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Effect of Integrated Nutrient Management on Productivity of Maize (*Zea mays* L.) Crop in The Saharanpur Region of Western Uttar Pradesh

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Abstract: The present investigation was conducted to evaluate the effect of integrated nutrient management (INM) on growth, phenology, yield attributes and yield of Maize in the Western Uttar Pradesh during 2023 and 2024. The field experiment was carried out at Rampur Maniharan, Saharanpur, using a Randomized Block Design with thirteen treatments and three replications. Treatments consisted of different combinations of recommended dose of fertilizers (RDF), farmyard manure (FYM), compost, phosphate-solubilizing bacteria (PSB), and vermicompost. The results indicated that INM significantly influenced crop growth and productivity. Among all treatments, 75% RDF + FYM @ 2 t/ha + PSB @ 1 kg/ha + Vermicompost @ 10 kg/ha (T7) recorded the highest pooled grain yield (9635.16 kg/ha), biological yield (21157.13 kg/ha), stover yield (11521.97 kg/ha), cob-bearing plants (175.29/plot), cob length (25.36 cm), grains per row (35.46), and test weight (286.87 g). The treatment 75% RDF + Compost @ 2 t/ha + PSB @ 1 kg/ha + Vermicompost @ 10 kg/ha (T4) remained statistically at par with T7 for most growth and yield parameters. In contrast, treatments based on 50% RDF with organics alone, particularly T8 and T11, recorded substantially lower yield and profitability. The findings demonstrate that partial substitution of mineral fertilizers with FYM or compost, PSB, and vermicompost is superior to sole application of 100% RDF for enhancing maize productivity under the agro-ecological conditions of Western Uttar Pradesh.

Keywords: Maize, integrated nutrient management, FYM, compost, PSB, vermicompost, grain yield, profitability

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in the world. Ranum *et al*. (2014) reported that maize underpins food–feed systems and industrial supply chains, while FAOSTAT (2025) documented its expanding role in global production, trade, and consumption. In India, maize has gained substantial importance because of its high productivity, adaptability, and suitability under both irrigated and rainfed systems. Kalhapure *et al*. (2013) observed that hybrid maize can generate income comparable to several cash crops within a relatively short growth period, which has encouraged its wider adoption.

However, sustained maize productivity depends on more than fertilizer input alone. Vanlauwe *et al*. (2010) explained that long-term soil fertility management requires the integration of organic, inorganic, and biological sources to maintain nutrient balance and soil function. Similarly, IFA (2025) emphasized the "right source, right rate, right time, right place" principle as the foundation of efficient nutrient stewardship. In intensive maize production, sole reliance on mineral fertilizers may provide

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immediate yield gains, but it may not fully sustain soil health or nutrient-use efficiency over time. Geisseler and Scow (2014) noted that continuous mineral fertilization can simplify microbial communities, whereas the addition of organics improves microbial biomass and enzymatic activity.

Organic amendments such as FYM, compost, and vermicompost contribute to soil organic carbon, cation exchange capacity, water retention, and nutrient buffering. Albiach *et al*. (2000) showed that organic amendments improve microbial activity and soil quality, while Manna *et al*. (2005) and Bhattacharyya *et al*. (2010) reported that long-term manuring enhances soil organic matter and stabilizes yield. Biofertilizers also play an important role in maize nutrition. Khan, Zaidi, and Wani (2007) demonstrated that phosphate-solubilizing bacteria can increase the availability of fixed phosphorus through organic acid secretion and phosphatase activity. In addition, Pampolino *et al*. (2012) reported that site-specific and integrated nutrient management frameworks improve yield and profitability in cereal systems.

Previous studies have also confirmed the value of balanced nutrition in maize. Chivenge *et al*. (2011) found synergistic yield gains when organic and mineral nutrient sources were combined, while Ciampitti and Vyn (2012) highlighted the importance of staged nutrient supply to match maize uptake patterns. Cakmak (2008) further noted that balanced nutrition, especially with adequate micronutrient support, improves crop vigor and grain quality. Conservation-oriented studies by Gathala *et al*. (2015) and Sapkota *et al*. (2017) also demonstrated that residue retention and organic inputs improve rooting, water-holding capacity, and yield stability.

In view of the above, the present study was undertaken to assess the effect of integrated nutrient management on productivity of maize in the Saharanpur region of Uttar Pradesh

MATERIALS AND METHODS

Experimental site

The experiment was conducted during 2023 and 2024 at farmers' fields in Rampur Maniharan, Saharanpur district, Uttar Pradesh. The district lies between 77°15′ and 76°00′ east longitude and 27°10′ and 29°34′ north latitude, at an altitude of approximately 275.05 m above mean sea level. The region is agriculturally important and lies below the foothills of the Himalayas.

