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Soil Properties and Microbial Population after Harvesting of Cauliflower (*Brassica oleraccea* var. L. *Botrytis*) cv. Pusa Snowball K-1 as Influenced by Organic Manures and Liquid Formulations

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ABSTRACT

A field experiment was carried out during **rabi** 2018-19 and 2019-20 at Rajasthan College of Agriculture, MPUAT, Udaipur to study the soil properties and microbial population after harvesting of cauliflower (*Brassica oleraccea* L. var. *Botrytis*) cv. Pusa Snowball K-1 as influenced by organic manures and liquid formulations. The 18 treatment combinations, comprising three types of organic manures and six types of liquid formulations, were evaluated on cauliflower crop with three replications under split plot design. In the organic manure treatment M_3 (FYM 1/3rd + PROM 1/3rd + NC 1/3rd equivalent to 100% RDN) and in liquid formulation L_1 treatment (panchagavya @ 3% spray) were reported significantly higher in soil organic carbon (0.72%), available nitrogen (244.4 kg/ha), available phosphorus (21.2 kg/ha), maximum soil bacteria (66.2 x 10^6 cfu/g), fungi (27.3 x 10^4 cfu/g) and actinomycetes (35.7 x 10^4 cfu/g).

Key words : Organic manures, liquid formulations, microbial population and soil properties

INTRODUCTION

Cauliflower is one of the most important winter season vegetables among the cole crops which belong to the genus *Brassica* of the family Cruciferae with chromosome number 2n = 18. It is a cold weather hardy crop and thrives best in cool and moist climate. This had originated from Cyprus and the first crop of cauliflower was introduced in India in sixth century A. D. There is a great demand for this vegetable on account of its delicious taste. Due to abortive floral parts which are fleshy and closely crowded, these are used for culinary purpose either alone or mixed with potato. Pickle can also be prepared from the firm curd. Cauliflower has high protein and peculiar regarding in stability of vitamin C after cooking. Raw cauliflower provides good amount of nutrients and vitamins. Hundred grams of cauliflower contain vitamin C (46.4 mg), vitamin K 16 µg, folate (57.0 µg), vitamin B_6 (0.2 mg), fiber (2.5 g), potassium (303.0 mg), manganese (0.2 mg) and vitamin B_5 (0.7 mg). As weather is a limiting factor in the production of cauliflower, the plant grows best in cool day time temperatures 70-85°F (21-29°C), with plentiful sun shine and moist soil conditions high in organic matter and sandy soils.

In plant nutrition, farm yard manure and compost play important roles, as they act directly to increase the crop yields either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. These organics supply nitrogen, phosphorus, potassium and micronutrients like Fe, S, Mo and Zn, etc. in available form to the plants through biological decomposition and improve physico-chemical properties of soil such as aggregation, aeration, permeability, water holding capacity, slow release of nutrients, increase in cation exchange

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capacity, stimulation of soil flora and fauna, etc. Organic manure increases cation exchange capacity, water holding capacity and soil phosphate availability besides enhancing fertilizer use efficiency and soil microbial population, reducing nitrogen losses due to slow nutrient release (Tadesse *et al.*, 2014).

Neem cake is a plant originated concentrated organic manure mainly obtained from fresh fruits of neem (*Azadirachta indica* L.) after extraction of oil (as a residue). Neem cakes contain not only nitrogen but also some phosphoric acid and besides a large quantity of potash. Declining fertilizer use efficiency, especially of phosphorus and continuous building of insoluble phosphorus reserve in soils is a growing concern world over and efforts are being made to replace the use of 100% water soluble phosphorus with that of organic carbon linked phosphorus. PROM technology, in which natural rock-phosphate is being integrated with organic manures during composting process, has emerged as suitable alternative to our needs. In liquid organic formulations, panchagavya has the potential to promote growth and provide resistance in the plant system. Panchagavya consists of five products viz., cow dung, urine, milk, curd and ghee and is used widely in agriculture, especially for and horticultural crops (Pathak and Ram, 2013).

