



Comparative assessment of organic, integrated and precision nitrogen management on growth, productivity and economics of wheat (*Triticum aestivum*) under Trans Indo-Gangetic Plains

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ABSTRACT

Integrated nitrogen management involving organic manure such as FYM, leaf compost and mungbean residue compost with inorganic fertiliser along with precision nitrogen management through GreenSeeker is vital for optimising the yield potential of wheat (*Triticum aestivum* L.). The present study was carried out during winter (*rabi*) seasons of 2023–24 and 2024–25 at ICAR-Indian Agricultural Research Institute, New Delhi for optimising wheat productivity through integrated and precision nitrogen management. The experiment was laid out in a randomised complete block design (RCBD) having 14 treatments with three replications. The combination of integrated and precision nitrogen management showed overall superior response in terms of growth, yield and economics of wheat than organic, inorganic and integrated treatments. Among the treatments, 50% N through FYM + rest as GS-guided resulted in significantly higher plant height, dry-matter accumulation, number of tillers, leaf area index, crop growth rate, relative growth rate and economics. This treatment led to significantly higher grain (13.7–14.4%), straw (3.6–4.3%) and biological (1.1–7.9%) yields than inorganic treatment (100% N through fertiliser). The net returns (9.6%) were also higher than inorganic treatment (100% N through fertiliser). The organic treatments, viz. 100% N FYM, 100% N LC and 100% N MRC has incurred higher cost of cultivation than inorganic, integrated, and integrated with precision treatments. Among organic treatments, 100% N MRC has incurred higher cost of cultivation. Therefore, the study suggests that the adoption of integrated nitrogen management with precision could potentially reduce cost of cultivation, as well as enhance the growth and productivity of wheat.

Keywords: Compost, Farmyard manure, Green Seeker, Integrated nitrogen management, Precision nitrogen management

Wheat (*Triticum aestivum* L.) is the second most important food crop in India after rice, occupying approximately 31.4 mha and producing 110.6 mt (Singh *et al.* 2025). With global wheat demand projected to increase by 35–62% by 2025 relative to levels in 2010 (van Dijk *et al.* 2021) enhancing wheat productivity has become a national target to bridge the consumption-production gap. Over exploitation of land resources without adequate nutrient replenishment significantly contributes to declining productivity (Bationo *et al.* 2007). Exclusive reliance on inorganic fertilisers causes nutrient leaching and runoff, particularly nitrogen (N) and phosphorus (P) leading to environmental degradation and deteriorating soil properties (Gupta *et al.* 2018). Continuous application of chemical

fertilisers even in balanced proportions cannot sustain crop productivity due to soil health deterioration (Zia *et al.* 2000). Long-term fertiliser experiments under intensive cereal-based systems revealed declining productivity trends despite recommended NPK applications (Mahajan and Sharma 2005) indicating negative impacts of inorganic fertilisers on soil health and sustainable productivity. The most practical approach for efficient nutrient management involves mobilising all available, accessible, and cost-effective plant nutrients from multiple sources. Organic manure integration is well-established for maintaining soil fertility and sustaining crop productivity. Organic inputs enhance soil physical and nutritional status, stimulate microbial activities, and contribute substantial major nutrients while improving soil properties. Continuous organic matter addition increases humus content, improves soil structure, enhances cation exchange capacity, and provides substrates for microbial activities (Bohme and Bohme 2006). However,

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organic systems face challenges with nutrient availability compared to high-input chemical systems. Given India's large population, complete dependence on organic farming is impractical, necessitating integrated approaches combining organic and inorganic nutrient sources. Combined organic-inorganic applications sustain yields while building soil quality (Kumara *et al.* 2013, Brar *et al.* 2015).

Nitrogen (N) being the most limiting nutrient in irrigated cereal systems, requires strategic management due to its dynamic nature and susceptibility to losses through volatilisation, denitrification, and leaching. Poor synchrony between crop N demand and supply results in approximately 30% recovery efficiency in wheat (Krupnik *et al.* 2004). Indo-Gangetic plains' alluvial soils are characteristically N-deficient, prompting excessive applications that reduce efficiency, increase costs, and cause environmental concerns. Cost-effective N management requires understanding indigenous N supply variations. The GreenSeeker® optical sensing system utilising normalised difference vegetative index calculations offers precision N management through early-season reflectance measurements correlating with plant N status (Raun *et al.* 2011). Limited research exists on comparative influences of composts, fertiliser rates, and precision N management on wheat growth, productivity, and economics. Therefore, this study investigates integrated and precision N management effects on wheat growth, productivity, and profitability.

