Effect of organic manures and biofertilizers on soil properties, productivity and nutrient uptake of Indian mustard

ABSTRACT

A field experiment was conducted during the rabi season 2020-21 to study the effect of organic manures and bio-fertilizers on soil properties, productivity and nutrient uptake of Indian mustard at Deendayal Upadhyay Centre of Excellence for Organic Farming (DDUCE-OF), CCSHAU, Hisar. The experiment comprised of eight treatments involving Farm Yard Manure (FYM), Vermicompost (VC) and Poultry Manure (PM) alone and along with biofertilizers (BF), an absolute control and a cow based formulation treatment. The results revealed that the treatment 100% RDN through PM+BF produced significantly higher seed and stover yield of mustard which was at par with treatment 100% RDN through VC+BF and 100% RDN through FYM+BF as compared to other treatments. Maximum seed (29.84 q ha^{-1}) and stover (74.75 q ha^{-1}) yields were received under treatment 100% RDN through PM+BF which was 27.5 % and 16.7 % higher over control, respectively. Similarly, highest total NPK uptake (116.2 kg ha^{-1} for total N, 19.9 kg ha^{-1} for total P and 83.5 kg ha^{-1} for total K) were recorded in the treatment 100% RDN through PM+BF. The highest soil restorative effect *i.e.* soil organic carbon (0.67 %), available N (162 kg ha^{-1}), available P (13.7 kg ha^{-1}) and available K (280 kg ha^{-1}) were also observed under treatment 100% RDN through PM+BF. These organic amendments such as FYM, vermicompost, poultry manures alone and along with biofertilizers had significantly improved the seed and stover yields as well as uptake of nutrients by Indian mustard.

Keywords: FYM, Vermicompost, Poultry Manure, Mustard, Yield, NPK Uptake

INTRODUCTION

Mustard and Rapeseed/Toria are the third most important edible oilseed crops of the world after soybean and oil palm. Globally, India account for 21.7% and 10.7% of the total acreage and production. In India, mustard is grown in an area of 7.40 million hectare and the production is 7.70 million tonnes with the productivity of 1040 kilogram per hectare, respectively (Anonymous, 2019). Both mustard and rapeseed are grown in Haryana in an area of up to 6.0-6.5 lac hectares, out of which, mustard is sown in about 90% of the area of the State. Mustard is grown in both the irrigated and rainfed areas and their yield depend on the weather conditions. The oil content varies from 37 to 49% and oil cake is used as feed and manure. The nutrient management is one of the most important agronomic factors that affect the Indian mustard reported by Hadiyal *et al.*, (2017). But application of all the needed fertilizer through chemical

fertilizers had deleterious effect of soil fertility, unsustainable yields. While organic manures and biofertilizers would be able to maintain soil fertility and sustain crop productivity. Organic manures improve the physical and nutritional system of soil and also enhance the activity of soil micro flora.

Organic cultivation is an environmentally viable approach to agriculture through its use of farm yard manures, compost, green manuring crops and cow based solid and liquid bioformulation to provide nutrients and cultural practices to manage weeds, insects and pathogens. On the other hand, organic farming has potential benefits in comparison to conventional farming in promoting soil structure formation, enhancing soil biodiversity, protecting environment, improving soil quality, food quality and safety and also, ensuring premium price. Decomposition of organic manures in the soil helps in preventing various disease causing pathogens by different types of biological reactions (Ramesh *et al*., 2010). Thus, organic production systems have the potential to achieve sustainability of agricultural systems. Keeping in view the importance, the present investigation was taken up to study the effect of organic manures and biofertilizers on soil properties, productivity and nutrient uptake of Indian mustard.

MATERIALS AND METHODS

The experiment was laid out in Randomized Block Design (RBD) with three replication during Rabi, 2020 at DDUCE-OF farm, CCSHAU, Hisar. Eight treatments viz. 100% RDN through Farm Yard Manure (FYM), Vermicompost (VC) and Poultry Manure (PM) alone and along with biofertilizer (BF) and Cow based Bio-Formulation were selected. Accounting the recommended dose of nitrogen (80 kg N ha^{-1}), specific amount of well-decomposed FYM, VC and PM were applied to the corresponding treatment plots before sowing of the crop and thoroughly incorporated into the soil. Cow Urine Based Liquid Organic bio-Formulation (CUBLOF)@400 ltr./ha was applied after 1st and 2nd irrigation each. Mustard variety RH-725 was used as a test crop and treated with Azotobacter + PSB @ 5 ml/kg seed. Mustard seed was sown with 5 kg/ha in lines at a row spacing of 45 cm as per treatment. The depth of seed was kept 4 to 5 cm. After thinning twice, the plant to plant distance was maintained at 10-15 cm. The crop was sown on 17th October, 2020 and was harvested on 2nd April, 2021, respectively. The samples of mustard crop at harvesting stage were collected and washed properly with tap water, distilled water, acidified deionized water and deionized water sequentially. Henceforth, the samples were shade dried followed by drying in the oven at 65 ± 20°C. The seed and stover

samples were then ground and stored in paper bags with proper labelling for analysis of various parameters.

