Impact of Different Organic Nutrient Sources on Soil Chemical Properties in Rabi-Season Rapeseed Cultivation

ABSTRACT

Aims: The aim of the experiment was to check the effect of various organic soil amendments on the soil chemical properties

Study design: The design of the experiment was RandomizedBlock Design (RBD).

Place and Duration of Study: Instructional-cum Research Farm, Department of Agronomy, Assam Agricultural University, Jorhat, Assam, India, during the rabi season of 2018-19.

Methodology: A total of 11 treatments were considered *viz.,* Control (T_0), Farmyard manure @ 10 t/ha (T_1), Vermicompost @ 5 t/ha (T_2), Poultry Manure @ 5 t/ha (T_3), Farmyard manure @ 5 t/ha + Vermicompost @ 2.5 t/ha (T_4), Farmyard manure @ 5 t/ha + Poultry Manure @ 2.5 t/ha (T_5), Vermicompost @ 2.5 t/ha + Poultry Manure @ 2.5 t/ha (T_6), Farmyard manure @ 5 t/ha + Vermicompost @ 2.5 t/ha + Mustard Oil Cake @ 1 t/ha (T_7), Farmyard manure @ 5 t/ha + Poultry Manure @ 2.5 t/ha + Mustard Oil Cake @ 1 t/ha (T_8), Vermicompost @ 2.5 t/ha + Poultry Manure @ 2.5 t/ha + Mustard Oil Cake @ 1 t/ha (T_9), and Farmyard manure @ 5 t/ha + Vermicompost @ 1.25 t/ha + Poultry Manure @ 1.25 t/ha + Mustard Oil Cake @ 1 t/ha (T_{10}).

Results: Results revealed significantly higher levels of organic carbon, available nitrogen (N) and phosphorus (P_2O_5) in the soil after crop harvest following the application of different organic nutrient sources compared to the control.

Conclusion: The application of various organic amendments increased the nutrient uptake by the soil. Organic inputs like Farmyard manure, vermicompost, poultry manure, and their combinations improved soil moisture retention, boosted organic carbon content, and resulted in higher levels of available nitrogen and phosphorus in the soil after harvest compared to the control plot.

Keywords: Organic nutrients, rapeseed, chemical properties, spring season

1. INTRODUCTION

Rapeseed is an essential oilseed crop that has become more well-known worldwide because of its economic importance and adaptability [23]. Its significance extends beyond the generation of edible oil; it also plays a part in crop rotations, the creation of biofuel, and the provision of animal feed that is high in protein [23]. Managing the chemical characteristics of the soil is essential for successful rapeseed cultivation as it greatly impacts the crop's development, yield, and quality[1]. The use of organic sources has drawn attention among other nutrient management options because of its potential to improve nutrient availability, strengthen soil health, and support sustainable farming practices. Controlling the chemical characteristics of the soil, such as pH, nutrient availability, cation exchange capacity (CEC), organic matter content, and salinity, is essential to its effective growth. These variables have a major impact on the intake of micronutrients, nitrogen, phosphorus, potassium, sulphur, and other key elements that are critical for the growth, yield, and oil quality of rapeseed. The use of compost, animal dung, green manure, and crop leftovers in organic nutrient management is becoming more widely acknowledged as a sustainable way to improve soil health, increase nutrient availability, and lessen dependency on chemical fertilizers. These organic supplements promote the long-term productivity and sustainability of rapeseed production while reducing environmental impacts by boosting microbial activity, increasing soil organic matter, and contributing to the cycling of nutrients[2].

Farmers are being forced to increase crop yields due to the growing demand for oilseeds and food grains, which frequently means using a lot of chemical fertilizers. However, the quality of food and the health of the land are at risk when these fertilizers are used carelessly to provide necessary nutrients. Important micronutrients like zinc and boron are being depleted due to the ongoing usage of inorganic inputs, especially in rainfed areas [3]. In addition to lowering soil productivity, this depletion has had a detrimental effect on microbial activity and soil fertility. According to research, organic nutrient sources can enhance the chemical, biological, and physical characteristics of soil and offer a long-term substitute for chemical fertilizers.

To increase soil organic carbon, supply vital plant nutrients, and enhance soil qualities, a variety of organic inputs have been used over time, including compost, farmyard manure (farmyard manure), vermicompost, crop residues, green manures, green leaf manuring, and biofertilizers [4,5]. Particularly animal dung has long been prized for its capacity to improve soil fertility, providing a more affordable and sustainable option to mineral fertilizers. Enhancing soil organic matter and stimulating the activity of beneficial microorganisms and enzymes are two key benefits of proper nutrition management using organic sources. It has been demonstrated that applying organic materials over an extended period of time increases crop yield, soil biological activity, and organic matter content. Therefore to study the after effects of soil chemical properties a field experiment was initiated in order to study the after effects of soil nutrient composition and its comparison effect with initial status of the soil.