MATERIALS AND METHODS

The present study was carried out during the winter (*rabi*) seasons of 2023–24 and 2024–25 at ICAR-Indian Agricultural Research Institute, New Delhi. The soil of the experimental field was sandy loam texture with pH=7.8, EC=0.41 dS/m, organic C=0.362%, available N=147.8 kg/ha, available P=13.02 kg/ha and K=286.4 kg/ha at 0–15 cm soil depth. The experiment was laid out using randomised complete block design (RCBD) with 14 treatments comprised of Control (No manure and fertiliser application); three organic treatments, viz. 100% recommended dose of nitrogen (RDN) through farm yard manure (FYM) as basal (100% N FYM); 100% RDN through leaf compost (LC) as basal (100% N LC); 100% RDN through mungbean residue compost (MRC) as basal (100% N MRC); one inorganic treatment, viz. 100% RDN through fertiliser as 33% N basal, 33% N at 20–25 days after sowing (DAS) and remaining 33% at 45–50 DAS (100% N F); three integrated treatments, viz. 50% RDN through FYM as basal + 50% RDN through fertiliser as two splits after 1st and 2nd irrigation (50% N FYM + 50% N F); 50% RDN through LC as basal + 50% RDN through fertiliser as two splits after 1st and 2nd irrigation (50% N LC + 50% N F); 50% RDN through MRC as basal + 50% RDN through fertiliser as two splits after 1st and 2nd irrigation (50% N MRC + 50% N F); six integrated with precision treatments, viz. 50% RDN through FYM as basal + 25% RDN through fertiliser after 1st irrigation + remaining need based nitrogen application through GreenSeeker (50% N FYM + 25% N F + GS); 50% RDN through LC as basal +

25% RDN through fertiliser after 1st irrigation + remaining need based N application through GreenSeeker (50% N LC + 25% N F + GS); 50% RDN through MRC as basal + 25% RDN through fertiliser after 1st irrigation + remaining need based nitrogen application through GreenSeeker (50% N MRC + 25% N F + GS); 50% RDN through FYM as basal + remaining need based nitrogen application through GreenSeeker (50% N FYM + GS); 50% RDN through LC as basal + remaining need based nitrogen application through GreenSeeker (50% N LC + GS); 50% RDN through MRC as basal + remaining need based nitrogen application through GreenSeeker (50% N MRC + GS) and replicated thrice. Sowing of wheat variety HD-3086 was done on 15th November 2023 and 13th November 2024 at a row spacing of 22.5 cm. The recommended doses were 150 kg N, 60 kg P₂O₅, and 40 kg K₂O/ha. Nitrogen applied as per the treatment and the entire amounts of P and K were applied during sowing. The quantity of nitrogen applied through organic sources and quantity of organic materials added under different treatments are given in Table 1. Nitrogen content (%) of FYM, leaf compost and MRC were 0.97, 0.93 and 1.2, respectively. Six irrigations were given to wheat during first and second year. To estimate plant height, five plants were randomly tagged and height was measured. Leaf area meter was used for measuring leaf area index. A 50 cm row of continuous plant stand was randomly selected from three different locations in each plot for estimating dry weight.

The mean crop growth rate (CGR) and relative growth rate (RGR) were worked out at different growth stages as per Blackman (1919) and Watson (1952), respectively. To

Table 1 Nitrogen applied through organic sources and quantity of organic materials added under different treatments

Treatments	N (kg/ha) applied through organic source	Organic material added (t/ha)
Control	0	0
100% N FYM	150	15.464
100% N LC	150	16.129
100% N MRC	150	12.500
100% N F	0	0
50% N FYM + 50% N F	75	7.732
50% N LC + 50% N F	75	8.065
50% N MRC + 50% N F	75	6.250
50% N FYM + 25% N F + GS	75	7.732
50% N LC + 25% N F + GS	75	8.065
50% N MRC + 25% N F + GS	75	6.250
50% N FYM + GS	75	7.732
50% N LC + GS	75	8.065
50% N MRC + GS	75	6.250

N, Nitrogen; FYM, Farm yard manure; LC, Leaf compost; MRC, Mungbean residue compost; F, Fertiliser; GS, GreenSeeker.

determine wheat grain, straw yield and biological yield, a net plot area of 5 m × 3.6 m was harvested manually and dried under sun for three days followed by threshing in a thresher. The threshed grains were cleaned and grain yield was measured at 12% moisture content. Harvest index is calculated by dividing the grain yield with biological yield. The economic analysis was done by:

$$\text{Net returns} = \text{Gross returns} - \text{Cost of cultivation}$$

$$\text{BCR} = \text{Net returns} / \text{total cost of cultivation}$$

The analysis of variance of data (ANOVA) was done for a randomised complete block design (RCBD) and the least significant difference (LSD) was determined to compare the treatment means at 5% level of significance.

Weather during crop period was optimum during both the years. Total rainfall received during the study period was 68.1 mm and 226.8 mm in 2023–24 and 2024–25, respectively. The higher rainfall was received in the year 2024–25 and maximum received during 12th week of 2024–25. Total evaporation during crop growth period was 505.7 and 501.8 mm in 2023–24 and 2024–25, respectively. The maximum temperature during crop growth period was ranged between 26°C and 27.8°C and the minimum temperature during crop growth period was ranged between 11.2°C and 12.4°C in 2023–24 and 2024–25, respectively.

