

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 [1].

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 [2]. 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 [3].

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 [4]. 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 [5].

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 [7].

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 [8]. 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 [9]. 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.

Treatments	Notation	Treatment combinations
T ₁	o ₁ f ₁	80% RDN through FYM enriched with NPK consortium @ 5 lit/ha
T ₂	o ₁ f ₂	80% RDN through FYM enriched with Ghan-Jeevamrut @ 250 kg/ha
T ₃	o ₂ f ₁	80% RDN through Poultry manure enriched with NPK

		consortium @ 5 lit/ha
T ₄	O ₂ f ₂	80% RDN through Poultry manure enriched with Ghan-Jeevamrut @ 250 kg/ha
T ₅	O ₃ f ₁	80% RDN through Vermicompost enriched with NPK consortium @ 5 lit/ha
T ₆	O ₃ f ₂	80% RDN through Vermicompost enriched with Ghan-Jeevamrut @ 250 kg/ha
T ₇	O ₄ f ₁	60% RDN through FYM enriched with NPK consortium @ 5 lit/ha
T ₈	O ₄ f ₂	60% RDN through FYM enriched with Ghan-Jeevamrut @ 250 kg/ha
T ₉	O ₅ f ₁	60% RDN through Poultry manure enriched with NPK consortium @ 5 lit/ha
T ₁₀	O ₅ f ₂	60% RDN through Poultry manure enriched with Ghan-Jeevamrut @ 250 kg/ha
T ₁₁	O ₆ f ₁	60% RDN through Vermicompost enriched with NPK consortium @ 5 lit/ha
T ₁₂	O ₆ f ₂	60% RDN through Vermicompost enriched with 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 (Table 2), 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.

Table 2. Required quantity of organic manures and bio-enhancer

Sr. No.	Organic manure	N (%)	Kg/ml/g per plot	Kg/lit per hectare
1.	FYM	0.49	7.94 kg (80% RDN) 5.95 kg (60% RDN)	16326 kg (80% RDN) 12244 kg (60% RDN)
2.	Poultry manure	2.91	1.34 kg (80% RDN) 1.00 kg (60% RDN)	2749 kg (80% RDN) 2062 kg (60% RDN)
3.	Vermicompost	1.17	3.32 kg (80% RDN) 2.49 kg (60% RDN)	6838 kg (80% RDN) 5128 kg (60% RDN)
4.	NPK consortium	-	2.43 ml	5 lit.
5.	Ghan jeevamrut	-	121.5 g	250 kg

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.

For Total Soluble Solid (TSS) measurement, the curds were cut into small pieces and crushed thoroughly to make a homogenous extract. Then poured on lense and reading was recorded with the help of digital refractometer (HI 96801) in °Brix. The collection of selected plant's leaves analysed for estimation of a, b and total chlorophyll (mg/100g) as per method suggested by Sadasivam and Manickam [10].

For soil analysis, soil samples were taken randomly up to 0-15 cm depth at different places of the experimental field before the transplanting and after harvesting and dried in shade condition and crush the soil clods lightly and grind with the help of wooden pestle and mortar. Pass the entire quantity through 2 mm stainless steel sieve. Remix the entire quantity of sieved soil thoroughly before analysis. pH, EC, % OC, Analysis of Available N, available P, available K treatment wise as per procedure given by Jackson [11].

The samples were collected from selected plant per treatment and dried in hot air oven in 60°C and 24hr. Afterthat, crused and sieved the sample and followed procedure given by Jackson [11] for NPK uptake. After determining the contents the uptake value by each plant components were calculated by the formula.

$$\text{Dry matter yield (kg/ha)} \times \text{Nutrient content (\%)} = \text{Nutrient uptake (kg/ha)}$$

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 [11]. Ibrahim *et al.* [12] also observed the result of balanced and improved nutrient uptake in vermicompost in Chinese cabbage. Similar result found by Meena *et al.* [13] in broccoli, Chatterjee [14] in cabbage, Singh *et al.* [15] in chilli, Baliah *et al.* [16] in okra, Tayade *et al.* [17] in amaranthus and Sawant *et al.* [18] in radish.

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 3. 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.* [19] and Jeyabal and Kuppaswamy [7]. According to Suklabaidiya *et al.* [4] higher per cent of organic carbon found in cauliflower in vermicompost with *Azotobacter*. 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.* [4] and Sarangthem *et al.* [21]. 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 [22]. This was also reported by Devi *et al.* [23]. 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.

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

Table 4. Effect of organic manures and bio-enhancer on soil attributes and nutrient uptake of plant at harvest in cauliflower

Microbial activity not only contributes to an increase of dissolved organic substances and also affects organic matter in soil (Marschner and Kalbitz [24]; Kalbitz *et al.* [25]. According to Dinesh *et al.* [26] 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.* [27], Mayer *et al.* [28], Piotrowska *et al.* [29], Mir *et al.* [30] and Chandana *et al.* [31]. 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.

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.

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