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Effect of nutrient management on soil properties in Inceptisols of Agra

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Abstract
The field experiment was conducted at R.B.S. College, Bichpuri, Agra to evaluate the effect of nutrient management on soil properties in Inceptisols of Agra. The experiment was layout in randomized block design with ten treatments of T1- 100% RDF 80:40:40, T2- 100% RDF + S 20kg/ha + FYM 5t/ha, T3- 100 % RDF + Zn 5kg/ha + FYM 5t/ha, T4 - 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha, T5- 75 % RDF + S 20kg/ha + FYM 5t/ha, T6- 75 % RDF + Zn 5kg/ha + FYM 5t/ha, T7- 75 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t/ha, T8- 50 % RDF + S 20kg/ha + FYM 5t/ha, T9- 50 % RDF + Zn 5kg/ha + FYM 5t/ha, T10- 50 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t/h, with three replications. The study found that applying (T4) @ 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha-1 significantly improved soil organic carbon, available nutrients (N, P, K, S and Zn) compared to other treatments. Application of (T4) @ 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha-1 recorded significantly higher EC, pH, soil organic C, available nitrogen, phosphorus, potassium, sulphur and zinc over (T9) @ 50 % RDF + Zn 5kg/ha + FYM 5t/ha treatment.

Introduction

Among the primary nutrients, phosphorus is the most important constraint for increasing oilseed production because of the nutrient's requirement of oilseeds, in general is high. The P compounds (ADP and ATP) in fact as energy currency within the plant. It plays a vital role in plant metabolism. Thus, phosphorus influences the vigour of plants and root growth. Sulphur is constituent of three S containing amino acids (cystine, cysteine and methionine) which are building blocks of protein. Sulphur is also enhancing nitrogen fixation in some oilseed like groundnut and soyabean, since it is an active constituent of nitrogenous enzyme, which is vital for N2 fixation. Oilseed rape has a strong pungency for nitrogen because of the high level of nitrogen However, excess application of nitrogenous fertilizers beyond a certain limit induced lodging and eventually lessened grain yield and its components sulphur is a crucial element for rapeseed-mustard in determining its seed yield, oil content, quality and resistance to various biotic and abiotic stresses. Besides promoting chlorophyll formation and oil synthesis, it is an important constituent of seed protein, amino acids, various enzymes, and glucosinolates. Soils of India had multiple nutrient deficiencies, mainly of N, P, K, S and Zn and their use have become essential to obtain optimum crop yield. FYM helps in maintaining soil sustainability in terms of nutrients supply capacity of soil. The increase in productivity of the crops might be attributed due to its essential role of all nutrients present in FYM for plant growth through its effect as a good source of soil organic matter which improves the physio-chemical and biological properties of soil. Application of FYM also increases cation exchange capacity and helps in keeping soil micro nutrients in available form through its chelating action as well as microbial activity in soil besides supplying macro and micro plant nutrients. crops and use of high analysis sulphur devoid fertilizers coupled.

Materials and Methods

The field experiments were conducted at the Agricultural Research farm of R.B.S. College Bichpuri, Agra located in semi-arid or gray steppe arid region of South-Western Uttar Pradesh during two consecutive kharif seasons of 2023-25 and 2024-25 on sandy loam soil. The soil had EC 0.19 dSm-1, pH 8.38, organic carbon 4.3 g kg-1, available N 192.6, P 13.8 and K 209.5 kg ha-1. The soil had CaCl2 extractable sulphur content of 15.3 kg ha-1 and DTPA extractable zinc 0.82 mg kg-1. The experiment was laid out in randomized block design with three replications. The treatments were comprised of T1- 100% RDF 80:40:40, T2- 100% RDF + S 20kg/ha + FYM 5t/ha, T3- 100 % RDF + Zn 5kg/ha + FYM 5t/ha, T4 - 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha, T5- 75 % RDF + S 20kg/ha + FYM 5t/ha, T6- 75 % RDF + Zn 5kg/ha + FYM 5t/ha, T7- 75 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t/ha, T8- 50 % RDF + S 20kg/ha + FYM 5t/ha, T9- 50 % RDF + Zn 5kg/ha + FYM 5t/ha, T10- 50 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t/h.

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. For the rest of the soil quality parameters such as chemical (pH, EC), available N, P, K, S, and Zn parameters, soil samples that passed through 2-mm sieves were used. Soil pH and EC were measured in a 1:2 soil/water suspension (Richards, 1954), organic carbon by wet oxidation with sulfuric acid (H2SO4) + potassium dichromate (K2Cr2O7) (Walkley and Black, 1934), available N by alkaline-KMnO4 oxidizable N method (Subbiah and Asija, 1956), available P by 0.5 M sodium bicarbonate (NaHCO3) extraction method (Olsen et al., 1954), available K (Hanway and Heidel, 1952) , available sulfur by 0.15% CaCl2 (Williams and Steinbergs, 1959), and Available Zn by DTPA method (Lindsay and Norvell, 1978).

