

Original Research Article

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Effect of Vermicompost and P Enriched Biocompost on Soil Properties under French bean Crop

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ABSTRACT

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An experiment was conducted at the experimental farm of Department of Soil Science, CSKHPKV, Palampur by taking French bean crop during kharif, 2009. Biocompost and vermicompost were prepared by using cow dung and weeds and were inoculated with microbial inoculants and rock phosphate. Biocompost and vermicompost were analysed and the best one among nine composts prepared *i.e.* 50% each of cowdung and substrate+ 2% rock phosphate + inoculants and three vermicomposts *i.e.* the one prepared by using *Eupatorium* waste, on the basis of nutrient content, was selected and applied to the crop in combination with fertilizers depending upon the treatment. There were twelve treatments and three replications in randomized block design. An increase in pH, organic carbon (12.42 g kg⁻¹), CEC [12.84 cmol (p⁺) kg⁻¹], available N, P and K (467.6 kg ha⁻¹, 16.4 kg ha⁻¹ and 191.5 kg ha⁻¹ respectively), biomass carbon (89.34 µg g⁻¹), water holding capacity, field capacity, permanent wilting point and total microbial count was observed in the treatments where vermicompost and biocompost were applied @ 15 t ha⁻¹.

Introduction

French bean (*Phaseolus vulgaris* L.), a member of family fabaceae, is one of the most ancient and popular warm season vegetable crop grown worldwide for its green pods. It is an important source of protein, calcium, iron and vitamins in human diet. The crop is known by various names as French bean, common bean, snap bean, kidney bean and navy bean. In India, it is commercially cultivated in Himachal Pradesh, Jammu and Kashmir, hills of Utrakhand, North-Eastern states and peninsular India, covering an area of about 1,50,000 ha with annual production

of 4,20,000 tonnes and ranks 4th in green bean production in the world. Its cultivation in Northern Indian plains is rather restricted in account of limited period of favorable weather conditions. It occupies an area of 3,197 ha with annual production of 33,112 metric tonnes in Himachal Pradesh. Biocompost and vermicompost supplement the nutrient requirements of crops. Concerning the economic sustainability, the low cost of compost is useful to farmer as well to human society. Vermicompost is reported to be rich in nutrient elements (Jambhekar, 1992) and biocompost also contains high amount of nutrients than ordinary compost or FYM.

Organic manuring systems fitted effectively in intensive cropping systems are likely to play a decisive role in sustainable agriculture.

Materials and Methods

An experiment was conducted at the experimental farm of Department of Soil Science, CSKHPKV, Palampur by taking French bean crop during kharif, 2009. Biocompost and vermicompost were prepared by using cow dung and weeds and were inoculated with microbial inoculants and rock phosphate. Nine biocomposts and three vermicomposts were prepared and analyzed and the best one among nine composts prepared i.e. 50% each of cow dung and substrate+ 2% rock phosphate + inoculants and three vermicomposts i.e. the one prepared by using *Eupatorium* waste, on the basis of nutrient content, was selected and applied to the crop in combination with fertilizers depending upon the treatment. There were twelve treatments and three replications in randomized block design. The field experiment was conducted on French bean using following treatments: T₁: 100% P + N fixer + P solubilizer, T₂: 100% P + 100% N, T₃: 75% P + N fixer + P solubilizer, T₄: 75% P + 100% N, T₅: 100% P + N fixer + P solubilizer + biocompost, T₆: 75% P + 100% N + biocompost, T₇: 100% P + 100% N + biocompost, T₈: 75% P + inoculation with N-fixers and P solubilizers + biocompost, T₉: 100% P + inoculation with N-fixers and P solubilizer + vermicompost, T₁₀: 100% P + 100% N + vermicompost, T₁₁: 75% P + inoculation with N-fixers and P solubilizer + vermicompost, T₁₂: 75% P + 100% N + vermicompost.