2. MATERIAL AND METHODS

A field experiment was conducted during the rabi season of 2018-2019 at the Instructional-cum-Research farm of Assam Agricultural University, Jorhat to assess the impact of various organic management techniques on the chemical properties of the soil after harvest. During the crop season, the maximum temperatures ranged from 21.3°C to 27.2°C, and the minimum from 8.1°C to 14.2°C, with relative humidity averaging between 90-99% in the morning and 53-77% in the evening. The area received an average rainfall of 75.60 mm, against total evaporation of 134.40 mm, with an average of 6.64 hours of bright sunshine per day. The soil in the experimental field was acidic (pH 5.1) with poor organic carbon content (0.53%) and medium levels of available nitrogen (274.20 kg/ha), phosphorus (26.95 kg/ha), and potassium (192.00 kg/ha). The experiment was set up in a randomized block design with three replications, comprising 11 treatments. Control (T_0), Farmyard manure @ 10 t/ha (T_1), Vermicompost @ 5 t/ha (T_2), Poultry Manure @ 5 t/ha (T_3), Farmyard manure @ 5 t/ha + Vermicompost @ 2.5 t/ha (T_4), Farmyard manure @ 5 t/ha + Poultry Manure @ 2.5 t/ha (T_5), Vermicompost @ 2.5 t/ha + Poultry Manure @ 2.5 t/ha (T_6), Farmyard manure @ 5 t/ha + Vermicompost @ 2.5 t/ha + Mustard Oil Cake @ 1 t/ha (T_7), Farmyard manure @ 5 t/ha + Poultry Manure @ 2.5 t/ha + Mustard Oil Cake @ 1 t/ha (T_8), Vermicompost @ 2.5 t/ha + Poultry Manure @ 2.5 t/ha + Mustard Oil Cake @ 1 t/ha (T_9), and Farmyard manure @ 5 t/ha + Vermicompost @ 1.25 t/ha + Poultry Manure @ 1.25 t/ha + Mustard Oil Cake @ 1 t/ha (T_{10}). Different doses of organic nutrients was considered so as to find the effective, economic and environmentally benefit one. The TS-67 variety of rapeseed was sown at a rate of 12 kg/ha in shallow furrows, maintaining a 30 cm distance between rows, and planted uniformly at a depth of 4-5 cm. The plots assigned for the application of farmyard manure, vermicompost, poultry manure, and other organic inputs were carefully marked, and the designated amounts of each manure, calculated on a dry weight basis, were uniformly distributed according to the treatment plans. These organic inputs were applied three days before sowing, ensuring that they were thoroughly incorporated into the soil to enhance nutrient availability and optimize conditions for rapeseed growth. Following the crop harvest, soil samples were collected from each plot (0-15 cm), air-dried, ground, and sieved through a 2 mm diameter sieve to prepare them for analysis. These samples were used to estimate soil organic carbon, available nitrogen, phosphorus, and potassium levels. Soil organic carbon was determined using Walkley and Black wet digestion method, [6]. Available nitrogen was measured using the alkaline potassium permanganate method as proposed by Subbiah and Asija, [7] and was expressed in kg/ha. The available phosphorus content was determined by the Bray I method, with the help of a spectrophotometer at 660 nm wavelength as proposed by Jackson [8], while available potassium was assessed using the Flame photometric method [8], with both results also expressed in kg/ha. Soil pH was determined using glass electrode method as outlined by Jackson [8]. Additionally the soil physical properties were also analyzed initially with respect to following procedures as described in Table 1. The data recorded under the lab experiment was subject to analysis of variance for randomized block design given by Panse and Sukhame [9].

3. RESULTS AND DISCUSSION

The application of various organic nutrient sources led to significant effects on the final chemical properties of the soil. Per cent organic carbon content in soil after the crop harvest was significantly affected by different organic sources of nutrients. All the organic sources of nutrients showed similar effect (ranging from 0.560 to 0.577%), but significantly higher organic carbon content over the control (0.523%). This aligns with the findings of Majumder and his co-workers [10], who reported an increase in soil organic carbon with the addition of FARMYARD MANURE, showing an increase of up to 104.98 g/kg over the initial value. Kamal and his coworkers [11] similarly noted that organic fertilizers boost soil organic carbon levels. Numerous studies have demonstrated that bulky organic manures enhance overall soil health, reduce soil moisture evaporation, and improve the soil environment [12,13]. Significant increases in soil organic matter with poultry manure application [4] and with the use of 100% organic nutrient sources (FARMYARD MANURE + Vermicompost + Neem cake) [15] have also been reported.

