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Effect of Organic and Inorganic Sources of Nutrients on Soil Properties after Crop Harvest

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ABSTRACT

A field experiment was carried out at the Agricultural Research Farm of R.B.S. College, Bichpuri, Agra, during the kharif seasons of 2021 and 2022 to evaluate the influence of organic and inorganic nutrient sources on soil properties. The experiment was laid out in a randomized block design with eleven treatments: (T1) 5 t FYM ha^{-1}, (T2) 2.5 t vermicompost (VC) ha^{-1}, (T3) 50% RDF ha^{-1}, (T4) 50% RDF + 5 t FYM ha^{-1}, (T5) 50% RDF + 2.5 t FYM ha^{-1}, (T6) 50% RDF + 2.5 t FYM + 1.25 t VC ha^{-1}, (T7) 75% RDF ha^{-1}, (T8) 75% RDF + 5 t FYM ha^{-1}, (T9) 75% RDF + 2.5 t FYM ha^{-1}, (T10) 75% RDF + 2.5 t FYM + 1.25 t VC ha^{-1}, and (T11) 100% RDF, with three replications. Results indicated that treatment T10 (75% RDF + 2.5 t FYM + 1.25 t VC ha^{-1}) was significantly superior to all other treatments. Application of T10 resulted in markedly higher soil organic carbon and available nitrogen, phosphorus, and potassium compared to the sole FYM treatment (T1). The improvement in soil properties under T10 over T1 was recorded as 17.2% for soil organic carbon, 18.7% for available nitrogen, 71% for available phosphorus, and 12.75% for available potassium. These findings highlight the effectiveness of integrating organic and inorganic nutrient sources for enhancing soil fertility.

Keywords: *INM, Soil Organic Carbon, Nitrogen, Phosphorus, Potassium.*

Introduction

Applying farmyard manure (FYM) to the soil improves its physical characteristics, particularly its ability to retain water, and increases its fertility. With the introduction of high-analysis chemical fertilisers, organic manures – possibly the primary providers of plant nutrients in traditional agriculture – are given less attention [1]. Recent research has demonstrated that a strategic combination of organic manures and fertilisers can more effectively preserve soil fertility and maintain high levels of productivity in the long term. However, chemical fertiliser will continue to be the primary tool for accelerating agricultural production. As a result, using chemical fertilisers and organic manure in the right amounts takes on particular importance in crop production as a complement to one another [2-3]. The purpose of this investigation is to evaluate the direct and residual consequences of phosphorus on crops. Enhancing soil health, cutting production costs, and increasing output are the three interconnected elements of the sustainability triangle. Thus, it is necessary to design an appropriate blend that includes chemical fertilisers and organic manures for a certain cropping system and soil.

Materials and Methods

The field experiments were conducted at the Agricultural Research Farm of R.B.S. College, Bichpuri, Agra, located in the semi-arid or gray steppe arid region of southwestern Uttar Pradesh, during the *kharif* seasons of 2021 and 2022. The soil of the experimental site was sandy loam in texture, with initial properties including an EC of 0.18 dS m^{-1}, pH 8.3, organic carbon 3.9 g kg^{-1}, available nitrogen 188.6 kg ha^{-1}, available phosphorus 12.4 kg ha^{-1}, and available potassium 205.6 kg ha^{-1}. The experiment was laid out in a randomized block design with three replications and consisted of eleven treatments: 5 t FYM ha^{-1} (T1), 2.5 t vermicompost ha^{-1} (T2), 50% RDF ha^{-1} (T3), 50% RDF + 5 t FYM ha^{-1} (T4), 50% RDF + 2.5 t FYM ha^{-1} (T5), 50% RDF + 2.5 t FYM + 1.25 t vermicompost ha^{-1} (T6), 75% RDF ha^{-1} (T7), 75% RDF + 5 t FYM ha^{-1} (T8), 75% RDF + 2.5 t FYM ha^{-1} (T9), 75% RDF + 2.5 t FYM + 1.25 t vermicompost ha^{-1} (T10), and 100% RDF comprising 100 kg N, 60 kg P_2O_5, and 40 kg K_2O ha^{-1} (T11). Organic manures were applied before sowing, while fertilizers were applied according to recommended agronomic practices. Post-harvest soil samples were collected and analyzed to assess changes in soil organic carbon and available nitrogen, phosphorus, and potassium using standard laboratory procedures.

