inorganic forms, rapid mineralization and thus made available to the crops (Miller *et al*.,1987; Kachroo and Razdan, 2006).

The significant build up of available soil nitrogen due to fertilizer application could be attributed to increased activity of nitrogen fixing bacteria, thereby resulting in higher accumulation of nitrogen in soil (Miller *et al*., 1987). Sheeba and Chellamuthu (1999) ascribed such build up in the available N status of the soil due to mineralization of N from added FYM. The increase in available N status of the soil with combined use of fertilizers and FYM might be explained in terms of their residual effect and build up of inorganic N fractions of the soil due to biochemical degradation and mineralization. Similar findings have also been reported by Pal *et al*. (1993), Saravanam and Nambisan (1994) and Srinivasan *et al*. (2000). Kumar (2004) was also of the opinion that there is strong build up of available N in the soil with increased application of N in garlic crop. This may be due to increased activity of nitrogen fixing bacteria resulting in higher content of N in soil. On the other hand, Fan and Messick (2007) were of the opinion that N application also help in its availability in the soil, uptake and concentration in the plant tissues. Minimum nitrogen content (230.98 kg/ha) was, however recorded in T_1 (Absolute control) as no fertilizers were added in the control plots.

Highest recovery of available phosphorus in organic manure treatments might be due to solubilization of soil phosphorus by organic acids produced during decomposition/ mineralization of organic manures and release of phosphorus contained in the organic manures. It might also be due to the formation of soluble complexes between humic/fulvic acids and phosphate. The complex organic anions and hydroxyl acids such as tartaric, citric, malonic and malic acids liberated during the decomposition of organic matter might have chelated Al^{+}, Fe^{+3} and Ca^{+2} and decreased the phosphate precipitating power of these cations thereby increased the phosphorus availability (Reddy *et al*., 1990).

The different doses of NPK significantly influenced the potassium build up in soil after harvest. The highest available potassium content in soil was recorded at 100 per cent RDF followed by 75 and 50 per cent RDF. Increase in available K might be due to the direct addition to the available K pool of the soil, besides reduced K-fixation and release of K due to the interaction of organic matter with clay. Babar and Dongale (2011) also reported that available nitrogen, phosphorus and potassium in soil increased significantly with the application of organic, inorganic and their integration compared to control. Sharma *et al*. (2009) also observed similar findings in cauliflower.

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