IMPACT OF INTEGRATED NUTRIENT MANAGEMENT ON SOIL PHYSICO-CHEMICAL PROPERTIES AND SOIL FERTILITY UNDER INDIAN MUSTARD (*BRASSICA JUNCEA* L.)

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ABSTRACT
A field experiment was conducted during the *rabi* seasons of 2024-25 and 2025-26 at the Student Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India to evaluate the impact of Integrated Nutrient Management (INM) on soil physico-chemical properties and soil fertility under Indian mustard (*Brassica juncea* L.). The experiment was laid out in a Randomized Block Design with three replications comprising ten nutrient management treatments involving different combinations of recommended dose of fertilizers (RDF), farmyard manure (FYM), vermicompost, phosphate-solubilizing bacteria (PSB) and *Azotobacter*. Soil samples collected after harvest were analyzed for physical and chemical properties. Integrated application of organic manures, biofertilizers and inorganic fertilizers significantly improved soil health over the control. The treatment comprising 50% RDF + PSB + 2.0 t ha^{-1} vermicompost + 5.0 t ha^{-1} FYM (T_{10}) recorded the lowest bulk density (1.24 Mg m^{-3}), particle density (2.34 Mg m^{-3}), soil pH (7.47) and electrical conductivity (0.32 dS m^{-1}), while exhibiting the highest total porosity (46.02%), water holding capacity (39.51%), cation exchange capacity (14.15 Cmol(p^{+}) kg^{-1}), organic carbon (0.451%), exchangeable calcium (3.40 Cmol(p^{+}) kg^{-1}) and magnesium (1.00 Cmol(p^{+}) kg^{-1}) in T_{10}. However, the highest available nitrogen (198.83 kg ha^{-1}) was recorded under 100% RDF (T_2), whereas the maximum available phosphorus (24.08 kg ha^{-1}), potassium (228.42 kg ha^{-1}) and sulphur (9.75 kg ha^{-1}) were observed under 75% RDF + PSB + 1.0 t ha^{-1} vermicompost + 2.5 t ha^{-1} FYM (T_6). The study demonstrates that integrated nutrient management effectively enhances soil physical and chemical properties while improving nutrient availability, thereby contributing to sustainable mustard production.

KEYWORDS: Integrated nutrient management, Indian mustard, Soil fertility, Vermicompost, Farmyard manure, Phosphate-solubilizing bacteria.

INTRODUCTION
Mustard is one of the oldest recorded spices, with references dating back to 3000 BC. It was originally known as a condiment, with the term derived from the Latin *mustum* (Singh *et al.,* 2025). Indian mustard (*Brassica juncea* L. Czern & Coss.) is a major *rabi* oilseed crop and a cornerstone of India's edible oil economy, contributing nearly one-third of domestic vegetable oil production and ranking among the leading rapeseed-mustard producers globally (Upadhyay *et al.,* 2026). Indian mustard (*Brassica juncea* L.) emerges as a crop of strategic importance in addressing global food security. Mustard seeds are a rich source of oil and protein, catering to the dual demand for edible oils and nutritional supplements (Singh *et al.,* 2026).
Mustard is a nutrient-demanding crop that requires an adequate and balanced supply of essential macronutrients like nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) (Mahto *et al.,* 2024). The appropriate application of fertilizers helps to supply all the essential nutrients to plants which play a critical role in maximizing the yield

potential of Indian mustard. When Farm Yard Manure (FYM), vermicompost (VC) and bio-fertilizers like *Azotobacter* are used in conjunction with fertilizers, these improve the physical, chemical and biological properties of the soil (Selim, 2018). In present agriculture scenario use of chemical fertilizer is increasing to boost up crop production. Generally, oilseed crops are raised under rainfed conditions with low input and poor management practices leading to lower productivity level. (Lal *et al.,* 2015).

Integrated nutrient management (INM) is an age-old method of supplying secondary and micronutrients in addition to basic nutrients to meet crop nutrient requirements through organic sources. In addition to having a positive influence on soil health, INM is effective in restoring and maintaining soil fertility, crop yield, preventing secondary and micronutrient deficiencies, improving nutrient-use efficiency and economizing fertilizer use (Singh, Dwivedi and Datta. 2012). INM can reduce dependency on high doses of chemical fertilizers, reduce nutrient losses (leaching, volatilization) and enhance nutrient use efficiency-yielding both agronomic and environmental benefits (Meitei *et al.,* 2025). Organic manure fertilization significantly improved the physico-chemical and biological properties of the soil, such as pH, bulk density, enzymatic activity, soil aggregation, soil organic carbon and both macro and micro-nutrients (Dhaliwal *et al.,* 2023).

Farm Yard Manure enhances the soil's biological, chemical and physical characteristics and boosts its water-holding capacity for optimal water utilization. Although in little amounts, it can provide the plant with all the nutrients it needs. The following elements are found in Farm Yard Manure: (0.5 %) Nitrogen, (0.25 %) Phosphorus, (0.5 %) Potassium, (0.08 %) Sodium, (0.02 %) Sulphur, (0.004 %) Zinc, (0.0003 %) Copper, (0.007 %) Manganese and (0.45 %) Iron, according to research (Singh 2014). Enriched vermicompost (EVC) has emerged as a promising organic amendment in this context (Bhargava *et al.,* 2023). Unlike ordinary compost, enriched vermicompost is fortified with essential nutrients such as phosphorus, sulphur and micronutrients (e.g., zinc, boron), along with beneficial microbial inoculants (Chiranjeeb *et al.,* 2020).