Climate and weather conditions

The climate of the study area is semi-arid subtropical, characterized by hot summers and cold winters. Summer temperatures may

Table 1: Meteorological data during the maize growing period

Month	*Min temp. (°C)*	*Max temp. (°C)*	*Avg temp. (°C)*	*Min RH (%)*	*Max RH (%)*	***Avg RH (%)***	***Rainfall (mm)***
Season I (2023)							
Jun-23	22.3	40.0	31.2	63.0	100.0	81.5	303.0
Jul-23	23.2	37.5	30.4	75.0	100.0	87.5	1065.0
Aug-23	26.5	35.0	30.8	72.0	100.0	86.0	249.5
Sep-23	25.0	35.5	30.3	71.0	100.0	85.5	142.5
Oct-23	19.0	32.5	25.8	55.0	92.0	73.5	37.0
Season II (2024)							
Jun-24	28.0	45.5	36.8	79.0	100.0	89.5	36.8
Jul-24	25.0	37.5	31.3	78.0	100.0	89.0	31.3
Aug-24	27.0	36.0	31.5	82.0	100.0	91.0	31.5
Sep-24	23.0	37.0	30.0	79.0	100.0	89.5	30.0
Oct-24	20.0	35.6	27.8	74.0	98.0	86.0	27.8

rise to 45–48°C, whereas winter temperatures may fall below 5°C. Most rainfall is received through the southwest monsoon.

Soil characteristics

The soil was sandy loam in texture. Pre-sowing soil analysis indicated medium organic carbon and medium available nitrogen, phosphorus, and potassium status, with near-neutral to slightly alkaline soil reaction and non-saline conditions.

Table 2: Initial physico-chemical properties of experimental soil

Property	*2023*	*2024*
Fine sand (%)	55.1	55.7
Silt (%)	21.8	21.4
Clay (%)	20.2	21.1
Texture	Sandy loam	Sandy loam
Organic carbon (%)	0.64	0.69
Available N (kg/ha)	294	310
Available P (kg/ha)	25	28
Available K (kg/ha)	280	289

Treatments and experimental design

The experiment was laid out in Randomized Block Design (RBD) with 13 treatments and 3 replications.

Table 3: Treatment details

Treatment	*Combination*
T1	100% RDF
T2	75% RDF + Compost @ 2 t/ha
T3	75% RDF + Compost @ 2 t/ha + PSB @ 1 kg/ha
T4	75% RDF + Compost @ 2 t/ha + PSB @ 1 kg/ha + Vermicompost @ 10 kg/ha
T5	75% RDF + FYM @ 2 t/ha
T6	75% RDF + FYM @ 2 t/ha + PSB @ 1 kg/ha
T7	75% RDF + FYM @ 2 t/ha + PSB @ 1 kg/ha + Vermicompost @ 10 kg/ha
T8	50% RDF + Compost @ 3 t/ha
T9	50% RDF + Compost @ 3 t/ha + PSB @ 1 kg/ha
T10	50% RDF + Compost @ 3 t/ha + PSB @ 1 kg/ha + Vermicompost @ 10 kg/ha
T11	50% RDF + FYM @ 3 t/ha
T12	50% RDF + FYM @ 3 t/ha + PSB @ 1 kg/ha
T13	50% RDF + FYM @ 3 t/ha + PSB @ 1 kg/ha + Vermicompost @ 10 kg/ha

Crop management

Nitrogen was supplied through urea, phosphorus through single superphosphate, and potassium through muriate of potash. Full doses of phosphorus and potassium and half of nitrogen were applied at sowing, while the remaining nitrogen was top-dressed later. FYM was incorporated two weeks before sowing. Compost and vermicompost were applied seven days before sowing. PSB was applied with the organic source during field preparation and again 25–30 days after sowing.

Observations and statistical analysis

Data were recorded on plant height, plant population, leaf area, stem diameter, phenological traits, yield attributes, grain yield, stover yield and biological yield. The data were subjected to analysis of variance (ANOVA) appropriate for RBD, and treatment differences were tested at the 5% level of significance.