Soil samples were collected from the surface layer (0-15 cm) of all the plots before treatment application and immediately after crop harvest. The pH and Electrical Conductivity (EC) were determined in (1:2) soil:water suspension with the help of glass electrode pH meter and conductivity meter bridge, respectively using an Eutech pH meter (Jackson, 1967). Organic Carbon (OC) was estimated by wet digestion method (Walkley and Black, 1934). Soil texture was determined using qualitative methods by feel method given by Soil Science Division Staff. 2017. Available nitrogen was determined using steam distillation method (Subbiah and Asija, 1956) and estimated on Gerhardt's Fully automatic N analyzer (VAPODEST 500 C). Available P was determined by the method of Olsen *et al.* (1954) and estimated on double beam UV spectrophotometer. Available potassium was determined using neutral normal ammonium acetate method (Hanway and Heidal, 1952) and estimated on flame photometer. DTPA-extractable micronutrients in soil samples were determined by Lindsay and Norvell (1978) using Atomic Zeenit 700 P Atomic absorption spectrophotometer (Analytik Jena). The data collected on various parameters were analysed statistically according to the experimental design using OPSTAT software, CCSHAU, Hisar.

Nutrient content of Farm Yard Manure (FYM), Vermicompost (VM) and Poultry Manure (PM)

Nutrient content of Farm Yard Manure (FYM), Vermicompost (VM) and Poultry Manure (PM) were analyzed for Total N, P and K content. A set of 8 treatments comprising 100% of recommended nitrogen dose (RDN) given through three sources of organic manures alone (*viz*., farmyard manure (FYM), vermicompost (VM) and poultry manure (PM) as well as along with biofertilizers. The NPK contents in FYM, VM and PM were 0.65, 1.87 and 2.40% N, 0.40, 0.80 and 1.60% P and 0.85, 0.95 and 1.70% K, respectively.

Initial soil physico-chemical and microbial properties of Experimental site

The soil was loam in texture having pH 7.80 with EC of 0.80 dS m^{-1}. The soil organic carbon (SOC) was observed medium *i.e.* 0.69%. The available N, P and K contents of soil were 160, 13.5 and 275 kg ha^{-1}, respectively. The status of available N was low (<250 kg ha^{-1}), P was medium and K was high in content (10-20 kg ha^{-1} for P & >250 kg ha^{-1} for K). The initial status of DTPA extractable Zn (1.10 mg kg^{-1}), Fe (10.2 mg kg^{-1}), Mn (13.3 mg kg^{-1}) and Cu (1.46 mg

kg^{-1}) was observed sufficient in amount. The initial bacterial count of experimental soil was $3.6x10^8$ CFU Count per g of soil.

RESULTS AND DISCUSSION

Effect of organic manures and biofertilizers on seed and stover yield of Indian mustard

The moong bean seed yield during kharif season was poor due to white fly infestation and results were found non-significant. However, seed and stover yield of mustard increased significantly with the application of different organic manures alone (*viz*., farmyard manure (FYM), vermicompost (VM) and poultry manure) and along with biofertilizers over control (Table 1). Maximum mustard yields (29.84 q ha^{-1} in seed and 74.75 q ha^{-1} in stover) were obtained under treatment 100% RDN through PM+BF. However, minimum seed and stover yields (23.41 & 64.09 q ha^{-1}) were obtained from the control, where there was no application of organic manure. The interaction effect of different organic amendments on seed and stover yield of mustard were found to be significant. Similar finding were observed by Kumar and Singh (2019) and reported that significant enhancement in seed (12.7 %) and stover (10.2 %) yields was recorded, respectively with the application of organic manures along with biofertilizers over control.

Table 1. Effect of organic manures and biofertilizers on seed and stover yield of Indian mustard

Treatment	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})
Control	23.41	64.09	87.50
100% RDN through FYM	25.00	71.89	96.89
100% RDN through VC	26.59	72.02	98.61
100% RDN through PM	27.78	74.49	102.27
100% RDN through FYM+BF	27.46	73.13	100.59
100% RDN through VC+BF	27.78	73.84	101.62
100% RDN through PM+BF	29.84	74.75	104.59
Cow based bioformulation	24.60	72.15	96.75
CD (P=0.05)	2.72	6.19	7.64

Effect of organic manures and biofertilizers on N, P, K content and their uptake by Indian mustard

