



## Strategies for enhancing maize (*Zea mays*) productivity and profitability through integrated nutrient management in rainfed agro-ecosystems

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### ABSTRACT

A field experiment was conducted during rainy (*kharif*) seasons of 2023 and 2024 at Research Farm of ICAR-Indian Agricultural Research Institute, New Delhi to study the effects of integrated nutrient management (INM) on productivity and profitability of rainfed maize (*Zea mays* L.) under maize–mustard (*Brassica juncea* L.) cropping system. The study comprised of ten INM treatments, including absolute control, sole recommended dose of nitrogen (RDN) and combinations of inorganic fertilisers with farmyard manure (FYM), leaf compost (LC) and crop residues (CR) replicated thrice in randomised complete block design. The combination of 50% RDN + FYM (2.0 t/ha) + LC (2.0 t/ha) recorded the highest cob length (15.2–16.1 cm), cob girth (8.54–8.66 cm), 1000-grain weight (255.1–258.2 g), grain yield (5.53–5.62 t/ha), stover yield (9.21–9.35 t/ha) and biological yield (14.74–14.98 t/ha). This treatment produced 35% and more than 110% higher grain yield compared to 100% RDN and absolute control, respectively. It also exhibited maximum gross returns (+131.4%), net returns (+231.3%) and net benefit-cost ratio (+185.8%) based on the two-year mean. The treatment T<sub>6</sub> consistently recorded the highest N uptake (1.73–152.2%), P uptake (0.55–185.5%) and K uptake (5.5–136%) by grain and stover, respectively over other treatments. Various yield attributing characters, 1000-seed weight, cob length and cob girth demonstrated significantly higher positive correlation with grain yield. The study concluded that integrated nutrient management with 50% RDN + FYM + LC is a highly productive, economically viable and sustainable strategy for rainfed maize cultivation in the Indo-Gangetic Plain region (IGPR), reducing reliance on chemical fertilisers and enhancing long-term soil fertility and sustainability.

**Keywords:** Economics, Farmyard manure, INM, Maize, Nitrogen, Organic nutrients, Yield

Maize (*Zea mays* L.) is one of the most important staple crops globally, serving as a vital source of food, animal feed and industrial raw material. Maize is a nutrient exhaustive crop with high demands for both macro (N, P, K and S) and micronutrients (Zn, Fe, Cu, Mn and B) to realise its yield potential (Singh *et al.* 2022). However, intensive and imbalanced fertilisation practices in maize-based cropping systems particularly across the Indo-Gangetic Plain (IGP) have led to a soil organic carbon (SOC) reduction by 0.26–0.33% and nitrogen use efficiency (NUE) below 40% (Jat *et al.* 2020), in spite of being a significant contributor to the national food security.

Integrated nutrient management (INM) has emerged as a sustainable strategy for optimising crop yield and enhancing long-term soil health (Meena *et al.* 2021). Organic sources including decomposing crop residue not only supply essential macronutrients (N, P, K, S) but also help in mobilising bound nutrients in plant available form while

minimising nutrient losses and enhancing nutrient uptake. Conjunctive use of organic and inorganic sources of plant nutrients has been shown to improve soil fertility, nutrient availability and long-term sustainability of maize-based cropping systems (Meena *et al.* 2025). Despite its potential, poor nutrient management remains a major limitation in rainfed agricultural systems. Judicious use of diverse sources of nutrients is essential for achieving optimal productivity under such conditions. Although organic sources contribute to soil health and provide secondary- and micro-nutrients, low soil fertility coupled with overreliance on single source is a major hurdle in optimisation of maize yield and moisture retention under rainfed conditions were also reported by (Kumar *et al.* 2024).

Similarly, these findings clearly indicate that integrated nutrient management in maize contributes to higher yields, enhanced profitability and improved soil health across different production systems. The benefits are consistent: balanced nutrient supply through combined use of fertilisers and organic inputs ensuring sustained release of nutrients; microbial inoculants enhance nutrient mobilisation and uptake; residue retention and intercropping improve soil

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organic matter and biological activity; and partial fertiliser substitution reduces input costs without yield sacrifice. Importantly, INM not only improves productivity under intensive systems but also stabilises yields and soil fertility in marginal and fragile ecosystems. However, INM strategies specifically tailored to maize-based cropping systems under rainfed conditions in the Indo-Gangetic Plain regions remain underexplored.