The mean relative humidity during the crop period was 85% and 82.3% in 2023–24 and 2024–25, respectively. The daily weather data has been taken from of the meteorological observatory and depicted in Fig.1 and Fig. 2.

RESULTS AND DISCUSSION

Agronomic growth parameters of wheat: The wheat plant height was significantly influenced by different nitrogen management strategies during both the years (Table 2). The maximum plant height at 90 DAS was recorded in 50% N FYM + GS treatment (94.3 and 95.9 cm in 2023–24 and 2024–25, respectively) which was statistically higher over other treatments. This was followed by 50% N LC + GS (92.5 and 94.1 cm) and 50% N MRC + GS (90.8 and 92.4 cm) treatments. 100% N F performed better than organic sources alone achieving plant height of 81.8 and 83.5 cm. However, the integration of organic and inorganic sources consistently outperformed single-source applications indicating the synergistic effects of combined nitrogen management. Similar results were reported by Sulochna *et al.* (2018) and Kabato *et al.* (2022). A similar trend was observed in dry matter production at 90 DAS during both the years (Table 2). The highest dry matter accumulation was observed in 50% N FYM + GS treatment (767.3 and 775.3 g/m² in 2023–24 and 2024–25, respectively) representing a 18.5% and 18.7%

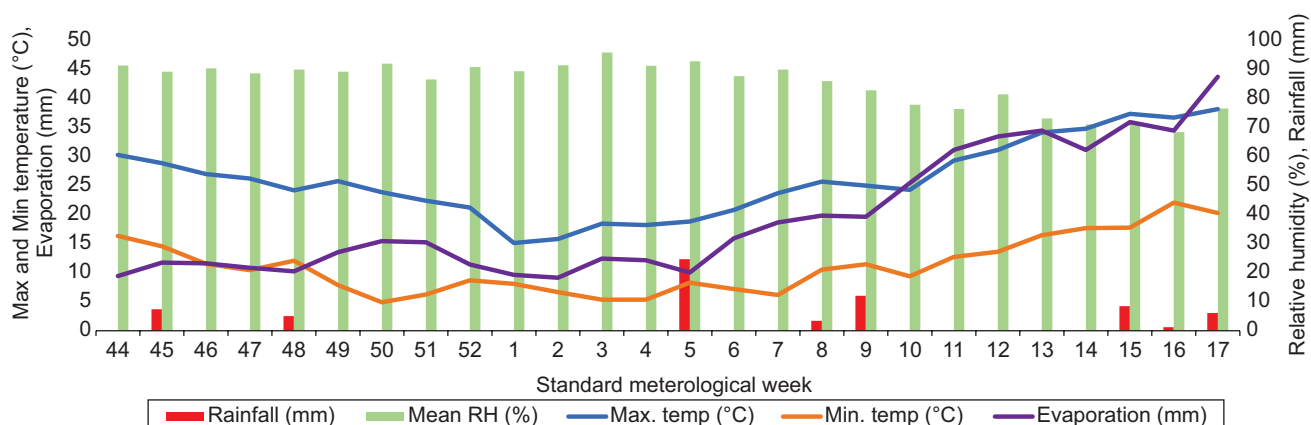


Fig. 1 Weather data during crop experimentation period (rabi 2023–24).

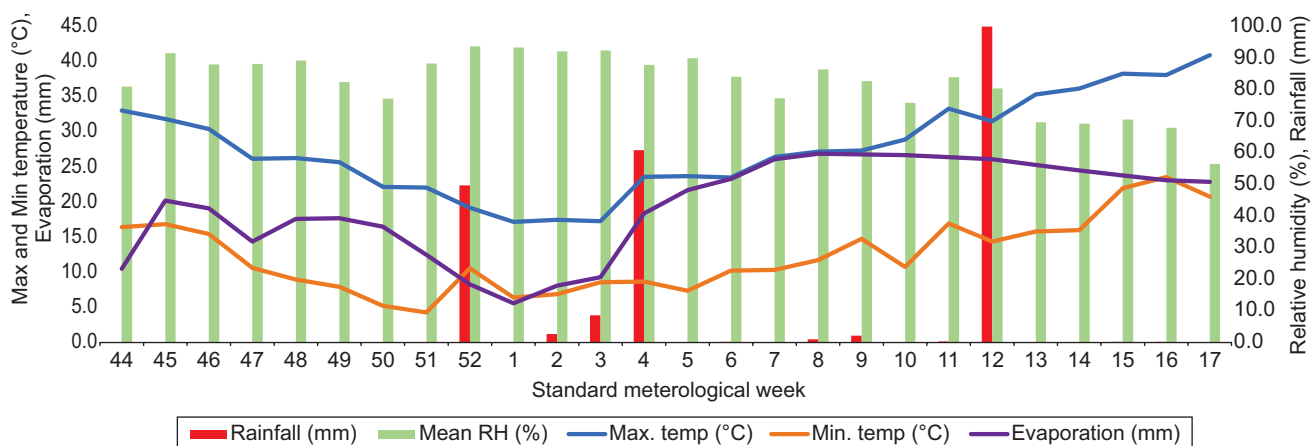


Fig. 2 Weather data during crop experimentation period (rabi 2024–25).

