

Effect of Enriched Organic Manures And Bio-enhancer On Quality, Soil Attributes And Nutrient Uptake In Cauliflower (*Brassica oleracea* var. *botrytis*)

ABSTRACT

Background: The extensive use of chemical fertilizers to boost vegetable production has been acknowledged, but its long-term consequences on soil health, ecology and other natural resources are detrimental. These effects extend to beneficial soil microorganisms and human beings. Therefore, there is a need of organic resources for plant nutrition.

Methodology: An experiment was carried out during *rabi* season, 2020 at College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Dist. Mehsana, Gujarat. It was laid out in randomized block design with factorial concept with three replications comprised of two factors *viz.*, different organic manures with six level *i.e.*, 80% RDN through FYM (o_1), 80% RDN through Poultry manure (o_2), 80% RDN through Vermicompost (o_3), 60% RDN through FYM (o_4), 60% RDN through Poultry manure (o_5) & 60% RDN through Vermicompost (o_6) and bio-enhancer with two level *i.e.*, NPK consortium @ 5 lit/ha (f_1) and Ghan-Jeevamrut @ 250 kg/ha (f_2).

Results: Among different application of organic manures, 80% RDN through Vermicompost performed significantly superior over other treatment with respect to TSS (7.07 °Brix), chlorophyll a (62.31 mg/100g), chlorophyll b (24.78 mg/100g), total chlorophyll content (87.09 mg/100g), available N (236.16 kg/ha), P (36.12 kg/ha) and K (361.07 kg/ha) in soil, N uptake (67.90 kg/ha), P uptake (8.46 kg/ha) and K uptake (61.74 kg/ha) by plant. Among different bio-enhancer, NPK consortium @ 5 lit/ha was found significantly superior with respect to chlorophyll b (24.00 mg/100g), total chlorophyll (83.10 mg/100g), organic carbon (0.36%) in soil, N uptake (63.61 kg/ha), P uptake (7.79 kg/ha) and K uptake (59.60 kg/ha) by plant. However, the interaction effect of both organic manures and bio-enhancer has found non-significant in terms of quality, soil attributes and nutrient uptake.

Keywords: Organic manures, Bio-enhancer, NPK consortium, Nutrient uptake, Cauliflower

1. INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is a highly popular cruciferous vegetable crop. The curd is consumed in various forms such as raw or cooked vegetables, curries, soups and pickles. The term "cauliflower" originated from the Latin word "*caulis*" meaning "cabbage" and "*floris*" meaning "flower". This vegetable has its origin in the Mediterranean region and has a chromosome number of $2n=18$. It was introduced to India in 1822 by Dr. Jemson from England during the time of the East India company [27].

Nutritionally, cauliflower (per 100 g of edible portion) contains moisture 90.8%, protein 2.6%, fat 0.4%, mineral matter 1%, total carbohydrate 4%, fiber 1.2%, thiamine 0.04 mg, riboflavin

0.1 mg, niacin 1 mg, vit-C 56 mg, phosphorus 57 mg, calcium 33 mg, sodium 53 mg and potassium 138 mg and iron 1.23 mg, magnesium 18 mg, sulphur 231 mg, zinc 0.4 mg and chlorine 34 mg [23]. Through, cauliflower is primarily grown for consumption as a vegetable eaten after bowel or steaming or drying as pickling and it has anti-cancer property also and protects again bowel cancer due to presence of indol-3-carbinol with anti-inflammatory properties due to its omega-3 and vitamin K [4].

In recent decades, conventional agriculture had a negative impact on soil and plant health. The more use of chemical fertilizers has long-term consequences on soil health, beneficial soil microorganisms and human beings [26]. Consequently, there is a growing demand for organic farming as a means to safeguard soil and plant health. Organic farming has gained momentum in recent years due to its inherent advantages. It plays a crucial role in sustaining crop production while maintaining dynamic soil nutrient levels and a safe environment [14].

There is different source of organic manures like farm yard manures, vermicompost, poultry manures, etc. can be used as a source of nutrient. Farm yard manure (FYM) is principal source of organic matter to maintain the soil health. Vermicompost is greatly humified through the fragmentation of the parent organic materials by earthworm sand colonization by microorganisms. Vermicomposts are finely divided peat-like materials with high porosity, aeration, drainage, water-holding capacity [6]. Poultry manure with high proportion of organic carbon content improves organic matter of the soil and retains substantial amounts of soil water and this subsequently increases the water content of soil upon application of the manure [10].

