Research Article

Influence of Organic and Biodynamic Manures on Soil Microbial Dynamics and Soil Nutrient Parameters in Chrysanthemum (*Dendranthema grandiflora* Tzvelev) cv. Thai Chen Queen

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Abstract

Excessive use of inorganic fertilizers in raising of crops is deleterious to soil health and environment. Application of organic and biodynamic manures help to maintain soil fertility, soil microbial population and quality flower production. Keeping in view, an experiment was conducted at Model Floriculture Centre, GBPUAT, Pantnagar, during 2018-19 and 2019-20 to study the response of effects of organic nutrient management practices on the biological properties of soil in chrysanthemum cv. Thai Chen Queen. The experiment consisted of sixteen treatment combinations plotted using a randomised block design, replicated thrice. During chrysanthemum harvest, soil treated with Panchagavya 6 % + common basal dose (T_7) had considerably higher bacterial, fungal, and actinomycetes populations, as well as more N-fixers and P-solubilizers than the other treatment combinations. Additionally, the impact of organic farming practices on soil health in the region was investigated using basic soil parameters. The results indicate that when 6% Panchagavya along with common basal dose is applied, both the microbial population and essential nutrients increased in soil. The pH, E.C and organic carbon concentrations were all close to neutral.

Keywords: Chrysanthemum, Panchagavya, Jivamrita, Bio-fertilizers, Soil microbial population, Soil nutrient parameters, Organic farming

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Introduction

Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) is one of the most popular flowering plants belonging to Asteraceae family. Chrysanthemum ranks second in the cut flower trade after rose at the Dutch auctions, which is a good indicator of its global business. In India, chrysanthemum is valued as a commercial flower crop as well as a popular exhibition flower. It is widely grown as a cut flower, loose flower, or pot plant [1]. Chrysanthemum is famous by different names in various languages in India. It is called "*Chandramallika*" in Bengali, "*Shevanti*" in Marathi and Gujarati. In Hindi, its known as *guldaudi* meaning flower of Daud, which suggests that chrysanthemum was grown in the Mughal period of the country [2].

Organic manures directly help to increase the productivity of soil in the long run and produce chemical residue-free healthy crops [3]. Hence, there is an urgent need for the development of organic modules and promoting organic cultivation technologies of cut flowers [4]. It is pertinent to mention that "cow" plays a vital role in most organic farming systems prevalent in India and elsewhere [5]. Panchagavya is one of the liquid organic manures which is prepared using five cow products namely cow dung, urine, milk, ghee, and curd. Panchagavya is a low-cost organic liquid manure with regulatory substances like IAA (Indoleacetic acid), GA, cytokinins, essential plant nutrients and effective microorganisms that promote plant development. The application of Jivamrita to soil improves the soil considerably. Credit for the development of recipes for Jivamrita and its extensive use goes to Sh. Palekar, a strong natural farming promoter [6], In addition, Jivamrita has a high microbial load, which multiplies and improves the soil. Increased soil microbial activity ensures that nutrients are available in soil and are absorbed by crops [7]. Panchagavya and Jivamrita have good potential as manure to improve physical, chemical and biological properties of soil. The standard agricultural practices degrade crops and soil in commercial chrysanthemum cultivation. However, organic farming can eliminate these difficulties, as chemical fertilisers continuously deteriorate soil health, growth and productivity-related issues, ultimately affecting human health and the environment. With this issue in mind, the current investigation on growth, flowering and post-harvest life of chrysanthemum (*Dendranthema grandiflora* Tzvelev.) cv. Thai Chen Queen in response to organic and biodynamic manures was designed to slow down the widespread use of chemical fertilisers and promote chrysanthemum growth through the application of two liquid organic bio-enhancers, namely, Panchagavya and Jivamrita.

Materials and Methods

The present investigation was carried out during 2018-19 and 2019-20 at Model Floriculture Centre, G.B. Pant University of Agriculture and Technology, Pantnagar. The experiment was laid out in a randomized block design (RBD) with three replications. There were sixteen treatments which were applied as T_1 : Control, T_2 : 1 % Panchagavya + Common basal dose (CBD), T_3 : 2 % Panchagavya + CBD, T_4 : 3 % Panchagavya + CBD, T_5 : 4 % Panchagavya + CBD, T_6 : 5 % Panchagavya + CBD, T_7 : 6 % Panchagavya + CBD, T_8 : 7 % Panchagavya + CBD, T_9 : 8 % Panchagavya + CBD, T_{10} : 9% Panchagavya + CBD, T_{11} : 10 % Panchagavya + CBD, T_{12} : 10 % Jivamritha + CBD, T_{13} : 20 % Jivamrita + CBD, T_{14} : 30 % Jivamrita + CBD T_{15} : 40 % Jivamrita + CBD, T_{16} : 50 % Jivamrita + CBD.