MATERIALS AND METHODS

Field experiment was conducted during **rabi** seasons of 2018-19 and 2019-20 on Entisol soil. The soil of experimental field was clay loam in texture, slightly alkaline low in organic carbon (0.61%), nitrogen (190 kg/ha), available phosphorus (17.28 kg/ha), high in potassium (251.45 kg/ha) at Horticultural Farm, Rajasthan College of Agriculture, MPUAT, Udaipur (24°35′ N latitude and 72°42′ E longitude and at an elevation of 582.17 m above mean sea level). The experiment was laid out in a split plot design (SPD) with three replications.

The experiment included the 18 treatment combinations comprising three main plots of organic manures and six sub-plots with liquid formulations. The recommended dose of fertilizer for cauliflower crop is 120 : 80 : 40 NPK/ha as per the package of practices for the Agro-climatic zone-IVa of Rajasthan state. Four weeks old healthy seedlings of variety Pusa Snowball K-1 of cauliflower were transplanted in already prepared beds at a spacing of 60 x 45 cm during evening hours in the first week of October, 2018 and 2019, respectively.

The details of used organic manures and liquid formulations are given as under :

Three main plot treatments of organic manures (M) were :

(a) M_1–FYM 1/3rd + Vermicompost 1/3rd + Neem cake 1/3rd equivalent to 100% RDN,
(b) M_2–FYM 1/3rd + Enriched compost 1/3rd + Vermicompost 1/3rd equivalent to 100% RDN and
(c) M_3–FYM 1/3rd + PROM 1/3rd + Neem cake 1/3rd equivalent to 100% RDN.

Six sub-plot treatments of liquid formulations spray (L) were :

(a) L_1–Panchagavya spray (3%) at curd initiation and 15 DACI (days after curd initiation),
(b) L_2–Jeevamrut (spray @ 500 litre/ha) at curd initiation and 15 DACI,
(c) L_3–Cow urine spray (10%) at curd initiation and 15 DACI,
(d) L_4–Vermiwash spray (10%) at curd initiation and 15 DACI,
(e) L_5–Matka khad spray (10%) at curd initiation and 15 DACI and
(f) L_6–Control (water spray) at curd initiation and 15 DACI.

Studied Characters

The yield/ha was calculated by multiplying the net yield per plot with number of plots/ha. It was measured in q/ha.

The organic carbon content in soil was estimated by Walkley and Black's rapid titration method.

Available nitrogen was determined by alkaline potassium permanganate method.

Available phosphorus was determined by Olsen's method. It was extracted from soil with 0.5 M $NaHCO_3$ at pH 8.5 to develop colour by $SnCl_2$, and to measure colour intensity on spectrophotometer.

Available potassium was measured by extracting it with neutral 1 N ammonium acelate and measured on flame photometer.

Microbial population was estimated by using serial dilution plate method. The experimental field was surveyed and soil samples were collected from each treatment plot (18 treatments). The soil (0-30 cm depth) was collected in polythene bags and placed at 4°C. The initial microbial population was counted by adopting serial dilution pour plate technique on yeast extract mannitol agar (YEMA).

RESULTS AND DISCUSSION

The yield of cauliflower was significantly affected by organic manures application during both the years of investigation (Table 1). The maximum yield per plot (12.93 kg) and yield per hectare (239.4 q/ha) were recorded significant in M_3 treatment (FYM 1/3rd + PROM 1/3rd + Neem cake 1/3rd equivalent to 100% RDN), while yield per plot (9.93 kg) and yield per hectare (183.9 q/ha) were recorded under M_2 treatment (FYM 1/3rd + Enriched compost 1/3rd + Vermicompost 1/3rd equivalent to 100% RDN). A considerable impact of PROM and FYM for increased yield for enhanced establishment of micro-organism population in rhizosphere as the organic matter in addition for providing physical properties ensured nutrient availability and food supply for plants (Devanda, 2020). Phosphorus is important for protein synthesis, chlorophyll and for establishment of good root mass. Similar findings were reported through using organic manures by Eifediyi *et al.* (2015) in okra, Tripathi *et al.* (2016) in cauliflower, Aechra *et al.* (2017) in cowpea, Miglani *et al.* (2017) and Negi *et al.* (2017) in broccoli and Sharma and Suryavanshi (2020) in cauliflower.