However, traditional bulky organic manure tends to have low nutrient concentration and releases nutrients slowly during the initial stages. This can lead to significant reductions in crop yields and farm income. To overcome this, the enrichment of organic manure with beneficial microbial cultures has proven effective [9]. These cultures enhance nutrient availability and improve soil physical properties such as structure and water holding capacity. In beneficial microbial culture, NPK consortium and Ghan-Jeevamrut are good sources. NPK consortium is the one-time solution for all the macronutrients (N, P, K) requirement of crops. NPK Consortium contains *Azotobacter chroococcum* (ABA-1), *Azospirillum lipoferum* (ASA-1), *Bacillus coagulans* and two *Bacillus* spp. Ghan-jeevamrut is resulting into significant reduction in cost of cultivation of all the crops and better profitability (B:C ratio) in organic farming [13]. Therefore, the present experiment was undertaken to investigate the "Effect of enriched organic manures and bio-enhancer on quality, soil attributes and nutrient uptake in cauliflower (*Brassica oleracea* var. *botrytis*).

2. MATERIAL AND METHODS

During the winter season of 2020, an experiment was conducted at College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, located in Jagudan, Mehsana District, Gujarat. The experiment followed a randomized block design with a factorial concept, consisting of 12 treatment combinations. Each treatment combination was replicated three times to ensure reliable results.

Treatment details are as under:

Table 1. The details of treatment combination.

Enriched Organic manures (O)

- (O₁) 80% RDN through FYM
- (O₂) 80% RDN through Poultry manure
- (O₃) 80% RDN through Vermicompost
- (O₄) 60% RDN through FYM

(o₅) 60% RDN through Poultry manure

(o₆) 60% RDN through Vermicompost

Bio-enhancer (F)

(f₁) NPK consortium @ 5 lit/ha

(f₂) Ghan-Jeevamrut @ 250 kg/ha

A specific amount of various organic fertilizers, along with specific amounts of liquid organic substances, is needed according to the treatment and applied ten days prior to transplanting. Twelve distinct piles of organic fertilizers were prepared, each with the appropriate quantity specified by the treatment, and placed in a shaded area. The necessary quantity of liquid organic substances, as per the treatment, was added to each pile and thoroughly mixed. The piles were then covered with a shade net to protect them and ensure they remain moist by providing adequate watering.

All cultural practices were followed regularly during crop period and observations were recorded on quality, soil attributes and nutrient uptake *i.e.*, TSS, chlorophyll a, chlorophyll b total chlorophyll content in leaves, pH, EC, Organic carbon, Available N, P, K in soil after harvesting as well as nitrogen, phosphorus and potassium uptake by plant. The data on these parameters were subjected to statistical analysis to draw logical conclusions.

3. RESULTS AND DISCUSSION

Effect of organic manures on quality of cauliflower

The differences in quality parameters *viz.*, TSS, chlorophyll a, chlorophyll b and total chlorophyll content in leaves due to effect of organic manure were found significant. The results indicated that significantly highest TSS (7.07 °Brix), chlorophyll a (62.31 mg/100 g), chlorophyll b (24.78 mg/100 g) and total chlorophyll content (87.09 mg/100 g) in leaves were found significantly better with the treatment o₃ (80% RDN through Vermicompost), whereas minimum with o₅ (60% RDN through Poultry manure) (Table 2). Vermicompost showed better result with NPK consortium that increased TSS than other treatments which might be possible due to the enhanced activity of the hydrolytic enzyme which converted the complex polysaccharides into simple sugar [7]. Ibrahim *et al.* [8] also observed the result of balanced and improved nutrient uptake in vermicompost in Chinese cabbage. Similar result found by Meena *et al.* [18] in broccoli, Chatterjee [2] in cabbage, Singh *et al.* [25] in chilli, Baliah *et al.* [1] in okra and Tayade *et al.* [28] in amaranthus.

Effect of bio-enhancer on quality of cauliflower

The differences in quality parameter *viz.*, chlorophyll b and total chlorophyll content due to effect of organic manure were found significant, while TSS and chlorophyll a were found non-significant. The data indicated that (Table 2) significantly highest chlorophyll b (24.00 mg/100 g) and total chlorophyll content (83.10 mg/100 g) was recorded in treatment f₁ (NPK consortium @ 5 lit/ha), whereas minimum chlorophyll b (22.70 mg/100g) and total chlorophyll content (78.98 mg/100 g) was recorded in treatment f₂ (Ghan-Jeevamrut @ 250 kg/ha).