Common basal dose consisted of vermicompost and bio-fertilizers comprising of *Azotobacter*, *Azospirillum*, PSB (phosphorus solubilising bacteria) as well as potash bacteria. Biofertilizer cultures were obtained from the Division of Microbiology, ICAR - Indian Agricultural Research Institute (IARI), Pusa, New Delhi. Vermicompost and CBD @ 5 kg/bed were applied one day prior to transplantation in experimental plots according to the layout and treatment combinations. One-month-old rooted cuttings of chrysanthemum of uniform size were transplanted at 40 × 40 cm^2 spacing, with nine plants in each plot. Soil samples were collected from the surface layer (0–15 cm) of all the plots before treatment applications and immediately after harvesting of chrysanthemum in two seasons. Five random cores were taken from each plot with a 5-cm diameter tube auger and bulked. Soil samples were air-dried and ground to pass through a 2-mm sieve. All soil samples meant for chemical analysis were stored at room temperature until required for analysis. The rest of the soil samples were immediately transferred to the laboratory for analysis of enzyme activities. Soil samples were kept at 4ºC in plastic bags and analysed within 2 weeks. The soil pH was determined in 1:2.5 soil: water suspension [8]. Using an EC meter, electrical conductivity was measured and expressed as dSm^{-1}[9]. Oxidizable soil organic C was determined by the method of [10]. Available nitrogen was determined by alkaline potassium permanganate method [11] and available phosphorus by the method as described [12]. Available potassium was determined with 1N ammonium acetate solution and flame photometer [8]. Estimation of soil microbial population was done by the method of soil analysis [13] and P-solubilizers as well as N-fixers in rhizosphere soil was determined by the method given by [14]. The technique of analysis of variance (ANOVA) for randomized block design (RBD) was adopted [15].

Results and Discussion

Microbial parameters

Data pertaining to application of biodynamic manures and biofertilizers on soil microbial population of chrysanthemum cv. Thai Chen Queen are presented in **Table 1**. Perusal of data in Table 1 and **Figures 1** and **2** clearly reflect that soil microbial population were significantly influenced by the various treatments. Treatment combination of T_7 (6 % Panchagavya + CBD) resulted in maximum bacterial population (290 x 10^5, 288 x 10^5 CFU g^{-1}), fungal population (142 x 10^5, 140 x 10^5 CFU g^{-1}) and actinomycetes population (147 x 10^5, 146 x 10^5 CFU g^{-1}) as well as more N-fixers (74 x 10^4, 71 x 10^4 CFU g^{-1}) and P-solubilizers (163 x 10^3,160 x 10^3 CFU g^{-1}) in both seasons of 2018-19 and 2019-20, respectively whereas all these microbial population were recorded minimum in control. However, application of T_{16} (50 % Jivamrita + CBD) recorded second highest microbial parameters after T_7. The increase in the microbial population of organically treated chrysanthemum plots is attributed to the use of biofertilizers in combination with liquid organic manures such as Panchagavya and Jivamrita. Macro and micronutrients are present in Panchagavya, as well as a variety of bioagents including Azospirillum, Azotobacter, Phosphobacteria, and Pseudomonas [16], as well as growth-promoting enzymes and essential plant nutrients [17-18], whereas application of Jivamritha will increase microbial population. These microbes enhance the availability of nutrients, such as nitrogen, phosphorus and potassium to plants by a variety of methods, including potassium, phosphate, zinc solubilization, iron chelation, and IAA generation, thereby enhancing plant growth. Increase in the microbial population functions as an indicator for soil fertility and health. Microbial communities play a crucial role in the functioning of ecosystem, both in terms of direct interactions with plants and in terms of nutrient and organic matter cycling. They play a critical role in ensuring the stability and productivity of agricultural systems and natural ecosystems. Increased population results in increased microbial biomass in the soil, which serves as a temporary store for labile nutrients. The above results are in concurrence with the findings of [19] in capsicum, [20] in field bean, [21] in black gram and [22] in rice.

