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Performance of cauliflower as influenced by organic inputs and microbial consortium

Purbashree Hazarika, Deepa Borbora Phookan* and Sapna Barua
Department of Horticulture, Assam Agricultural University, Jorhat 785013

ABSTRACT

An investigation was carried out during 2013-2014 and 2014-2015 to study the performance of cauliflower (*Brassica oleracea* L. var. *botrytis*) cv. Pusa Snowball K-1 as influenced by organic inputs and microbial consortium in the Department of Horticulture, Assam Agricultural University, Jorhat. The experiment was conducted in Randomized Block Design and replicated three times. The trial included three different organic manures each at two levels along the microbial consortium and one treatment with recommended dose of fertilizer. The treatment which received recommended dose of NPK along with FYM (T_1) produced the highest curd yield (280.81q ha^{-1}) followed by the treatment which received 5 t ha^{-1} enriched compost along with microbial consortium (T_8) recorded 209.04 q ha^{-1}. Among the organic treatments, the above treatment showed the highest values like curd size (103.46 cm^2), leaf number (18.73) and ash content of curd (6.79%). Quality parameters like ascorbic acid (60.13 mg 100 g^{-1}) was highest in treatment receiving 5 t ha^{-1} enriched compost and consortium (T_8) and leaf ash content (7.28%) in treatment that received 5 t ha^{-1} compost with microbial consortium treatment (T_4). Soil parameters revealed that pH, soil organic matter content, N, P, K and MBC were found better in plot treated with enriched compost 5t ha^{-1} and microbiol consortium (T8).

Key words: Cauliflower, enriched compost, microbial consortium, vermicompost.

INTRODUCTION

Among the vegetables, cauliflower (*Brassica oleracea* L. var. *botrytis*), is one of the important and popular vegetables in the world as well as in India due to its palatability, nutrient content, anti-oxidant and anti-inflammatory properties. To increase the productivity and profitability of vegetable crops, the use of chemical fertilizers, pesticides and other chemical inputs are increasing day by day resulting in economic, environmental and ecological problems, which adversely affected the sustainability of agricultural system. Long term use of only chemical fertilizers also has adverse effect on soil physical and biological properties, biodiversity, quality of the produce and human health. Organic farming is one of the fastest growing sectors of agriculture worldwide and its goal is to balance systems of soil organisms, plants, animals and humans (Karanatsidis and Berova, 3). An ideal organic fertilizer should be capable of giving reasonable yields, increase soil fertility, soil health and quality and sustain productivity. Application of microbial inoculants contributes significantly to the soil surface ecosystem by their organic acid secretions in decomposing soil organic matter, nutrient chelation, fixation and hormonal action (Zahir *et al.*, 15). Transformation of nutrients in soil is an enzyme mediated biochemical process facilitated by a group of microorganisms.

*Corresponding author's E-mail: deepajorhat111@yahoo.co.in

MATERIALS AND METHODS

The present investigation was carried out on cauliflower (*B. oleracea* L. var. *botrytis*) cultivar Pusa Snowball K-1 in RBD with three replications and eight treatments in the Experimental Farm, Department of Horticulture, AAU, Jorhat during 2013-2014 and 2014-2015. The experiment on the effect of eight treatments consisting of NPK (80:60:60 kg ha^{-1}) + 10 t ha^{-1} FYM(T_1), rock phosphate + microbial consortium (T_2), T_2 + compost 2.5 t ha^{-1} (T_3), T_2 + compost 5 t ha^{-1} (T_4), T_2 + vermicompost 2.5 t ha^{-1} (T_5), T_2 + vermicompost 5 t ha^{-1} (T_6), enriched microbial compost 2.5 t ha^{-1} + consortium (T_7) and enriched microbial compost 5 t ha^{-1} + consortium (T_8). The soil of the experimental plot was sandy loam and each size of each experimental plot was 8.1 m^2. Half of urea, full dose of SSP, MOP and borax were applied as basal dose microbial consortium was mixed with respective organic nutrients at a ratio of 1:100 and mixed properly and water was sprinkled and heaped. The heaps were covered by gunny bags for multiplication of the organisms. After 8-10 days the mixture were applied in the plots as per treatment. Wood ash and banana pseudostem ash were applied along with organic manures irrespective of treatments. In the second year, uniform treatment was allotted to the same plot were prepared by hoeing. Before planting, seedling root dip treatment was done with slurry of microbial consortium and kept for 15 to 20 min. Seedlings were then transferred to main field and planted during afternoon by maintaining the spacing 45 cm between rows and 45 cm between plants. Observations on yield, quality, chemical and biological parameters of soil were recorded as per standard procedures.