Results and Discussion

Composts

The vermicompost exhibited higher values of total nitrogen, phosphorus, potassium and

microbial biomass nitrogen whereas P enriched biocompost exhibited higher values of organic carbon, C: N ratio, microbial population and biomass sulphur. The values of biomass nitrogen were same in both the composts. The soil sample before sowing of crop was taken and was analyzed for physical, chemical and microbiological properties. The soil was having texture silty clay loam, pH 5.2, cation exchange capacity 11.0 cmol (p⁺) kg⁻¹, organic carbon 10.5 g kg⁻¹, available N, P and K 390 kg ha⁻¹, 11.5 kg ha⁻¹ and 169.12 kg ha⁻¹ respectively, microbial biomass carbon 65.80 µg g⁻¹ and microbial count as 3.2×10⁷ cfu g⁻¹ bacteria, 2.9×10⁵ cfu g⁻¹ fungi and 19×10⁴ cfu g⁻¹ actinomycetes. Similar results were reported by Jambhekar (1992), Saxsena *et al.*, (1998), Vasanthi and Kumaraswamy (1999), Sarangthen and Singh (2005), Manna *et al.*, (1997), Thakur and Sharma (1998) and Manna and Ganguly (1999).

Soil properties

After the harvest of crop, representative soil samples from each plot were taken from the depths of 0-0.15 m and were analyzed for chemical, physical and microbiological properties of soil.

Soil reaction (pH)

The pH of the soil samples 0-0.15 m varied between 5.2 and 5.4 and the results revealed that there was an increase in pH after application of biocompost and vermicompost over the recommended dose of fertilizers. Increase in pH by the application of vermicompost was also recorded by Yagi *et al.*, (2003).

Cation exchange capacity

Cation exchange capacity in the soil from 0-0.15 m varied between 11.15 cmol (p⁺) kg⁻¹ and 12.84 cmol (p⁺) kg⁻¹. The highest value of cation exchange capacity was recorded in the

treatment 100% NPK + vermicompost followed by 100% NPK treatment. The highest value of cation exchange capacity was recorded in the treatment 100% P and K + biofertilizers + PEB + 100% K followed by 100% P and K + biofertilizer + vermicompost. The cation exchange capacity was significantly higher in the above mentioned treatments than the recommended dose of fertilizers. Lowest value of cation exchange capacity at the depth of 0-0.15 m [$11.15 \text{ cmol (p}^+) \text{ kg}^{-1}$] was observed in the treatment 75% P + 100% N and K + vermicompost. Cation exchange capacity increased with the application of vermicompost in 0-0.15 m depth of soil. There is release of cations with the decomposition of organic matter which would have increased the cation exchange capacity. Similar results were given by Yagi *et al.*, (2003). An increase was observed in case of cation exchange capacity in the treatment 100% NPK + vermicompost over 100% NPK treatment in 0-0.15 m depth of soil.

Organic carbon

The values of the organic carbon content of the soil are presented in the table 1. Results show that the values of organic carbon varied between 10.78 and 12.42 g kg^{-1} in 0-0.15 m soil. Highest organic carbon content was recorded in the treatment 75% P + biofertilizer + P enriched biocompost + 100% K followed by 75% P + 100% N and K + P enriched biocompost treatment which was 1.5 percent higher than 100% NPK treatment. The organic carbon content in 0-0.15 m depth of soil in the treatment 75% P + biofertilizers + P enriched biocompost + 100% K was found to be significantly higher than the 100% NPK treatment.

Application of vermicompost also increased the organic carbon content in the soil over recommended dose of fertilizers. Vermicompost is organic in nature and

originally rich in organic carbon content. On the other hand, worms increased organic carbon in the cast because of selective feeding on non humified material within the soil matrix and secretion of mucopolysaccharide in their gut. The results were similar to those presented by Singh *et al.*, (2007), Anwar *et al.*, (2005) and Yagi *et al.*, (2003).

Available nitrogen

The available N content was found highest in the treatment 100% P and K + biofertilizer + P enriched biocompost in 0-0.15 m depth of soil. The available nitrogen content in 0-0.15 m soil depth was found significantly higher in the treatment 100% P and K + biofertilizer + P enriched biocompost than 100% NPK treatment. Available nitrogen was recorded to be lowest (412.9 kg ha^{-1}) in the treatment 100% NPK + vermicompost.

Available phosphorus

The available P content in 0-0.15 m depth of soil ranged between 11.0 kg ha^{-1} – 16.4 kg ha^{-1} . The available P content was recorded highest in the treatment 100% P and K + biofertilizers + vermicompost @ 15 t ha^{-1} which was 24.24 per cent higher than the 100% NPK treatment in 0-0.15 m and 42.61 per cent higher than initial soil. A significant increase in available P content was recorded in the treatment 100% P and K + biofertilizer + vermicompost over 100% NPK treatment. The application of 100% P through fertilizers, vermicompost and P solubilizers increased the available P content of the soil. 75% P + 100% N and K + P enriched biocompost treatment recorded lowest values of available P (11.0 kg ha^{-1}) content at the depth of 0-0.15 m. On decomposition of organic matter by various microorganisms, the organic phosphorus is converted slowly to inorganic form. The increase in available P content of soil can also be explained on the basis of results of Negi

(1986) who reported that supply of high levels of phosphorus helps in the build-up of available P of the soil.