Soil nutrient parameters

The data pertaining to soil nutrient parameters under different treatments are presented in **Table 2**. The soil nutrient parameters like nitrogen, phosphorous and potassium were significantly increased in treatment T_7 (6 % Panchagavya

+ CBD) followed by treatment T_{16} (50 % Jivamrita + CBD). Minimum soil nutrient status was found in treatment T_1 (control). Application of liquid manures i.e., Panchagavya and Jivamritha significantly influenced nutrient concentration of chrysanthemum plots during both the years i.e., 2018-19 and 2019-20. The nutrient concentration increased with increased levels of Panchagavya and Jivamrita application along with combination of CBD. Among the treatment combinations, application of 6 % Panchagavya + CBD recorded significantly higher nutrient content of N, P and K % in plants followed by 50 % Jivamrita + CBD at all the stages during both the years. This may be due to liquid manures contain macro and micro nutrients which are readily available for plant growth and development. Increased availability of nutrients due to build-up of soil micro flora result in increased bacteria, fungi, actinomycetes, P solubilizer and N fixer population in the soil. Panchagavya has been found to be helpful for improving soil physical properties by increasing soil porosity and maintaining aggregate stability. Panchagavya has a great influence on soil chemical properties as it acts as pH moderator in alkaline and acidic soil due to its neutral pH (6.82). It also enhanced nutrient status of soil and increased more uptakes of nutrients due to more solubilisation [23]. The above results are in accordance with the findings of [24-27].

Table 1 Effect of Panchagavya and Jivamrita on population of fungal, bacterial, actinomycetes N-fixers and P-solubilizers during the year 2018-19 and 2019-20

Treatments /Combin-ations	**Bacterial Population (10^5 CFU g^{-1})**		**Pool-ed**	**Fungal Population (10^5 CFU g^{-1})**		**Pool-ed**	**Actinomycetes Popu lation (10^5 CFU g^{-1})**		**Pool-ed**	**N-Fixers (10^4 CFU g^{-1})**		**Pool-ed**	**P- Solubilizers (10^3 CFU g^{-1})**		**Pool-ed**
	2018-19	**2019-20**		**2018-19**	**2019-20**		**2018-19**	**2019-20**		**2018-19**	**2019-20**		**2018-19**	**2019-20**	
Control (T_1)	94	91	93	37	35	36	39	37	38	31.00	30.00	30.50	42.00	41.00	41.50
1% Panchagavya + CBD* (T_2)	176	172	174	54	52	53	45	44	44	45.00	41.00	43.00	110.00	108.00	109.00
2% Panchagavya + CBD* (T_3)	123	121	122	79	75	77	74	72	73	46.00	45.00	45.50	113.00	111.00	112.00
3% Panchagavya + CBD* (T_4)	220	218	219	87	86	86	92	91	91	68.00	65.00	66.50	154.00	152.00	153.00
4% Pancha gavya +CBD* (T_5)	195	194	194	63	60	61	82	80	81	48.00	45.00	46.50	98.00	97.00	97.50
5% Pancha gavya + CBD* (T_6)	141	138	140	38	36	37	44	42	43	44.00	43.00	43.50	107.00	105.00	106.00
6% Panchagavya + CBD* (T_7)	290	288	289	142	140	141	147	146	146	74.00	71.00	72.50	163.00	160.00	161.50
7% Panchagavya + CBD* (T_8)	102	101	101	40	38	39	40	39	40	63.00	60.00	61.50	121.00	118.00	119.50
8% Panchagavya + CBD* (T_9)	202	200	201	82	79	80	88	86	87	64.00	61.00	62.50	126.00	125.00	125.50
9% Panchagavya + CBD* (T_{10})	103	101	102	45	44	44	38	37	38	61.00	59.00	60.00	116.00	114.00	115.00
10%Panchaga vya + CBD* (T_{11})	144	141	143	55	54	54	52	51	51	56.00	54.00	55.00	124.00	122.00	123.00
10% Jivamrita + CBD* (T_{12})	161	162	162	76	75	76	58	55	57	55.00	52.00	53.50	109.00	108.00	108.50
20% Jivamrita + CBD* (T_{13})	154	153	153	43	41	42	45	44	44	60.00	58.00	59.00	127.00	125.00	126.00
30% Jivamrita + CBD* (T_{14})	133	131	132	73	72	72	65	64	64	53.00	50.00	51.50	132.00	130.00	131.00
40% Jivamrita + CBD* (T_{15})	144	140	142	75	74	74	81	80	81	58.00	56.00	57.00	136.00	137.00	136.50
50% Jivamrita + CBD* (T_{16})	237	236	237	121	120	121	119	118	119	70.00	69.00	69.50	158.00	154.00	156.00