The uptake of N, P and K in mustard seed was from 47.47 to 74.27, 9.43 to 15.13 and 12.80 to 17.63 kg ha^{-1}, respectively under treatment 100% RDN through PM+BF. The corresponding values were from 25.37 to 41.97, 3.03 to 4.77 and 50.77 to 65.80 kg ha^{-1} in mustard stover (Table 2, 3 and 4). Treatment 100% RDN through PM+BF produced significantly higher N, P and K content and their uptake in seed and stover, however, it was statistically at par to treatment 100% RDN through VC+BF and 100% RDN through FYM+BF. Highest Total N, P and K uptake (116.2 kg ha^{-1}, 19.9 kg ha^{-1} and 83.5 kg ha^{-1}) were recorded in the treatment 100% RDN through PM+BF (Figure 1). This might be due to proper establishment of roots, higher absorption of mineral nutrients from soil, transport of more nutrients to seed, vigorous plant growth and higher seed and straw yields under proper availability of nutrients. The overall increase in uptake of nitrogen was the cumulative effect of rise in their concentration in plant tissues and in yield levels. The interaction effect of organic amendments i.e. FYM, vermicompost and poultry manure alone and along with biofertilizers on NPK content and their uptake by Indian mustard were found to be significant and the results are in conformity with Singh *et al.* (2020) who's revealed that all the growth, nutrient uptake of nitrogen, phosphorus and potassium, increased significantly under the treatment of organic manures.

Table 2. Effect of organic manures and biofertilizers on N content and its uptake by Indian mustard

Treatment	N content (%)		N Uptake (kg ha^{-1})	
	Seed	Stover	Seed	Stover
Control	2.03	0.40	47.47	25.37
100% RDN through FYM	2.20	0.46	55.10	32.93
100% RDN through VC	2.28	0.49	60.60	35.23
100% RDN through PM	2.30	0.49	63.77	36.70
100% RDN through FYM+BF	2.36	0.51	64.83	37.73
100% RDN through VC+BF	2.38	0.52	66.07	38.60
100% RDN through PM+BF	2.49	0.56	74.27	41.97
Cow based bioformulation	2.14	0.44	52.60	31.47
CD (P=0.05)	0.18	0.07	7.20	5.24

Table 3. Effect of organic manures and biofertilizers on P content and its uptake by Indian mustard

Treatment	P content (%)		P Uptake (kg ha^{-1})	
	Seed	Stover	Seed	Stover
Control	0.40	0.05	9.43	3.03
100% RDN through FYM	0.44	0.05	11.13	3.60
100% RDN through VC	0.45	0.06	12.00	4.00
100% RDN through PM	0.47	0.06	13.10	4.30
100% RDN through FYM+BF	0.48	0.06	13.13	4.43
100% RDN through VC+BF	0.49	0.06	13.50	4.67
100% RDN through PM+BF	0.51	0.06	15.13	4.77
Cow based bioformulation	0.42	0.05	10.27	3.60
CD (P=0.05)	0.05	0.01	1.95	0.42

Table 4. Effect of organic manures and biofertilizers on K content and its uptake by Indian mustard

Treatment	K content (%)		K Uptake (kg ha^{-1})	
	Seed	Stover	Seed	Stover
Control	0.55	0.79	12.80	50.77
100% RDN through FYM	0.57	0.83	14.17	59.50
100% RDN through VC	0.57	0.84	15.27	60.50
100% RDN through PM	0.58	0.84	16.03	62.83
100% RDN through FYM+BF	0.58	0.86	15.97	63.33
100% RDN through VC+BF	0.58	0.87	16.13	64.23
100% RDN through PM+BF	0.59	0.88	17.63	65.80
Cow based bioformulation	0.57	0.83	14.00	59.50
CD (P=0.05)	0.02	0.04	1.65	6.57