increase over 100% N F treatment in 2023–24 and 2024–25, respectively. This was followed by 50% N LC + GS (752.2 and 761.2 g/m²) and 50% N MRC + GS (737.0 and 746.0 g/m²) treatments. Increased dry matter accumulation may be due to better nitrogen utilisation from organic sources and synchronised nitrogen application using the GreenSeeker. Tiller production is crucial yield determining component in wheat was significantly influenced by different nitrogen management strategies during both the years (Table 2). The maximum number of tillers was recorded in 50% N FYM + GS treatment (378.0 and 383.3 tillers/m² in 2023–24 and 2024–25, respectively) followed by 50% N LC + GS and 50% N MRC + GS treatments. Among organic sources, FYM consistently performed better than leaf compost and mungbean residue compost, likely due to progressive and gradual release of nitrogen during crop period and better soil conditioning properties. The 100% fertiliser treatment (100% N F) showed good tillering (348.3 and 353.0 tillers/m²) but was inferior to integrated approaches suggesting that sole dependence on chemical fertilisers may not optimise tiller production. The control treatment produced the lowest number of tillers (266.7 and 250.0 tillers/m²), demonstrating the essential role of nitrogen in tiller development. Leaf area index is an important indicator of photosynthetic capacity responded positively to integrated with precision nitrogen management treatments during both the years (Table 2). The highest LAI was achieved by 50% N FYM + GS treatment

(5.16 and 5.29 in 2023–24 and 2024–25, respectively), which was significantly higher over other treatments. The enhanced LAI in GreenSeeker-integrated treatments may be due to improved leaf development and canopy architecture resulting from optimised nitrogen nutrition. These results are similar with the research finding of Jat *et al.* (2022). Paul *et al.* (2013) reported higher plant height, dry matter accumulation and tillers/m² with the integration of FYM with fertiliser.

Physiological growth rates of wheat: The experimental results revealed that applied treatments produced marked variation in wheat growth rates (Fig. 3 and 4). The CGR representing the rate of dry matter accumulation per unit ground area per unit time showed temporal variation across all treatments. The CGR values were lowest during initial period of 30–60 DAS (2.64–3.66 g/m²/day) reached maximum during period of 60–90 DAS (8.60–11.80 g/m²/day) and thereafter decreased during 90 DAS-harvest (6.14–7.76 g/m²/day) following the typical sigmoid growth pattern of wheat. The 50% N FYM + GS treatment consistently recorded the highest CGR during all the crop growth stages achieving maximum values of 11.76–11.80 g/m²/day during 60–90 DAS which was statistically higher over all other treatments which is 11.34% higher CGR compared to the 100% N F treatment during period of 60–90 DAS indicating enhanced photosynthetic efficiency and optimal nutrient utilisation through real time crop sensing

Table 2 Effect of integrated and precision nitrogen management on plant height, dry-matter accumulation, number of tillers, leaf area index at 90 days after sowing of wheat during 2023–24 and 2024–25

Treatment	Plant height (cm)		Dry matter accumulation (g/m)		Tillers/m ²		LAI	
	2023–24	2024–25	2023–24	2024–25	2023–24	2024–25	2023–24	2024–25
Control	70.7	64.4	410.3	386.9	266.7	250.0	3.93	3.74
100% N FYM	80.5	81.9	623.8	628.8	325.3	331.0	4.42	4.77
100% N LC	77.1	78.5	610.5	615.5	315.0	320.0	4.38	4.74
100% N MRC	72.8	74.4	600.4	606.4	304.7	309.7	4.35	4.72
100% N F	81.8	83.5	647.3	653.3	348.3	353.0	4.69	4.82
50% N FYM + 50% N F	84.4	86.0	677.1	683.1	356.7	362.3	4.79	4.92
50% N LC + 50% N F	82.5	84.1	663.9	670.9	355.3	359.3	4.75	4.87
50% N MRC + 50% N F	82.0	83.7	650.4	657.4	350.0	354.7	4.70	4.81
50% N FYM + 25% N F + GS	88.9	90.7	722.2	729.2	365.7	369.7	4.91	5.04
50% N LC + 25% N F + GS	87.1	88.9	707.4	715.4	362.7	368.0	4.86	4.96
50% N MRC + 25% N F + GS	85.9	87.0	692.2	700.2	359.7	364.3	4.82	4.94
50% N FYM + GS	94.3	95.9	767.3	775.3	378.0	383.3	5.16	5.29
50% N LC + GS	92.5	94.1	752.2	761.2	372.3	380.3	5.04	5.17
50% N MRC + GS	90.8	92.4	737.0	746.0	369.7	377.3	4.96	5.09
SEM ±	2.8	3.1	9.9	9.1	6.3	6.2	0.01	0.01
LSD (<i>p</i> =0.05)	8.4	9.4	30.1	27.7	20.1	18.7	0.03	0.03

Treatment details are given under Materials and Methods.

