

Effect of Integrated Nutrient Management (INM) Modules on yield, yield attributes and profitability of Indian mustard [*Brassica juncea* (L.)] in Western U.P.

Abstract

A field experiment was conducted to study the effect of integrated nutrient management (INM) modules on Indian mustard (*Brassica juncea* L.) in Western U.P., variety Pusa Vijay at Crop Research Centre (CRC), Main Campus, Modipuram Meerut, during Rabi season, 2020-21. The soil of experimental field was sandy loam texture, alkaline in nature with pH (8.25), low in organic carbon (0.42%) and available nitrogen (181.60 kg/ha), available phosphors (16.50 kg/ha), available potassium (230.47 kg/ha) and available sulphur (7.38 kg/ha). Ten treatments of different nutrient management practices consisting T₁ Control, T₂ 100% RDN (120 kg N/ha), T₃ 75% RDN, T₄ 75% RDN + 25% through Vermicompost (VC), T₅ 75% RDN + 25% through Poultry Manure (PM), T₆ 75% RDN + 25% through Press Mud Compost (PMC), T₇ 75% RDN + 25% through [VC, PM (1:1)], T₈ 75% RDN + 25% through [VC, PMC (1:1)], T₉ 75% RDN + 25% through [PM, PMC (1:1)], T₁₀ 75% RDN + 25% through [VC, PM, PMC (1:1:1)] were tested in randomized block design with three replications. The experimental results revealed that yield attributes (siliqua length, siliqua plant⁻¹, seeds siliqua⁻¹ and test weight), yield (grain and stover), The increment in seed yield with application of 75% RDN + 25% through [VC, PM, PMC (1:1:1)] was 130.98 % over control. The Maximum gross return and net return were recorded with the application of 75% RDN + 25% through [VC, PM, PMC (1:1:1)], however B:C ratio was lower than the use of RDF only but in application of vermicompost, press mud compost and poultry manure improved the physio-chemical properties of soil which may improve the sustainability of production system.

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Comment [H2]: Where is the data on soil physico-chemical properties?

Key words: Integrated Nutrient Management (INM) Modules, Yield, Yield attributes, Profitability

1. INTRODUCTION

Rapeseed and mustard are the major Rabi oilseed crops of India and stand next to groundnut in the oilseed economy, it is an important oilseed crops of the family Cruciferae and occupy a prominent place among the leading oilseed crops being next to groundnut both in area and production, meeting the fat requirement of about 50 per cent population in the state of Uttar Pradesh, Punjab, Rajasthan and Assam. Oilseeds, the second largest agricultural commodity after cereals in India, play a significant role in India's agrarian economy, sharing 14% of the gross cropped area and accounting for nearly 1.5% of the gross national production and 8% of the value of all agricultural products. The gap in supply is being met through huge imports costing more than Rs. 26000 crores during 2009-10 (Hegde and Sudhakara, 2011). It is cultivated over an area of about 65.17 lakh hectares with production of 57.4 lakh tonnes of seed in India. The average yield of mustard is 1234 kg/ha in 2014-15 and it is cultivated over an area of about 5.8 million hectare with production 6.3 million tons in 2014-2015 In India. In Uttar Pradesh, mustard is grown on 0.82 million hectare area with production of 0.90 million tones and productivity of 1141 kg/ha. (Anonymous, 2015). Identification of the critical inputs to enhance the mustard production is need of hour. Apart from improved varieties and judicious irrigation, use of balanced fertilizers is critical for realizing higher yield. Indian soils are becoming deficient in N, P, and K along with S, Zn, and B due to intensive cultivation and use of high analysis fertilizers.

Under such situation organic manures can be exploited to boost the soil health condition vis-à-vis production of crops and to improve fertilizer use efficiency. Nitrogen is the most important nutrient, which determines the growth of the mustard crop and increases the amount of protein and yield. Phosphorus and potash are known to be efficiently utilized in the presence of nitrogen. It promotes flowering, setting of siliqua and increase the size of siliqua and yield (Singh and Meena, 2004). Balanced combination of FYM, biofertilizers and chemical fertilizers facilitate profitable and sustainable production (Singh and Sinsinwar, 2006). The integrated plant nutrient management is maintenance or adjustment of soil fertility and plant nutrient supply to an optimum level for sustaining desired crop production through optimization of benefits from all possible sources of plant nutrients. Various sources of plant nutrients such as organic manures, fertilizers and bio-fertilizers were even though applied in mustard in an integrated manner (Chand, 2007). Fertilizers are very important sources of plant nutrients for increasing agricultural production. The mineral fertilizer could supply one or two nutrients but integrated use of macro- and micro-nutrient fertilizers and organic residues would provide N, P, K, S, Zn, Fe and B to plant and soil and resist occurrence of multiple nutrient deficiencies. The role of organic fertilizers in plant nutrition is now attracting the attention of agriculturists and soil scientists throughout the world. If sufficient quantity of organic manures is added along with mineral fertilizers then perhaps there would be no need of adding micro-nutrients (Prasad *et al.*, 2009).

