

Impact of organic sources of nutrients and fertilizer management practices on secondary and micronutrients status in sunflower grown alluvial soil

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ABSTRACT

Adequate quantity of manure and fertilizers use as nutrient management are directly change in soil and plant properties. A field experiment was conducted in 2022 and 2023 at the agricultural farm of Shri Murali Manohar Town P.G. College, Ballia, by used twelve treatment combinations of organic resources viz and chemical fertilizers to assessed the effects of organic manures and inorganic fertilizers on soil fertility paradigm. Two-year pooled data revealed significant variations in nutrient availability. The highest available sulfur (12.1 mg kg^{-1}) was recorded in T_9 (GL @ 40 t ha^{-1}), exchangeable calcium ($8.75 \text{ cmol (pz) kg}^{-1}$) and calcium carbonate (2.09%) in T_3 (PM @ 10 t ha^{-1}), and magnesium ($4.9 \text{ cmol (pz) kg}^{-1}$) in T_2 (PM @ $8 \text{ t ha}^{-1} + 50\% \text{ RDF}$). Maximum available micronutrients were observed as follows, boron (0.48 mg kg^{-1}), zinc (0.63 mg kg^{-1}), and iron (8.48 mg kg^{-1}) in T_{11} ($100\% \text{ RDF} + 40 \text{ kg S ha}^{-1} + 12 \text{ kg Zn ha}^{-1} + 3 \text{ kg B ha}^{-1}$), copper (0.85 mg kg^{-1}) in T_6 (C @ $20 \text{ t ha}^{-1} + 50\% \text{ RDF}$), and manganese (7.62 mg kg^{-1}) in T_2 (PM @ $8 \text{ t ha}^{-1} + 50\% \text{ RDF}$). These findings highlight the efficacy of integrated nutrient management in enhancing secondary nutrient and micronutrient availability, supporting sustainable soil fertility and sunflower productivity in alluvial soils.

Keywords: *Inorganic fertilizer, Micronutrients, Organic manures and Secondary Nutrients.*

Sunflower (*Helianthus annuus* L.) is a globally significant oilseed crop grown extensively in different soils, its cultivation is highly nutrient-demanding, relying not only on primary macronutrients but also on secondary nutrients and micronutrients critical for photosynthesis, enzyme activation, seed development, and oil quality (Marschner, 2012; Zhao *et al.*, 2014). In alluvial soils, which are inherently fertile but often subject to intensive cropping systems, the balance use of nutrients can be significantly influenced by management practices such as the application of organic manure and inorganic fertilizers (Brady & Weil, 2008). Continuous reliance on inorganic fertilizers without adequate organic inputs exacerbates nutrient imbalances, reduces micronutrient availability, and contributes to soil degradation over time (Mandal *et al.*, 2000). The dynamic interplay between organic and inorganic nutrient sources significantly influences soil nutrient pools. Organic amendments facilitate the slow release of nutrients, enhance soil microbial activity, and increase cation exchange capacity (CEC), which improves the

retention and availability of secondary and micronutrients (Singh *et al.*, 2016). In contrast, inorganic fertilizers provide readily available nutrients but can lead to leaching, soil acidification, and long-term declines in micronutrient levels (Tisdale *et al.*, 1993). Secondary nutrients and micronutrients, though required in smaller quantities, are indispensable for the resilience of sunflowers to biotic and abiotic stresses, particularly in nutrient-poor soils (Mohapatra, and Sahoo, 2023). Despite their importance, research on manure and fertilizer effects has predominantly focused on primary nutrients, leaving a critical knowledge gap regarding secondary and micronutrient dynamics (Jones and Smith, 2023). Combining organic and inorganic sources has emerged as a sustainable strategy for optimizing nutrient availability, reducing environmental impacts, and meeting global demand for sunflower oil and seeds (Zhang *et al.*, 2020). In the context of sunflower cultivation in the alluvial soils of Ballia, understanding to evaluate the effects of various organic sources of nutrient and management practices on the availability

and uptake of secondary and micronutrients in sunflower-grown alluvial soils.

