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Effect of Nitrogen and Sulphur Supplementation through Organic Sources on Soil Properties in the Bundelkhand Region of Uttar Pradesh

Anil Kumar Sahu[1,*], Yogesh Singh[1], Awanish Kumar[2], Kushal Pal Singh[1], Deepchandra[1], Hemant Sahu[3], Munna Lal[3]

[1]Department of Agricultural Chemistry and Soil Science, R. B. S. College Bichpuri, Agra, India
[2]Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India
[3]ICAR-CRIDA, Santoshnagar, Hyderabad, India

Corresponding Author: Anil Kumar Sahu
Email: anilkumarsahu.ata@gmail.com

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Abstract
The integrated use of mineral fertilizers and organic materials is widely recognized as a sustainable approach for crop production. A field experiment was conducted in the nursery organic farm at Karguwanji, Bundelkhand University, Jhansi, Uttar Pradesh, during the Rabi season of 2019-20 to evaluate the effect of nitrogen and sulphur supplementation through organic sources on soil properties in tomato (Solanum lycopersicum L.). The experiment comprised nine treatments laid out in a Randomized Block Design (RBD) with three replications. The results revealed a significant influence of organic sources on soil chemical properties. Soil pH was not significantly affected by the treatments. Electrical conductivity (EC), available phosphorus, and available potassium reached their highest values in treatment T_8 (50% Vermicompost + 50% Farm Yard Manure + 30 kg/ha S). Available nitrogen was highest in T1 (100% FYM), whereas available sulphur was highest in the Recommended Dose of Fertilizers (T0).

Introduction

Nitrogen plays a crucial role in plant metabolism and vegetative growth. Inorganic plant nutrition has historically been dominated by nitrogen because it enhances both crop yield and quality. Understanding the interaction of nitrogen with other essential plant nutrients is vital for optimizing plant growth and development. An increased nitrogen supply boosts vegetative growth, subsequently raising the demand for other nutrients in the root zone.

Sulphur is equally essential for plants as a major constituent of most plant proteins and their amino acid fragments, such as cystine, methionine, and glutathione. Sulphur availability in soil depends heavily on organic matter content, soil texture, and soil pH (Chao et al., 1962). Total sulphur amount and sulphate retention capacity (SO4) are generally lower in coarse-textured soils and can be further diminished by the application of limestone and phosphate (Camargo and Raij, 1989).

Vermicomposting is a biological process involving interactions between earthworms and microorganisms, leading to earthworm biomass production and vermicompost. This practice provides high-quality organic manure while minimizing environmental pollution and health hazards, helping maintain soil in a proper homeostatic state. It also aids in detoxifying excessive heavy metals like copper and lead. Vermicomposting offers a practical solution to declining soil fertility, soil degradation, and the indiscriminate use of chemical fertilizers (Pilli and Sridhar, 2019). Farm Yard Manure (FYM) is another valuable organic fertilizer rich in essential nutrients like nitrogen, phosphorus, and potassium, which promote robust plant growth.

Materials and Methods

The field experiment was conducted during the Rabi season of 2019-20 at the nursery organic farm, Karguwanji, Bundelkhand University, Jhansi, Uttar Pradesh. Geologically, Jhansi is situated between the Pahuj and Betwa rivers at an average elevation of 225 meters above mean sea level (MSL), at at 78°3411E longitude and 25°2655N latitude. The soil had EC 0.57 dSm-1, pH 6.96 organic carbon 0.39 %, available N 109.91, P 17.31 and K 170.10 kg ha-1. The soil had CaCl2 extractable sulphur content of 13.86 kg ha-1. The experiment consists of nine treatments and three replications with Randomized Block Design (RBD).The treatments were comprised of T0: RDF 100:75:55 (Through chemical fertilizer), T1: 100% N from FYM, T2: 100% N from V.C., T3: 100% N from FYM+20kg/ha sulphur through gypsum, T4: 100% N from FYM+30kg/ha sulphur through gypsum, T5: 100% N From C+20kg/ha sulphur through gypsum, T6: 100% N From V.C+30 kg/ha From sulphur through gypsum, T7: 50% N From FYM+50%N From VC+20kg/ha sulphur through gypsum, T8: 50% N From FYM+50% from VC+30kg/ha sulphur through gypsum.

Soil Sampling and Analysis

Soil samples were collected from a 0-15 cm depth before fertilizer application, air-dried, mixed thoroughly, and sieved. Soil organic carbon (SOC) was estimated using soil passing through a 0.2 mm sieve via the Walkley and Black (1934) wet oxidation method. Chemical parameters (pH, EC, available N, P, K, and S) were determined using standard analytical procedures. 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).

Statistical Analysis

The data recorded during the course of investigation were subjected to analysis statistically using analysis of variance techniques (ANOVA) for randomized block design as prescribed by Concharan and Cox (1959). Standard error of mean in each case and the critical difference only for significant cases were computed at 5% levels of probability as under.

Results and Discussion

Soil pH and EC

Soil reaction (pH) under different organic sources was non-significant after harvest of tomato crop. The maximum available pH 7.53 was recorded in the treatment T8 (50 %N from FYM+ 50 % N from VC+30 kg/ha S through gypsum). The lowest pH was recorded in T7 (50 % V.C+50 % FYM+20 kg/ha S). Soil pH data was presented in (Table-1). Han et al., (2016) organic manure treated plot was significantly increased soil reaction (pH). The results of this study were in agreement with the results of several studies that have shown organic manure treatment increased soil pH, but chemical fertilizer treatments, such as NPK fertilizer, decreased soil pH (Warren Fonteno 1993; Whalen et al. 2000; Liu et al. 2010).