Potassium

The available K content was found highest in the treatment 75% P + biofertilizers + vermicompost + 100% K in 0-0.15 m depth of soil which was 20.3 per cent and 25.4 per cent higher than 100% NPK treatment respectively.

Available potassium was recorded lowest in the treatment 100% P and K + biofertilizer + vermicompost (144.4 kg ha⁻¹) at the depth of 0-0.15 m. Application of vermicompost increased the available potassium content of soil. Similar reports were reported by Patil and Bhilare (2001), Bhalerao *et al.*, (2002), Chettri *et al.*, (2004) and Sitangshu and Mondal (2004). Likewise, significant improvement in fertility status of the soils due to addition of FYM or crop residues have also been reported by Singh *et al.*, (1997) and Roy *et al.*, (2001). Anwar *et al.*, (2005) also reported higher values of organic carbon, available N and P in the plots receiving organic manures in addition to mineral fertilizer compared to

those plots treated with chemical fertilizers alone. The potassium content of the vermicompost and biocompost is high which would have also increased the available K content in soil. The results are similar to the findings of Kapur *et al.*, (1981) Ganai and Singh (1988), Pati Ram (1994) and Bhalerao *et al.*, (2002). Also the uptake of potassium in the treatment 75% P+ 100% K + biofertilizer + vermicompost was less so the content of potassium was higher in the soil.

Microbiological properties of soil

Total microbial count

Bacterial population

The bacterial population in the soil was found to be significantly higher in the treatment 100% P and K + biofertilizer + P enriched biocompost in 0-0.15 m depths which was 23.68 per cent higher than 100% NPK treatment and was at par with 75% P + biofertilizer + P enriched biocompost + 100% K and 100% P and K + biofertilizer treatment respectively and 46.87 per cent higher than initial status of soil.

Table.1 Effect of different treatments on chemical and microbiological properties of soil after harvest of French bean

Treatment	pH	CEC	Organic carbon	Available N (kg ha ⁻¹)	Available P (kg ha ⁻¹)	Available K (kg ha ⁻¹)	Bacteria (X 10 ⁷ cfu g ⁻¹ soil)	Fungi (X 10 ⁵ cfu g ⁻¹ soil)	Actinomyces (X 10 ⁴ cfu g ⁻¹ soil)	Microbial biomass carbon (µg g ⁻¹)
0-0.15 m										
T ₁	5.2	11.20	10.92	449.4	15.3	162.2	4.0	3.2	22	75.08
T ₂	5.2	11.50	10.78	420.3	13.2	159.2	3.8	3.3	23	69.85
T ₃	5.3	11.18	10.82	424.0	14.1	158.2	3.7	3.4	24	80.78
T ₄	5.3	11.75	10.88	453.8	12.4	147.0	3.8	3.4	25	78.88
T ₅	5.4	12.78	11.80	467.6	15.8	189.2	4.7	4.1	23	88.39
T ₆	5.4	12.60	12.29	423.4	11.0	166.6	4.4	4.2	25	78.88
T ₇	5.4	12.78	11.82	452.7	14.4	180.5	4.3	4.6	29	89.34
T ₈	5.3	11.22	12.42	434.5	15.4	155.2	4.6	4.1	28	75.56
T ₉	5.3	12.12	11.57	449.4	16.4	144.4	4.2	3.5	27	86.01
T ₁₀	5.4	12.84	11.73	412.9	13.8	166.1	4.1	3.2	21	67.00
T ₁₁	5.4	12.33	11.40	459.9	14.1	191.5	4.1	3.3	22	75.56
T ₁₂	5.3	11.15	11.20	444.2	14.8	171.2	4.2	4.3	26	79.83
CD (P=0.05)	NS	0.28	0.80	32.57	1.15	20.80	0.30	0.30	2.38	7.55
Initial	5.2	11.00	--	390.0	11.5	169.1	3.2	2.9	19	65.80

Table.2 Effect of different treatments on physical properties of soil after harvest of French bean

Treatments	Water holding capacity (%)	Field capacity (%)	Permanent wilting point (%)
0-0.15 m			
T ₁	56.1	25.16	16.58
T ₂	56.0	25.15	16.38
T ₃	56.2	25.35	16.39
T ₄	56.2	25.34	16.24
T ₅	56.1	25.51	16.40
T ₆	56.1	25.80	16.15
T ₇	56.2	25.30	16.33
T ₈	56.2	25.10	16.48
T ₉	56.8	26.69	17.58
T ₁₀	57.2	26.65	17.72
T ₁₁	57.1	26.52	17.66
T ₁₂	57.2	26.84	17.42
CD (P=0.05)	0.37	0.89	0.43
Initial	56	25.81	16.10

The biocompost contains higher count of bacteria over vermicompost which would have increased bacterial population in soil also.