From the foregoing, it is evident that sustainable maize production under rainfed conditions requires efficient nutrient management strategies that address both nutrient and moisture limitations (Patel *et al.* 2022). Integrated use of organic and inorganic nutrient sources offers a viable approach to improve nutrient synchrony, enhance soil moisture retention, increase resource use efficiency and restore soil health in inherently low-fertility rainfed soils. However, systematic evaluation of different nutrient management practices with respect to crop yield, quality, nutrient uptake, economics and soil health remains inadequate. Therefore, the present study was undertaken to assess the performance of integrated nutrient management practices in rainfed maize with the objective of identifying sustainable and economically viable nutrient management options for rainfed agro-ecosystems.

MATERIALS AND METHODS

The field experiment was conducted during the rainy (*khariif*) seasons of 2023 and 2024 at ICAR-Indian Agricultural Research Institute (28°38'23" N, 77°09'27" E, 228.6 m amsl), New Delhi. The mean annual normal rainfall received was 650 mm and 850 mm, respectively in each year. The soil of the experimental site was sandy loam in texture and nearly neutral in reaction (*pH* 7.2) and soil organic carbon content was 0.48% (low). Available nitrogen, phosphorus and potassium of the site were 183.5, 17.05 and 245.5 kg/ha, respectively and had low micronutrient status. The experiment was carried out with ten treatments in a randomised block design (RBD) replicated thrice and the treatment combinations were T<sub>1</sub>, Absolute control; T<sub>2</sub>, 100% recommended dose of nitrogen (RDN); T<sub>3</sub>, 50% RDN + farm yard manure (FYM) (4.0 t/ha); T<sub>4</sub>, 50% RDN + leaf compost (LC) (4.0 t/ha); T<sub>5</sub>, 50% RDN + crop residues (CR) (4.0 t/ha); T<sub>6</sub>, 50% RDN + FYM (2.0 t/ha) + LC (2.0 t/ha); T<sub>7</sub>, 50% RDN + FYM (2.0 t/ha) + CR (2.0 t/ha); T<sub>8</sub>, 50% RDN + LC (2.0 t/ha) + CR (2.0 t/ha); T<sub>9</sub>, FYM (5.0 t/ha) + LC (2.5 t/ha) + CR (2.5 t/ha); T<sub>10</sub>, FYM (10.0 t/ha) + LC (5 t/ha) + CR (5 t/ha).

The maize variety HQPM-5 was sown on 4<sup>th</sup> July 2023

and 6<sup>th</sup> July 2024 at a spacing of 60 cm × 20 cm using a seed drill with a seed rate of 25 kg/ha. The fertilisers were applied at the recommended dose with nitrogen supplied through urea, phosphorus through single superphosphate (SSP) and potassium through muriate of potash (MOP). 50% of the nitrogen, full of P and K were applied as basal as per treatment in each plot and rest 50% of nitrogen was applied at tasseling stage [55–60 days after sowing (DAS)]. Organic amendments like farmyard manure and leaf compost were incorporated as per treatment with the last ploughing as basal dose and crop residue applied after sowing of the crop. Life-saving irrigation, weed and disease pest management were undertaken in each year.

Data on yield attributes as well as yield parameters including grain, stover and biological yield were taken. The harvesting of crop was done from net plot area leaving border rows separately for each plot followed by threshing. After cleaning, the grains were sun-dried to 12% moisture content before weighing. Straw yield was recorded after drying the stover. Economic indicators, namely cost of cultivation, gross return, net return and net benefit-cost ratio were also calculated. The harvest index (Camargo-Alvarez *et al.* 2023) and net B:C ratio were calculated using formulae:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield (t/ha)}}{\text{Grain + Stover yield (t/ha)}} \times 100$$

$$\text{Net B:C ratio} = \frac{\text{Net return (₹/ha)}}{\text{Total cost of cultivation (₹/ha)}}$$

Data were analysed statistically using the analysis of variance (ANOVA) approach for a randomised block design (RBD) in SAS 9.4 software (SAS Institute Inc., Cary, NC, USA). To compare treatment means, the critical difference (CD) at the 5% probability level was determined following the procedures described by Gomez and Gomez (1984). A Pearson’s correlation coefficient matrix was constructed among the key growth attributes, yield and economics of rainfed maize using Microsoft Excel (2010).

