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Biological properties of soil and nutrient uptake in cauliflower (*Brassica oleracea* var *botrytis* L.) as influenced by integrated nutrient management

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Abstract
A field study was carried out at Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (H P) during 2015-2016 to study the effect of INM on biological properties of soil and nutrient uptake in cauliflower (*Brassica oleracea* var *botrytis* L.) Nine different treatments with three replications each were carried out in the plot of RBD design. The nine treatments, T_1 -Absolute control, T_2 -70% NPKM + 30% N through FYM and VC (50:50), T_3 -80% NPKM + 20% N through FYM and VC (50:50), T_4 -90% NPKM + 10% N through FYM and VC (50:50), T_5 -100% NPK + FYM, T_6 -100% NPK + Vermicomposting, T_7 -110% NPKM (50:50 of FYM and VC as per N content), T_8 -120% NPKM (50:50 of FYM and VC as per N content), T_9 -130% NPKM (50:50 of FYM and VC as per N content). PGPR applied to all treatments except $T_{1,}$ T_5 and T_6. The biological property of soil was significantly enhanced by the application of combined use of organic, inorganic fertilizers and PGPR after harvest of crop during both the years of experimentation. Results revealed that treatment T_2 -80% NPKM + 30% N through FYM and VC (50:50) with PGPR, significantly enhanced the biological properties of soil and nutrient uptake in cauliflower.

Keywords: Biological properties, soil, nutrient uptake, cauliflower, *Brassica oleracea* var *botrytis* L.

Introduction

Micro-organisms are important for agriculture in order to promote the circulation of plant nutrients. Plant growth promoting rhizobacteria (PGPR) are able to exert a beneficial effect upon plant growth. Biological N fixation (BNF) provides a major source of nitrogen for plants as a part of environmentally friendly agricultural practices. Apart from fixing N_2, PGPR can affect plant growth directly by the synthesis of phytohormones and vitamins, inhibiting plant ethylene synthesis, enhancing stress resistance, improving nutrient uptake, solubilizing inorganic phosphate, and mineralizing organic phosphate (Dobbelaere *et al*. 2003 [4]; Lucy *et al*. 2004) [11]. Integrated use of fertilizer, manure and bio fertilizers improve soil fertility and crop growth. They are also reported to have an effective role in improving disease resistance in the crop by producing antibacterial and anti-fungal compounds and also produce growth regulators (Singh, 2004) [21]. Organic manures act not only as a source of nutrients and organic matter, but also increase size, biodiversity and activity of the microbial population in soil, influence structure, nutrient turnover and many other related physical, chemical and biological properties of the soil (Gruhn *et al.* 2000) [6]. Among different vegetable crops, cauliflower (*Brassica oleracea* var. *botrytis* L.) is one of the most important winter vegetable crops belonging to the genus Brassica of the family Cruciferae. In general, the cauliflower growing soils of hilly areas having problems of nitrogen availability, phosphorus fixation with varying deficiencies of micronutrient elements. To achieve higher yield levels, farmers are indiscriminately using chemical fertilizers which are leading to deterioration of soil health without any appreciable increase in the yield levels. Moreover, in the wake of high input cost of chemical fertilizers, there is need to substitute a part of the nutrient requirement through organic sources of nutrients to make crop cultivation an economically viable proposition.

Material and Methods

The field experiment was conducted in two consecutive years (2015 and 2016) in the Department of Soil Science and Water Management, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh located at 30º 51′ N latitude and 76º 11′ E longitude and an elevation of 1175 m above mean sea level having average slope of 7-8 percent. Initial soil samples (0-15 cm depth) were collected to analyze the properties of soil. Soil samples were analyzed for biological properties (Microbial count, Microbial activity and

Microbial biomass) as per standard procedures (Table 1). A total of nine treatments; T_1 -Absolute control, T_2 -70% NPKM + 30% N through FYM and VC (50:50), T_3 -80% NPKM + 20% N through FYM and VC (50:50), T_4 -90% NPKM + 10% N through FYM and VC (50:50), T_5 -100% NPK + FYM, T_6 -100% NPK + Vermicompost, T_7 -110% NPKM (50:50 of FYM and VC as per N content), T_8 -120% NPKM (50:50 of FYM and VC as per N content), T_9 -130% NPKM (50:50 of FYM and VC as per N content) were evaluated in Randomized Block Design with the three replications. Manures were incorporated as basal dose at the time of field preparation. Half dose of N and full amount of P and K were applied as basal during planting, and rest of N was top dressed in two splits at 30 and 60 days after planting. The source of nitrogen, phosphorus and potash were urea, single super phosphate and muriate of potash, respectively. PGPR was applied as root dip treatment for 30 minutes before transplanting of cauliflower. Five plant samples at the time of harvest were also randomly collected from each plot and mixed separately to determine concentrations of N, P and K uptake at harvest.