Interaction effect of organic manure and bio-enhancer on quality of cauliflower

interaction effect of organic manures and bio-enhancer on quality parameter was found non-significant.

Table 2. Effect of organic manures and bio-enhancer on quality parameters of cauliflower at harvest

Treatments	TSS (°Brix)	Chlorophyll a (mg/100g)	Chlorophyll b (mg/100g)	Total chlorophyll (mg/100g)
Organic manure (O)				
O ₁	6.62	60.61	24.06	84.67
O ₂	6.48	58.03	23.89	81.93
O ₃	7.07	62.31	24.78	87.09
O ₄	6.49	54.69	22.78	77.47
O ₅	6.36	53.76	21.44	75.20
O ₆	6.49	56.74	23.15	79.89
S.Em. ±	0.146	1.665	0.663	2.273
C.D. at 5%	0.43	4.88	1.94	6.67
Bio-enhancer (F)				
f ₁	6.60	59.10	24.00	83.10
f ₂	6.57	56.28	22.70	78.98
S.Em. ±	0.084	0.961	0.383	1.312
C.D. at 5%	NS	NS	1.12	3.85
Interaction (O × F)				
S.Em. ±	0.206	2.355	0.937	3.214
C.D. at 5%	NS	NS	NS	NS

Effect of organic manures on soil attributes and nutrient uptake in cauliflower

Application of organic manure on organic carbon, available N, P and K in soil as well as N, P and K uptake by plant after harvesting was found significant. The maximum organic carbon (0.39%), available N (236.16 kg/ha), available P (36.12 kg/ha) and available K (361.07 kg/ha) in soil, nitrogen uptake (67.90 kg/ha), phosphorus uptake (8.46 kg/ha) and potassium uptake (61.74 kg/ha) by plant were recorded in treatment o₃ (80% RDN through Vermicompost), while minimum was recorded under the treatment o₅ (60% RDN through Poultry manure) (Table 3).

It might be due to vermicompost improve organic carbon and other soil properties due to considered as positive changes brought about in the soil and small-scale physical, chemical, and biological changes that might influence by vermicompost [6]. Also increased the amounts of organic carbon, improvements in pH, decreased soil bulk densities, improved soil porosities and water-holding capacities and increased microbial populations of soil in response to vermicompost treatments was reported by Maheswarappa *et al.* [15] and Jeyabal and Kuppuswamy [10]. According to Suklabaidiya *et al.* [26] higher per cent of organic carbon found in cauliflower in vermicompost with *Azotobactor*. Increased in available nitrogen content in soil and also improve the phosphorus and potassium content due to the more mineral elements contents and also their available forms Edwards *et al.* [6]. These was also reported by Narayanan *et al.* [20], Suklabaidya *et al.* [26] and Sarangthem *et al.* [22]. This application showed better with respect to NPK uptake by plant because it increased and made available the macro and micronutrient and vital plant promoting substance for plant which helped to increase plant uptake, Sharma [24]. This was also reported by Devi *et al.* [3]. However, effect of organic manure on pH and EC in soil after harvesting was found non-significant.

Effect of bio-enhancer on soil attributes and nutrient uptake in cauliflower

Maximum organic carbon (0.36%) in soil, nitrogen uptake (63.61 kg/ha), phosphorus uptake (7.79 kg/ha) as well as potassium uptake (59.60 kg/ha) by plant were recorded in treatment f₁ (NPK consortium @ 5 lit/ha) after harvesting.

Microbial activity not only contributes to an increase of dissolved organic substances and also affects organic matter in soil (Marschner and Kalbitz [16]; Kalbitz *et al.* [11]. According to Dinesh *et al.* [5] application of bio-fertilizers that contain living microorganisms is one of the management practices that can help to maintain or increase the content of organic matter and improve soil fertility. Also found the similar result of Khaliq *et al.* [12], Mayer *et al.* [17] and Piotrowska *et al.* [21]. Effect of NPK consortium was significantly increase the nitrogen uptake and also increase uptake of phosphorus and potassium due to the beneficial effect of combined use of organic manure with biosource which enhanced the nutrient availability. Enhanced microbial activities in the root zone, decomposes organic manures and also fixed unavailable form of mineral nutrients into available forms in soil (Edwards *et al.* [6], which might have resulted in larger NPK uptake by plant. Effect of bio- enhancer found non-significant with regards to pH, EC, available N, P and K in soil after harvesting.