Farmyard manure (FYM), leaf compost (LC) and crop residue were used as organic nutrient sources. The nutrient composition and C:N ratio of the organic amendments were determined on a dry-weight basis prior to application (Table 1). Leaf compost was prepared from locally available deciduous tree leaf litter collected from farm boundaries and nearby fallow lands. Composting was carried out using the aerobic pit method with periodic turning and moisture regulation. The compost was allowed to decompose for 90–120 days and only well-decomposed material was used

Table 1 Nutrient composition and C:N ratio of organic amendments used in the experiment

Organic amendment	Organic carbon (%)	Total N (%)	Total P (%)	Total K (%)	C:N ratio
Farmyard manure	18.5	0.58	0.26	0.52	32:1
Leaf compost	22.4	1.12	0.34	0.68	20:1
Crop residue (maize stover)	38.6	0.48	0.18	1.12	80:1

Values are expressed on dry-weight basis after laboratory analysis and organic amendments were applied uniformly as per treatment specifications.

Table 2 Effect of integrated nutrient management practices on yield attributes and profitability of maize (2-year pooled mean)

Treatments	No. of cobs/ plant	Cob length (cm)	Cob girth (cm)	Test weight (g)	Returns ( $\times 10^3$ ₹/ha)		NB:C ratio
					Gross	Net	
T <sub>1</sub>	1.00	10.32	6.03	243.4	64.1	27.0	0.73
T <sub>2</sub>	1.33	12.06	6.64	248.8	102.0	64.3	1.70
T <sub>3</sub>	1.33	15.11	8.39	254.3	133.3	87.9	1.94
T <sub>4</sub>	1.17	14.33	7.61	253.2	117.2	76.8	1.90
T <sub>5</sub>	1.33	12.89	7.61	250.7	116.6	76.1	1.89
T <sub>6</sub>	1.33	15.70	8.60	256.7	135.5	93.1	2.20
T <sub>7</sub>	1.17	15.00	8.38	255.1	134.0	91.6	2.16
T <sub>8</sub>	1.33	14.80	7.90	253.8	118.0	77.6	1.92
T <sub>9</sub>	1.00	11.93	6.66	250.7	110.2	59.4	1.17
T <sub>10</sub>	1.17	12.96	7.23	251.9	116.0	50.2	0.76
SEM $\pm$	0.28	0.86	0.70	6.6	5.9	3.9	0.12
LSD ( $p=0.05$ )	NS	2.54	1.70	NS	17.4	11.7	0.35

Treatment details are given under Materials and Methods. NS, Non-significant, NB:C, Net benefit-cost ratio.

for field application. Crop residue consisted of maize stover from the previous season, which was air-dried, chopped into 5–7 cm pieces and applied as surface mulch immediately after sowing in residue-based treatments. The residue was not incorporated into the soil in order to reduce evaporative losses and enhance soil moisture conservation under rainfed conditions.

## RESULTS AND DISCUSSION

**Yield attributes:** The performance of maize in terms of cob development and grain characteristics exhibited considerable variation across the different nutrient management treatments (Table 2). While the number of cobs/plant was statistically non-significant, but consistently recorded under integration of different nutrient sources as: 50% RDN + FYM (2.0 t/ha) + LC (2.0 t/ha), 50% RDN + FYM (4.0 t/ha) and 50% RDN + CR (4.0 t/ha). Significant differences ( $p < 0.05$ ) were observed in cob length and cob girth across treatments, with the most prominent results recorded under T<sub>6</sub> which produced the longest cobs (15.27 cm in 2023 and 16.13 cm in 2024), representing a 47.8% and 56.4% increase over the absolute control. Cob girth was also maximum in the same treatment (8.54 cm and 8.66 cm), 35.1% and 51.1% greater than the control in 2023 and 2024, respectively. These values were statistically at par with 50% RDN + FYM (4.0 t/ha) and 50% RDN + FYM (2.0 t/ha) + CR (2.0 t/ha). These results underline the efficacy of integrating organic and

inorganic nutrient sources in improving physical yield traits.