RESULTS AND DISCUSSION

Table 1 showed the maximum plant height of 62.39 cm, 21.05 number of leaves, 64.67 cm plant spread and 908.77 cm^2 leaf area were recorded in T_1 {RDF (80:60:60 kg NPK + 10 t FYM ha^{-1})} which was followed by 59.76, 18.73, 61.22 and 835.43 cm^2 in T_8 (enriched compost 5 t ha^{-1} + microbial consortium) respectively. Recommended dose of fertilizer recorded the higher value of growth parameters due to the quick and readily availability of major nutrients like nitrogen, phosphorus and potassium to the plants at earlier stages of growth. These results are supported by the report of Sharma (7) on tomato. The higher concentration of nitrogen has the tendency to increase cell number and cell size with overall increase in growth characters. Similar result was also reported by Thakur *et al.* (11). The possible reason for better growth characters under organic sources might be attributed to the added organic nutrient, which would have improved the physical, chemical and biological properties of soil that helped in better nutrient absorption and utilization by plant resulting better plant growth. This might be attributed to certain growth promoting substances secreted by the bio-fertilizers, which in turn might have led to better root development, better transportation of water, uptake and deposition of nutrients. These findings are in conformity with Merentola *et al.* (4) in cabbage and Vimera *et al.* (13) in king chilli.

Table 2 represented the yield attributing parameters of cauliflower, where inorganic treatment showed the highest curd size (133.42 cm^2) and yield (280.81 q/ha) was recorded in conventional treatment. This could be due to the rapid availability and utilization of nitrogen for various internal processes in the plant. Irrespective of the types of nutrient sources in all cases, the treatments receiving enriched compost 5 t ha^{-1} with microbial consortium recorded 209.04 kg ha^{-1} and 103.46 cm^2 curd size was recorded in T_8 (enriched compost 5 t ha^{-1} + consortium), which was highest among the organic treatments. Increase in the yield is due to the supply of additional nutrient through organics as well as improvement in the physical and biological properties of soil (Sharma *et al.*, 8). The increase might be also due to fact that these nutrients are being important constituents of nucleotides, proteins, chlorophyll and enzymes, which are involve in various metabolic process having direct impact on vegetative and reproductive phases of the plants. The increase in curd size is might be due to the better plant stand and direct contribution of organic inputs with microbial consortium in improving the fertility condition of the soil because of bacterial activities. It is seemed that organic manure need more time for nutrients to be available for plant absorption. However, the beneficial effect of organic manure on yield may be due to an increase in organic matter rate caused by the generation of carbon dioxide during compost decomposition (Wilkinson, 14) and improvement of the soil physical conditions, which encouraged the plant to have a good root development by improving the aeration of the soil (Arisha *et al.*, 1). The increase in yield and yield components due to the application of microbial consortium can be attributed to the release of bioactive substances having similar effect as that of growth regulators besides enhancement of nutrient absorption.

Table 1. Effect of organic manures and microbial consortium on plant growth characters of cauliflower.

Treatment	Plant height (cm)	Leaf No.	Plant spread (cm)	Leaf area (cm^2)
T1 : RDF (80:60:60 kg -1ha NPK + 10 t ha^{-1})	62.39	21.05	64.67	908.77
T2 : Rock phosphate + microbial consortium	52.08	12.18	50.77	578.77
T3 : T2 + Compost (2.5 t ha^{-1})	53.64	17.97	56.37	717.53
T4 : T2 + Compost (5 t ha^{-1})	57.13	17.08	57.83	649.37
T5 : T2 + vermicompost (2.5 t ha^{-1})	57.73	18.07	56.23	631.18
T6 : T2 + vermicompost (5 t ha^{-1})	58.77	17.87	57.33	655.17
T7 : Enriched compost (2.5 t ha^{-1} + microbial consortium	57.99	17.58	59.23	797.88
T8 : Enriched Compost (5 t ha^{-1}) + microbial consortium	59.76	18.73	61.22	835.43
CD at 5%	2.86	1.92	2.91	145.12

Table 2. Effect of organic manures and microbial consortium on yield contributing characters of cauliflower.