CBD*: Common basal dose; CBD: Consists of vermicompost @ 5 kg/bed and bio-fertilizers comprising of *Azotobacter*, *Azospirillum*, PSB (Phosphorus solubilizing bacteria) as well as potash bacteria.

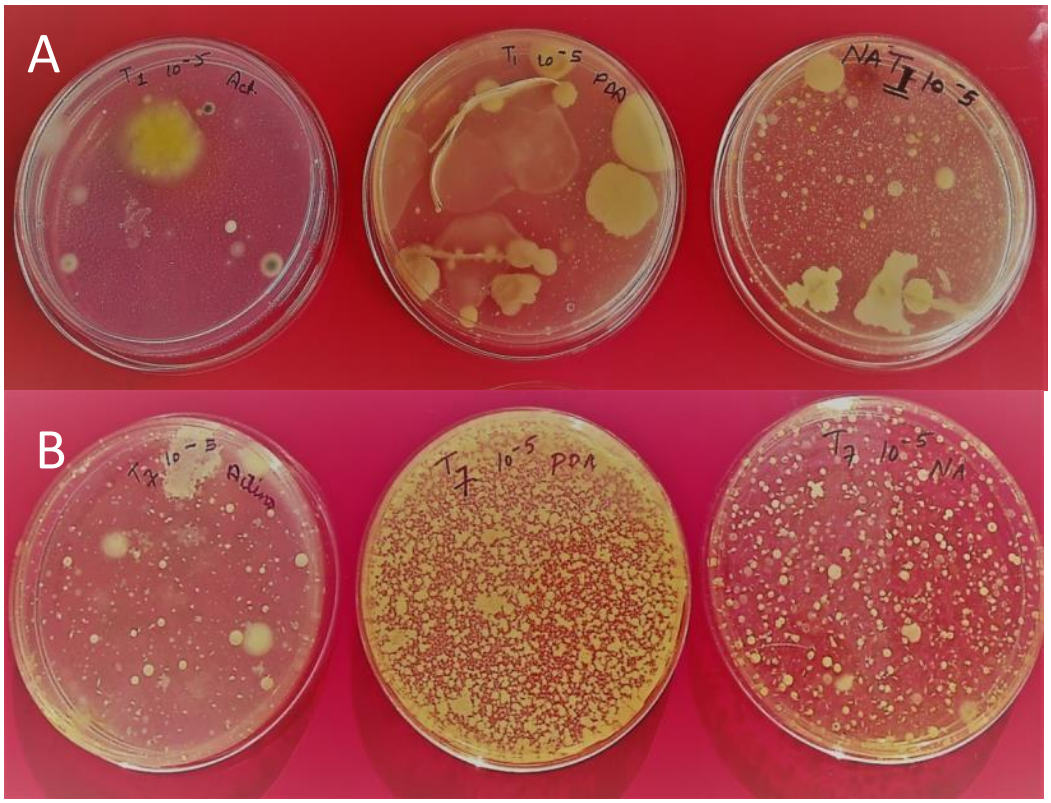

Figure 1 (A) Control (T_1) has less growth of microbial population (Actinomycetes, Fungal and Bacterial), (B) 6 % Panchagavya + CBD *(T_7) has excellent growth of microbial population (Actinomycetes, Fungal and Bacterial)