Presently, numerous strains of microbes have been isolated and employed for their use as bio-fertilizers. *Azotobacter* and *Azospirillum* the two major micro-organisms that are found to help rapeseed-mustard group of crops to fix atmospheric nitrogen. Among these a popular one is *Azotobacter* which is non-symbiotic N_2-fixing bacteria, highly diverse and globally widespread in soils. *Azotobacter* represents a group of Gram negative, free-living, nitrogen fixing aerobic bacteria. This bacterial group may represent the dominant natural source of N in ecosystems lacking symbiotic nitrogen (Aasfar *et al.,* 2021). Phosphate Solubilizing Bacteria (PSB) promote seed germination and initial vigour of the plants by producing growth promoting substances. Application of PSB results in increased mineral and water uptake, root development, vegetative growth and Nitrogen (N) fixation (Gangwal *et al.,* 2011).

MATERIALS AND METHODS

The field experiment was conducted during the *rabi* seasons of 2024-25 and 2025-26 at the Student Instructional Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, (U.P.) on sandy loam soil to study the impact of Integrated Nutrient Management (INM) on soil physico-chemical properties and soil fertility under mustard (*Brassica juncea* L.). The experimental site falls under subtropical climate zone of Indo-Gangetic plains situated at $26^0 29`25''$ North latitude and $80^0 18`03''$ East longitude at 125.9 m mean sea level. The experiment was laid out in Randomized Block Design (RBD) with three replications. Each replication comprised of ten treatment combinations *viz.,* Absolute Control, 100% RDF, 75% RDF, 50% RDF. The Treatment combinations in RBD are T_1: Absolute control, T_2: 100% RDF, T_3: 75% RDF + PSB, T_4: 75% RDF + 2.0-ton Vermicompost, T_5: 75% RDF + 5.0 ton FYM, T_6: 75% RDF + PSB + 1.0 ton Vermicompost + 2.5 ton FYM, T_7: 50% RDF + 4.0 ton Vermicompost, T_8: 50% RDF + 10 ton FYM, T_9: 50% RDF + PSB + *Azotobacter*, T_{10}: 50% RDF + PSB + 2.0 ton Vermicompost + 5.0 ton FYM in a plot size 4.4 x 3.2 m^2 (Net plot). RDF (NPKS) 120:50:40:30. N, P, K, S were applied in the form of urea (46% N), Single Super Phosphate (SSP) (16% P_2O_5, 21% Ca, 12% S), Muriate of Potash (MOP) (60% K_2O), vermicompost (1.2 - 2.5 % N, 0.9 - 1.7 % P, 1.5 - 2.5 % K), FYM (0.5 % N, 0.25 % P_2O_5, 0.5 % K_2O) and Biofertilizer (*Azotobacter* and Phosphate Solubilizing Bacteria (PSB) respectively.

The initial soil properties of the experiment site were analyzed and it had values of BD 1.37, PD 2.47, Total porosity 44.64%, WHC 29.14%, pH 7.63 (1:2.5), Electrical Conductivity (EC) of 0.36 dSm^{-1}, organic carbon 0.422%, CEC 8.76%, available N (173.97 kg ha^{-1}), available P (16.98 kg ha^{-1}), available K (190.6 kg ha^{-1}), available S (8.82 kg ha^{-1}), exchangeable Ca (1.48 Cmol(p^+) kg^{-1}), exchangeable Mg (0.41 Cmol(p^+) kg^{-1}).

Soil sampling analysis

The estimate various soil parameters, plot-wise V-shaped soil sampling were done after the crop harvest. From the experiment site four soil cores were sampled randomly from 0-15 cm soil layer of each plot after Mustard harvest. Following the procedure for reducing the soil volume by quadratation, the sample were brought the laboratory in plastic bags for analysis of their physical and chemical properties.

Core samples were collected from the field to estimate bulk density (Bodman, 1942). The soil samples collected were air-dried, mixed well, passed through 2-mm sieve and stored for analyses. Particle density was measured by pycnometer method (Richards, 1954) and total porosity was measured by graduated cylinder method (Chopra and Kanwar, 1991). Water holding capacity measured by keen box method (Keen, 1921). The Ca^{2+} and Mg^{2+} were estimated as described in USDA handbook 60. Soil pH and Electrical Conductivity at 25^0C (1:2.5 soil: water) were determined using the potentiometric method described by Jackson (1973) and organic carbon estimation was carried out using the wet oxidation method developed by Walkley and Black (1934). While available nitrogen in the soil was evaluated using the alkaline permanganate method by Subbiah and Asija (1956), available Phosphorus was calculated using the approach suggested by Olsen *et al.* (1954). The available potassium was measured using the neutral ammonium acetate extraction method and analyzed with the flame photometer, as described by Toth and Prince (1949). The available sulphur in soil was evaluated using turbidimetric method by Chesnin and Yein (1951), Exchangeable Ca, Exchangeable Mg was analyzed by titration method (Schwarzenbach, 1969).

Statistical Analysis

The data were statistically analyzed using 'OPSTAT' (Sheoren *et al.* 1998) software of CCS Haryana Agricultural University, Hisar, Haryana.