The highest test weight was recorded under 50% RDN + FYM (2.0 t/ha) + LC (2.0 t/ha), measuring 255.08 g in 2023 and 258.29 g in 2024. This exceeded the absolute control by 4.7% and 6.2% and surpassed the 100% RDN treatment by 2.8% in 2024. Although statistically non-significant, this consistent improvement in grain weight further reinforces the beneficial impact of INM practices on grain filling and kernel development.

The superior performance of the T<sub>6</sub> treatment can be attributed to the complementary nutrient release dynamics of its components: leaf compost is rich in water soluble carbohydrates (12%) and has low C: N ratio (18:1), promoting early nitrogen availability at initial crop stages (Ahmed *et al.* 2021). FYM ensures a sustained release of

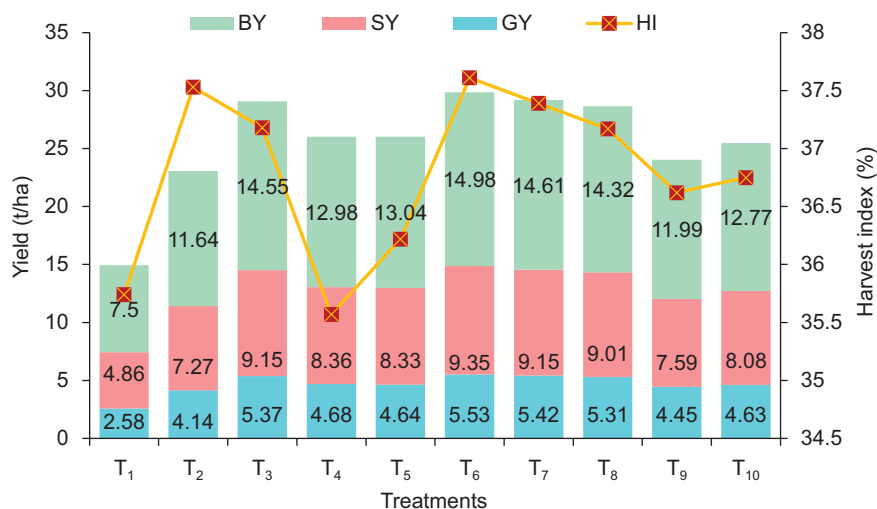


Fig. 1 Effect of integrated nutrient management practices on productivity of maize (kharif 2023).

GY, Grain yield; SY, Stover yield; BY, Biological yield; HI, Harvest index. Treatment details are given under Materials and Methods.

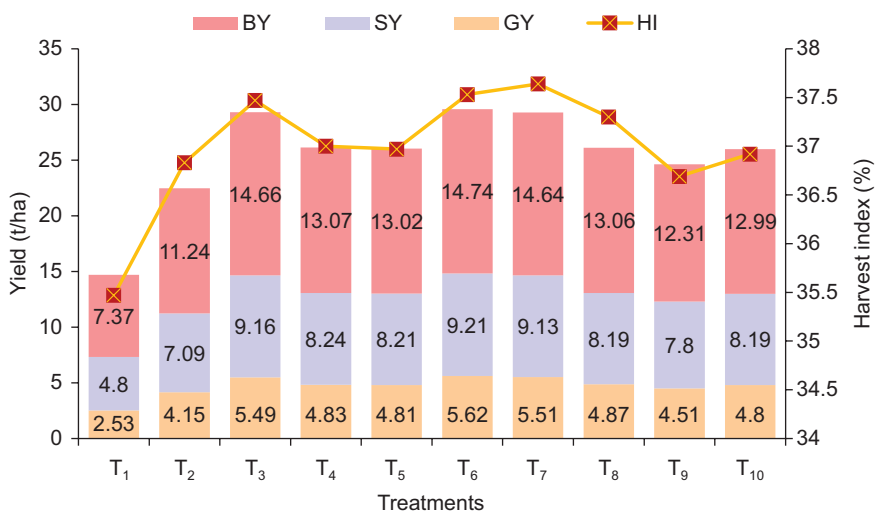


Fig. 2 Effect of integrated nutrient management practices on productivity of maize (*kharif* 2024). GY, Grain yield; SY, Stover yield; BY, Biological yield; HI, Harvest index. Treatment details are given under Materials and Methods.