Results and Discussion

Effect of different treatments on biological properties of soil

Microbial biomass carbon (mg MB-C/ 100g soil)

Microbial biomass carbon was significantly increased by conjoint application of bacterial inoculants with chemical fertilizers and higher microbial biomass was recorded under treatment T_3 (120.26 mg MB-C 100g^{-1} soil) which was statistically at par with T_8 (118.78 mg MB-C100g^{-1} soil) and T_9 (118.58 mg MB-C100g^{-1}soil) whereas, the lowest microbial biomass-C was recorded with treatment T_1 (96.31mg MB-C100g^{-1} soil). Anderson and Domsch (1978) [1] reported range of microbial biomass carbon in agricultural soil from 15 to 240 mg MB-C100g^{-1} soil. These results are further supported by the findings of Saini *et al*. (2005) [16] and Sparling (1985) [22] they also reported significant influence of integrated nutrient management on microbial biomass carbon.

Bacterial count

The bacterial population was significantly enhanced by the application of combined use of organic, inorganic fertilizers and PGPR after harvest of crop. The pooled data pertaining to soil bacteria revealed that soil receiving 80% NPKM +30% FYM and VC on N equivalence basis + PGPR (T_3) recorded maximum microbial count (218.62 × 10^6 cfu g^{-1} soil) which was statistically at par with T_9 (216.85× 10^6 cfu g^{-1}soil) and T_8 (216.59× 10^6 cfu g^{-1}soil), while minimum (167.10 × 10^6 cfu g^{-1}soil) bacterial count withT_1.

Fungal count

Treatment (T_3) recorded maximum fungal count (4.92 × 10^4 cfu g^{-1} soil) which was statistically at par with T_8 (4.84 × 10^4cfu g^{-1} soil), T_9 (4.64 × 10^4 cfu g^{-1} soil) and T_7 (4.55 × 10^4 cfu g^{-1} soil) while minimum (3.05 × 10^4 cfu g^{-1} soil) fungal count was noted in T_1.

Actinomycetes count

Soil receiving 80% NPKM +30% FYM and VC on N equivalence basis + PGPR (T_3) recorded higher actinomycetes count (4.96 × 10^4cfu g^{-1} soil) which was statistically at par with T_9 (4.92 × 10^4 cfu g^{-1} soil) and T_8 (4.91 × 10^4 cfu g^{-1} soil), while lower (3.12 × 10^4 cfu g^{-1}soil) actinomycetes count was noted in T_1.

The soil harbour a dynamic population of microorganisms, their abundance in rhizosphere gives an indication of their possible role in decomposition of organic matter, fixation of atmospheric nitrogen, phosphate solubilization, transformations of nutrient elements, etc. The application of chemical fertilizers along with organic and PGPR inoculants registered a significant increase in total microbial population over uninoculated control. These results are in conformation with those of Selvi *et al*. (2004) [19] and Qureshi *et al*. (2005) [15]. They have reported that 100 per cent N alone and control treatment had minimum microbial population; however, the balanced fertilization i.e., 100 per cent NPK + FYM and biofertilizer enhanced the bacterial count in the soil.

Microbial activity (CO_2 evolution g^{-1} soil)

The rate of CO_2 evolution in treatment comprising different levels of inorganic fertilizers + organic manures + PGPR increased up to 48 hour and then followed a sudden decrease and remained in decreasing trend with increase in incubation period (Figure 1). However, the rate of CO_2 evolution was higher under treatment T_2 and lower was recorded with T_1 after 24 hrs of incubation period. This might be ascribed to increase in microbial population by conjoint application of bacterial inoculation with chemical fertilizers. The results are further in conformation with those of Schinner *et al*. (1980) [18], Islam and Weil (2002) [8] and Kaushal *et al*. (2013) [10].