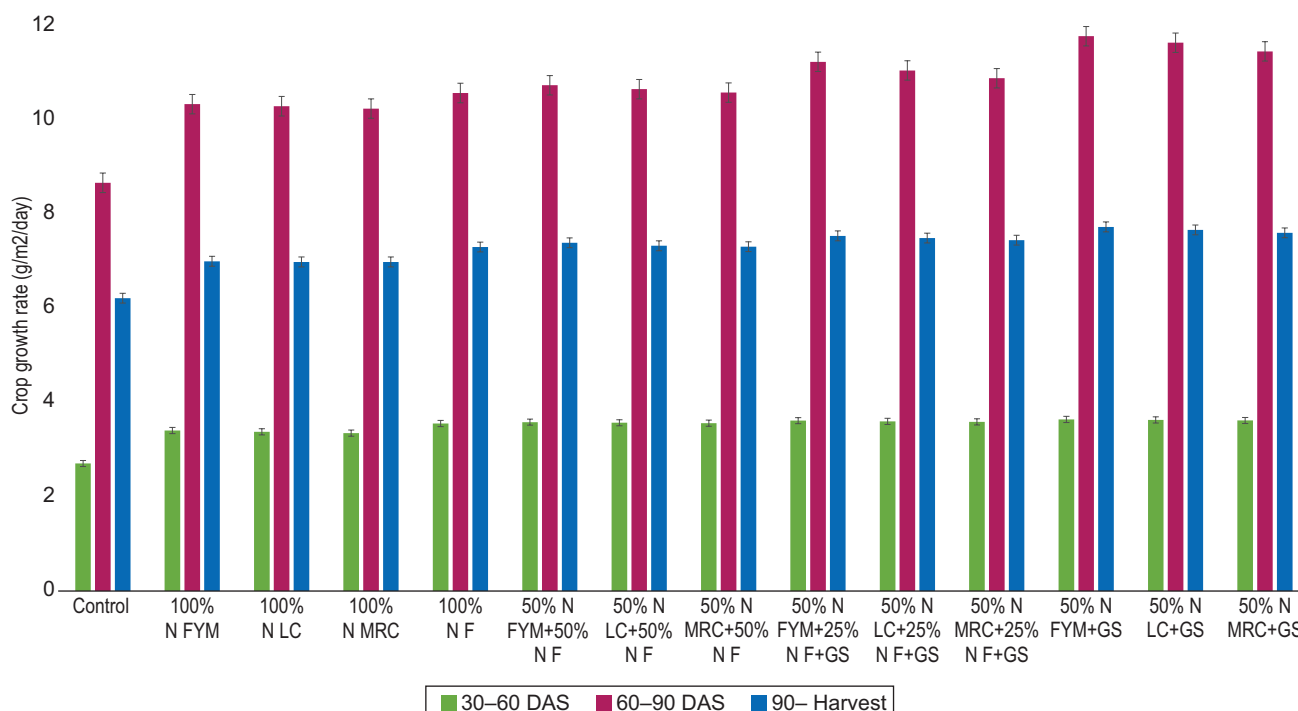


Fig. 3 Effect of integrated and precision nitrogen management on wheat crop growth rate (mean of two years). DAS, Days after sowing. Treatment details are given under Materials and Methods.