The soil properties were significantly affected by organic manures application during both the years of investigation i. e. 2018-19 and 2019-20, and also in pooled analysis (Table 2). The highest pooled data on soil organic carbon (0.72%), available nitrogen (244.4 kg/ha) and available phosphorus (21.2 kg/ha) were recorded in M_3 treatment (FYM 1/3rd + PROM 1/3rd + Neem cake 1/3rd equivalent to 100% RDN), while the lowest pooled data on soil organic carbon (0.68%), available nitrogen (198.6 kg/ha) and available phosphorus (19.1 kg/ha) were recorded under M_2 treatment (FYM 1/3rd+Enriched compost 1/3rd+Vermicompost 1/3rd equivalent to 100% RDN). However, the effect of organic manures on available potassium (kg/ha) was observed non-significant during 2018-19 and 2019-20, and in pooled analysis. It might be due to the fact that application of organic matter improved porosity, soil structure and WHC and reduced the bulk density. The chemical properties viz., available nutrients and soil organic carbon also improved. All these had valuable impacts on soil health, crop growth and yield on sustained basis. Such findings were also supported by Sridhar *et al.* (2014), Jagadeesha *et al.* (2019) and Udom *et al.* (2019).

Effect of organic manures on microbial population in the soil was found significant (Table 3) during both the years of investigation i. e. 2018-19 and 2019-20, and also in pooled analysis. In which the highest pooled value of soil bacteria (66.2 x 10^6 cfu/g), fungi (27.3 x

Table 1. Effect of organic manures and liquid formulations on yield cauliflower

Treatment	Yield/plot (kg)			Yield/ha (q)		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Organic manures (M)						
M_1	10.02	10.72	10.37	185.60	198.60	192.10
M_2	9.69	10.17	9.93	179.40	188.40	183.90
M_3	12.37	13.48	12.93	229.10	249.70	239.40
S. Em±	0.14	0.18	0.08	2.50	3.40	1.40
C. D. (P=0.05)	0.53	0.71	0.23	9.90	13.20	4.30
Liquid formulations (L)						
L_1	11.55	12.39	11.97	213.90	229.40	221.70
L_2	10.80	11.58	11.19	200.00	214.40	207.20
L_3	10.45	11.19	10.82	193.50	207.20	200.30
L_4	10.93	11.72	11.33	202.50	217.10	209.80
L_5	10.60	11.35	10.98	196.30	210.20	203.30
L_6	9.83	10.53	10.18	182.10	195.00	188.60
S. Em±	0.21	0.22	0.11	3.80	4.00	2.00
C. D. (P=0.05)	0.60	0.63	0.30	11.10	11.60	5.50

Table 2. Effect of organic manures and liquid formulations and their interactive effect on soil, available N, P_2O_5 and K_2O content in soil after final harvest

Treatment	Available N (kg/ha)			Available P (kg/ha)			Available K (kg/ha)		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Organic manures (M)									
M_1–FYM 1/3rd+vermicompost 1/3rd+neem cake 1/3rd equivalent to 100% RDN	212.9	219.7	216.3	19.8	20.4	20.1	264.5	265.8	265.2
M_2–FYM 1/3rd+enriched compost 1/3rd+ vermicompost 1/3rd equivalent to 100% RDN	195.4	201.8	198.6	19.0	19.3	19.1	262.3	264.2	263.2
M_3–FYM 1/3rd+PROM 1/3rd+neem cake 1/3rd equivalent to 100% RDN	243.0	245.8	244.4	20.7	21.8	21.2	266.9	268.7	267.8
S. Em±	2.6	3.2	1.5	0.2	0.3	0.1	2.8	3.5	1.6
C. D. (P=0.05)	10.2	12.7	4.3	0.9	1.1	0.4	NS	NS	NS
Liquid formulations (L)									
L_1–Panchagavya spray (3%)	216.6	221.3	218.9	20.1	21.0	20.6	264.2	266.4	265.3
L_2–Jeevamrut spray @ 500 l/ha)	221.1	225.5	223.3	19.6	20.3	19.9	265.2	266.9	266.1
L_3–Cow urine spray (10%)	217.8	223.8	220.8	20.0	20.6	20.3	265.0	266.4	265.7
L_4–Vermiwash spray (10%)	217.2	222.2	219.7	19.7	20.4	20.1	265.5	267.4	266.5
L_5–Matka khad spray (10%)	217.5	223.1	220.3	19.8	20.5	20.2	264.7	266.4	265.5
L_6–Control (water spray)	212.4	218.5	215.5	19.6	20.1	19.8	262.5	264.0	263.2
S. Em±	4.2	4.1	2.1	0.4	0.4	0.2	5.1	5.0	2.6
C. D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS–Not Significant.