Table 1.Initial physico-chemical properties of the experimental site (0-15 cm)

Soil property	Percent content/ value	Remarks	Method employed
A. Mechanical composition			
i) Sand (%)	58.00	Sandy loam	International pipette method (Piper, 1966) [16]
ii) Silt (%)	25.40		
iii) Clay (%)	16.56		
B. Physical properties			
i) Bulk density (g/cm^3)	1.48		Core sampler method (Black,1965)[17]
ii) Field capacity (% w/w)	24.45		Pressure plate apparatus (Richards and Fireman, 1943) [18]
iii) Permanent wilting point (% w/w)	11.20		Pressure plate apparatus (Richards and Fireman, 1943) [17]
iv) Water holding capacity (%)	35.35		Ken Rackzowski box (Piper,1966) [16]
C. Chemical properties			

Soil property	Percent content/ value	Remarks	Method employed
i) Soil reaction (pH)	5.10	Acidic	Glass electrode method, (Jackson, 1973) [8]
ii) Organic carbon (%)	0.53	Poor	Wet Digestion Method (Walkey and Black, 1934) [7]
iii) Available N (kg/ha)	274.20	Medium	Alkaline potassium permanganate method (Subbiah and Asija,1956)
iv) Available P_2O_5 (kg/ha)	26.95	Medium	Bray-I Method (Jackson, 1973) [8]
v) Available K_2O (kg/ha)	192.00	Medium	FlamePhotometerMethod (Jackson, 1973) [8]

Table 2. Effect of organic sources of nutrients on organic carbon and nutrient status in soil after harvest of rapeseed

Treatments	Organic carbon (%)	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
T_0: Control	0.523	233.12	21.62	271.49
T_1 : FARMYARD MANURE @ 10 t/ha	0.577	292.58	27.62	273.73
T_2 : Vermicompost @ 5 t/ha	0.567	292.06	28.33	273.73
T_3 : Poultry manure @ 5 t/ha	0.560	283.91	27.98	272.83
T_4 : FARMYARD MANURE @ 5 t/ha + V.C @ 2.5 t/ha	0.573	291.18	28.99	276.42
T_5 : FARMYARD MANURE @ 5 t/ha + P.M @ 2.5 t/ha	0.570	284.03	27.66	273.28
T_6 : V.C @ 2.5 t/ha + P.M @ 2.5 t/ha	0.570	282.57	29.73	274.18
T_7 : FARMYARD MANURE @ 5 t/ha + V.C @ 2.5 t/ha + MOC @ 1 t/ha	0.573	284.92	30.77	276.87
T_8 : FARMYARD MANURE @ 5 t/ha + P.M @ 2.5 t/ha + MOC @ 1 t/ha	0.573	289.38	28.70	275.07
T_9 : V.C @ 2.5 t/ha + P.M @ 2.5 t/ha + MOC @ 1 t/ha	0.577	289.48	29.73	274.62
T_{10} : FARMYARD MANURE @ 5 t/ha + V.C @ 1.25 t/ha + P.M @ 1.25 t/ha + MOC @ 1 t/ha	0.577	289.38	32.23	274.62
S.Em (±)	0.006	4.31	1.70	1.92
CD (P=0.05)	0.018	12.73	5.01	NS

Available N and phosphorus in soil determined after the crop harvest was also found significantly higher with the application of all the organic sources of nutrients *viz.,* FARMYARD MANURE, vermicompost, poultry manure and mustard oil cake either alone or in different combinations over the control. In respect to available N, it ranged from 282.57 kg/ha with vermicompost 2.5 t/ha + poultry manure 2.5 t/ha to 292.58 kg/ha with FARMYARD MANURE 10 t/ha and all being significantly higher over the control. Significantly higher levels of available nitrogen (N) and phosphorus (P_2O_5) were recorded in the soil after crop harvest following the application of different organic nutrient sources compared to the control. However, the available potassium (K_2O) did not show significant differences across treatments. Long-term experiments in a soybean-wheat cropping sequence at Akola by Potkileand their coworkers [19] showed that the application of FARMYARD MANURE, vermicompost, compost, and crop residues improved productivity and soil fertility. Reports also indicated that organic manures enrich soil nitrogen content, likely due to the accumulation of nitrogen through the mineralization of organic nitrogen [20,21]. Similarly, increased soil phosphorus availability following organic fertilizer application has been documented [22].

4. CONCLUSION

The application of various sources of organic amendments increased the nutrient uptake of the soil. The use of organic inputs such as farmyard manure, vermicompost, poultry manure, and combinations thereof enhanced soil moisture retention, increased organic carbon content and led to higher levels of available nitrogen and phosphorus in the soil after harvest. These benefits can be attributed to the improved soil structure, increased organic matter, and enhanced nutrient cycling facilitated by organic amendments. Consequently, adopting organic nutrient management practices offers a sustainable approach to maintaining soil health, improving crop yields, and reducing reliance on chemical fertilizers, ultimately contributing to long-term agricultural sustainability.

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3.

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