Nutrient uptake of crops

N uptake

Higher N uptake was recorded under treatment T_3 (64.57 kg ha^{-1}) which was found statistically at par with T_9 (63.62 kg ha^{-1}) and T_8 (63.47 kg ha^{-1}). Whereas, lowest with T_1 (42.01 kg ha^{-1}).

P uptake

Effect of integrated nutrient management was significant and higher P uptake (9.91 kg ha^{-1}) was recorded under T_3 which was statistically at par with T_9 (9.89 kg ha^{-1}), T_8 (9.88 kg ha^{-1}) and lowest under T_1 (6.89 kg ha^{-1}).

K uptake

Effect of conjoint application of inorganic and organic was significant and higher K uptake (51.43 kg ha^{-1}) was recorded under T_2 which was statistically at par with T_9 (50.77 kg ha^{-1}) and T_8 (50.42 kg ha^{-1}) and lowest with T_1 (31.92 kg ha^{-1}).

The combined application of organic and chemical fertilizers with bacterial isolates also increased the uptake of N, P and K significantly over inoculated control. The different treatments showed significant effect on total N uptake. The similar trend was obtained in case of P and K uptake for both the years of experimentation. By addition of FYM and VC there is enhancement of nutrient availability (NPK) which ultimately enhanced microbial activity and conversion of unavailable to available form of nutrients and by improved physical and biochemical condition of soil (Sarangthem *et al*. 2011)[17]. Direct enhancement of mineral uptake due to increase in specific ion fluxes at root surface in the presence of plant growth promoting rhizobacteria has also been reported by Bertrand *et al.* (2000) [3], Bais *et al.*(2004) [2], and Gilroy and Jones (2000) [5]. Tilak *et al.* (2005) [24] also reported that PGPR isolates helps in uptake of minerals such as nitrate, phosphate and potassium. Milosevic *et al*. (1995) [12] also reported that increase in nitrogen uptake is due to increase in bacterial count in cabbage growing soil which supported our findings. Parmar *et al*. (1998) [13] and Sharma *et al*. (2009) [20]

also reported increased uptake of nutrients due to organic and inorganic sources which might have resulted in improved physical environment; favored, proliferous root system for better absorption of water and nutrients.

Curd yield

Maximum curd yield (329.25 q ha^{-1}) was recorded under treatment T_3 with 80% NPKM +30% N through FYM and VC (50:50) irrespective of integration with organics (FYM and VC) or bacterium inoculation which was statistically at par with T_4 (319.56 q ha^{-1}) and T_6 (315.13 q ha^{-1}). The minimum curd yield (210.06 q ha^{-1}) was recorded in control (T_1). The improved yield of cauliflower as a result of integrated use of organic manure and chemical fertilizers with PGPR might be due to improved photosynthetic and metabolic activity, which led to increase in various plant metabolites responsible for cell elongation (Hatwar *et al.* 2003) [7]. The findings suggested that, reduction of 20% recommended inorganic is possible if FYM and Vermicompost with PGPR inoculation of plants. Kanwar and Paliyal (2006) [9] were able to execute a net saving of 50% of synthetic fertilizer by substituting Vermicompost for FYM along with 100% NPK.