Comment [H3]: It is confusing specify the nutrient.

Comment [H4]: Restructure the sentence to make it meaningful.

The purpose of the current study was to investigate the response of Indian mustard (*Brassica juncea* (L.) ~~for in terms of their~~ yield, yield attributes and profitability under different integrated nutrient management modules in Western Uttar Pradesh.

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Material and method

The field experiment was conducted at CRC farm of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.)-located in Indo-Gangetic plains of Western Uttar Pradesh. Meerut lies on national highway 58 and is at a distance of 70 km from Delhi. The weekly mean maximum temperature during crop growing period varied between 34.4⁰C to 18.2⁰C, whereas the mean minimum temperature was between 5.9⁰C to 20.7⁰C. The area receives mean annual rainfall of 845 mm, of which more than 80% is received in the month of July- September through south-west monsoon. The mean relative humidity during crop period varied between 94.8 to 26.5 per cent. Before sowing of mustard, soil samples to a depth of 0-15 cm were taken randomly from 10 places in the experimental field. The collected samples were mixed homogenously and a composite soil sample was drawn, air dried, powdered and allowed to pass through 2 mm sieve for analyses of soil physical and chemical properties. The soil of experimental site was sandy loam in texture, low in available nitrogen and organic carbon, medium in available phosphorus and potassium and slightly alkaline in reaction. The predominant soil at the experimental site is classified as *Typic Ustochrept* with sandy-loam texture having pH 7.4, bulk density 1.49 g/cm³, low organic carbon content (0.42%), Soil samples for 0–15 cm depth at the site were collected and tested prior to applying treatments and the basic properties were low available nitrogen, low organic carbon, available phosphorus, available potassium medium and alkali in reaction. The gross and net plot size were 5.1 x 4.3 m² and 4.1 x 2.7 m², respectively. In order to find out the best nutrient treatment in mustard, field investigation was carried out with ten treatments. Experiment was laid out randomized block design with three replications. Ten nutrient management treatments (T₁) Control, (T₂) 100% RDN (120 kg- N/ha), (T₃) 75 % RDF, (T₄)

75% RDN + 25% through Vermicompost (VC), (T₅) 75% RDN + 25% through Poultry Manure (PM), (T₆) 75% RDN + 25% through Press Mud Compost (PMC), (T₇) 75% RDN + 25% through [VC , PM (1:1)], (T₈) 75% RDN + 25% through [VC , PMC (1:1)], (T₉) 75% RDN + 25% through [PM , PMC (1:1)], (T₁₀) 75% RDN + 25% through [VC , PM, PMC (1:1:1)] were used for the experimentation. Plant-to-plant distance was maintained ~ 45 cm in a row spacing of 15 cm. NPK was applied 120, 60, 40 kg/ha at the time of seed bed preparation as per recommendation. To ensure proper germination, field was prepared after *pre-sowing* irrigation and subsequent irrigation was given as per requirement. Economics of treatments was computed on the basis of prevailing market price of inputs and outputs under each treatment. The total cost of cultivation of crop was calculated on the basis of different operations performed and materials used for raising the crop including the cost of fertilizers and seeds. The cost of labour incurred in performing different operations was also included. Statistical analysis of the data was done as per the standard analysis of variance technique for the experimental designs following SPSS software based programme, and the treatment means were compared at $P < 0.05$ level of probability using t-test and calculating CD values.

Comment [H5]: Recheck? Is it row to row distance 15 cm and plant to plant 45 cm?

Result and discussion

Yield attributes

The maximum length of siliqua (6.15 cm) was recorded in T₁₀ (75% RDN + 25% through [VC , PM, PMC (1:1:1)]) treatment, which remained statistically at par with T₉ (75% RDN + 25% through [PM, PMC (1:1)]) treatment but significantly higher than rest of the treatments. The minimum (4.21 cm) length of siliqua was noted in T₁ (control) treatments. Number of siliqua plant⁻¹ ranged from 175.30 to 318.70 under different treatments. The maximum number of siliqua plant⁻¹ (318.70) was recorded in T₁₀ (75% RDN + 25% through [VC, PM, PMC (1:1:1)], which was significantly at par with T₉ but T₇ superior than rest of the treatments. The treatments T₁₀ (318.70) recorded 81.80% more number of siliqua plant⁻¹ than control was noticed in T₁ (control).