nutrients during the critical reproductive phase (Kumar *et al.* 2021). 50% RDN supplements the immediate nutrient demand during rapid vegetative growth, especially at the knee-high stage. This synergistic nutrient supply pattern enhances nutrient synchrony, improves assimilate partitioning and promotes efficient kernel development, ultimately leading to higher grain weight and overall productivity. These findings are consistent with previous studies reporting 15–25% improvement in yield attributes under FYM + RDN combinations (Jat *et al.* 2020, Sow *et al.* 2024), highlighting the effectiveness of integrated nutrient management strategies in enhancing maize productivity.

**Productivity of rainfed maize:** All INM treatments significantly outperformed the control in both 2023 and 2024 (Fig. 1 and 2). Among the treatments, T<sub>6</sub> recorded the highest grain yield i.e. 5.53 t/ha in 2023 and 5.62 t/ha in 2024 representing increase of 114.3% and 122.2%, respectively, over the control. This treatment was statistically at par with 50% RDN + FYM (4.0 t/ha) and 50% RDN + FYM (2.0 t/ha) + CR (2.0 t/ha). Lowest grain yield was consistently recorded in control with 2.58 t/ha in 2023 and 2.53 t/ha in 2024. A similar trend was also observed in stover yield, where T<sub>6</sub> treatment produced the significantly higher values of 9.35 t/ha in 2023 and 9.21 t/ha in 2024 which were 92.4% and 91.9% higher than the control, respectively. Biological yield followed the same pattern, with the highest yields again recorded as 14.98 t/ha in 2023 and 14.74 t/ha in 2024, showing improvements of 99.7% and 99.9% over the control, respectively. Harvest index (HI) values ranged from 35.4–37.6% with no statistically significant differences among treatments.

The superior performance of the T<sub>6</sub> treatment can be attributed to enhanced nutrient synchrony and balanced nutrient supply as per crop demand at different growth stages, which boosted biomass production and reproductive sink strength as noted by Meena *et al.* (2021). The

synergistic effect of FYM and LC improved soil organic matter content, nutrient availability and moisture retention, while the inorganic nitrogen ensured targeted nutrient delivery during critical growth phases. Similar improvements in maize productivity through organic-inorganic nutrient integration have also been reported by Sahoo *et al.* (2025).

**Nutrient uptake:** Nutrient uptake for nitrogen (N), phosphorus (P) and potassium (K) in both grain and stover varied significantly under various treatment combinations over both the years 2023 and 2024 (Fig. 3 and 4). The treatment 50% RDN + FYM (2.0 t/ha) + LC (2.0 t/ha) consistently recorded the highest nutrient uptake across all parameters.

Grain N uptake was highest under the T<sub>6</sub> treatment, reaching 87.63 kg/ha in 2023 and 88.36 kg/ha in 2024, which marked improvements of 120% and 123%, respectively over the control (39.80 and 39.69 kg/ha). Stover N uptake also peaked in the same treatment with 37.51 kg/ha in 2023 and 42.61 kg/ha in 2024, translating to 139% and 165% increase as compared to the control (Fig. 3A).

Grain P uptake increased from 7.00 and 6.71 kg/ha in the control to 18.74 and 20.65 kg/ha under T<sub>6</sub> during 2023 and 2024, representing 168% and 208% improvements, respectively. Stover P uptake showed a similar pattern, rising from 5.94 and 6.98 kg/ha in the control to 16.94 and 19.34 kg/ha in the same treatment, registering 185% and 177% increases (Fig. 3B).