Treatment	Curd size (cm)	Curd compactness	Unmarketable curd (%)	Yield/ha (q)	B:C ratio
T1 : RDF (80:60:60 kg^{-1} ha NPK + 10 t ha^{-1})	133.42	49.13	7.92	280.81	2.93
T2 : Rock phosphate + microbial consortium	67.70	57.93	14.58	69.42	0.45
T3 : T2 + compost (2.5 t ha^{-1})	85.13	68.99	13.75	129.13	1.71
T4 : T2 + compost (5 t ha^{-1})	92.50	78.85	12.92	136.94	1.43
T5 : T2 + vermicompost (2.5 t ha^{-1})	89.78	58.36	11.25	173.73	2.08
T6 : T2 + vermicompost (5 t ha^{-1})	102.83	54.38	8.90	186.32	1.53
T7 : Enriched compost (2.5 t ha^{-1} + microbial consortium	91.00	76.31	9.75	191.77	2.61
T8 : Enriched compost (5 t ha^{-1}) + microbial consortium	103.46	71.17	8.58	209.04	1.81
CD at 5%	13.79	19.70	1.78	24.81	

Table 2 Contd…

Treatment	Ascorbic acid (mg 100 g^{-1})	Total mineral content of leaf (mg)	Total mineral content of curd (mg)
T_1 : RDF (80:60:60 kg^{-1} ha NPK + 10 t ha^{-1})	37.19	5.08	6.33
T_2 : Rock phosphate + microbial consortium	37.29	4.48	5.68
T_3 : T_2 + compost (2.5 t ha^{-1})	43.28	5.10	6.05
T_4 : T_2 + compost (5 t ha^{-1})	47.58	7.28	6.25
T_5 : T_2 + vermicompost (2.5 t ha^{-1})	50.65	5.12	6.17
T_6 : T_2 + vermicompost (5 t ha^{-1})	56.69	5.38	6.61
T_7 : Enriched compost (2.5 t ha^{-1} +microbial consortium	59.99	5.15	6.33
T_8 : Enriched compost (5 t ha^{-1}) + microbial consortium	60.13	6.10	6.79
CD at 5%	3.13	0.25	0.03

It is evident from the present study that the maximum value of curd compactness (78.85) was recorded in T_4 (Compost 5 t ha^{-1} + microbial consortium). The comparative higher level of curd compactness might be due to action of specific soil nutrients, which might be made more readily available into the soil for plant absorption as a result of organic manures with microbial consortium, which in term might activate specific enzymes for the synthesis of these compounds. It is therefore, certain specific nutrients in soil play a vital role in determining these quality parameters. Similar finding was reported by Sable and Bhamare (6) on cauliflower. The least unmarketable curd was observed in T_1 {RDF (80:60:60 kg NPK + 10 t FYM ha^{-1})} of 7.92% followed by T_8 (enriched compost 5 t ha^{-1} + microbial consortium) of 8.58%. This might be due to the readily availability and uptake of major nutrients and micro-nutrients by the plants.

Ash content represented the total amount of non-combustible substances, *i.e.* minerals present in the plant product. In the present study ash content of 7.28 and 6.79% was found highest in T_4 (T_2 + Compost 5 t ha^{-1}) and T_8 (Enriched compost 5 t ha^{-1} + Consortium) for leaf and curd, respectively (data not shown). This might be due to the increase in quality parameters, because soil that has been managed organically has more microorganisms, which produce many compound that influence the plant to absorb more micronutrients from soil.