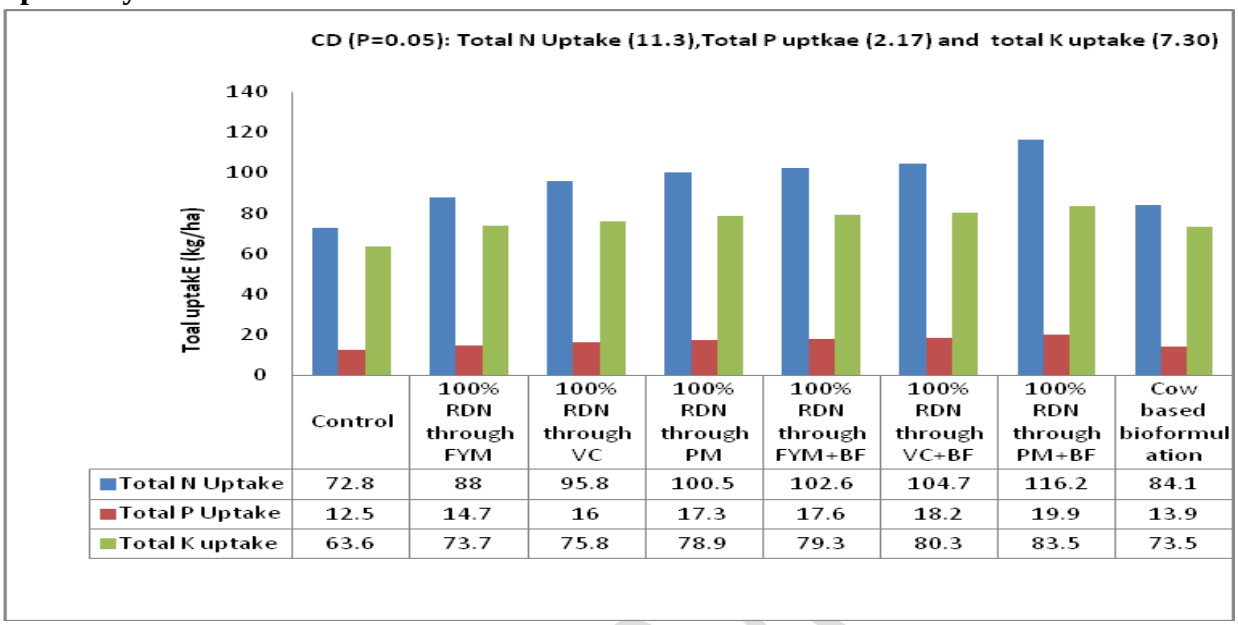
Effect of organic manures and biofertilizers on soil properties after harvest of Indian mustard

A perusal of the data (Table 5) reveals that organic carbon, available N, P and K content of post harvest soil increased and/or maintained with the application of organic manures alone and along with bio-fertilizers. The maximum values of soil organic carbon (0.67 %), available N (162 kg ha^{-1}), available P (13.7 kg ha^{-1}) and available K (280 kg ha^{-1}) were observed under treatment 100% RDN through FYM, poultry manure and vermicompost with bio-fertilizers and the minimum under control and cow based bioformulation. The interaction effects of organic amendments i.e. FYM, vermicompost and poultry manure alone and along with biofertilizers on post-harvest soil properties i.e. pH, availabe P and K were found to be significant during first year trial whereas, it was non-significant on EC, SOC and Available N. These results are in agreement with those of Ahlawat *et al.* (2023), Sharma *et al.* (2017) and Kumar and Singh (2019) who's reported that application of farm yard manure also increased the soil organic carbon and available NPK in post harvest soil as compared to control. This may be attributed to the beneficial role of organic manures creating favorable conditions for microbial activities in mineralization process, nutrient content and their uptake as well as increase availability of available nutrient pool in the soil.

Table 5. Effect of organic manures and biofertilizers on soil properties after harvest of Indian mustard

Treatment	**Soil properties**					
	pH (1:2)	**EC (ds/m)**	**SOC (%)**	**Avail. N (kg/ha)**	**Avail. P (kg/ha)**	**Avail. K (kg/ha)**
Control	7.80	0.80	0.65	159	13.3	269
100% RDN through FYM	7.79	0.79	0.66	160	13.4	272
100% RDN through VC	7.79	0.79	0.66	161	13.5	272
100% RDN through PM	7.78	0.79	0.67	162	13.4	274
100% RDN through FYM+BF	7.78	0.77	0.67	161	13.7	276
100% RDN through VC+BF	7.78	0.77	0.67	161	13.7	278
100% RDN through PM+BF	7.77	0.78	0.67	162	13.7	280
Cow based bioformulation	7.78	0.79	0.65	159	13.5	270
CD (P=0.05)	0.02	NS	NS	NS	0.15	5.81

Figure 1. Effect of organic manures and biofertilizers on total N, P, K content and their uptake by Indian mustard



	Control	100% RDN through FYM	100% RDN through VC	100% RDN through PM	100% RDN through FYM+BF	100% RDN through VC+BF	100% RDN through PM+BF	Cow based bioformulation
Total N Uptake	72.8	88	95.8	100.5	102.6	104.7	116.2	84.1
Total P Uptake	12.5	14.7	16	17.3	17.6	18.2	19.9	13.9
Total K uptake	63.6	73.7	75.8	78.9	79.3	80.3	83.5	73.5

CONCLUSIONS AND PERSPECTIVES

From the present findings, it can be concluded that the application of organic manures along with biofertilzers would help in the sustainable production of Indian mustard under organic farming in this locality to decrease the dependence on inorganic fertilizers. This research elucidates the regular addition of organic manures alone and along with biofertilizers in the soil is the only way to maintain the soil health and quality. In order for farming to help mitigate the potential for devastating environmental effects, we need to move to modern organic methods.

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