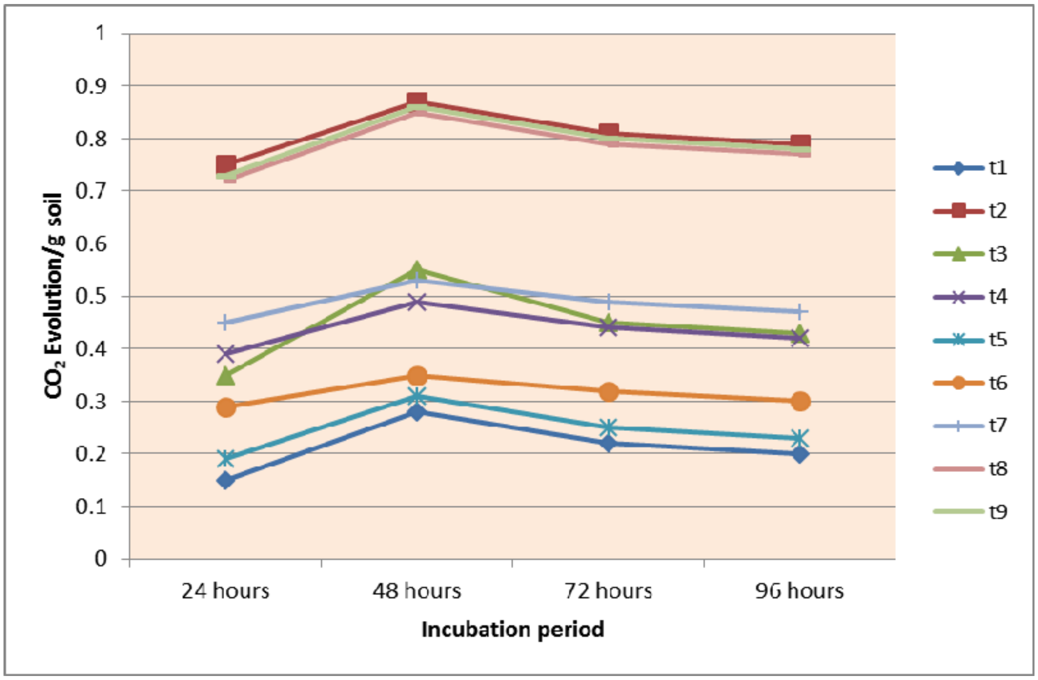

Fig 1: Microbial activity as influenced by integrated nutrient management

Table 1: Methods followed for the analysis of microbial parameters

Microbiological status		
1.	Total microbial count (10^5 cfu/g)	Subba Rao (1999)
2.	Total microbial biomass carbon	Soil fumigation extraction method (Vance *et al.*1987)
3.	Microbial activity	CO_2 Evolution Method (Parmer and Schmidt,1964)

Table 2: Microbial count and biomass as influenced by integrated nutrient management

Treatment	Microbial biomass	Bacterial count (10^6cfu g^{-1})	Fungal count	Actinomycetes count
	(mg MB-C $100g^{-1}$ soil)	(10^4cfu g^{-1})		
T_1	96.31	167.10	3.05	3.12
T_2	108.79	197.03	3.97	4.87
T_3	120.26	218.62	4.92	4.96
T_4	109.29	202.70	4.39	4.92
T_5	103.03	185.01	3.47	4.15
T_6	105.73	193.50	3.75	4.31
T_7	112.13	207.41	4.55	4.87
T_8	118.78	216.59	4.84	4.91
T_9	118.58	216.85	4.64	4.92
CD 0.05	2.63	4.94	0.38	0.48

Table 3: Nutrient uptake and yield as influenced by integrated nutrient management

Treatment	Nitrogen uptake	Phosphorus uptake	Potassium uptake	Curd yield
	(kg ha^{-1})			(q ha^{-1})
T_1	42.01	6.89	31.92	210.055
T_2	55.22	9.31	42.85	284.262
T_3	64.57	9.91	51.43	329.250
T_4	58.09	9.39	46.40	319.355
T_5	51.84	9.14	39.49	267.873
T_6	53.19	9.21	40.03	274.688
T_7	59.50	9.44	48.56	315.128
T_8	63.47	9.88	50.42	310.477
T_9	63.62	9.89	50.77	309.825
CD 0.05	1.87	0.40	1.00	14.32

References

1. Anderson JPE, Domsch KH. Physiological method for the quantitative measurement of microbial biomass in soils. Soil Biology and Biochemistry 1978; 10:215-221.
2. Bais HP, Park SW, Weir TL, Callaway RM, Vivanco JM. How plants communicate using the underground information superhighway. Trends Plant Science 2004; 9:26-32.
3. Bertrand H, Plassard C, Pinochet X, Touraine B, Normand P, Cleyetmarcel JC. Stimulation of the ionic transport system in *Brassica napus* by a plant growth promoting rhizobacterium (*Achromobacter* spp.)