RESULT & DISCUSSION

Physical properties of soil

Bulk Density (BD): The different integrated nutrient management treatments significantly influenced the bulk density (BD) of the soil after harvest. The lowest bulk density (1.24 Mg m^{-3}) was recorded under T_{10} (50% RDF + PSB + 2.0 t vermicompost + 5.0 t FYM), which indicates that the combined application of vermicompost, farmyard manure (FYM), phosphate-solubilizing bacteria (PSB) and inorganic fertilizers improved soil aggregation, increased soil organic matter and enhanced pore space, thereby reducing soil compaction. The highest bulk density (1.37 Mg m^{-3}) was observed under the absolute control (T_1), indicating that the absence of organic amendments resulted in comparatively higher soil compaction and poorer soil structure (Table 1, fig. 1). Similar findings were reported by Bhattacharyya *et al.* (2010), Patra *et al.* (2023).

Particle Density (PD): The different integrated nutrient management treatments significantly influenced the particle density (PD) of the soil after harvest. The lowest particle density (2.34 Mg m^{-3}) was recorded under T_{10} (50% RDF + PSB + 2.0 t vermicompost + 5.0 t FYM), which indicates that the combined application of vermicompost, farmyard manure (FYM), phosphate-solubilizing bacteria (PSB) and inorganic fertilizers improved soil organic matter and aggregation, thereby reducing the proportion of dense mineral particles in the soil. The highest particle density (2.47 Mg m^{-3}) was observed under the absolute control (T_1), indicating that the absence of organic amendments resulted in comparatively higher soil compactness and lower organic matter content (Table 1, fig. 1). Similar observations were reported by Brady and Weil (2017) and Ramesh *et al.* (2010).

Total Porosity: The different integrated nutrient management treatments significantly influenced the total porosity of the soil after harvest. The highest total porosity (46.02%) was recorded under T_{10} (50% RDF + PSB + 2.0 t vermicompost + 5.0 t FYM), which indicates that the combined application of vermicompost, farmyard manure (FYM), phosphate-solubilizing bacteria (PSB) and inorganic fertilizers improved soil aggregation, increased organic matter content and enhanced the formation of pore spaces within the soil. The lowest total porosity (44.64%) was observed under the absolute control (T_1), indicating that the absence of organic amendments resulted in comparatively lower pore space and poorer soil physical condition. The effect on total porosity was statistically non-significant ($P > 0.05$) (Table 1, fig. 2). Similar results were reported by Lal (2016).

Water Holding Capacity (WHC): The different integrated nutrient management treatments significantly influenced the water holding capacity (WHC) of the soil after harvest. The highest water holding capacity (39.51%) was recorded under T_{10} (50% RDF + PSB + 2.0 t vermicompost + 5.0 t FYM), which indicates that the combined application of vermicompost, farmyard manure (FYM), phosphate-solubilizing bacteria (PSB) and inorganic fertilizers substantially improved soil structure and organic matter content, thereby enhancing the soil's ability to retain water. The lowest water holding capacity (29.14%) was observed under the control treatment (T_1), indicating that the absence of organic amendments resulted in comparatively lower moisture retention and poorer soil physical condition (Table 1, fig. 2). Similar findings were reported by Brady and Weil (2017).

Table 1: Impact of INM on BD, PD, Total porosity and WHC of soil in mustard crop. (pooled mean of 2 years)

Treatments	Bulk Density (Mg m^{-3})	Particle Density (Mg m^{-3})	Total Porosity (%)	Water Holding Capacity (WHC) (%)
T_1	1.37	2.47	44.64	29.14
T_2	1.36	2.46	44.70	30.37
T_3	1.35	2.44	44.83	30.57
T_4	1.33	2.43	44.87	30.63
T_5	1.32	2.41	44.98	32.90
T_6	1.31	2.40	45.55	34.56
T_7	1.26	2.37	45.61	35.07

T_8	1.28	2.36	45.65	35.48
T_9	1.30	2.39	45.64	35.12
T_{10}	1.24	2.34	46.02	39.51
SEm (±)	0.011	0.02	0.389	0.292
CD (P = 0.05)	0.034	0.06	NS	0.874