Grain K uptake was also highest in T<sub>6</sub> with 33.55 kg/ha in 2023 and 38.51 kg/ha in 2024, showing dramatic increase of 228% and 291% over the control (10.23 and 9.84 kg/ha), respectively. Stover K uptake increased from 64.22 and 65.72 kg/ha in the control to 152.30 and 154.40 kg/ha under the integrated treatment, reflecting 137% and 135% improvements (Fig. 4). The superior nutrient uptake observed in the T<sub>6</sub> treatment can be attributed to the complementary release patterns of organic and inorganic nutrient sources. Leaf compost, with its low carbon-to-nitrogen (C: N) ratio, promoted rapid nitrogen mineralisation during early growth stages. Farmyard manure (FYM) ensured a steady nutrient release throughout mid to late growth, while the inorganic nitrogen component met peak nutrient demands during critical phases such as tasseling and grain filling. This synchrony between nutrient supply and crop demand improved uptake efficiency, biomass partitioning and overall plant health, highlighting the advantages of integration of nutrient sources in enhancing nutrient uptake over sole reliance on inorganic sources (Jamwal *et al.* 2024). Better nutrient availability to plants by integrating organic sources might be owing to improved root activity and microbial

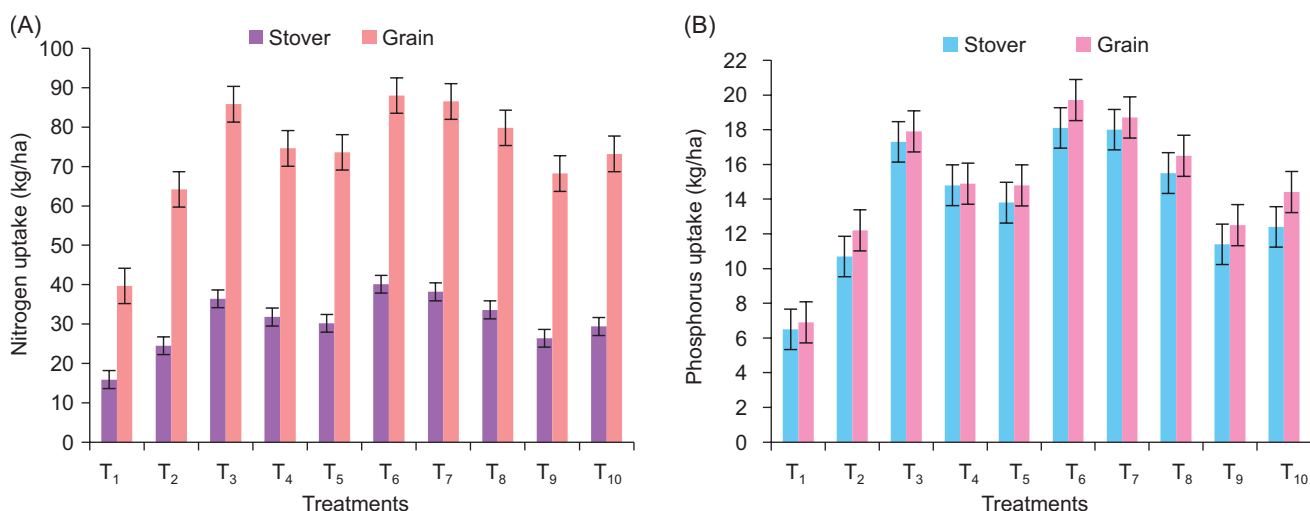


Fig. 3 Effect of integrated nutrient management practices on nitrogen (A) and phosphorus (B) uptake in stover and grain of maize 2023 and 2024 (data 2-year pooled mean).

Critical Difference (CD at  $p=0.05$ ) error bar. Treatment details are given under Materials and Methods.

biomass thereby facilitating higher nutrient uptake (Kumar *et al.* 2018). Overall, integrated nutrient treatments, particularly the combination of 50% RDN + FYM (2 t/ha) + LC (2 t/ha), significantly enhanced the uptake of major macronutrients (N, P and K) in maize. This underscores the potential of organic-inorganic nutrient integration in improving nutrient-use efficiency and crop productivity under sustainable maize production.

