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Response of Integrated Nitrogen Management on Growth and Yield of Mustard (*Brassica juncea* L.)

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Abstract

A field study was carried out during the Rabi season of 2024–25 at the agricultural research farm of Vivekananda Global University, Jaipur. The main objective was to evaluate the impact of different INM practices on the growth, yield, quality, soil fertility, and economic performance of Indian mustard. The findings demonstrated that INM significantly enhanced various growth parameters, yield attributes, and overall crop productivity. Among the treatments, T9-comprising 75% (RDN- Recommended Dose of Nitrogen) supplemented with 25% nitrogen through an equal mix of vermicompost, poultry manure, and farmyard manure (1:1:1)-consistently delivered the best results. This treatment recorded the maximum values for plant height, number of primary branches, dry matter accumulation, leaf area index (LAI), and crop growth rate (CGR). Although variations in relative growth rate (RGR) were statistically non-significant, chlorophyll content was considerably higher in T9, followed by T6 and T8. Yield-contributing traits such as siliqua length, siliquae per plant, seeds per siliqua, and test weight showed notable improvements under INM, with T9 producing the highest seed yield of 40.84 q/ha, almost three times greater than the control (13.45 q/ha). Quality indicators like protein and oil content were also significantly enhanced, with T9 showing a protein content of 23.16%. Based on these findings, T9 is recommended for maximizing mustard yield and improving soil fertility in Western Uttar Pradesh, while T6 serves as a viable alternative for those seeking high returns with relatively lower input costs.

Keywords: Intrgrated nitrogen management, RDF, FYM, Vermicompost and Yield

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Introduction

Mustard (*Brassica juncea* L.) is one of the most important oilseed crops in India, contributing significantly to the edible oil economy. It is grown predominantly during the Rabi season under varying agro-climatic conditions. Despite its potential, mustard yield is constrained by suboptimal nutrient management practices, particularly nitrogen, which plays a pivotal role in vegetative and reproductive growth. The efficiency of nitrogen use can be enhanced by integrating it with organic nutrient sources that improve soil health, microbial activity, and nutrient availability over time.

Integrated Nitrogen Management (INM), involving combinations of chemical fertilizers with organic manures such as vermicompost, poultry manure, and farmyard manure (FYM), has shown potential in enhancing crop productivity and sustainability [1, 2]. Organic manures not only supply macro and micronutrients but also improve the physical and biological properties of soil, leading to better root development and nutrient uptake [3]. Moreover, blending different organic sources in specific proportions may exhibit synergistic effects, resulting in better crop response compared to single-source applications.

Keeping these aspects in view, the present investigation was undertaken to assess the effect of integrated nitrogen management involving inorganic and organic sources (vermicompost, poultry manure, and FYM) on growth traits, physiological parameters, and yield performance of mustard.

Materials and Methods

A field experiment was conducted during the Rabi season on loamy soil with low nitrogen and medium phosphorus and potassium levels. The experiment was laid out in a Randomized Block Design (RBD) with nine treatments replicated three times**.** The treatments included: T1 – Control, T2 – 100% Recommended Dose of Nitrogen (RDN) (120 kg N ha^{-1}), T3 – 75% RDN + 25% N through Vermicompost (VC), T4 – 75% RDN + 25% N through Poultry Manure (PM), T5 – 75% RDN + 25% N through Farm Yard Manure (FYM), T6 – 75% RDN + 25% N through equal mixture of VC

and PM, T7 – 75% RDN + 25% N through equal mixture of VC and FYM, T8 – 75% RDN + 25% N through equal mixture of PM and FYM and T9 – 75% RDN + 25% N through equal mixture of VC, PM, and FYM Fertilizers were applied as per treatment at sowing. NRCHB-101 variety of mustard was used for experimentation. Organic manures were incorporated 15 days before sowing on a nitrogen equivalent basis. The region experiences a semi-arid climate with extreme temperatures throughout the year. Summer temperatures soar as high as 48 °C, while winter temperatures can drop to as low as -1.0°C, often leading to frosts. The annual rainfall averages between 400-500 mm, primarily from the Southwest monsoon during July and August, with minimal precipitation in winter and summer. During the crop season, maximum temperatures ranged from 37.9 °C to 17.3 °C, and minimum temperatures ranged from 21.5 °C to 0.3 °C. A total of 94.5 mm of rainfall was recorded during this period. Relative humidity varied from 34% to 69%, and average sunshine hours ranged from 4.1 to 9.7 hours per day. Detailed weekly meteorological observations are provided in Table 3.1 and visually represented in Figure 3.1. Data were recorded on plant height, number of branches, dry matter accumulation, LAI, CGR, RGR, and yield attributes. Statistical analysis was carried out using ANOVA and means were compared using Critical Difference (CD) at 5% probability level [4].