Table 3. Effect of organic manures and bio-enhancer on soil attributes and nutrient uptake of plant at harvest in cauliflower

Treatments	pH	EC (dS/m)	% Organic carbon	Available N (kg/ha)	Available P ₂ O ₅ (kg/ha)	Available K ₂ O (kg/ha)	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
Organic manure (O)									
O ₁	7.93	0.29	0.36	215.73	32.51	332.14	67.59	8.29	61.72
O ₂	7.90	0.30	0.35	226.61	31.99	341.83	64.92	7.23	60.84
O ₃	7.85	0.28	0.39	236.16	36.12	361.07	67.90	8.46	61.74
O ₄	7.98	0.31	0.33	198.81	28.98	316.98	55.23	6.49	51.60
O ₅	7.95	0.31	0.29	204.16	28.81	287.60	50.33	6.65	47.11
O ₆	7.90	0.29	0.34	217.31	30.04	317.21	56.57	6.68	52.89
S.Em. ±	0.125	0.008	0.017	7.679	1.616	15.274	3.781	0.531	3.645
C.D. at 5%	NS	NS	0.05	22.52	4.74	44.80	11.09	1.56	10.69
Bio-enhancer (F)									
f ₁	7.91	0.30	0.36	218.88	31.99	338.00	63.61	7.79	59.60
f ₂	7.93	0.29	0.32	214.04	30.83	314.28	57.23	6.80	52.37
S.Em. ±	0.072	0.005	0.010	4.434	0.933	8.818	2.183	0.307	2.104
C.D. at 5%	NS	NS	0.03	NS	NS	NS	6.40	0.90	6.17
Interaction (O × F)									
S.Em. ±	0.177	0.011	0.024	10.860	2.285	21.601	5.347	0.752	5.154
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Interaction effect of organic manure and bio-enhancer on soil attributes and nutrient uptake in cauliflower

interaction effect of organic manures and bio-enhancer on soil attributes as well as nutrient uptake by plant was found non-significant (Table 3).

4. CONCLUSION

From the present experiment it may be concluded that in cauliflower, among different application of organic manures 80 per cent RDN through Vermicompost improves quality, soil attributes and nutrient uptake of cauliflower. With regards to bio-enhancer, NPK

consortium @ 5 lit/ha improves quality as well as soil attributes and nutrient uptake of cauliflower.

REFERENCES

1. Baliah NT, Priyathini LS, Priya C. Effect of organic fertilizers on growth and biochemical characteristics of okra (*Abelmoschus esculentus* L. Monench). *Int. J. Sci. Res.* 2015;6(1):679-682.
2. Chetterjee R, Jana JC, Paul PK. Enhancement of head yield and quality of cabbage (*Brassica oleracea*) by combining different sources of nutrients. *Indian J. Agric. Sci.* 2012;82(4):324-328.
3. Devi S, Choudhary M, Jat PK, Singh SP, Rolaniya MK. Influenced of organic and biofertilizers on yield and quality of cabbage (*Brassica oleracea* var. *Capitata*). *Int. J. Chem. Stud.* 2017;5(4):818-820.
4. Dhaliwal, MS. Handbook of vegetable crops. *Kalyani publishers.* New Delhi; 2012.
5. Dinesh R, Srinivasan V, Hamza S, Manjusha A. Short-term incorporation of organic manures and biofertilizers influences biochemical and microbial characteristics of soils under an annual crop Turmeric (*Curcuma longa* L.). *Bioresour. Technol.* 2010;101:4697-4702.
6. Edwards CA, Arancon NQ, Sherman R. Vermiculture technology: earthworms, organic wastes, and environmental management. *CRC press*, Boca Raton, Florida; 2011.
7. Gangadhar K, Devakumar N, Vishwajith, Lavanya G. Growth, yield and quality parameters of chilli (*Capsicum annum* L.) as influenced by application of different organic manures and decomposers. *Int. J. Chem. Stud.* 2020;8(1):473-482.
8. Ibrahim A, Mohammed TA, Narayan S. Effect of different sources of plant nutrients on growth, yield and quality of Chinese cabbage (*Brassica rapa* L. var. *pekinensis*). *Int. J. Chem. Stud.* 2018;6(2):3120-3122.
9. Jacob S, Banerjee R. Nutrient enrichment of organic manure through biotechnological means. *Waste and Biomass Valorization.* 2016;8:645–657.
10. Jeyabal A, Kuppuswamy G. Recycling of organic wastes for production of vermicompost and its response in rice–legume cropping system and fertility. *Eur. J. Agron.* 2001;15:153-170.
11. Kalbitz K, Schwesig D, Schmerwitz J, Kaiser K, Haumaier L, Glaser B, Ellerbrock R, Leinweber P. Changes in properties of soil derived dissolved organic matter induced by biodegradation. *Soil Biol Biochem.* 2003;35:1129-1142.
12. Khaliq A, Kaleem AM, Hussain T. Effects of integrated use of organic and inorganic nutrient sources with effective microorganisms (EM) on seed cotton yield in Pakistan. *Bioresour Technology.* 2006;97:967–972.
13. Kumari R, Thakur KS, Lalhruaitluangi N. Effect of different organic nutrient sources on soil properties in onion (*Allium cepa* L.). *Int J Curr Microbiol Appl Sci.* 2019;8(4):1783-1792.