Electrical conductivity of soil after harvest of tomato crop increased significantly due to combined application of nitrogen and sulphur through organic

Table 1. Effect of organic source of N and S application on status of pH, EC, SOC, Available-N, P, K and S in soil after harvest of crop

Treatment	pH	EC (dSm-1)	SOC%	N (kg ha-1)	P (kg ha-1)	K (kg ha-1)	S (ppm)
T0	7.33	0.62	0.46	109.64	17.20	135.67	15.13
T1	7.33	0.23	0.51	116.67	17.00	114.13	14.00
T2	7.10	0.51	0.39	87.00	15.00	129.33	11.67
T3	7.30	0.52	0.48	109.94	13.67	125.00	13.80
T4	7.33	0.60	0.44	96.66	8.10	128.33	12.47
T5	7.33	0.60	0.49	110.29	9.67	141.67	12.00
T6	7.33	0.53	0.55	110.37	8.00	171.67	10.43
T7	7.27	0.64	0.51	110.00	12.63	108.67	13.73
T8	7.53	0.65	0.39	84.29	17.20	175.00	9.47
SEm(±)	0.16	0.02	0.03	5.68	1.19	11.17	0.69
CD (5%)	N/A	0.05	0.08	17.18	3.61	33.77	2.09

Note. Values are reproduced from the supplied source document.

sources. The maximum electrical conductivity (0.65) was recorded in the treatment T8 (50% N from FYM+ 50% N from VC+30 kg/ha S through gypsum). The lowest EC was recorded in T1 (100 % FYM). Han et al., (2016) reported that the electrical conductivity (EC) was increased after the application of organic manure and NPK fertilizer, and the highest electrical conductivity was observed in the soil treated with the combined organic manure with combination of chemical fertilizers (NPK).

Soil Organic Carbon

Soil organic carbon concentration after harvest of tomato crop increased significantly due to combined application of different organic sources of nitrogen and sulphur. The maximum organic carbon (0.55 %) was recorded in the treatment T6 (100 % V.C+30 kg/ha S) and treatment T2 and T8 found lowest organic carbon (Table 3 & figure 3). The decrease in organic matter was found in control. Islam et al. (2013) found that the shared use of organic manure and chemical sources amplified soil organic matter content. Munoz et al. (2004), Sharma et al. (2022) and Sharma et al. (2016) reported that organic fertilizer sources such as poultry manure, vermicompost, and FYM contain a large amount of nutrients and organic matter which are beneficial for soil physical, chemical and biological properties as well as, soil organic carbon sequestration.

Available-N

After harvest of crop the available nitrogen content in soil was significantly increased due to combined application of nitrogen and sulphur through organic sources. The maximum available nitrogen (116.67 kg/ha) was recorded in the treatment T1 than the other treatments. The lowest available nitrogen was recorded under the treatments T8 (84.29 kg/ha). The mean data of available nitrogen presented in (Table-1). Nitrogen is a key component of enzymes, vitamins, chlorophyll and other cell constituents, all of which are essential for crop growth and development. It is thus one of the most important nutrients required for tomato crop yield. The application of organic manures and inorganic fertilizers increased the nutrient availability and soil microbial activity which resulting in more nutrient uptake ultimately enhanced the growth of tomato crop. These results are in line with Abdul et al. (2013), Laxminarayanan, (2004) Sharma et al. (2017) and Sharma et al. (2022) who reported high N uptake with combined application of organic and inorganic fertilizers.

Available-P

The available phosphorus in soil was significantly influenced by the application of different organic sources. The maximum available phosphorus (17.20 kg/ha) was recorded in the treatment T8 (50%FYM+ 50% VC+30 kg S through gypsum) and minimum value of available phosphorus T6 (100% VC + 30kg/ha S) followed by T4 and T9as compared to control (Table-1). The present study were similar to the findings of Manoj et al. (2012), Sharma et al. (2018) and Sharma et al. (2020) who reported the highest uptake and residual nutrients availability of N, P and K with the application of N, P and K through inorganic fertilizers and organic fertilizer. Ghosh et al. (2014) support the results of the study that the integration of organic fertilizers along with synthetic fertilizers results into highest P uptake by plants.

Available-K

The availability of potassium after harvest of crop was significantly increase by the application of different organic sources. The maximum available potassium after the crop harvest under the treatments T8 (175.00 kg/ha) followed by T6 and T5 respectively (Table-1). In the cause of more potassium uptake and availability by tomato plants is the effect of organic sources of fertilizers on solubilization mineralization of potassium pools in the soil. Sreelatha et al. (2006) and Ghosh et al. (2014), Sharma et al. (2024) and Indoria et al. (2025) who showed that combined use of organic and mineral fertilizers significantly increased the plant potassium uptake.

Available-S

The availability of sulphur in soil was significantly influenced by the application of different organic sources of sulphur and nitrogen. The maximum available sulphur (15.13 ppm) was recorded in the treatment T0 and minimum value of available sulphur T8 (9.47ppm) as compared to other treatments (Table-1). The sulphur application in the soil promoted increases the uptake and availability Silva et al. (2014). Similar results were also reported by Santosh et al. (2007) and Orman and Kalpan (2011).

Conclusion

The integrated application of organic nutrient sources (FYM and vermicompost) combined with sulphur significantly influences soil chemical properties. While soil pH remained stable, key fertility metrics such as electrical conductivity, organic carbon, and available macronutrients (phosphorus and potassium) improved markedly. Specifically, treatment T8 (50% FYM + 50% VC + 30 kg/ha S) proved most effective for enhancing electrical conductivity, phosphorus, and potassium availability, whereas T6 maximized organic carbon and T1 favored available nitrogen. Therefore, integrated nutrient management provides an effective, sustainable strategy for maintaining soil health and fertility in tomato cultivation in the Bundelkhand region.

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