Fungal population

The fungal population was found significantly higher than rest of the treatments i.e. 4.6×10^5 cfu g⁻¹ soil in the treatment recommended NPK + P enriched biocompost in 0-0.15 m soil depth. It was higher than 100% recommended dose of fertilizers and initial soil. The biocompost contains highest fungal population which has increased the fungal population in the 0-0.15 m depth of soil.

Actinomycetes population

The population of actinomycetes was found highest in the treatments where vermicompost was added (0-0.15 m). There was an increase of 20.88 per cent over 100% NPK treatment. The actinomycetes population in the treatments receiving vermicompost was significantly higher than 100% NPK

treatment and initial soil. Similar results for increasing in microbial population were also reported by Kale *et al.*, (1992), Malewar *et al.*, (1999) and Hangarge *et al.*, (2004).

Microbial biomass carbon

The values of biomass carbon varied between 67 and 89.34 µg g⁻¹ soil in 0-0.15 m depth. The highest value of biomass carbon was recorded in the treatment 100% NPK + P enriched biocompost in 0-0.15 m soil. Lowest values of biomass carbon were observed in the treatment 100% NPK+ vermicompost at the depth of 0-0.15 m.

A significant increase in the values of biomass carbon was recorded in the treatments 100% NPK + P enriched biocompost and 100%P and K + biofertilizer + P enriched biocompost in 0-0.15 m which was 27.9 per cent higher over 100% NPK treatment. Biofertilizer based integrated nutrient management package treatment showed the highest content of soil microbial biomass carbon, which was at par with the

treatment of 50% recommended dose of fertilizers plus 50% N through FYM (Gogoi *et al.*, 2010). Findings of Ghoshal and Singh (1994) and Rao (2007) supported such results. The organic carbon content in this treatment is higher which would have increased the biomass carbon in this treatment.

Physical properties of soil

Water holding capacity

The water holding capacity was recorded highest in the treatment 75% P + 100% N and K + vermicompost i.e. 57.2 per cent which was significantly higher than 100% NPK treatment and 75% P + 100% N and K + P enriched biocompost treatment. The lowest water holding capacity (56.0 per cent) was recorded in the treatment 100% NPK at the depth of 0-0.15 m.

Field capacity

The moisture content at field capacity was recorded highest i.e. 26.84 per cent in the treatment 75% P + 100% N and K + vermicompost which was significantly higher than 100% recommended dose of fertilizers and 75% P + 100% N and K + P enriched biocompost treatment. Lowest field capacity (25.10 per cent) was recorded in the treatment 75%P + biofertilizers + P enriched biocompost + 100% K at the depth of 0-0.15 m.

Permanent wilting point

The moisture content at permanent wilting point was recorded highest i.e. 17.72 per cent in the treatment 100% NPK + vermicompost at 0-0.15 m depth. The moisture content at permanent wilting point was significantly higher than 100% recommended dose and 100% NPK + P enriched biocompost treatment at 0-0.15 m depth. Permanent

wilting point was recorded lowest in the treatments 75% P + 100% N and K + P enriched biocompost (16.15 per cent) (Table 2).

Water holding capacity and moisture content at field capacity and permanent wilting point was increased by the use of vermicompost. This could be ascribed to the improvement in structural condition of soil due to application of vermicompost with inorganics (Bhatnagar *et al.*, 1992). Since the application of fertilizers and organic matter together resulted in improvement in soil organic carbon therefore improvement in soil water holding capacity and plant available water in soil is expected. Also the higher water holding capacity of the added organic matter in turn might have increased the water holding capacity of soil. Similar results were also reported by Hangarge (2002), Selvi *et al.*, (2005) and Deshmukh *et al.*, (2007).

The applications of either vermicompost or biocomposts prove beneficial to maintain the soil health in terms of soil physical, chemical and microbiological properties as compared to the application of inorganic fertilizers alone.

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