Results and discussion

EC and pH

The Electrical Conductivity (EC) in the soils varied from 0.24 to 0.33 dSm-1 across the treatments. However, application of (T4) @ 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha-1 recorded non-significantly higher EC value in soil (0.33 dSm-1) compared to control (T9) @ 50 % RDF + Zn 5kg/ha + FYM 5t/ha (0.24 dSm-1). Significantly higher pH value in soil with the application of (T4) @ 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha-1 was recorded (8.33) compared to control (T9) @ 50 % RDF + Zn 5kg/ha + FYM 5t/ha (8.14) respectively. The results obtained in the present study corroborate the findings Solanki et al. (2015) and Khambalkar et al. (2017).

Soil organic carbon

The soil organic carbon in soil increased significantly with each level of nutrient management treatments as compared to control. Among the different nutrient management treatments, application of (T4) @ 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha-1 recorded significantly higher the SOC in soil (5.32 g kg-1) followed by (T2) @ 100% RDF + S 20kg/ha + FYM 5t/ ha-1 (5.18

Table 1. Effect of nutrient management on pH, EC, SOC, available-N, available-P, available-K, available-S and available-Zn in soil

Treatments	pH	EC dSm-1	OC (g kg-1)	N (kg ha-1)	P (kg ha-1)	K (kg ha-1)	S (kg ha-1)	Zn (mg kg-1)
T1	8.20	0.26	4.56	197.4	14.4	209.9	14.2	0.56
T2	8.36	0.31	5.18	231.4	16.6	242.5	16.5	0.68
T3	8.33	0.30	5.05	225.7	16.2	233.8	16.0	0.65
T4	8.41	0.33	5.32	239.8	17.1	247.6	17.1	0.70
T5	8.28	0.28	4.81	212.9	15.2	217.3	15.0	0.60
T6	8.26	0.27	4.69	203.5	15.0	222.0	14.6	0.58
T7	8.31	0.29	4.95	219.1	15.7	226.5	15.5	0.62
T8	8.14	0.25	4.32	186.7	13.4	188.7	13.2	0.52
T9	8.11	0.24	4.14	178.0	12.8	180.6	12.4	0.50
T10	8.16	0.25	4.44	191.6	14.0	209.7	13.6	0.54
SEM±	0.02	0.03	0.16	9.67	0.79	7.54	0.49	0.04
CD @ 5%	0.05	NS	0.34	20.31	1.65	15.83	1.02	0.08

Note. Values are presented as reported in the source document.

g kg-1), (T3) @ 100 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (5.05 g kg-1), (T7) @ 75 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t/ ha-1 (4.95 g kg-1), (T5) @ 75 % RDF + S 20kg/ha + FYM 5t/ ha-1 (4.81 g kg-1), (T6) @ 75 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (4.69 g kg-1), (T1) @ 100% RDF ha-1 (4.56 g kg-1), (T10) @ 50 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t ha-1 (4.44 g kg-1), (T8) @ 50 % RDF + S 20kg/ha + FYM 5t/ ha-1 (4.32 g kg-1) compared to (T9) @ 50 % RDF + Zn 5kg/ha + FYM 5t/ha (4.14 g kg-1) respectively. The present observations support and extend the earlier reports Singh and Kumar (2015) and Majumder et al. (2017) and Sharma et al. (2017)

Available nitrogen

Among the different nutrient management treatments, application of (T4) @ 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha-1 recorded significantly higher the available nitrogen in soil (239.8 kg ha-1) followed by (T2) @ 100% RDF + S 20kg/ha + FYM 5t/ ha-1 (231.4 kg ha-1), (T3) @ 100 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (225.7 kg ha-1), (T7) @ 75 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t/ ha-1 (219.1 kg ha-1), (T5) @ 75 % RDF + S 20kg/ha + FYM 5t/ ha-1 (212.9 kg ha-1), (T6) @ 75 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (203.5 kg ha-1), (T1) @ 100% RDF ha-1 (197.4 kg ha-1), (T10) @ 50 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t ha-1 (191.6 kg ha-1), (T8) @ 50 % RDF + S 20kg/ha + FYM 5t/ ha-1 (186.7 kg ha-1) compared to (T9) @ 50 % RDF + Zn 5kg/ha + FYM 5t/ha (178.0 kg ha-1) respectively. These findings are in agreement with those reported by Singh and Kumar (2015), Majumder et al. (2017) Sharma et al. (2016) and Sharma et al. (2024).