In the present study, the highest ascorbic acid content (60.13 mg 100 g^{-1}) was recorded in T_8 (enriched compost 5 t ha^{-1} + consortium) and the lowest ascorbic acid content of 37.19 mg 100 g^{-1} was observed in treatment receiving RDF. The findings are in close agreement with those earlier reported by Sable and Bhamare (6) on cauliflower. There is a general observation that the organically managed crops have usually higher vitamin C than the conventionally fertilized crop because when a plant is exposed with more nitrogen, it increases protein production and reduces carbohydrates synthesis. Since vitamin C is synthesized from carbohydrates, its levels are also reduced. In case of organically managed soil, plants are generally exposed with comparatively lower amount of nitrogen and several plant nutrients are released slowly over time. Therefore, organic crop would be expected to maintain higher vitamin C and carbohydrates and less protein as reported by Bahadur *et al.* (2) in broccoli.

Results on soil analysis (Table 4) at harvest showed significant variation among treatments in respect of soil pH, organic carbon content, available nitrogen, phosphorus and potassium. Organic carbon of soil acts as a sink and source of nutrients for microbial population, which regulates the availability of different nutrients through microbial transformation. The net increase in organic carbon was much higher with organic manures in combination with microbial consortium. It is probably due to application of organic inputs and their releasing behaviour of different acids. However, before experimentation organic carbon and soil pH of 0.62% and 4.60 were found, respectively. There was significant increase in soil pH (5.69) and organic carbon (0.92%) when enriched compost 5 t ha^{-1} was applied in combination with microbial consortium (T_8). This might be due to increase in microbial activities in the root zone which decomposes organic manures and also fix unavailable form of mineral nutrient into available forms in soil thereby substantiates crop requirement and improve organic carbon level and stabilize soil pH. Similar result was also reported by Tekasangla *et al.* (10) on cauliflower.

The highest available nitrogen of 285.89 kg ha^{-1} was recorded under treatment with Enriched compost 5 t ha^{-1} + consortium (T_8). Organically managed soil exhibited great of biological activity of inoculated microorganism as well as their potential nitrogen fixation (Melero *et al*., 5). The lowest nitrogen content of 261.44 kg ha^{-1} was recorded in T_1 {RDF (80:60:60 kg NPK + 10 t FYM ha^{-1})}. This might be due to leaching and other losses with chemical fertilizers as compared to organic manures (Umlong, 12).

The increased available phosphorus in T_8 might be attributed to the improvement of soil condition due to the application of compost and the phosphate solubilising and mineralizing ability of the micro organisms from the soluble form of phosphorus sources (Tao *et al*., 9). Microbial culture plays a vital role in the release of phosphorus both from native and applied phosphorus sources due to production of phosphate solubilising enzymes. It is established that application of PSB along the rock phosphate significantly increased the available phosphorus status in soil, which could be attributed to the production of organic acids The minimum phosphorus content of soil (42.35 kg ha^{-1}) was recorded in consortium with rock phosphate inoculated treatment (T_2), which might be due to the lower rate of fixation of phosphorus during initial stage and also due to non-availability of actively solubilising microbes.

In case of residual potassium, treatment receiving enriched compost 5 t ha^{-1} with microbial consortium showed higher phosphorus content of (146.34 kg ha^{-1}) than the other treatments including T_1 {RDF (80:60:60 kg NPK + 10 t FYM ha^{-1})}. This might be due to release of potassium from these organic amendments and also due to solubilisation of mineral based potassium or native potassium. Besides, it could be also due to prevention of leaching loss due to retention of more potassium by organic components, while inorganic fertilizers could have released potassium at a faster rate. These results were similar to the earlier findings reported by Umlong (12).

From this study considering yield , quality and B:C it is concluded that among the different treatments, Enriched compost 2.5 t ha^{-1} was

Table 4. Effect of organic manures and microbial consortium on soil parameters.