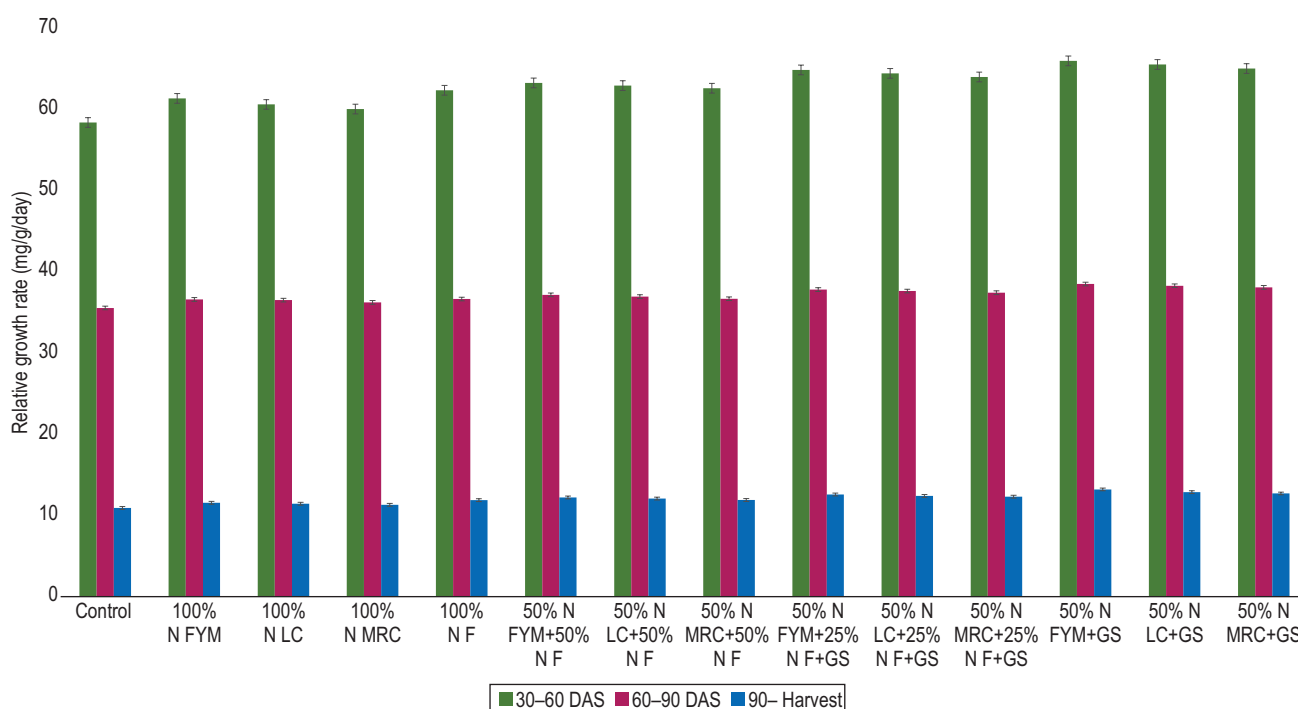


Fig. 4 Effect of integrated and precision nitrogen management on wheat relative growth rate (mean of two years). DAS, Days after sowing. Treatment details are given under Materials and Methods.

and need based nitrogen application. The RGR represents the efficiency of dry matter production per unit of existing plant material. The RGR showed a characteristic decline from 30–60 DAS period to 90 DAS-harvest period with the highest values recorded during period of 30–60 DAS (58.13–66.10 mg/g/day). The 50% N FYM + GS treatment consistently recorded the highest RGR during all the crop

growth stages which is 5.8% higher compared to the 100% N F treatment during period of 30–60 DAS demonstrating higher physiological efficiency through optimised nitrogen nutrition. Similar results were also reported by Jat *et al.* (2022) and Pramanick *et al.* (2024).

Grain, straw and biological yields of wheat: Grain yield of wheat was significantly affected by different nitrogen

Table 3 Effect of integrated and precision nitrogen management on yield and harvest index of wheat during 2023–24 and 2024–25

Treatment	Grain yield (t/ha)		Straw yield (t/ha)		Biological yield (t/ha)		Harvest index (%)	
	2023–24	2024–25	2023–24	2024–25	2023–24	2024–25	2023–24	2024–25
Control	3.30	3.12	5.83	5.58	9.14	8.70	36.05	35.83
100% N FYM	4.90	5.39	7.66	8.08	12.57	13.46	39.10	37.58
100% N LC	4.83	5.28	7.60	7.97	12.44	13.25	38.85	37.68
100% N MRC	4.61	5.06	7.27	7.94	11.89	12.99	38.88	36.68
100% N F	5.48	5.55	8.64	8.82	14.12	14.36	38.87	38.82
50% N FYM + 50% N F	5.63	5.79	8.81	9.02	14.44	14.81	39.15	38.87
50% N LC + 50% N F	5.56	5.74	8.76	8.92	14.32	14.66	38.85	38.79
50% N MRC + 50% N F	5.51	5.68	8.67	8.87	14.19	14.54	38.92	38.68
50% N FYM + 25% N F + GS	6.02	6.13	8.89	9.07	14.91	15.20	40.38	40.35
50% N LC + 25% N F + GS	5.93	6.08	8.86	8.99	14.79	15.07	40.11	40.38
50% N MRC + 25% N F + GS	5.76	5.93	8.82	8.95	14.59	14.89	39.51	39.84
50% N FYM + GS	6.23	6.35	9.01	9.14	15.24	15.49	40.86	40.98
50% N LC + GS	6.18	6.29	8.93	9.12	15.11	15.40	40.87	40.80
50% N MRC + GS	6.06	6.18	8.92	9.10	14.98	15.28	40.45	40.43
SEM ±	0.15	0.14	0.31	0.29	0.33	0.32	1.21	1.10
LSD ($p=0.05$)	0.46	0.43	0.95	0.89	1.02	0.96	3.68	3.35

N, Nitrogen; FYM, Farm yard manure; LC, Leaf compost; MRC, Mungbean residue compost; F, Fertiliser; GS, GreenSeeker. Treatment details are given under Materials and Methods.