Available phosphorus

The available phosphorus in soil increased significantly with each level of nutrient management treatments as compared to control. Among the different nutrient management treatments, application of (T4) @ 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha-1 recorded significantly higher the available phosphorus in soil (17.1 kg ha-1) followed by (T2) @ 100% RDF + S 20kg/ha + FYM 5t/ ha-1 (16.6 kg ha-1), (T3) @ 100 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (16.2 kg ha-1), (T7) @ 75 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t/ ha-1 (15.7 kg ha-1), (T5) @ 75 % RDF + S 20kg/ha + FYM 5t/ ha-1 (15.2 kg ha-1), (T6) @ 75 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (15.0 kg ha-1), (T1) @ 100% RDF ha-1 (14.4 kg ha-1), (T10) @ 50 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t ha-1 (14.0 kg ha-1), (T8) @ 50 % RDF + S 20kg/ha + FYM 5t/ ha-1 (13.4 kg ha-1) compared to (T9) @ 50 % RDF + Zn 5kg/ha + FYM 5t/ha (12.8 kg ha-1) respectively. The present results align with the findings reported by Singh and Kumar (2015), Majumder et al. (2017), Sharma et al. (2020) and Sharma et al. (2022)

Available potassium

Among the different nutrient management treatments, application of (T4) @ 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha-1 recorded significantly higher the available potassium in soil (251.3 kg ha-1) followed by (T2) @ 100% RDF + S 20kg/ha + FYM 5t/ ha-1 (242.6 kg ha-1), (T3) @ 100 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (236.6 kg ha-1), (T7) @ 75 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t/ ha-1 (229.5 kg ha-1), (T5) @ 75 % RDF + S 20kg/ha + FYM 5t/ ha-1 (222.7 kg ha-1), (T6) @ 75 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (216.9 kg ha-1), (T1) @ 100% RDF ha-1 (209.6 kg ha-1), (T10) @ 50 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t ha-1 (204.4 kg ha-1), (T8) @ 50 % RDF + S 20kg/ha + FYM 5t/ ha-1 (195.2 kg ha-1) compared to (T9) @ 50 % RDF + Zn 5kg/ha + FYM 5t/ha (186.6 kg ha-1) respectively. The present results align with the findings reported by Singh and Kumar (2015), Majumder et al. (2017), Sharma et al. (2022) and Indoria et al. (2025).

Available sulphur

Among the different nutrient management treatments, application of (T4) @ 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha-1 recorded significantly higher the available sulphur in soil (17.1 kg ha-1) followed by (T2) @ 100% RDF + S 20kg/ha + FYM 5t/ ha-1 (16.5 kg ha-1), (T3) @ 100 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (16.0 kg ha-1), (T7) @ 75 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t/ ha-1 (15.5 kg ha-1), (T5) @ 75 % RDF + S 20kg/ha + FYM 5t/ ha-1 (15.0 kg ha-1), (T6) @ 75 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (14.6 kg ha-1), (T1) @ 100% RDF ha-1 (14.2 kg ha-1), (T10) @ 50 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t ha-1 (13.6 kg ha-1), (T8) @ 50 % RDF + S 20kg/ha + FYM 5t/ ha-1 (13.2 kg ha-1) compared to (T9) @ 50 % RDF + Zn 5kg/ha + FYM 5t/ha (12.4 kg ha-1) respectively. The results obtained in the present study corroborate the findings Akram et al. (2024) Sharma et al. (2018) and Sharma et al. (2024).

Available zinc

Among the different nutrient management treatments, application of (T4) @ 100% RDF + S 20kg/ha +Zn 5kg/ha + FYM 5t/ha-1 recorded significantly higher the available zinc in soil (0.70 mg kg-1) followed by (T2) @ 100% RDF + S 20kg/ha + FYM 5t/ ha-1 (0.68 mg kg-1), (T3) @ 100 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (0.65 mg kg-1), (T7) @ 75 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t/ ha-1 (0.62 mg kg-1), (T5) @ 75 % RDF + S 20kg/ha + FYM 5t/ ha-1 (0.60 mg kg-1), (T6) @ 75 % RDF + Zn 5kg/ha + FYM 5t/ ha-1 (0.58 mg kg-1), (T1) @ 100% RDF ha-1 (0.56 mg kg-1), (T10) @ 50 % RDF + S 20kg/ha + Zn 5kg/ha + FYM 5t ha-1 (0.54 mg kg-1), (T8) @ 50 % RDF + S 20kg/ha + FYM 5t/ ha-1 (0.52 mg kg-1) compared to (T9) @ 50 % RDF + Zn 5kg/ha + FYM 5t/ha (0.50 mg kg-1) respectively. The results obtained in the present study corroborate the findings Majumder et al. (2017) Lal et al., (2020) Sharma et al. (2022) and Akram et al. (2024).

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