Soil Sampling and Analysis

Soil samples were collected during 2023 from the plow layer (0-20 cm depth) from the experimental plot after the crop harvest. These samples were partitioned and passed through standard prescribed sieves for further use in a different kind of analysis. The soil samples that passed through the 0.2-mm sieve were used for estimating soil organic carbon (SOC). For the rest of the soil quality parameters such as chemical (pH, EC), available N, P, K, S, and Zn, soil samples that passed through 2-mm sieves were used. Soil pH and EC were measured in a 1:2 soil/water suspension [1], organic carbon by wet oxidation with sulfuric acid (H_2SO_4) + potassium dichromate ($K_2Cr_2O_7$) [2], available N by alkaline-$KMnO_4$ oxidizable N method [3], available P by 0.5 M sodium bicarbonate ($NaHCO_3$) extraction method [4], available K [5], available sulfur by 0.15% $CaCl_2$ [6], and available Zn by DTPA method [7].

Results and Discussion

SOIL STUDIES:

EC and pH

Application of T10 (75% RDF + 2.5 t FYM + 1.25 t VC/ha) recorded non-significantly higher EC values in soil (0.35 dSm^{-1}) compared to (T1) 5 t FYM/ha (0.25 dSm^{-1}). Significantly higher pH value in soil with the application of T10 (75% RDF + 2.5 t FYM + 1.25 t VC/ha was recorded (8.43) compared to (T1) 5 t FYM/ha (8.12), respectively (Table 1). Similar results were also reported by [8] and [9].

Soil organic carbon

The SOC content in soil increased significantly with each level of organic and inorganic sources of nutrient management treatments as compared to T1 (Table 1). Among the inorganic and organic sources of nutrient management treatments, application of T10 (75% RDF + 2.5 t FYM + 1.25 t VC/ha) recorded significantly higher SOC content in soil (4.53 g/kg) followed by (T11) 100% RDF (100 kg N + 60 kg P_2O_5 + 40 kg K_2O/ha) (4.47 g/kg), (T8) 75% RDF + 5 t FYM/ha (4.41 g/kg), (T9) 75% RDF + 2.5 t FYM/ha (4.36 g/kg), (T7) 75% RDF/ha (4.32 g/kg), (T6) 50% RDF + 2.5 t FYM + 1.25 t VC/ha (4.25 g/kg), (T4) 50% RDF + 5 t FYM/ha (4.18 g/kg), (T5) 50% RDF + 2.5 t FYM/ha (4.13 g/kg), (T3) 50% RDF/ha (4.09 g/kg), (T2) 2.5 t VC/ha (4.01 g/kg) and (T1) 5 t FYM/ha (3.87 g/kg) respectively. Similar results were also reported by [10] and [8].

Available nitrogen

The available-N in soil maximum significantly with each level of inorganic and organic sources of nutrient management treatments as compared to T1 (Table 1). Among the organic and inorganic sources of nutrient management treatments, application of T10 (75% RDF + 2.5 t FYM + 1.25 t VC/ha) recorded significantly higher available-nitrogen in soil (219.4 kg/ha) followed by (T11) 100% RDF (100 kg N + 60 kg P_2O_5 + 40 kg K_2O/ha) (216.9 kg/ha), (T8) 75% RDF + 5 t FYM/ha (213.1 kg/ha), (T9) 75% RDF + 2.5 t FYM/ha (208.7 kg/ha), (T7) 75% RDF/ha (205.2 kg/ha), (T6) 50% RDF + 2.5 t FYM + 1.25 t VC/ha (202.3 kg/ha), (T4) 50% RDF + 5 t FYM/ha (198.6 kg/ha), (T5) 50% RDF + 2.5 t FYM/ha (194.0 kg/ha), (T3) 50% RDF/ha (190.4 kg/ha), (T2) 2.5 t VC/ha (187.8 kg/ha) and (T1) 5 t FYM/ha (184.8 kg/ha) respectively. These results are in favour of [11] and [8].