Comment [H6]: Write as per the data given in Table 1. From CD value T10 is at par with T9 and T7. Rewrite the sentence.

The maximum number of seed siliqua⁻¹ (11.40) was found in T₁₀ (75% RDN + 25% through [VC, PM, PMC (1:1:1)], which was significantly superior to rest of the treatments. The treatment T₁₀ (11.40) recorded 52.00% more number of seed siliqua⁻¹. The minimum number of seed siliqua⁻¹ was noticed in T₁ (control).

Table 1 Effect of Integrated Nutrient Management (INM) Modules on length of siliqua (cm), siliqua plant⁻¹, seed siliqua⁻¹ and 1000 seed weight yield attributes of mustard

S.No.	Treatments	Length of siliqua (cm)	No. of siliqua plant ⁻¹	Seed siliqua ⁻¹	1000 seed weight (g)
T ₁	Control	4.21	175.30	7.50	4.15
T ₂	100% RDN (120 kg- N/ha)	4.85	209.89	9.65	4.55
T ₃	75% RDN	4.56	205.10	8.75	4.25
T ₄	75% RDN + 25% <u>through</u> Vermicompost (VC)	5.06	241.66	9.86	4.63
T ₅	75% RDN + 25% <u>through</u> Poultry Manure (PM)	5.65	296.60	10.11	4.90

T ₆	75% RDN + 25% through Press Mud Compost (PMC)	5.36	262.40	9.90	4.72
T ₇	75% RDN + 25% t through [VC , PM (1:1)]	5.88	309.83	10.23	4.94
T ₈	75% RDN + 25% t through [VC, PMC (1:1)]	5.52	285.50	9.96	4.78
T ₉	75% RDN + 25% t through [PM , PMC (1:1)]	6.03	315.69	10.35	5.16
T ₁₀	75% RDN + 25% t through [VC , PM, PMC (1:1:1)]	6.15	318.70	11.40	5.25
	SEm ±	0.08	3.51	0.11	0.06
	CD (P= 0.05)	0.25	10.51	0.32	0.18

Test weight ranged from 4.15 to 5.25 g under different treatments. ~~The maximum test weight (5.25 g) was recorded in T₁₀ (75% RDN + 25% Through [VC , PM, PMC (1:1:1)] , which was statistically at par with T₉ (75% RDN + 25% Through [PM, PMC (1:1)]) but T₁₀ 75% RDN + 25% ~~t~~Through [VC , PM, PMC (1:1:1)] is significantly superior over rest of the treatments except T₉ (75% RDN + 25% Through [PM, PMC (1:1)]).~~ Similar results have also been reported by Mishra (2003), Premi *et al.* (2005) and Kumawat *et al.* (2014).

Comment [H7]: Write the possible reason why T10 performed better than other treatments.

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Yield (q ha⁻¹)

The maximum seed yield (21.25 q ha⁻¹) was recorded in T₁₀ (75% RDN + 25% ~~t~~through [VC , PM, PMC (1:1:1)]) followed by T₉ (75% RDN + 25% ~~t~~through [PM, PMC (1:1)]). The seed yield obtained in T₁₀ treatments was 130.98 per cent higher than T₁. ~~s~~Stover yield ranged from 39.40 to 70.90 q ha⁻¹ under different treatments. The maximum ~~s~~Stover yield (70.90 q ha⁻¹) was recorded in T₁₀ (75% RDN + 25% Through [VC , PM, PMC (1:1:1)]) followed by T₉ (75% RDN + 25% Through [PM, PMC (1:1)]) which was 79.95 percent higher than T₁. ~~The M~~minimum ~~s~~Stover yield (39.40 q ha⁻¹) was noticed in T₁ (control).

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Table 2 Effect of Integrated Nutrient Management (INM) Modules on ~~seed, stover, biological~~ yield and harvest index (q ha⁻¹) of mustard

S.No.	Treatments	Seed Yield (q ha ⁻¹)	Stover yield (q ha ⁻¹)	Biological yield (q ha ⁻¹)	Harvest Index (%)
T ₁	Control	9.20	39.40	48.40	19.01
T ₂	100% RDN (120 kg N/ha)	14.65	57.93	72.58	20.65
T ₃	75% RDN	12.96	53.14	66.10	19.61
T ₄	75% RDN + 25% Vermicompost (VC)	17.95	65.75	83.70	21.44
T ₅	75% RDN + 25% Poultry Manure (PM)	18.72	66.18	84.90	22.05
T ₆	75% RDN + 25% Press Mud Compost (PMC)	18.32	62.78	84.10	20.78
T ₇	75% RDN + 25% Through [VC , PM (1:1)]	18.98	66.09	85.07	22.31
T ₈	75% RDN + 25% Through [VC, PMC (1:1)]	18.45	65.86	84.31	21.88