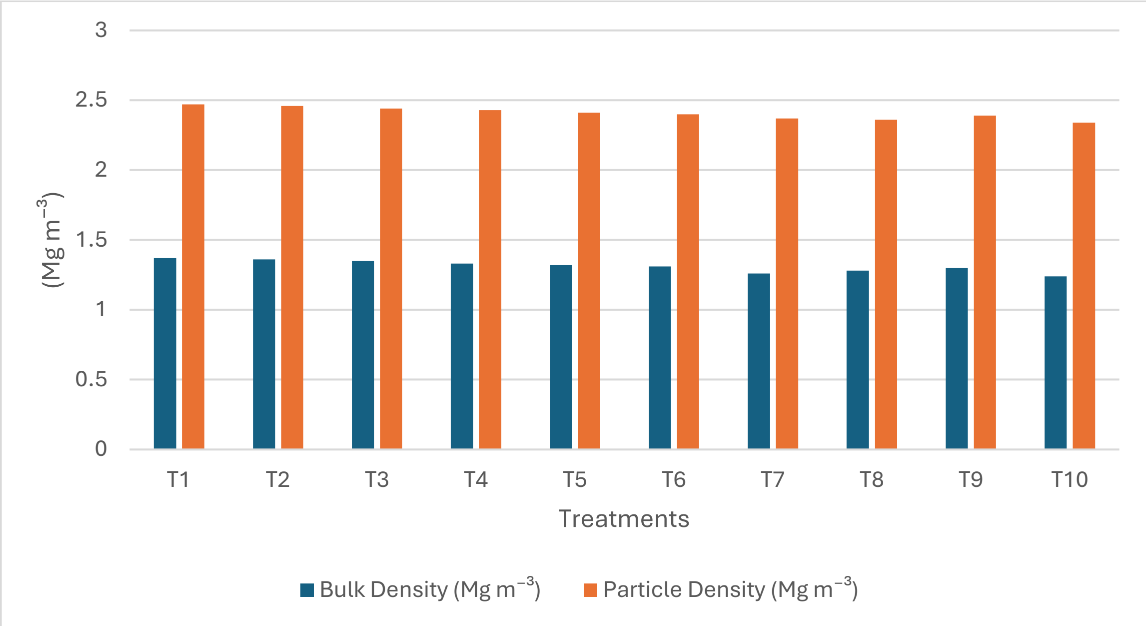

Figure 1: Impact of INM on BD and PD of soil in mustard crop

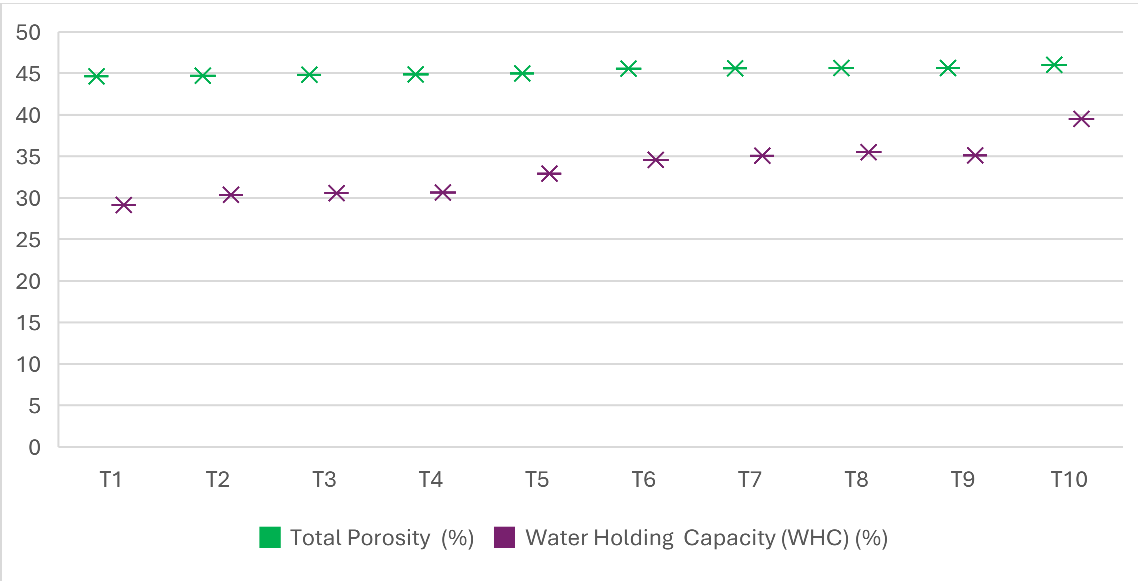

Figure 2: Impact of INM on Total porosity and WHC of soil in mustard crop

Chemical properties of soil

pH and Electrical Conductivity: The different integrated nutrient management treatments influenced the soil pH after harvest. The highest soil pH (7.63) was recorded in the absolute control (T_1) which indicates that the absence of organic amendments and biofertilizers resulted in minimal production of organic acids, thereby maintaining a relatively higher soil pH. The lowest soil pH (7.47) was recorded under T_{10} (50% RDF + PSB + 2.0 t vermicompost + 5.0 t FYM), indicating that the integrated application of vermicompost, farmyard manure (FYM), phosphate-solubilizing bacteria (PSB) and inorganic fertilizers promoted the production of organic acids during the decomposition of organic residues (Table 2, fig. 3). These organic acids, along with enhanced microbial activity, slightly reduced the soil pH and improved nutrient availability. Similar observations were reported by Goyal *et al.* (1999).

The different nutrient management treatments had a slight influence on the electrical conductivity (EC) of the soil after harvest. The highest EC (0.36 dS m^{-1}) was observed under the absolute control (T_1), indicating that the absence of integrated nutrient management resulted in comparatively higher residual soluble salts in the soil. The lowest EC (0.32 dS m^{-1}) was recorded under T_{10} (50% RDF + PSB + 2.0 t vermicompost + 5.0 t FYM), which indicates that the combined application of vermicompost, FYM, biofertilizers and inorganic fertilizers improved soil physical properties, enhanced nutrient uptake by plants and reduced the accumulation of soluble salts in the soil (Table 2, fig. 4). Similar findings were reported by Bhattacharyya *et al.* (2010) and Ramesh *et al.* (2010).

Cation Exchange Capacity: The different nutrient management treatments significantly influenced the cation exchange capacity (CEC) of the soil after harvest. The highest CEC (14.15 Cmol(p^+) kg^{-1}) was recorded under T_{10} (50% RDF + PSB + 2.0 t vermicompost + 5.0 t FYM), indicating that the integrated use of organic manures, biofertilizers and inorganic fertilizers substantially improved the cation exchange capacity of the soil (Table 2, fig. 5). The lowest CEC (8.76 Cmol(p^+) kg^{-1}) was observed under the absolute control (T_1). Similar findings were reported by Brady and Weil (2017) and Lal (2016).