RESULTS AND DISCUSSION

Growth and stand establishment

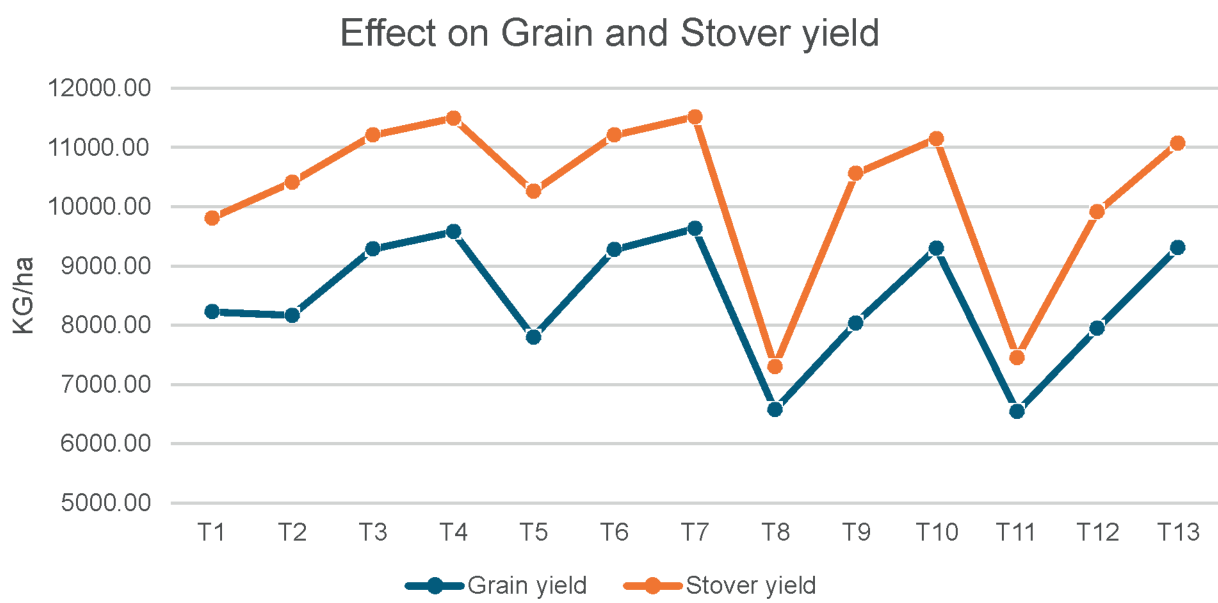
Integrated nutrient management significantly influenced maize growth throughout the crop period. The superiority of treatments integrating 75% RDF with organics, PSB, and vermicompost was consistently evident. The improved plant height, canopy development, and stand maintenance under T4 and T7 may be attributed to a more balanced and sustained nutrient supply, improved microbial activity, and better rhizosphere functioning. By contrast, the poor performance of T8 and T11 suggests that 50% RDF, even with higher quantities of organics, was insufficient to sustain vigorous crop growth in this production environment (Table 4)

Yield attributes

Yield attributes responded markedly to integrated nutrient management. Treatments combining 75% RDF + organics + PSB + vermicompost produced superior reproductive development. These results indicate that integrated nutrient supply improved both sink development and grain filling. FYM/compost likely improved nutrient buffering and moisture conditions, PSB enhanced nutrient availability, and vermicompost contributed growth-promoting effects that collectively supported better cob development and grain set (Table 5).

Yield performance

The yield response clearly established the superiority of integrated treatments over sole chemical fertilization and low-input treatments.



Grain and stover yields were significantly higher under 75% RDF + FYM/compost + PSB + vermicompost (T4 and T7) than under 100% RDF (T1) or 50% RDF + organics (T8-T13). Grain yield reached 9,635.16 kg/ha with 75% RDF + FYM @ 2 t/ha + PSB + Vermicompost (T7) and 9,571.93 kg/ha with 75% RDF + Compost @ 2 t/ha + PSB + Vermicompost (T4), compared with 8,219.85 kg/ha under 100% RDF (T1) and only 6,575.88 kg/ha under 50% RDF + Compost @ 3 t/ha (T8) and 6,536.20 kg/ha under 50% RDF + FYM @ 3 t/ha (T11).

Stover yield similarly increased to 11,521.97 kg/ha with 75% RDF + FYM + PSB + Vermicompost (T7) and 11,494.27 kg/ha with 75% RDF + Compost + PSB + Vermicompost (T4), vs 9,805.82 kg/ha under 100% RDF (T1).

Similar findings were also observed by Kannan, L.R., *et al.*, (2013) that integrated application of organic and inorganic nutrient sources improves maize productivity more effectively than sole application of chemical fertilizers, while also helping maintain or improve soil fertility over time and by Shobana *et al.*, (2008) that 50% more than recommended dose of NPK along with enriched FYM @ 750 kg ha-1 + biofertilizer recorded maximum growth and yield attributes resulting in higher grain and stover yield in maize crop.