management treatments during both the years (Table 3). The maximum grain yield was recorded in 50% N FYM + GS treatment (6.23 and 6.35 t/ha in 2023–24 and 2024–25, respectively) which was statistically higher over other treatments representing 13.7% and 14.4% increases over 100% N F treatment in 2023–24 and 2024–25, respectively. This was followed by 50% N LC + GS and 50% N MRC + GS. Among the organic treatments, 100% N through FYM consistently produced the highest grain yields (4.90 and 5.39 t/ha), followed by LC (4.83 and 5.28 t/ha) and MRC (4.61 and 5.06 t/ha) indicating the progressive nutrient release characteristics of FYM during crop growing period compared to other organic sources. The 100% inorganic fertiliser treatment (100% N F) yielded 5.48 and 5.55 t/ha, which was significantly higher than all individual organic treatments, highlighting the immediate nutrient availability and rapid uptake characteristics of chemical fertilisers. The superior grain yield under integrated nitrogen management with precision treatments can be attributed to sustained nutrient availability and optimal synchronisation of nitrogen supply with crop demand throughout the growing period. Similar results was reported by Kaur *et al.* (2018). Ratanoo *et al.* (2016) reported significantly higher yield attributes and yield with the use of GreenSeeker. Straw yield showed significant variation among nitrogen management treatments during both the years (Table 3). The 50% N FYM + GS treatment produced maximum straw yields (9.01 and 9.14 t/ha in 2023–24 and 2024–25, respectively), representing a

4.3% and 3.6% increase over 100% N F which yielded 8.64 and 8.82 t/ha in 2023–24 and 2024–25, respectively. This was followed by 50% N LC + GS and 50% N MRC + GS. Higher grain and straw yields with the combined application of compost and inorganic fertilisers may be due to improved nutrient availability and balanced nutrient supply to the crop (Seran *et al.* 2010, Suge *et al.* 2011). Smart application of N according to the GreenSeeker reading resulted in a significant improvement in yield with approximately 12 and 21% greater grain and straw yields, respectively, than 100% of the RDF and grain and straw yields decreased in the control plot where no nutrients were added (Pramanick *et al.* 2024). Biological yield representing total above-ground biomass ranged from 8.70–9.14 t/ha in control treatments to 15.24–15.49 t/ha in the best performed treatment. The 50% N FYM + GS treatment consistently produced the highest biological yields over all other treatments in both the years (Table 3). The substantial improvement in total biomass production demonstrates the synergistic effects of organic matter incorporation with precision nitrogen application technology. Harvest index is a critical parameter reflecting the efficiency of dry matter partitioning to economic yield. The control treatment showed relatively stable HI values (36.05% and 35.83% in 2023–24 and 2024–25, respectively) while most treatments have HI values between 38–41% indicating balanced vegetative and reproductive growth. The integrated nitrogen management with precision treatments achieved the highest harvest index values, with 50% N