Organic Carbon (OC): The different nutrient management treatments significantly influenced the organic carbon (OC) content of the soil after harvest. The highest organic carbon content (0.4508%) was recorded under T_{10} (50% RDF + PSB + 2.0 t vermicompost + 5.0 t FYM), indicating that the integrated application of organic manures, biofertilizers and inorganic fertilizers effectively enhanced soil organic carbon by increasing organic matter accumulation and improving microbial activity. The lowest organic carbon content (0.4220%) was observed under the absolute control (T_1) (Table 2, fig. 6). Similar findings were reported by Bhattacharyya *et al.* (2010), Patra *et al.* (2023).

Available Nitrogen: The different integrated nutrient management treatments significantly influenced the available nitrogen (N) content of the soil after harvest. The highest available nitrogen content (198.83 kg ha^{-1}) was recorded under T_2 (100% RDF), indicating that the recommended dose of fertilizers effectively maintained the residual nitrogen status of the soil. The absolute control (T_1) recorded the lowest available nitrogen content (173.97 kg ha^{-1}) (Table 2, fig. 7). Similar findings were reported by Subbiah and Bajaj (1962).

Available Phosphorus: The different nutrient management treatments significantly influenced the available phosphorus (P) content of the soil after harvest. The highest available phosphorus content (24.08 kg ha^{-1}) was recorded under T_6 (75% RDF + PSB + 1.0 t vermicompost + 2.5 t FYM), indicating that the superiority of integrated nutrient management in enhancing soil phosphorus availability. The absolute control (T_1) exhibited the lowest available phosphorus content (16.98 kg ha^{-1}) (Table 2, fig. 7). Similar observations were reported by Rodríguez and Fraga (1999) and Richardson *et al.* (2009).

Available Potassium: The different integrated nutrient management treatments considerably influenced the available potassium (K) content of the soil after harvest. Among the treatments, the highest available potassium content (228.42 kg ha^{-1}) was recorded under T_6 (75% RDF + PSB + 1.0 t vermicompost + 2.5 t FYM), which demonstrated the superiority of integrated application of inorganic fertilizers, biofertilizers and organic manures in improving the potassium status of the soil. The absolute control (T_1) registered the lowest available potassium content (190.59 kg ha^{-1}) (Table 2, fig. 7). Similar findings were reported by Patra *et al.* (2023).

Available Sulphur: The different integrated nutrient management treatments significantly influenced the available sulphur (S) content of the soil after harvest. The highest available sulphur content (9.75 kg ha^{-1}) was recorded under T_6 (75% RDF + PSB + 1.0 t vermicompost + 2.5 t FYM), indicating that the beneficial effect of integrating inorganic fertilizers with organic manures and biofertilizers in improving the sulphur status of the soil. The absolute control (T_1) registered the lowest available sulphur content (8.82 kg ha^{-1}) (Table 2, fig. 7). Similar findings were reported by Marschner, 2012.

Table 2: Impact of INM on chemical properties (pH, EC, CEC, OC, Avail. N, Avail. P, Avail. K, Avail. S) of soil in mustard crop (pooled mean of 2 years)

Treatments	pH	EC (dS m^{-1})	CEC (Cmol(p^+) kg^{-1})	OC (%)	Avail. N (kg ha^{-1})	Avail. P (kg ha^{-1})	Avail. K (kg ha^{-1})	Avail. S (kg ha^{-1})
T_1	7.63	0.36	8.76	0.422	173.97	16.98	190.59	8.82
T_2	7.62	0.35	9.39	0.432	198.83	23.61	225.09	9.65
T_3	7.60	0.35	10.90	0.434	182.23	22.81	221.65	9.39
T_4	7.59	0.34	11.47	0.435	195.24	22.45	221.82	9.55
T_5	7.57	0.35	12.07	0.446	187.84	21.63	218.98	9.44
T_6	7.56	0.33	12.38	0.447	191.00	24.08	228.42	9.75
T_7	7.54	0.34	11.97	0.448	186.08	19.67	216.80	9.37
T_8	7.52	0.33	13.44	0.449	185.40	18.87	211.98	9.36
T_9	7.50	0.34	10.48	0.450	180.55	19.71	208.62	9.34

T_{10}	7.47	0.32	14.15	0.451	186.94	20.70	203.55	9.42
SEm (±)	0.065	0.004	0.105	0.004	1.597	0.19	1.863	0.081
CD (P = 0.05)	NS	0.012	0.316	0.011	4.782	0.568	5.578	0.242