**Profitability:** The economic evaluation of various INM practices revealed that the treatment 50% RDN + FYM (2.0 t/ha) + LC (2.0 t/ha) consistently outperformed all others in terms of profitability and cost-effectiveness (Table 2). This treatment recorded the highest gross returns, amounting to ₹134.17 × 10<sup>3</sup>/ha in 2023 and ₹136.92 × 10<sup>3</sup>/ha in 2024, which were 110.8% and 112.3% higher than the control, respectively. Correspondingly, the net returns were also the highest at ₹91.26 × 10<sup>3</sup>/ha in 2023 and ₹95.01 × 10<sup>3</sup>/ha in 2024, representing 249.8% and 240.2% increases over the

control. In a separate assessment, this treatment also yielded the highest overall gross and net returns, reaching ₹153.4 × 10<sup>3</sup>/ha and ₹135.5 × 10<sup>3</sup>/ha, respectively, confirming its superior economic viability. The net Benefit-Cost (B:C) ratio was highest in the T<sub>6</sub> treatment, with values of 2.13 in 2023 and 2.27 in 2024, outperforming the next best treatment (T<sub>2</sub>) by 29.9% and 29.0%, respectively. The treatment also exhibited the maximum gross return (+131.4%), net returns (+231.3%) and net benefit-cost ratio (+185.8%) based on the two-year mean relative over control. An overall net B:C ratio of 2.20 further highlighted the economic efficiency of this integrated approach. In addition, treatments such as 50% RDN + FYM (2 t/ha) + Crop residue (2 t/ha) and 50% RDN + FYM (4 t/ha) with a net B:C ratio of 2.16 and 1.94, respectively improved substantial economic returns but remained slightly behind the FYM + LC combination. The superior economic performance of 50% RDN + FYM + LC can be attributed to its optimal yield-to-input cost

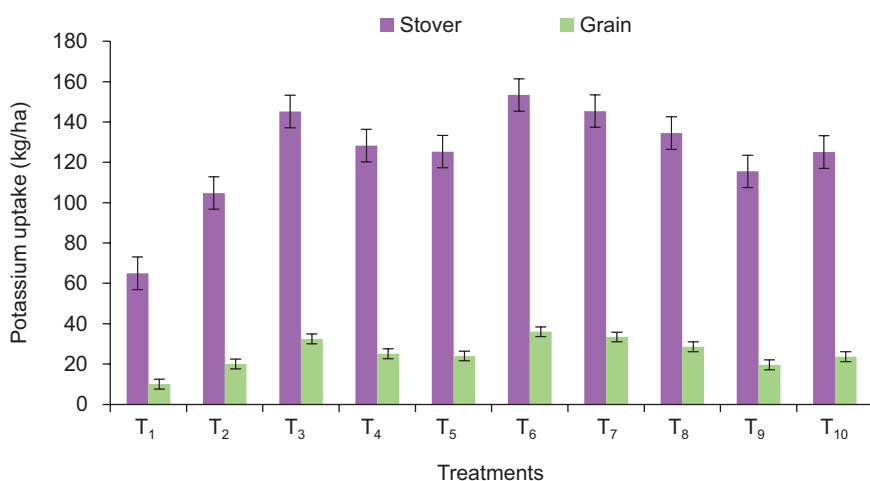


Fig. 4 Effect of integrated nutrient management practices on K uptake in grain and stover of maize 2023 and 2024 (data 2-year pooled mean).

Treatment details are given under Materials and Methods. Critical Difference (CD at  $p=0.05$ ) error bar.

ratio, reduced reliance on expensive inorganic fertilisers and the long-term residual benefits of organic amendments. This combination of integrated nutrient management not only enhances profitability but also supports sustainable soil and crop management in maize-based systems (Sow *et al.* 2024).

**Pearson correlation coefficient:** The correlation coefficient analysis (Table 3) of various traits revealed significant positive correlation relationships among yield attributes, yield and economics of rainfed maize. Grain yield demonstrated a highly significant and positive correlation with stover yield ( $r = 0.994^{***}$ – $0.998^{***}$ ), biological yield ( $r =$

Table 3 Pearson correlation between yield, yield attributes and profitability of maize (2023 and 2024)