MATERIALS AND METHODS

The experiment was conducted during two consecutive rabi seasons of 2021-2022 and 2022-2023 on agricultural farm of Shri Murli Manohar Town P. G. College Ballia (25° 76' N latitude, 84° 12' E longitude, and altitude 59 m), Uttar Pradesh, India. The variety used in this experiment was "KBSH-1." The treatments consisted of manure, fertilizer, and their combined use with twelve treatments: T₁ Control (RDF @ 100 N 60 P₂O₅ 40 K₂O kg ha⁻¹), T₂ PM @ 8 t ha⁻¹ + 50 % RDF, T₃ PM @ 10 t ha⁻¹, T₄ FYM @ 20 t ha⁻¹ + 50 % RDF, T₅ FYM @ 40 t ha⁻¹, T₆ C @ 20 t ha⁻¹ + 50 % RDF, T₇ C @ 40 t ha⁻¹, T₈ GL @ 20 t ha⁻¹ + 50 % RDF, T₉ GL @ 40 t ha⁻¹, T₁₀ PD @ 20 t ha⁻¹ + 50 % RDF, T₁₁ 100 % RDF + 40 kg S + 12 kg Zn + 3 kg B, T₁₂ Biochar @ 5t ha⁻¹ were laid out in a randomized block design (RBD) with three replications. Organic sources, including poultry manure, FYM, compost, water hyacinth, *Parthenium hysterophorus*, paddy straw, and biochar were used in this study. One-year old poultry manure was sourced from a local poultry farm, whereas well-decomposed FYM was obtained from a farmer, and compost purchased from the local market was evenly spread over the plot 20 days before sowing of seeds. Freshwater hyacinth and *Parthenium hysterophorus* were collected from the college farm pond and nearby fields, respectively, chopped, and incorporated into the soil four weeks before sowing for decomposition. Fresh paddy straw was chapped into 1-2 cm pieces and mixed into the soil one month before cultivation. Biochar was procured from Arista Eco Pvt. Ltd., Karnataka. The inorganic fertilizers viz urea, single super phosphate (SSP), and muriate of potash (MOP) were purchased from the local market and used as sources of RDF. A half dose of N with the full dose of P and K was applied as basal, and the remaining 50% of nitrogen was top-dressed 30 days after sowing (DAS). Sunflower seeds were sown at a spacing of 45 × 30 cm and a plot size was 3x5 meters. All other recommended agronomic plant protection was adopted to raise the crop, and intercultural practices were taken as per needed. Soil samples were collected from 0 cm to 15 cm soil layers from all the replications after harvesting the sunflower crop. The soil samples were analyzed for available sulphur was extracted by 0.15 % calcium

chloride solution (Williams and Steinbergs, 1969), exchangeable calcium and magnesium were analyzed by titration EDTA method (Jackson, 1973), Calcium carbonate analyzed by rapid titration method (Puri 1930), available Boron was determined by Azomethalin-H colorimetric through the hot water method (Gupta, 1967) and DTPA extractable- Zn, Cu, Fe and Mn DTPA extraction by atomic absorption spectrophotometer (Lindsay and Novell 1978).

RESULTS AND DISCUSSION

Secondary nutrients

Available sulfur levels in sunflower grown soil was (Table-1) ranged from 7.75 to 12.10 mg kg⁻¹ across treatments, the highest value (12.10 mg kg⁻¹) was observed in the GL @ 40 t ha⁻¹ (T₉), followed by (10.65 mg kg⁻¹) GL @ 20 t ha⁻¹ + 50 % RDF (T₈). The application of organic amendments such as green leaf manure likely enhanced sulfur availability due to the decomposition of sulfur containing organic compounds (Smith 2019), might be due to increased sulfur mineralization with green manure incorporation. The lowest value (7.75) was found in the Biochar @ 5t ha⁻¹ (T₁₂) due to lower sulfur content and mineralization in biochar (Jones & Brown, 2020). Calcium and magnesium levels showed moderate variability across treatments. Poultry manure alone and combination with 50% RDF resulted in the greater value of Ca concentrations (8.75 cmol (pz) kg⁻¹) in PM @ 10 t ha⁻¹ (T₃) and Mg concentrations (4.90 cmol (pz) kg⁻¹) in PM @ 8 t ha⁻¹ + 50 % RDF (T₂), (Eneji, *et al.*, 2003) reported that poultry manure application reflected enrich calcium and magnesium content. The calcium carbonate content ranged from 1.42% to 2.09%, with the highest values (2.09%) observed in PM @ 10 t ha⁻¹ (T₃), increased value might be attributed to the addition of poultry manure, which could enhance carbonate precipitation in the soil matrix and release of basic cations during decomposition (Singh and Sharma, 2018).

Micronutrients

The application of organic sources and chemical fertilizers management practices significantly influence the availability of micronutrients in sunflower cultivated alluvial soil (Table-2). The highest available Zn (0.63 mg kg⁻¹), Fe (8.48 mg kg⁻¹), and B (0.48 mg kg⁻¹) were recorded in 100% RDF + 40 kg S ha⁻¹ + 12 kg Zn ha⁻¹ + 3 kg B ha⁻¹ (T₁₁), might be direct

Table 1: Effect of organic sources of nutrients and fertilizer on secondary nutrients of sunflower grown soil (Pool data of 2022 and 2023 seasons).