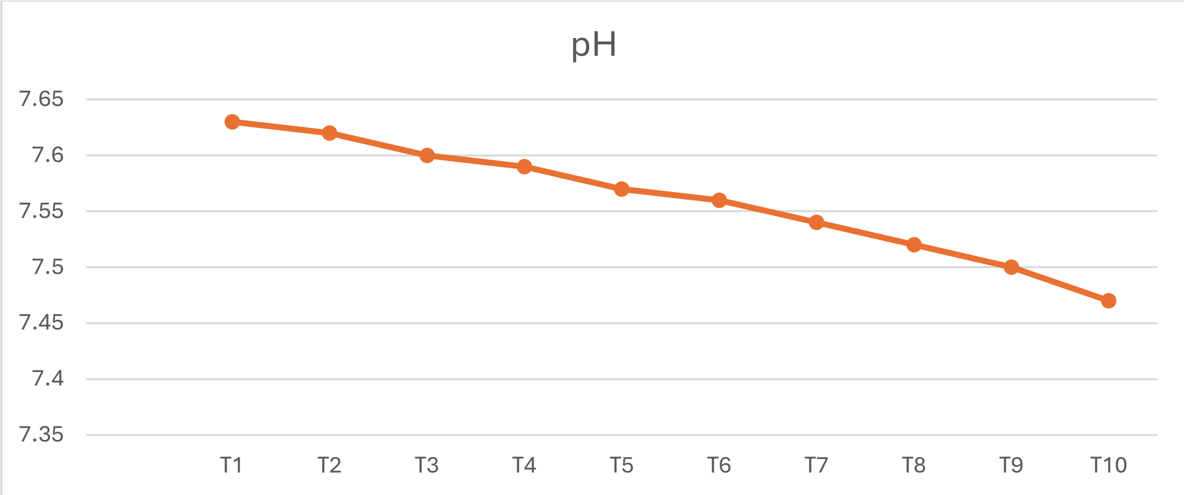

Figure 3: Impact of INM on soil pH in mustard crop

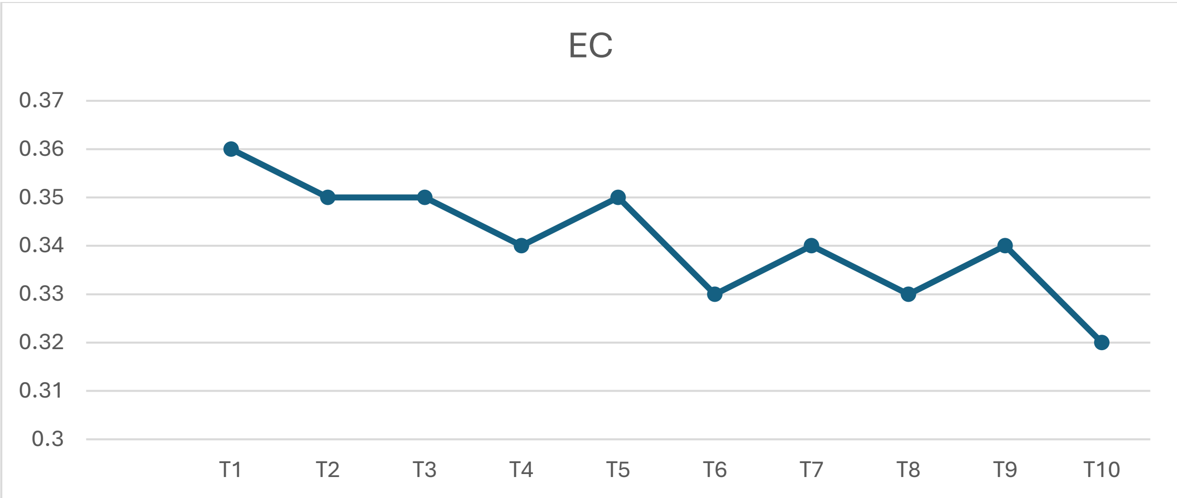

Figure 4: Impact of INM on soil EC in mustard crop

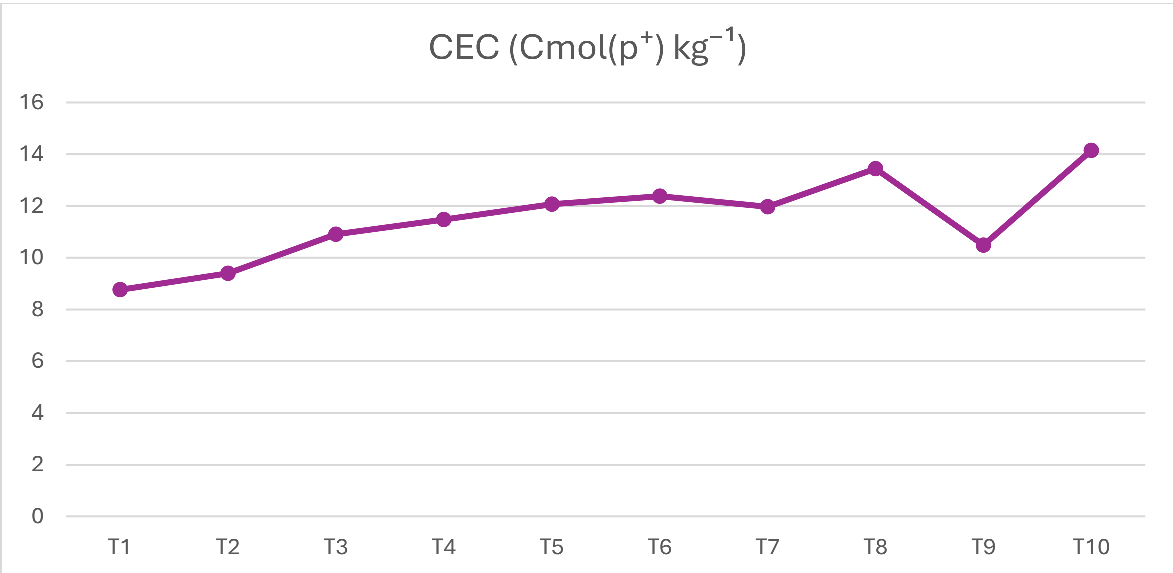

Figure 5: Impact of INM on soil CEC in mustard crop

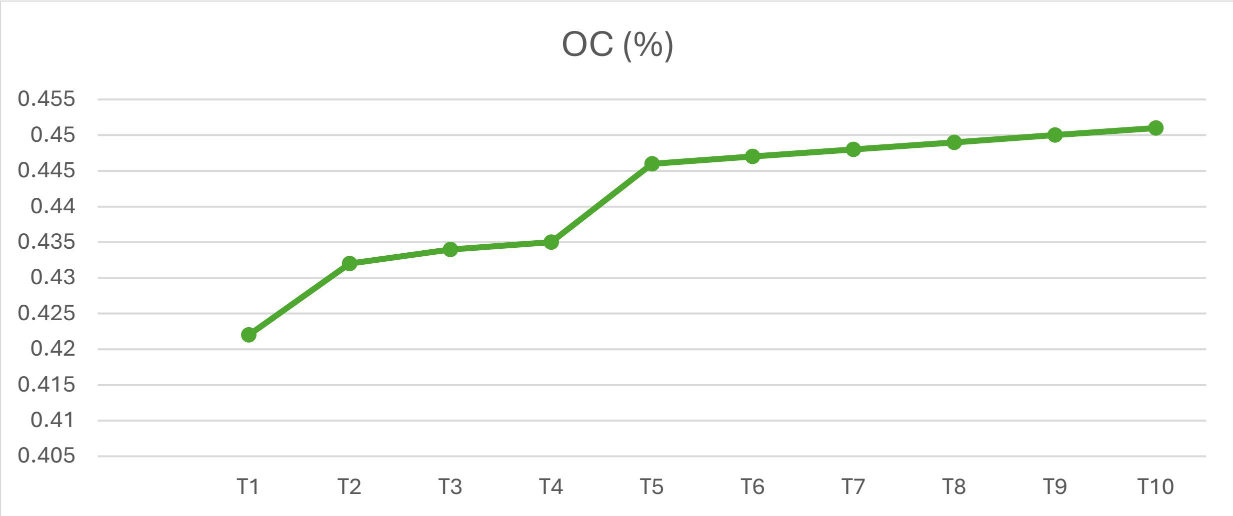

Figure 6: Impact of INM on soil OC in mustard crop

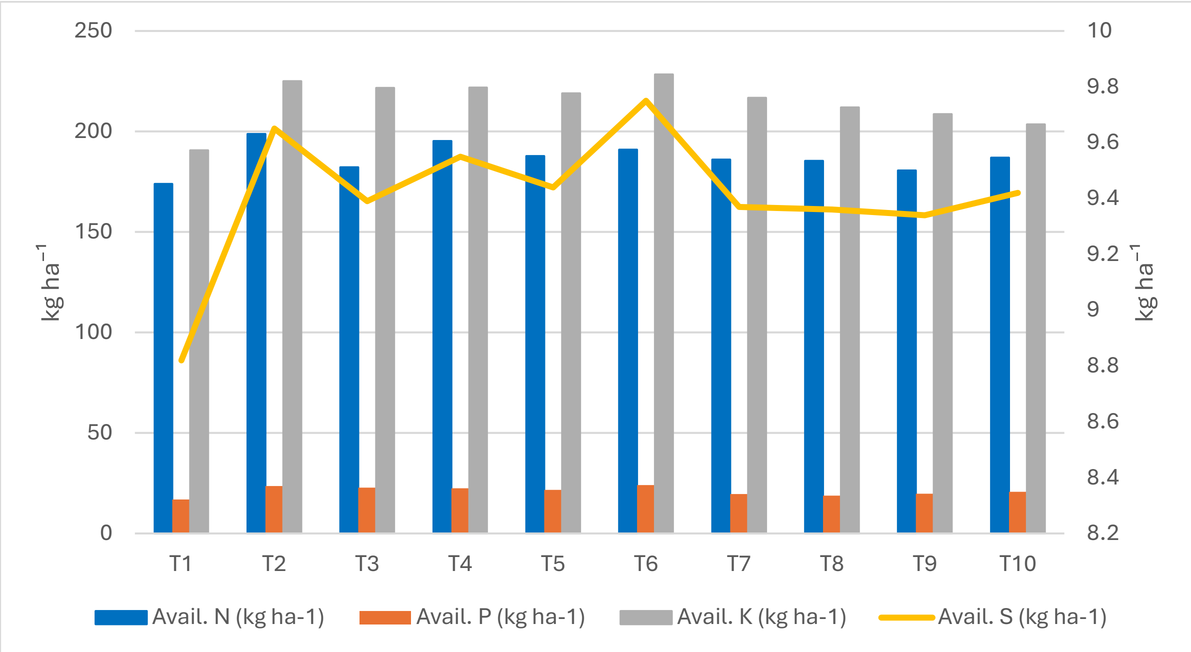

Figure 7: Impact of INM on avail. N, P, K and S of soil in mustard crop

Exchangeable Calcium and Magnesium: The different integrated nutrient management treatments significantly influenced the exchangeable calcium (Ca) and magnesium (Mg) contents of the soil after harvest. Among all the treatments, T_{10} (50% RDF + PSB + 2.0 t vermicompost + 5.0 t FYM) recorded the highest exchangeable calcium (3.40 Cmol(p^+) kg^{-1}) and exchangeable magnesium (1.00 Cmol(p^+) kg^{-1}), indicating that the beneficial effect of integrated application of organic manures, biofertilizers and inorganic fertilizers on improving the secondary nutrient status of the soil. The absolute control (T_1) recorded the lowest exchangeable calcium (1.48 Cmol(p^+) kg^{-1}) and magnesium (0.41 Cmol(p^+) kg^{-1}) contents (Table 3, fig. 8). Similar findings were reported by Brady and Weil (2017) and Bhattacharyya *et al.* (2010).