Treatment	Soil pH	Organic carbon (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1 : RDF (80:60:60 kg^{-1} ha NPK + 10 t ha^{-1})	4.75	0.66	261.44	44.25	133.10
T_2 : Rock phosphate + microbial consortium	5.24	0.78	265.97	42.35	121.62
T_3 : T_2 + compost (2.5 t ha^{-1})	5.33	0.85	267.55	52.41	127.38
T_4 : T_2 + compost (5 t ha^{-1})	5.44	0.90	273.17	54.35	130.59
T_5 : T_2 + vermicompost (2.5 t ha^{-1})	5.40	0.79	272.50	56.46	137.02
T_6 : T_2 + vermicompost (5 t ha^{-1})	5.38	0.82	277.95	60.87	141.11
T_7 : Enriched compost (2.5 t ha^{-1} + microbial consortium	5.53	0.88	275.18	62.70	141.38
T_8 : Enriched compost (5 t ha^{-1}) + microbial consortium	5.69	0.92	285.89	66.35	146.34
CD (5%)	0.12	0.02	0.95	0.91	1.06

applied in combination with microbial consortium (T_7) enhanced productivity of cauliflower as well as improved the soil health.

REFERENCES

1. Arisha, H.M.E., Gad, A.A. and Younes, S.E. 2003. Response of some pepper cultivars to organic and mineral nitrogen fertilizer under sandy soil conditions. *Zagazig J. Agric. Res*. **30**: 1875-99.

2. Bahadur, A., Singh, J. and Singh, K.P. 2003. Response of cabbage to organic manure and biofertilizers. *Indian J. Hort*. **61**: 278-79.

3. Karanatsidis,G., and Berova M. 2009. Effect of organic-N fertilizer on growth and some physiological parameters in pepper plants (*Capsicum annum* L.). *Biotech. Equip*. **23**: 254-57.

4. Merentola, Kanaujia, S.P. and Singh, V.B. 2012. Effect of integrated nutrient management on growth, yield and quality of cabbage (*Brassica oleraceae* var. *capitata*). *J. Soils Crops*, **22**: 233-39.

5. Merelo, S., Porros, J.D., Herencia, J.F. and Madegon, E. 2006. Chemical and biochemical properties in a silty loam soil under conventional and organic management. *Soil Tillage Res*. **90**: 162-70.

6. Sable, P.B. and Bhamare, V.K. 2007. Effect of biofertilizers (AZB and *Azospirillum*) alone and in combination with reduces levels of nitrogen on quality of cauliflower cv. Snowball-16. *Asian J. Hort*. **2**: 215-17.

7. Sharma, S.K. 1995. Seed production of tomato as influenced by nitrogen, phosphorus and potassium fertilization. *Annal. Agril. Res.* **16**: 399-400.

8. Sharma, R.P., Sharma, A. and Sharma, J.K. 2005. Productivity, nutrient uptake, soil fertility and economics as affected by chemical fertilizers and farm yard manure in broccoli (*Brassica oleracea* var. *italica*) in an entisol. *Indian J. Agric. Sci.* **75**: 576-79.

9. Tao. G., Jian, S., Cai, M. and Xie, G. 2008. Phosphate solubilising and mineralizing abilities of bacterial isolated from soil. *Pedosphere*., **18**: 515-23.

10. Tekasangla, Kanaujia, S.P. and Singh, P.K. 2015. Integrated nutrient management for quality production of cauliflower in acid alfisol of Nagaland. *Karnataka J. Agril. Sci.* **28**: 244-47.

11. Thakur, K.S., Thakur, R., Shukla, Y.R., Mehta, D.K. and Thakur, A.K. 2010. Effect of organic manures and biofertilizers on growth and yield of tomato (*Solanum lycopersicon* L.). *J. Hill Agri*. **1**: 190-92

12. Umlong, R.M. 2010. Growth, yield and quality of carrot (*Daucas carota* L.) as influenced by organics and lime. M.Sc. (Hort.) thesis, Assam Agricultural University, Jorhat.

13. Vimera, K., Kanaujia, S.P., Singh, V.B. and Singh, P.K. 2012. Effect of integrated nutrient management on growth and yield of King chilli under foothill condition of Nagaland. *J. Indian Soc. Soil Sci.* **60**: 45-49.

14. Wilkinson, S.R. 1979. Plant nutrient and economic value of animal manures. *J. Animal Sci*. **48**: 121-33.

15. Zahir, Z.A., Arshad, M. and Frankenberger, W.T. 2004. Plant growth promoting rhizobacteria: Applications and perspectives in agriculture. *Adv. Agron.* **81**: 97-168.

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