NT	GY	SY	BY	HI	CL	CG	NCPP	HSW	GR	NR	NB:C
GY	1										2023
SY	0.994***	1									
BY	0.997***	0.998***	1								
HI	0.61	0.548	0.595	1							
CL	0.899***	0.896***	0.896***	0.493	1						
CG	0.857**	0.861**	0.859**	0.436	0.945***	1					
NCPP	0.621	0.655*	0.654*	0.385	0.676*	0.647*	1				
TW	0.937***	0.928***	0.93***	0.522	0.962***	0.923***	0.56	1			
GR	0.983***	0.985***	0.986***	0.568	0.895***	0.882***	0.609	0.944***	1		
NR	0.929***	0.935***	0.937***	0.552	0.914***	0.905***	0.823**	0.904***	0.933***	1	
NB:C	0.75*	0.764*	0.767**	0.471	0.8**	0.784**	0.951***	0.732*	0.738*	0.93***	1
GY	1										2024
SY	0.998***	1									
BY	0.999***	1***	1								
HI	0.976***	0.966***	0.971***	1							
CL	0.928***	0.917***	0.921***	0.939***	1						
CG	0.937***	0.925***	0.929***	0.942***	0.984***	1					
NCPP	0.352	0.336	0.34	0.391	0.335	0.422	1				
TW	0.981***	0.978***	0.979***	0.972***	0.945***	0.925***	0.313	1			
GR	0.998***	0.994***	0.996***	0.983***	0.945***	0.949***	0.349	0.986***	1		
NR	0.921***	0.907***	0.912***	0.947***	0.954***	0.955***	0.3	0.912***	0.939***	1	
NB:C	0.715*	0.692*	0.7*	0.791**	0.822**	0.818**	0.245	0.718*	0.747*	0.926***	1

GY, Grain yield; SY, Stover yield; BY, Biological yield; HI, Harvest index; CL, Cob length; CG, Cob girth; NCPP, No. of cobs/plant; TW, 1000-seed weight; GR, Gross return; NR, Net return; NB:C ratio, Net benefit-cost ratio; NT, Notations. \*\*\*, Significant at 0.001 level; \*\* Significant at 0.01 level; \*, Significant at 0.05 level.

0.997\*\*\*–0.999\*\*\*), gross return ( $r = 0.983***$ – $0.998***$ ) and net return ( $r = 0.921***$ – $0.929***$ ) in both the seasons, underscoring yield as crucial indicator for determining biomass productivity as well as farm profitability. Further, among various yield attributing characters, 1000-seed weight, cob length and cob girth exhibited significantly higher positive correlation with grain yield ( $r = 0.857***$ – $0.981***$ ), indicating the significant role of cob characters and seed size in influencing the final yield. Moreover, number of cobs/plant showed non-significant positive correlation with grain yield indicated by r value ranging from 0.352–0.621 in both the seasons. Though harvest index was significantly correlated with grain yield ( $r = 0.61$ ) in 2023, a highly significant positive association ( $r = 0.976***$ ) with grain yield was observed in 2024. In addition, association between yield attributing characters demonstrated higher significant positive correlation between cob length and cob girth, whereas number of cobs/plant displayed moderate positive association with cob length and cob girth in 2023, whereas non-significant correlation was exhibited in 2024 with both attributes. Further, higher significant positive association of number of cobs/plant with net B:C ratio ( $r = 0.951***$ ) in 2023 implied its role in influencing the

profitability. However, in 2024, the profitability was more influenced by cob length, cob girth and 1000-seed weight compared to number of cobs/plant. Nearly perfect correlation among grain yield, biological yield, gross returns and net returns in both seasons was observed highlighting yield as the main determinant of economic viability. Overall, yield as well as economic profitability can be enhanced by simultaneous improvements of yield attributing characters of maize.

The study highlights the critical role of integrated nutrient management, particularly the combination of 50% RDN + FYM (2 t/ha) + Leaf Compost (2 t/ha). It significantly enhanced maize yield, nutrient uptake (NPK) and economic returns under rainfed conditions in the Indo-Gangetic Plain. This treatment outperformed 100% RDN alone, increasing grain yield by over 35% and net returns by nearly 30%, while doubling productivity compared to the control. Overall, this approach reduces dependence on chemical fertilisers, enhances physico-chemical and biological properties of soil and offers a sustainable and profitable strategy for maize cultivation in rainfed systems. Further, multi-location studies with diverse sources and doses can be undertaken for getting deeper insights.

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