10^4 cfu/g) and actinomycetes (35.7 x 10^4 cfu/g) was found significant under M_3 treatment (FYM 1/3rd + PROM 1/3rd + Neem cake 1/3rd equivalent to 100% RDN), while the lowest pooled value of soil bacteria (61.2 x 10^6 cfu/g), fungi (25.6 x 10^4 cfu/g) and actinomycetes (33.2 x 10^4 cfu/g) was recorded under M_2 treatment (FYM 1/3rd + enriched compost 1/3rd + vermicompost 1/3rd equivalent to 100% RDN). It was due to FYM helping in the conservation of soil moisture, which helped microbial growth and development. PROM was responsible for enhancing microbial population in soil which helped in conversion of soluble phosphorus in soil and neem cakes controlled harmful organisms like nematodes and

Table 3. Effect of organic manures and liquid formulations and their interactive effect on soil microbial population in soil after harvest

Treatment	Soil microbial population (cfu/g)								
	Bacteria (x 10^6 cfu/g)			Fungi (x 10^4 cfu/g)			Actinomycetes (x 10^4 cfu/g)		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Organic Manures (M)									
M_1–FYM 1/3rd+vermicompost 1/3rd+neem cake 1/3rd equivalent to 100% RDN	61.0	63.4	62.2	25.2	27.7	26.4	33.3	34.7	34.0
M_2–FYM 1/3rd+enriched compost 1/3rd+ vermicompost 1/3rd equivalent to 100% RDN	60.0	62.4	61.2	24.3	26.9	25.6	32.5	33.9	33.2
M_3–FYM 1/3rd+PROM 1/3rd+neem cake 1/3rd equivalent to 100% RDN)	65.0	67.4	66.2	26.0	28.7	27.3	34.9	36.5	35.7
S. Em±	0.7	0.9	0.4	0.3	0.4	0.2	0.4	0.5	0.2
C. D. (P=0.05)	2.7	3.4	1.2	1.1	1.5	0.5	1.5	1.9	0.6
Liquid formulations (L)									
L_1–Panchagavya spray (3%)	62.9	65.6	64.2	25.5	28.2	26.8	34.1	35.7	34.9
L_2–Jeevamrut spray (@ 500 l/ha)	62.3	64.9	63.6	25.2	27.8	26.5	33.7	35.2	34.4
L_3–Cow urine spray (10%)	61.4	63.8	62.6	24.9	27.4	26.2	33.0	34.5	33.8
L_4–Vermiwash spray (10%)	62.6	65.0	63.8	25.5	28.1	26.8	33.9	35.4	34.6
L_5–Matka khad spray (10%)	61.6	63.8	62.7	25.1	27.8	26.5	33.7	35.0	34.3
L_6–Control (water spray)	61.2	63.3	62.2	24.7	27.2	26.0	33.1	34.4	33.7
S. Em±	1.2	1.2	0.6	0.5	0.5	0.2	0.6	0.7	0.3
C. D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS–Not Significant.

pathogens and also reduced the alkaline content in the soil. These findings were strongly supported by findings of Anisa *et al.* (2016) and Devanda (2020) in okra, where it was noted that application of organic manures enhanced the microbe population in the soil.

The effect of liquid formulations was recorded significant during both the years of investigation of cauliflower (Table 1) in which maximum yield/plot (11.97 kg) and yield/ha (221.7 q/ha) were observed significant under L_1 treatment (panchagavya @ 3% spray), while average curd weight (0.509 kg), yield/plot (10.18 kg) and yield/ha (188.6 q/ha) were reported under L_6 treatment (control). It might be due to the reason that milk in panchagavya provided fat, carbohydrates, protein, amino acids, calcium and curd gave lactobacillus which worked as catalyst in the decomposition of organic waste. These were essential for yield of vegetable crops. Such results of present work were supported by Gopakkali (2014) in onion, Swain *et al.* (2015) in chilli and Kumar *et al.* (2018) in cauliflower.

The effect of liquid formulations was observed non-significant on soil properties and microbial population in the soil during both the years of investigation 2018-19, 2019-20 and in pooled analysis (Tables 2 and 3).

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