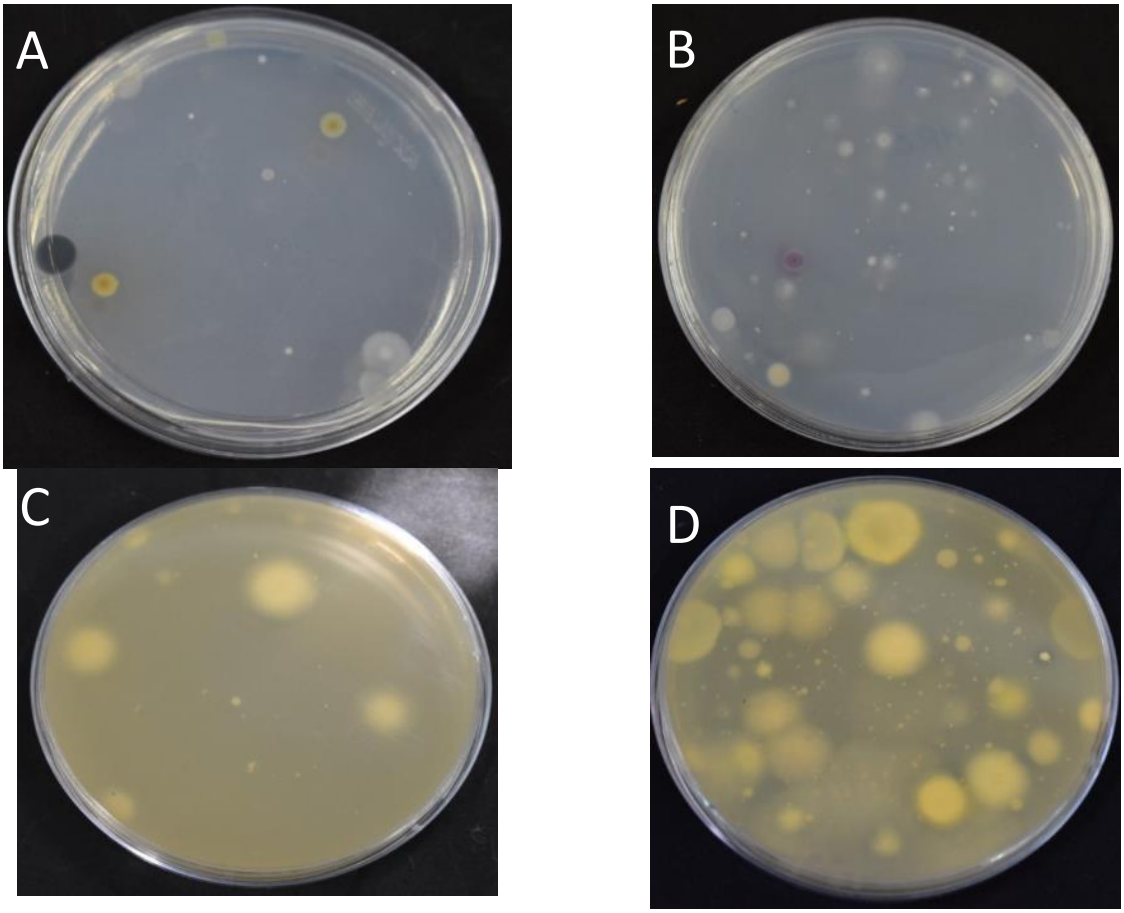

Figure 2 A. Control (T_1) showed minimum growth for N-fixers, B. 6 % Panchagavya + CBD *(T_7) showed excellent growth of N-fixers, C. Control (T_1) showed minimum growth for P-Solubilizers, D. 6 % Panchagavya + CBD *(T_7) showed excellent growth of P-solubilizers

Table 2 Effect of *Panchagavya* and *Jivamrita* on soil physical properties and nutrient parameters in chrysanthemum during the year 2018-19 and 2019-20