Table 3: Impact of INM on soil chemical properties (exchangeable Ca, Mg) in mustard crop. (pooled mean of 2 years)

Treatments	Exchangeable Ca (Cmol(p^+) kg^{-1})	Exchangeable Mg (Cmol(p^+) kg^{-1})
T_1	1.48	0.41
T_2	1.94	0.55
T_3	2.45	0.67

T_4	2.80	0.76
T_5	2.75	0.74
T_6	2.87	0.81
T_7	3.26	0.98
T_8	3.20	0.96
T_9	2.98	0.93
T_{10}	3.40	1.00
SEm (±)	0.025	0.007
CD (P = 0.05)	0.074	0.020

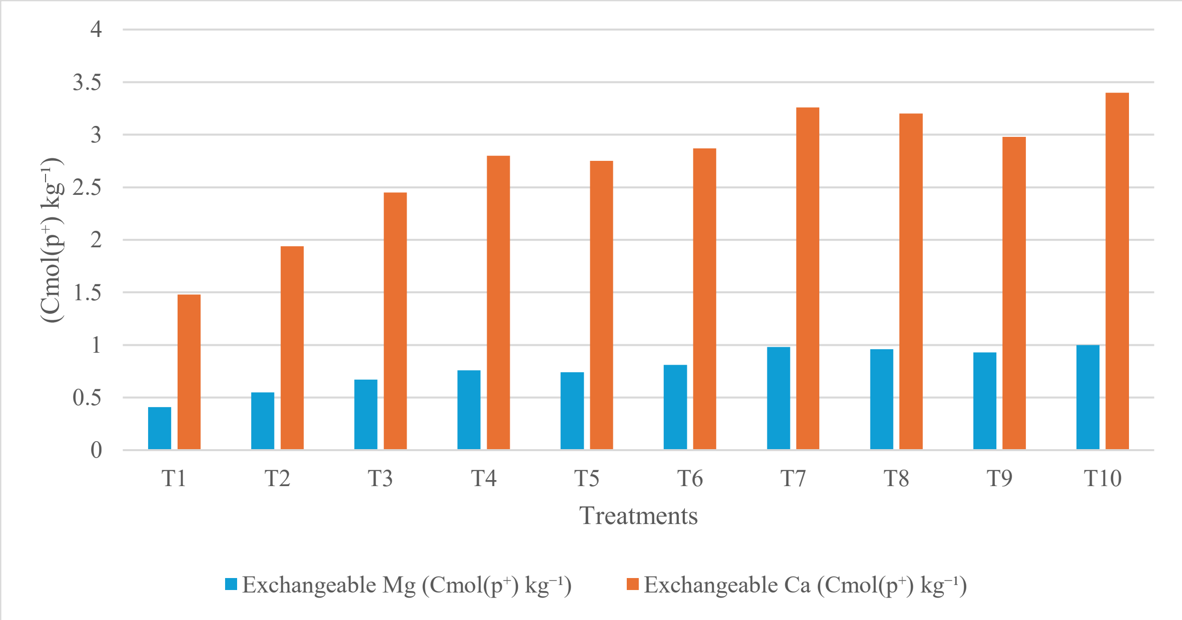

Figure 8: Impact of INM on exchangeable Ca and Mg of soil in mustard crop

CONCLUSION

The findings of the present investigation demonstrate that integrated nutrient management significantly improved the physico-chemical properties and fertility status of soil under mustard cultivation. The combined application of inorganic fertilizers with organic manures and biofertilizers proved superior to the sole application of chemical fertilizers or the control. Among the treatments, T_{10} (50% RDF + PSB + 2.0 t ha^{-1} vermicompost + 5.0 t ha^{-1} FYM) produced the most favorable soil physical characteristics by reducing bulk density and particle density while increasing total porosity, water-holding capacity, cation exchange capacity, organic carbon, exchangeable calcium and magnesium. The treatment T_6 (75% RDF + PSB + 1.0 t ha^{-1} vermicompost + 2.5 t ha^{-1} FYM) recorded the highest availability of phosphorus, potassium and sulphur, whereas 100% RDF (T_2) maintained the highest residual available nitrogen in the soil. These results indicate that integrating reduced levels of chemical fertilizers with organic manures and biofertilizers can effectively sustain soil fertility, improve nutrient availability and enhance overall soil health. Therefore, integrated nutrient management offers a sustainable and environmentally sound nutrient management strategy for mustard cultivation and can contribute to long-term agricultural productivity and soil resource conservation. The application of T_{10} (50% RDF + PSB + 2.0 t ha^{-1} vermicompost + 5.0 t ha^{-1} FYM) may be recommended for improving soil health under Indian mustard cultivation in the Indo-Gangetic plains.

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