Results and Discussion

Growth Parameters

The data (**Table 1**) indicated that integrated nitrogen management significantly influenced plant height, number of branches per plant, and dry matter accumulation at all stages. The maximum plant height (197.28 cm) was recorded with T9 (75% RDN + 25% N through VC+PM+FYM)**,** followed by T6 (193.69 cm)**.** The increase in plant height was due to sustained nutrient supply from combined organic and inorganic sources [5]. The highest number of branches (14.16) was also observed in T9, indicating enhanced growth potential under integrated nutrition. Dry matter accumulation followed a similar trend with T9 showing the highest values (144.34 g/m² at harvest), which is consistent with earlier findings on enhanced biomass due to organic amendments [6].

Table 1 Effect of integrated nitrogen management on growth traits of mustard

Treatment	Plant height (cm)				Number of branches per plant				Dry Matter Accumulation (g/m²)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1-Control	31.44	69.23	134.88	164.61	1.46	4.91	8.47	10.37	21.35	64.11	84.66	94.22
T_2-100% RDN (120 kg. N/ha)	32.35	73.84	141.27	174.4	1.69	5.7	9.73	11.41	25.46	72.02	97.84	109.33
T_3-75% RDN + 25% Vermicom post (VC)	33.7	78.88	149.19	182.5	1.95	6.17	10.45	12.22	29.71	79.09	105.61	119.39
T_4-75% RDN + 25% Poultry Mannure (PM)	34.59	80.11	151.78	185.87	2.06	6.39	10.96	12.67	30.94	83.55	109.27	124.17
T_5-75% RDN + 25% Farm Yard Manure (FYM)	33.25	76.52	146.07	179.33	1.94	5.92	10.17	12.07	27.83	76.6	101.06	114.8
T_6-75% RDN + 25% RDN [VC & PM (1:1)]	36.54	86.58	159.45	193.69	2.33	7.12	11.9	13.73	37.06	91.62	121.49	139.05
T_7-75% RDN + 25% RDN [VC & FYM (1:1)]	35.37	83.32	156.7	189.54	2.19	6.8	11.34	13.27	34.85	87.2	115.69	132.63
T_8-75% RDN + 25% RDN [PM & FYM (1:1)]	35.93	84.4	157.35	190.82	2.23	6.97	11.42	13.36	35.32	88.13	117.36	133.77
T_9-75% RDN + 25% RDN [VC, PM & FYM (1:1:1)]	37.87	89.77	164.53	197.28	2.45	7.39	12.41	14.16	39.4	94.79	124.25	144.34
SEm±	0.63	1.24	3.12	2.86	0.03	0.09	0.38	0.41	1.31	1.08	3.86	5.11
C.D. @5%	1.90	3.72	9.36	8.56	0.10	0.27	1.15	1.22	3.93	3.24	11.57	15.32

Leaf Area Index (LAI), CGR, and RGR

Table 2 shows that LAI values increased significantly with INM treatments. The maximum LAI (4.03) at 60 DAS and 3.30 at 90 DAS was recorded in T9. Similarly, CGR and RGR were also higher in T9, suggesting improved canopy development and photosynthetic efficiency due to better nutrient availability [7]. Although RGR differences were not statistically significant, higher values in integrated treatments indicated improved nutrient assimilation per unit of biomass. These findings are in line with earlier studies showing increased physiological efficiency under organic–inorganic combinations [8].

Yield Attributes and Yield

Yield attributing traits were significantly affected by INM treatments (**Table 3**). The maximum siliqua length (6.75 cm)**,** number of siliquae per plant (296.76)**,** seeds per siliqua (16.38), and test weight (6.72 g) were recorded in T9. These traits directly contributed to higher seed yield, which was also highest in T9 (40.84 q ha^{-1}) followed by T6 (37.83 q ha^{-1}). The lowest seed yield was observed in the control (13.45 q ha^{-1}). Straw and biological yields were also significantly enhanced in INM treatments, with T9 recording the highest biological yield (100.76 q ha^{-1})**.** Harvest index ranged from 33.41% (T1) to 39.52% (T9), suggesting better partitioning efficiency under integrated nutrient supply. These results confirm that combining 75% RDN with 25% N from a 1:1:1 mixture of vermicompost, poultry manure, and FYM can significantly improve growth, physiological efficiency, and yield performance in mustard [9, 10].