Treatments /Combinations	pH		Pooled	EC		Pooled	Organic carbon		Pooled	Nitrogen (kg/ha)		Pooled	Phosphorous (kg/ha)		Pooled	Potassium (kg/ha)		Pooled
	2018-19	2019-20		2018-19	2019-20		2018-19	2019-20		2018-19	2019-20		2018-19	2019-20		2018-19	2019-20	
Control (T_1)	7.68	7.66	7.67	0.40	0.38	0.39	0.537	0.53	0.533	198.0	190.50	194.27	13.52	12.58	13.047	155.43	148.65	152.04
1%Panchagavya+CBD* (T_2)	7.58	7.57	7.577	0.43	0.42	0.43	0.77	0.763	0.765	235.7	230.40	233.03	17.30	15.68	16.49	175.60	172.51	174.06
2% Panchagavya + CBD* (T_3)	7.64	7.63	7.633	0.50	0.47	0.49	1.243	1.23	1.237	238.3	234.60	236.47	17.68	15.86	16.77	177.83	175.42	176.63
3% Panchagavya + CBD* (T_4)	7.62	7.593	7.603	0.63	0.61	0.62	1.555	1.54	1.545	277.0	271.30	274.17	23.36	22.32	22.84	204.70	201.32	203.01
4% Panchagavya + CBD* (T_5)	7.42	7.42	7.41	0.52	0.50	0.51	1.42	1.41	1.415	228.3	223.80	226.07	16.92	15.64	16.28	171.10	169.81	170.46
5% Panchagavya + CBD* (T_6)	7.54	7.513	7.523	0.44	0.43	0.43	1.155	1.14	1.145	249.7	242.60	246.13	18.82	17.36	18.09	185.67	182.65	184.16
6% Panchagavya + CBD* (T_7)	7.20	7.183	7.19	0.82	0.78	0.80	1.633	1.623	1.625	288.3	284.30	286.30	24.88	25.40	25.14	214.63	213.62	214.13
7% Panchagavya + CBD* (T_8)	7.65	7.627	7.64	0.47	0.46	0.47	1.283	1.267	1.277	261.0	255.60	258.30	20.71	19.84	20.28	195.73	192.46	194.10
8% Panchagavya + CBD* (T_9)	7.61	7.62	7.603	0.56	0.52	0.54	1.323	1.303	1.311	273.7	270.50	272.10	22.60	21.66	22.13	201.33	198.73	200.03
9% Panchagavya + CBD* (T_{10})	7.57	7.577	7.577	0.53	0.50	0.52	1.507	1.503	1.504	243.0	238.60	240.83	18.44	17.92	18.18	181.17	178.64	179.90
10% Panchagavya +CBD* (T_{11})	7.47	7.45	7.46	0.55	0.54	0.54	0.95	0.94	0.945	215.7	210.20	212.93	16.55	15.98	16.26	166.63	164.51	165.57
10% Jivamrita+ CBD* (T_{12})	8.00	7.91	7.95	0.45	0.44	0.44	1.14	1.155	1.145	203.0	199.80	201.40	15.41	14.74	15.07	209.27	205.63	207.45
20% Jivamrita+ CBD* (T_{13})	7.88	7.793	7.837	0.47	0.42	0.44	1.27	1.263	1.265	266.0	262.40	264.20	20.71	19.90	20.30	198.53	195.25	196.89
30% Jivamrita + CBD* (T_{14})	7.70	7.68	7.69	0.54	0.52	0.53	1.353	1.35	1.352	254.7	250.60	252.63	19.95	19.10	19.53	190.13	188.63	189.38
40% Jivamrita+ CBD* (T_{15})	7.64	7.63	7.62	0.48	0.47	0.48	1.444	1.413	1.425	208.0	205.90	206.97	15.79	15.60	15.70	163.30	160.42	161.86
50% Jivamrita+ CBD* (T_{16})	7.54	7.527	7.537	0.67	0.65	0.66	1.57	1.557	1.565	283.3	280.20	281.77	24.10	23.42	23.76	212.53	210.91	211.73
S.E m±	0.095	0.124	0.105	0.007	0.008	0.009	0.019	0.018	0.022	3.614	3.444	3.312	0.323	0.242	0.286	2.713	1.568	2.617
C.D at 5%	0.275	0.263	0.306	0.021	0.024	0.026	0.055	0.051	0.063	10.476	9.994	9.613	0.938	0.703	0.831	7.875	4.552	7.595

CBD*: Common basal dose; CBD: Consists of vermicompost @ 5 kg/bed and bio-fertilizers comprising of *Azotobacter, Azospirillum,* PSB (Phosphorus solubilizing bacteria) as well as potash bacteria

Conclusion

The standard agricultural practices degrade crops and soil in commercial chrysanthemum growing. These issues can be resolved by organic farming, as chemical fertilisers impair soil health, growth, and productivity, ultimately

affecting human health and the environment. The analysis indicated that the application of T_7 (6 % Panchagavya + Common basal dose) increased microbial growth and had a significant effect on soil physical and nutritional parameters in chrysanthemum cultivation when compared to the control and other treatments.

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