Available phosphorus

The available phosphorus in soil increased significantly with each level of organic and inorganic sources of nutrient management treatments as compared to T1(table-1). Among the inorganic and organic sources of nutrient management treatments, application of T10 (75% RDF + 2.5 t FYM + 1.25 t VC/ha) recorded significantly higher available phosphorus in soil (19.8 kg/ha) followed by (T11) 100% RDF (100 kg N + 60 kg P_2O_5 + 40 kg K_2O/ha) (19.3 kg/ha), (T8) 75% RDF + 5 t FYM/ha (18.6 kg/ha), (T9) 75% RDF + 2.5 t FYM/ha (17.8 kg/ha), (T7) 75% RDF/ha (16.9 kg/ha), (T6) 50% RDF + 2.5 t FYM + 1.25 t VC/ha (16.3 kg/ha), (T4) 50% RDF + 5 t FYM/ha (15.7 kg/ha), (T5) 50% RDF + 2.5 t FYM/ha (14.4 kg/ha), (T3) 50% RDF/ha (13.2 kg/ha), (T2) 2.5 t VC/ha (12.5 kg/ha) and (T1) 5 t FYM/ha (11.6 kg/ha) respectively. These results are in accordance with those of [11] and [8].

Available potassium

The available potassium content in soil increased significantly across all nutrient management treatments compared to T1 (Table 1). Among the integrated organic and inorganic nutrient sources, the application of T10 (75% RDF + 2.5 t FYM ha^{-1} + 1.25 t vermicompost ha^{-1}) recorded the highest available potassium (225.6 kg ha^{-1}), which was significantly superior to the other treatments. This was followed closely by T11 (100% RDF: 100 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1}) with 224.0 kg ha^{-1}, T8 (75% RDF + 5 t FYM ha^{-1}) with 222.7 kg ha^{-1}, T9 (75% RDF + 2.5 t FYM ha^{-1}) with 220.2 kg ha^{-1}, and T7 (75% RDF ha^{-1}) with 217.1 kg ha^{-1}. Moderate increases were also recorded under T6 (50% RDF + 2.5 t FYM + 1.25 t vermicompost ha^{-1}) with 215.2 kg ha^{-1}, T4 (50% RDF + 5 t FYM ha^{-1}) with 213.8 kg ha^{-1}, T5 (50% RDF + 2.5 t FYM ha^{-1}) with 211.1 kg ha^{-1}, T3 (50% RDF ha^{-1}) with 208.6 kg ha^{-1}, and T2 (2.5 t vermicompost ha^{-1}) with 205.2 kg ha^{-1}. The lowest potassium content (200.2 kg ha^{-1}) was observed under T1 (5 t FYM ha^{-1}). The superior performance of T10 may be attributed to improved mineralization, enhanced nutrient release, and better retention of potassium due to combined application of FYM and vermicompost along with inorganic fertilizers. These findings are consistent with earlier reports by [11] and [10], which also highlighted the positive impact of integrated nutrient management on available soil potassium.

Table 1. The effects of inorganic and organic sources of nutrients on pearl millet-lentil crop sequences and the fertility of alluvial soil of EC, pH, SOC, available N, P and K.

Treatments	EC (dSm^{-1})	pH	SOC (g/kg)	N (kg/ha)	P (kg/ha)	K (kg/ha)
T1	0.25	8.12	3.87	184.8	11.6	200.2
T2	0.25	8.14	4.01	187.8	12.5	205.2
T3	0.27	8.17	4.09	190.4	13.2	208.6
T4	0.28	8.21	4.18	198.6	15.7	213.8
T5	0.26	8.19	4.13	194.0	14.4	211.1
T6	0.28	8.25	4.25	202.3	16.3	215.2
T7	0.29	8.29	4.32	205.2	16.9	217.1
T8	0.31	8.36	4.41	213.1	18.6	222.7
T9	0.31	8.33	4.36	208.7	17.8	220.2
T10	0.35	8.43	4.53	219.4	19.8	225.6
T11	0.34	8.39	4.47	216.9	19.3	224.0
SEm±	0.034	0.055	0.104	4.07	1.10	4.02
CD @ 5%	NS	0.115	0.216	8.49	2.29	8.39

Conclusion

The study demonstrated that integrating organic and inorganic nutrient sources significantly improved soil properties after crop harvest. The combined application of FYM, vermicompost, and RDF—particularly treatment T10 (75% RDF + 2.5 t FYM + 1.25 t VC ha^{-1})—proved most effective in enhancing soil organic carbon and increasing the availability of nitrogen, phosphorus, and potassium. These improvements can be attributed to better nutrient mineralization, enhanced microbial activity, and improved soil structure under integrated nutrient management, the results highlight that balanced use of organic and inorganic inputs is essential for sustaining soil fertility, improving nutrient availability, and promoting long-term soil health in crop production systems.

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