Table 2 Effect of integrated nitrogen management on Leaf Area Index, Crop Growth Rate and Relative Growth Rate of mustard

Treatment	Leaf Area Index (LAI)			Crop Growth Rate (CGR) (g/m^2/day)			Relative Growth Rate (RGR) (mg/g/day)		
	30 DAS	60 DAS	90 DAS	30-60 DAS	60-90 DAS	90-Harvest	30-60 DAS	60-90 DAS	90-Harvest
T_1-Control	0.64	2.7	1.96	6.45	8.79	4.41	0.183	0.092	0.057
T_2-100% RDN (120 kg. N/ha)	0.65	2.95	2.18	6.78	8.98	4.57	0.196	0.1	0.062
T_3-75% RDN + 25% Vermicompost (VC)	0.74	3.27	2.46	6.87	9.05	4.65	0.202	0.107	0.067
T_4-75% RDN + 25% Poultry Mannure (PM)	0.76	3.43	2.69	6.89	9.07	4.69	0.205	0.11	0.07
T_5-75% RDN + 25% Farm Yard Manure (FYM)	0.73	3.21	2.33	6.8	9.02	4.6	0.199	0.104	0.065
T_6-75% RDN + 25% RDN [VC & PM (1:1)]	0.81	3.89	3.04	7.03	9.23	4.85	0.214	0.118	0.077
T_7-75% RDN + 25% RDN [VC & FYM (1:1)]	0.78	3.69	2.85	7.02	9.11	4.72	0.21	0.114	0.072
T_8-75% RDN + 25% RDN [PM & FYM (1:1)]	0.8	3.77	2.98	7	9.18	4.81	0.212	0.116	0.074
T_9-75% RDN + 25% RDN [VC, PM & FYM (1:1:1)]	0.83	4.03	3.3	7.12	9.32	4.96	0.217	0.12	0.08
SEm±	0.01	0.06	0.12	0.10	0.07	0.05	0.008	0.020	0.010
C.D. @5%	0.02	0.19	0.35	0.30	0.22	0.16	NS	NS	NS

Table 3 Effect of integrated nitrogen management on yield attributes and yields of mustard

Treatment	Siliqua Length (cm)	No. of Siliquae per Plant	No. of Seeds per Siliqua	Test Weight (g)	Seed Yield (q/ha)	Straw Yield (q/ha)	Biological Yield (q/ha)	Harvest Index (%)
T_1-Control	5.4	231.98	12.32	5.41	13.45	33.73	47.18	33.41
T_2-100% RDN (120 kg. N/ha)	5.59	251.27	13.38	5.66	19.66	45.89	65.55	36.22
T_3-75% RDN + 25% Vermicom post (VC)	5.86	261.84	14.15	5.87	27.62	48.58	76.20	37.07
T_4-75% RDN + 25% Poultry Mannure (PM)	5.98	266.39	14.3	5.97	28.49	50.61	79.10	37.66
T_5-75% RDN + 25% Farm Yard Manure (FYM)	5.77	256.52	13.45	5.78	24.13	47.24	71.37	36.29
T_6-75% RDN + 25% RDN [VC & PM (1:1)]	6.54	291.32	15.69	6.44	37.83	57.78	95.61	39.44
T_7-75% RDN + 25% RDN [VC & FYM (1:1)]	6.24	283.47	15.2	6.3	35.24	54.36	89.60	39.06
T_8-75% RDN + 25% RDN [PM & FYM (1:1)]	6.36	286.94	15.31	6.38	36.59	55.61	92.20	39.19
T_9-75% RDN + 25% RDN [VC, PM & FYM (1:1:1)]	6.75	296.76	16.38	6.72	40.84	59.92	100.76	39.52
SEm±	0.24	4.08	0.23	0.12	1.68	2.39	3.14	1.55
C.D. @5%	0.72	12.23	0.70	0.36	5.05	7.16	9.40	NS

Conclusion

Integrated nitrogen management significantly improved growth traits, leaf area development, physiological parameters, and yield performance of mustard. The treatment T9 (75% RDN + 25% N from VC+PM+FYM in 1:1:1 ratio) was the most effective, recording the highest values across all parameters, including seed yield (40.84 q ha^{-1}). This study suggests that integrating organic sources with reduced chemical nitrogen can enhance mustard productivity while improving soil health and reducing dependency on chemical fertilizers.

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