CONCLUSION

The present investigation clearly establishes that integrated nutrient management substantially enhances maize productivity in the Inceptisols of Western Uttar Pradesh. The treatment 75% RDF + FYM @ 2 t/ha + PSB @ 1 kg/ha + Vermicompost @ 10 kg/ha proved to be the most effective and profitable nutrient management package, producing the highest grain yield. The treatment 75% RDF + Compost @ 2 t/ha + PSB @ 1 kg/ha + Vermicompost @ 10 kg/ha remained statistically comparable for

Table 4: Effect of INM on major growth and phenological parameters of maize (pooled data)

Treatment No	*Plant height 45 DAS (cm)*	*Plant height 90 DAS (cm)*	*Plant population 45 DAS (plants/plot)*	*Plant population 90 DAS (plants/plot)*	*Leaf area 45 DAS (cm^2)*	*Leaf area 90 DAS (cm^2)*	*Stem diameter 45 DAS (mm)*	*Stem diameter 90 DAS (mm)*	*Days to 50% tasseling*	*Days to 50% silking*
T1	91.47	182.10	178.00	176.00	473.54	696.36	18.70	27.44	60.24	64.21
T2	79.77	175.98	173.50	171.00	460.22	691.83	17.34	24.73	63.26	68.92
T3	90.80	183.52	179.50	176.00	473.11	695.25	18.83	27.31	59.79	64.38
T4	94.19	185.10	182.50	180.00	477.25	699.72	19.37	28.61	58.94	63.84
T5	79.78	176.74	177.00	171.00	463.48	688.71	17.23	25.34	62.16	69.02
T6	90.42	181.89	177.00	174.00	474.30	695.58	18.60	26.50	60.76	65.11
T7	93.23	183.61	182.00	180.50	477.23	701.29	20.45	28.52	58.42	63.09
T8	72.60	164.57	171.50	168.00	454.45	680.58	16.21	22.62	64.75	74.21
T9	80.42	176.43	173.50	171.50	462.20	687.65	17.59	25.85	61.80	68.34
T10	90.44	180.98	178.00	173.50	472.22	694.08	18.52	27.24	58.76	65.43
T11	73.48	163.65	172.00	168.50	452.26	669.74	16.30	22.82	65.24	73.25
T12	80.95	176.36	175.50	172.50	461.09	689.84	17.40	25.40	61.74	68.17
T13	90.11	181.77	176.50	172.00	472.47	694.11	18.27	26.98	60.17	64.84
CD 5%	2.15	3.23	3.83	3.63	4.50	4.20	0.85	1.09	1.78	1.88
SE	1.04	1.56	3.00	1.76	2.15	1.98	0.42	0.53	0.87	0.91

Table 5: Effect of INM on yield attributes of maize (pooled data)

Treatment No	*Plants bearing cobs/plot*	*Cob girth (mm)*	***Cob length (cm)***	***Rows/cob***	***Grains/row***	***Test weight (g)***
T1	170.30	56.14	23.66	14.57	32.58	282.36
T2	164.92	52.23	21.18	14.23	29.48	269.43
T3	172.25	56.67	23.79	15.03	32.95	282.69
T4	174.73	58.79	25.01	16.02	35.22	285.43
T5	161.68	52.95	19.50	14.70	30.79	271.50
T6	170.24	56.50	23.54	14.44	32.64	281.70
T7	175.29	58.15	25.36	15.93	35.46	286.87
T8	152.30	46.60	15.55	13.19	25.53	249.38
T9	162.78	52.05	20.78	14.55	31.02	274.33
T10	169.69	56.10	23.42	15.19	32.25	281.62
T11	157.70	47.43	15.89	13.30	25.71	251.98
T12	164.27	52.73	20.12	14.20	29.96	272.04
T13	168.69	56.07	24.00	14.84	32.34	281.65
CD 5%	4.23	1.60	1.40	0.65	1.93	3.70
SE	2.05	0.78	0.68	0.32	0.94	2.00

most parameters. The findings from this study indicate that partial replacement of chemical fertilizers with organics and biofertilizers is not only feasible but agronomically advantageous. In contrast, 50% RDF-based treatments without adequate integration were clearly inferior in terms of growth, productivity, and profitability. Therefore, INM based on 75% RDF + FYM/compost + PSB + vermicompost may be recommended as a sustainable nutrient strategy for maize cultivation in similar agro-ecological regions.

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