Canadian Journal of Microbiology. 2000; 46: 229-236.
4. Dobbelaere SJ, Vanderleyden, Yaacov O. Plant growth-promoting effects of diazotrophs in the rhizosphere. Critical Rev. Plant Sci. 2003; 22:107-149.
5. Gilroy S, Jones DL. Through form to function of Broot hair development and nutrient uptake. Trends in Plant Science. 2000; 3:56-60.
6. Gruhn P, Francesco G, Montague Y. Integrated nutrient management, soil fertility and sustainable agriculture: Current issues and challenges. Vision discussion paper 32, IFPRI Washington, DC, 2000.
7. Hatwar GP, Gondane SU, Urkude SM, Gahukar OV. Effect of micronutrients on growth and yield of chilli. Soils & Crops. 2003; 13:123-125.
8. Islam KR, Weil RR. Soil quality indicator properties in mid-atlantic soils as influenced by conservation management. Journal of Soil and Water Conservation. 2002; 55:69-78
9. Kanwar K, Paliyal SS. Effect of integrated nutrient management on growth and yield of cabbage. Himachal Journal of Agricultural Research. 2006; 31(1):15-20.
10. Kaushal M, Kaushal R. Screening and characterization of rhizobacterial strains of *Bacillus* spp. isolated from rhizosphere of cauliflower (*Brassica oleracea* L. var. *botrytis*). African Journal of Microbiology Research. 2013; 7(17):1657-1663
11. Lucy ME, Reed, BRG. Applications of free living plant growth-promoting rhizobacteria. Antonie van Leeuwenhoek. 2004; 86:1-25
12. Milosevic N, Govedarica M, Jarak M, Bogdanovic D, Ubavic M, Curvardic M. Number of microorganisms and dehydrogenase activity in soils under peas, onion and cabbage. Mikrobiologia. 1995; 32(2):259-267
13. Parmar DK, Sharma PK, Sharma TR. Integrated nutrient supply system for 'DPP 68' vegetable pea (*Pisum sativum* var *arvense*) in dry temperate zone of Himachal Pradesh. Indian Journal of Agricultural Sciences. 1998; 68(2):84-86
14. Parmer C, Schmidt A. Organic matter. In: Methods of soil analysis, Part–I. C A Black (ed.). American Society of Agronomy Madison, USA. 1964, 1395-1397
15. Qureshi AA, Narayanaswamy G, Chhonkar PK, Balasundaram VR. Direct and residual effect of phosphate rocks in presence of phosphate solubilizers and FYM on the available P, organic carbon and viable counts of phosphate solubilizers in soil after soybean, mustard and wheat crops. Journal of the Indian Society of Soil Science. 2005; 53(1):97-100
16. Saini VK, Bhadari SC, Sharma SK, Tarafdar JC. Assessment of microbial biomass under integrated nutrient management in soybean winter maize cropping sequence. Journal of the Indian Society of Soil Sciences. 2005; 53(3):346-351
17. Sarangthem I, Misra ADD, Chakraborty Y. Cabbage productivity, nutrient uptake and soil fertility as affected by organic and biosources. Agricultural Science Digest 2011; 31(4):260.
18. Schinner FA, Niederbacher R, Nerwinger I. Influence of compound fertilizer and cupric sulfate on soil enzymes and CO_2 evolution. Plant and Soil 1980; 57:85-93.
19. Selvi D, Santhy P, Dhakshinamoorthy M, Maheshwari M. Microbial population and biomass in rhizosphere as influenced by continuous intensive cultivation and fertilization in an inceptisol. Journal of the Indian Society of Soil Science 2004; 52(3):254-257.
20. Sharma A, Kumar P, Parmar DK, Singh Y, Sharma KC. Bio-inoculants amendment substitutes synthetic fertilizers in cauliflower (*Brassica oleracea* var. *botrytis* L.) and influences growth, yield, nutrient uptake and residual soil fertility. Vegetable Science 2009; 36:22-26.
21. Singh AK. Effect of nitrogen and phosphorus on growth and curd yield of cauliflower var. Snowball-16 under cold arid region of ladakh. Haryana Journal of Horticulture Science 2004; 33(1):127-129.
22. Sparling GP. The Soil biomass. In: Vaughan D, Malcolm R E. (Eds.). Soil Organic Matter and Biological Activity. Martinus Nijoff/Dr. W. Junk, Dordrecht. Boston, Lanchester, 1985, 223.
23. Subba Rao NS. Soil Microorganism and Plant Growth. Oxford & IBH publishing cooperative. New Delhi. 1999; 252.
24. Tilak KR, Ranganayaki N, Pal KK, De R, Saxena AK, Nautiyal SC, Mittal S, Tripathi AK, Johri BN. Diversity of plant grown and soil health supporting bacteria. Current Science 2005; 89:136-150.
25. Vance ED, Brookes PC, Jenkinson DS. An extraction method for measuring soil microbial biomass C. Soil Biology and Biochemistry 1987; 19:703-707.