14. Lokanath H, Parameshwarappa K. Effect of Organics on the productivity of Spanish Bunch groundnut under rainfed farming situations. 19th World Congress of Soil Science, Soil Solutions for a Changing World; 2006.
15. Maheswarappa HP, Nanjappa HV, Hegde MR. Influence of organic manures on yield of arrowroot, soil physico-chemical and biological properties when grown as intercrop in coconut garden. Ann. Agric. Res.1999;20:318–323.
16. Marschner B, Kalbitz K. Controls of bioavailability and biodegradability of dissolved organic matter in soils. Geoderma. 2003;113:211–235.
17. Mayer J, Scheid S, Widmer F, Fliebbach A, Oberholzer HR. How effective are 'Effective microorganisms results from a field study in temperate climate. Appl Soil Ecol. 2010;46:230-239.
18. Meena K, Ram RB, Meena ML, Meena JK, Meena DC. Effect of organic manures and bio-fertilizers on growth, yield and quality of broccoli (*Brassica oleracea* var. *italica* Plenck.) cv. KTS-1. Chem. sci. rev. lett. 2017;6(24):2153-2158.
19. Mohamed AM, Sekar S, Muthukrishnan P. Prospects and potential of poultry manure. Asian Journal of Plant Science. 2010;9:172-182.
20. Narayan S, Ibrahim A, Khan FA, Hussain K, Malik AA, Mir SA, Narayan R. Organic nutrient management for improved plant growth and head yield of Chinese cabbage (*Brassica rapa* L. var *pekinensis*). Int J Curr Microbiol Appl Sci. 2018;7(9):3049-3059.
21. Piotrowska A, Długosz J, Zamorski R, Bogdanowicz P. Changes in some biological and chemical properties of an arable soil treated with the microbial biofertilizer UGmax. Pol J Environ Stud. 2012;21(2):455–463.
22. Sarangthem I, Mishra AD, Chakraborty Y. Cabbage productivity, nutrient uptake and soil fertility as affected by organic and bio-sources. Agric. Sci. Dig. 2011;31(4):260-64.
23. Savita, Jaipaul, Choudhary AK, Negi MS, Kumar A. Advances in vegetable agronomy. Post graduate school, IARI, New Delhi, India. 2014; pp 68.
24. Sharma K. Effect of different sources of nutrients on yield and quality of cauliflower (*Brassica oleracea* var. *botrytis*) Thesis, M.Sc. Dr Yashwant Singh Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh;2019.
25. Singh C, John SA, Jaiswal D. Effect of organics on growth, yield and bio-chemical parameters of chilli (*Capsicum annum* L.). J. Agric. Vet. Sci. 2014;7(2):27-32.
26. Suklabaidya A, Datta M, Kandpal BK. Response of organic sources and biofertilizer in soil fertility and yield of cauliflower in the foot hills of Tripura. Int. J. Agric. Sci. 2017;9(51):4874-4875.
27. Swarup V, Chatterjee S. Origin and Genetic Improvement of Indian Cauliflower. Econ. Bot. 1972;26(4):381-393.
28. Tayade MS, Bawkar SO, Kale VS, Deshmukh UB. Integrated nutrient management in amaranthus (*Amaranthus tricolor* L.). Asian J. Hort. 2012;7(2):291-293.