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Effect of Enriched Organic Manures and Bio-Enhancer on Quality, Soil Attributes and Nutrient Uptake in Cauliflower (*Brassica oleracea* var. *botrytis*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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)

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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 ^{o}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. MATERIALS 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:

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.

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].

Table 1. The details of treatment combination

Treatments	Notation	Treatment combinations
T_1	o_1f_1	80% RDN through FYM enriched with NPK consortium @ 5 lit/ha
T_2	o_1f_2	80% RDN through FYM enriched with Ghan-Jeevamrut @ 250 kg/ha
T_3	o_2f_1	80% RDN through Poultry manure enriched with NPK consortium @ 5 lit/ha
T_4	o_2f_2	80% RDN through Poultry manure enriched with Ghan-Jeevamrut @ 250 kg/ha
T_5	o_3f_1	80% RDN through Vermicompost enriched with NPK consortium @ 5 lit/ha
T_6	o_3f_2	80% RDN through Vermicompost enriched with Ghan-Jeevamrut @ 250 kg/ha
T_7	o_4f_1	60% RDN through FYM enriched with NPK consortium @ 5 lit/ha
T_8	o_4f_2	60% RDN through FYM enriched with Ghan-Jeevamrut @ 250 kg/ha
T_9	o_5f_1	60% RDN through Poultry manure enriched with NPK consortium @ 5 lit/ha
T_{10}	o_5f_2	60% RDN through Poultry manure enriched with Ghan-Jeevamrut @ 250 kg/ha
T_{11}	o_6f_1	60% RDN through Vermicompost enriched with NPK consortium @ 5 lit/ha
T_{12}	o_6f_2	60% RDN through Vermicompost enriched with Ghan-Jeevamrut @ 250 kg/ha

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

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.

$$Uptake\ \left(\frac{kg}{ha}\right) = \frac{Dry\ matter\ yield\ (kg/ha) \times Nutrient\ content\ (\%)}{100}$$

The data on these parameters were subjected to statistical analysis to draw logical conclusions.

3. RESULTS AND DISCUSSION

3.1 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 ^{o}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 o_3 (80% RDN through Vermicompost), whereas minimum with o_5 (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.

3.2 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 f_1 (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 f_2 (Ghan-Jeevamrut @ 250 kg/ha).

Table 3. Effect of organic manures and bio-enhancer on quality parameters of cauliflower at harvest

Treatments	TSS (^{o}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

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.

3.3 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 o_3 (80% RDN through Vermicompost), while minimum was recorded under the treatment o_5 (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 Kuppuswamy [7]. According to Suklabaidiya et al. [4] 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. [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.

3.4 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 f_1 (NPK consortium @ 5 lit/ha) after harvesting.

Table 4. 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_2O_5 (kg/ha)	Available K_2O (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

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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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Swarup V, Chatterjee S. Origin and Genetic Improvement of Indian Cauliflower. Econ. Bot. 1972;26(4):381-393.
2. Savita, Jaipaul, Choudhary AK, Negi MS, Kumar A. Advances in vegetable agronomy. *Post graduate school, IARI*, New Delhi, India. 2014; pp 68.
3. Dhaliwal, MS. Handbook of vegetable crops. *Kalyani publishers.* New Delhi; 2012.
4. Suklabaidya A, Datta M, Kandpal BK. Response of organic sources and biofertilizer in soil ferlity and yield of cauliflower in the foot hills of Tripura. Int. J. Agric. Sci. 2017;9(51):4874-4875.
5. 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.
6. Edwards CA, Arancon NQ, Sherman R. Vermiculture technology: earthworms, organic wastes, and environmental management. *CRC press,* Boca Raton, Florida; 2011.
7. 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.
8. Jacob S, Banerjee R. Nutrient enrichment of organic manure through biotechnological means. Waste and Biomass Valorization. 2016;8:645–657.
9. 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.
10. Sadasivam, S. and Manickam, A. (1997). Biochemical method. New Age International Publishers. New Delhi.
11. Jackson, M. L. (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi: 327-350.
12. 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.
13. 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.

14. 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.
15. 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.
16. Baliah NT, Priyathini LS, Priya C. Effect of organic fertilizers on growth and biochemical cheracteristics ok okra (*Abelmochus esculentus* L. Monench). Int. J. Sci. Res. 2015;6(1):679-682.
17. Tayade MS, Bawkar SO, Kale VS, Deshmukh UB. Integrated nutrient management in amaranthus (*Amaranthus tricolor* L.). Asian J. Hort. 2012;7(2):291-293.
18. Sawant A, Goud CR, Deshmukh P. Effect of integrated nutrient management on growth, yield and quality of Radish (*Raphanus sativus* L.). J. Pharm Innov. 2023;12(4):682-685.
19. 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.
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. 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.
22. 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.
23. 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.
24. Marschner B, Kalbitz K. Controls of bioavailability and biodegradability of dissolved organic matter in soils. Geoderma. 2003;113:211–235.
25. 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.
26. 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.
27. 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.
28. 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.
29. 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.
30. Mir RA, Ahmad MK, Bhat KR. Impact of bacterial consortium on plant growth development, fruit yield and disease resistance in tomato (*Solanum lycopersicum*). Asian J. Trop Biotechnol. 2023;20(1):1-9.
31. Chandana M, Padma M, Prabhakar BN, Joshi V, Mahender B, Gouthami P, Sathish G. Studies on effect of organic manures and biofertilizers on growth, yield and economics of turmeric (*Curcuma longa* L.) varieties. J. Pharm Innov. 2022;11(11): 824-832.

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