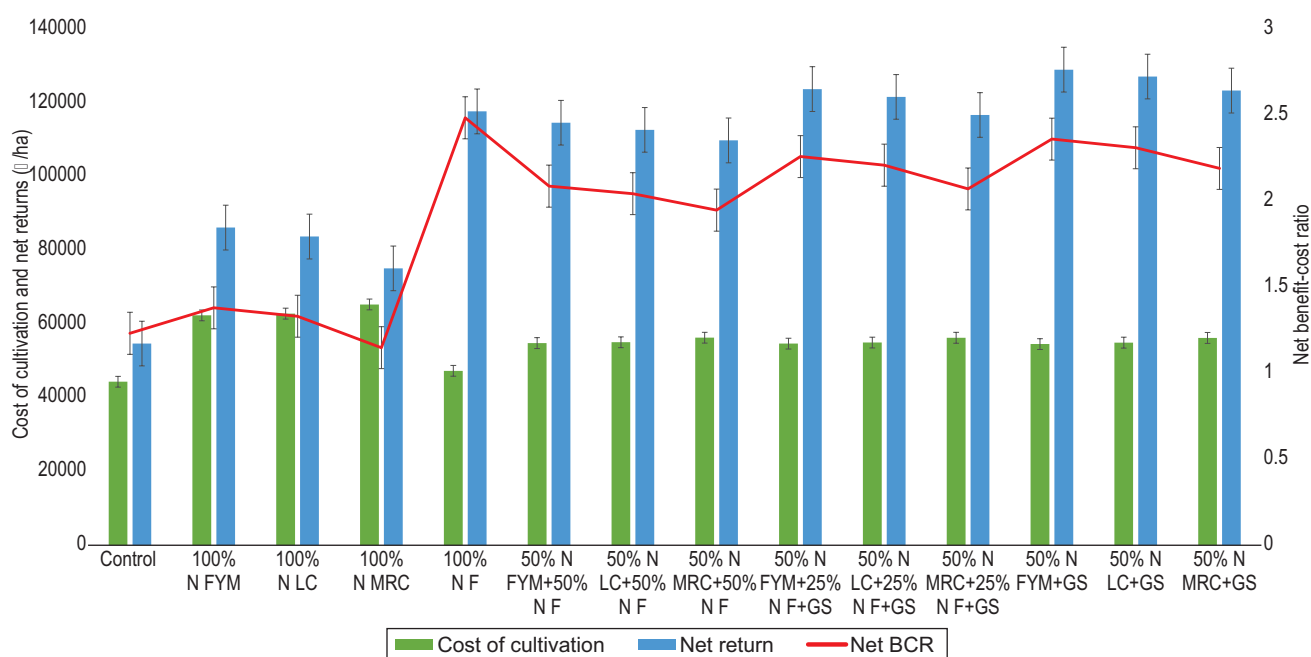


Fig. 5 Effect of integrated and precision nitrogen management on net return and net benefit cost ratio (Net BCR) of wheat (mean of two years).

Treatment details are given under Materials and Methods.

FYM + GS recording 40.86% and 40.98% HI in 2023–24 and 2024–25, respectively. Higher biomass and grain yield with higher harvest index recorded with the application of fertiliser with compost reported by Gaiind and Singh (2012).

Economics: The cost of cultivation varied significantly across different nitrogen management treatments (Fig. 5) ranging from ₹44,400/ha in the control treatment to ₹65,372.5/ha in the 100% N MRC treatment. Similar with results reported by Kaur *et al.* (2018). Among organic treatments, 100% N MRC incurred the highest cost (₹65,372.5/ha) followed by 100% N LC (₹62,891.67/ha) and 100% N FYM (₹62,427/ha). The higher costs associated organic treatments due to organic matter procurement, compost making and application. The inorganic treatment (100% N F) maintained relatively low cultivation costs of ₹47,350/ha representing only a 6.6% increase over the control treatment. Integrated treatments with combinations of organic and inorganic sources showed moderate cost increases ranging from ₹54,888–56,361/ha. Notably, integrated with precision treatments did not substantially increase compared to conventional integrated approaches with cultivation costs ranging from ₹54,635–56,333/ha. Similar results reported in wheat and rice by Gaiind and Singh (2013) where higher cost of cultivation under organic than INM and inorganic nutrient management. Net returns significantly affected by different nitrogen management treatments (Fig. 5). The highest net returns (₹129,146.98/ha) obtained under 50% N FYM + GS treatment representing a 9.6% increase over 100% N F (₹117,810.77/ha) followed closely by 50% N LC + GS (₹127,261.82/ha) and 50% N MRC + GS (₹123,461.82/ha). The control treatment recorded the lowest net returns of

₹54,751.06/ha emphasising the economic necessity of nitrogen application in wheat cultivation. 100% N F treatment generated substantial net returns which significantly outperforming all organic treatments. The 100% N FYM treatment achieved ₹86,258.60/ha, while 100% N LC and 100% N MRC recorded ₹83,826.23/ha and ₹75,184.28/ha, respectively. The lower net returns from organic treatments can be attributed to their higher input costs coupled with relatively lower yields compared to inorganic and integrated treatments. The higher net returns in integrated with precision nitrogen treatments resulted from 13.7–14.4% higher grain yields compared to sole inorganic treatment generating approximately ₹25,000–30,000 additional revenue per hectare. Gaiind and Singh (2016) reported INM resulted highest net returns than organic and conventional farming in wheat. Higher gross and net returns recorded in GreenSeeker treatments was due to higher grain yield was reported by Kaur *et al.* (2018).

The Benefit-Cost ratio (BCR) indicator of economic efficiency with 100% N F treatment recorded highest BCR of 2.49 indicating excellent economic returns on investment (Fig. 5). However, among integrated nitrogen management with precision treatments, 50% N FYM + GS achieved the highest BCR of 2.36, followed by 50% N LC + GS (2.31) and 50% N MRC + GS (2.19) demonstrating the economic viability of sustainable precision agriculture approaches. The wheat grain and straw production is impacted by increasing cost and treatment are the key causes of this trend in economic returns (Singh *et al.* 2015).

Integrated nitrogen management involving organic manure such as farmyard manure, leaf compost and mungbean residue compost with inorganics like fertiliser

along with precision nitrogen management through Green Seeker adopted in this study have shown notable improvements in the growth, yield, and economics of wheat. Specifically, 50% recommended dose of nitrogen through farm yard manure as basal and remaining need-based nitrogen application through Green Seeker practice resulted in a higher wheat productivity and profitability. The enhanced yields under integrated nitrogen management with precision treatments due to higher nutrient uptake results from higher nutrient availability due to integration of organic and inorganic sources and synchrony in demand of crop and supply of nutrient due to precision nitrogen management. Further, better synchrony in application of nitrogen under precision nitrogen management treatments may lead to reduced losses of nitrogen and impart pollution control co-benefit.

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