Symbol	Treatment	Available S (mg kg ⁻¹)	Ca	Mg	CaCO ₃ (%)
T ₁	Control (RDF)	9.1	5.7	3.95	1.89
T ₂	PM @ 8 t ha ⁻¹ + 50 % RDF	9.3	8.4	4.9	2.04
T ₃	PM @ 10 t ha ⁻¹	9.3	8.75	4.65	2.09
T ₄	FYM @ 20 t ha ⁻¹ + 50 % RDF	8.4	7.35	4.2	1.54
T ₅	FYM @ 40 t ha ⁻¹	8.55	6.6	3.65	1.63
T ₆	C@ 20 t ha ⁻¹ + 50 % RDF	8.05	5.65	3.75	1.42
T ₇	C@ 40 t ha ⁻¹	8.2	5.9	3.45	1.57
T ₈	GL @ 20 t ha ⁻¹ + 50 % RDF	10.65	6.1	3.35	1.66
T ₉	GL @ 40 t ha ⁻¹	12.1	6.05	3.15	1.81
T ₁₀	PS @ 20 t ha ⁻¹ + 50 % RDF	8.7	6.55	3	1.71
T ₁₁	100 % RDF + S + Zn+ B	10.15	5.5	3.5	1.62
T ₁₂	Biochar @ 5t ha ⁻¹	7.75	5.6	3.55	1.66
Sem ±		0.22	0.41	0.28	0.05
C.D. (0.05)		0.65	1.19	0.81	0.62

PM= Poultry manure, FYM= farmyard manure, C= Compost, GL= Green leaf, PD= Paddy straw

Table 2: Effect of organic sources of nutrients and fertilizer on micronutrients of sunflower grown soil (Pool data of 2022 and 2023 seasons).

Symbol	Treatment	Available Zn (ppm)	Available Fe (ppm)	Available Cu (ppm)	Available Mn (ppm)	Available B (ppm)
T ₁	Control (RDF)	0.58	7.65	0.57	5.44	0.33
T ₂	PM @ 8 t ha ⁻¹ + 50 % RDF	0.57	5.21	0.45	7.62	0.36
T ₃	PM @ 10 t ha ⁻¹	0.51	4.69	0.48	7.2	0.37
T ₄	FYM @ 20 t ha ⁻¹ + 50 % RDF	0.61	5.41	0.39	7.25	0.33
T ₅	FYM @ 40 t ha ⁻¹	0.58	6.54	0.32	5.05	0.35
T ₆	C@ 20 t ha ⁻¹ + 50 % RDF	0.55	8.06	0.85	5.38	0.35
T ₇	C@ 40 t ha ⁻¹	0.47	5.83	0.78	5.11	0.35
T ₈	GL @ 20 t ha ⁻¹ + 50 % RDF	0.45	7.98	0.33	7.23	0.34
T ₉	GL @ 40 t ha ⁻¹	0.59	5.49	0.35	5.35	0.36
T ₁₀	PS @ 20 t ha ⁻¹ + 50 % RDF	0.61	7.87	0.5	5.72	0.32
T ₁₁	100 % RDF + S + Zn+ B	0.63	8.48	0.67	6.9	0.48
T ₁₂	Biochar @ 5t ha ⁻¹	0.6	7.98	0.43	5.31	0.38
Sem ±		0.02	0.17	0.02	0.15	0.02
C.D. (0.05)		0.05	0.5	0.06	0.44	0.06

PM= Poultry manure, FYM= farmyard manure, C= Compost, GL= Green leaf, PD= Paddy straw

supplementation of Zn and B, coupled with sulfur's role in improving nutrient solubility and uptake. Sulfur enhances the availability of micronutrients and improving cation exchange capacity (CEC), as noted by Sahu *et al.*, (2007). The maximum available Cu (0.85 mg kg^{-1}) was observed in the treatment of C @ $20 \text{ t ha}^{-1} + 50\% \text{ RDF}$ (T_6), followed by (T_7) C @ 20 t ha^{-1} at 0.78 mg kg^{-1} . Compost, rich in humic substances, enhances Cu solubility, as supported by Ray and Das (1992), reported that improved nutrient retention with organic amendments. Available Mn was highest (7.62 mg kg^{-1}) in poultry manure @ $8 \text{ t ha}^{-1} + 50\% \text{ RDF}$ (T_2), might be linked to poultry manure, which stimulates microbial activity and reduces Mn to more available forms (Mn^{2+}), as discussed by Nandeeshha *et al.*, (2001).

CONCLUSION

The application of various organic, inorganic, and integrated nutrient sources has proven highly effective in enhancing the secondary and micronutrient status of sunflower crops in alluvial soils. These findings highlight the efficacy of organic resources, such as green leaf manure, poultry manure, Paddy straw, farmyard manure and compost, in optimizing soil fertility. This approach not only improves nutrient availability but also promotes sustainable sunflower productivity by enhancing soil health and reducing dependence on inorganic fertilizers in alluvial soils.

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Received on 10.01.2025 and Accepted on 13.02.2025