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Comment [H9]: Change the name of the treatments as per commented in Table 1

T ₉	75% RDN + 25% Through [PM , PMC (1:1)]	20.40	67.85	89.10	22.89
T ₁₀	75% RDN + 25% Through [VC , PM, PMC (1:1:1)]	21.25	70.90	92.15	23.06
	SEm ±	0.20	0.96	0.85	0.37
	CD (P= 0.05)	0.61	2.88	2.54	1.10

The maximum biological yield (92.15 q ha⁻¹) was recorded in T₁₀ 75% RDN + 25% Through [VC , PM, PMC (1:1:1)], which was 90.39 percent higher than T₁. The minimum biological yield (38.69 q ha⁻¹) was found in T₁ (control). The maximum harvest index recorded was in the treatment T₁₀ 75% RDN + 25% Through [VC , PM, PMC (1:1:1)] followed by treatment T₉ 75% RDN + 25% Through [PM, PMC (1:1)]. All these treatments T₉, T₇ and T₅ were significantly at par as compare to with T₁₀. The minimum harvest index percent was noticed in T₁ (control). Similar results have also been reported by Tripathi *et al.* (2010), Kumar *et al.* (2011), Singh *et al.* (2012) and Neha *et al.* (2014)

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Comment [H10]: Write down the possible reason for increased yield under T10.

The maximum oil content in grain (40.58%) was found in T₁₀ (75% RDN + 25% Through [VC , PM, PMC (1:1:1)]), which was 26.02 percent highest than T₁ and remained statistically higher than all of the other treatments except treatment T₇ and T₉. The minimum oil content in grain (32.20%) was recorded in T₁ (Control).

Comment [H11]: Give separate heading and then start the result and discussion for oil content and protein content. It may be placed after Table 3.

Table 3 Effect of Integrated Nutrient Management (INM) Modules on oil content and protein content (%) of mustard

S.No.	Treatments	Oil content (%)	Protein content (%)
T ₁	Control	32.20	16.78
T ₂	100% RDN (120 kg. N/ha)	37.45	17.18
T ₃	75% RDN	34.50	17.00
T ₄	75% RDN + 25% Vermicompost (VC)	37.60	17.35
T ₅	75% RDN + 25% Poultry Mannure (PM)	38.70	17.78
T ₆	75% RDN + 25% Press Mud Compost (PMC)	38.10	17.43
T ₇	75% RDN + 25% Through [VC , PM (1:1)]	38.98	18.20
T ₈	75% RDN + 25% Through [VC, PMC(1:1)]	38.42	17.56
T ₉	75% RDN + 25% Through [PM , PMC (1:1)]	39.30	18.30
T ₁₀	75% RDN + 25% Through [VC , PM, PMC (1:1:1)]	40.58	18.58
	SEm ±	0.58	0.26
	CD (P= 0.05)	1.74	0.77

Comment [H12]: Change name of the treatments and the mistakes as per comments in Table 1

The protein content in grain was significantly affected by different treatments and ranged from 16.78 to 18.58% under different treatments. The maximum protein content in grain (18.58%) was found in (T₁₀) 75% RDN + 25% Through [VC , PM, PMC (1:1:1)] which was 10.73 percent higher than T₁ and remain higher than all other treatments except

treatments T₁ and T₉ where as the minimum ~~p~~Protein content in grain (16.78%) was recorded in T₁ (Control). Similar results have also been reported by Kumar *et al.* (2011) and Singh *et al.* (2012).

Comment [H13]: How? See the CD value and then write results

Comment [H14]: Briefly explain the similarity with your findings.

Economics

The maximum gross return (Rs. 108211) was obtained in T₁₀ - 75% RDN + 25% ~~t~~Through [VC , PM, PMC (1:1:1)] followed by T₈ (Rs 103840). The minimum gross return was found (Rs. 48590) was found in T₁ (control plot). The maximum net return (Rs. 72453) was obtained in T₁₀ -75% RDN + 25% ~~t~~Through [VC , PM, PMC (1:1:1)] followed by T₉ (Rs. 70636). The minimum net return was found (Rs. 25689) was found in T₁ (control plot).

Table 4. Effect of Integrated Nutrient Management (INM) Modules on ~~cost of cultivation,~~ gross income, net income and benefit cost ratio ~~economics~~ of mustard

S.No.	Treatments	Cost of cultivation (Rs. ha ⁻¹)	Gross returns (Rs. ha ⁻¹)	Net return (Rs. ha ⁻¹)	B: C ratio
T ₁	Control	22901	48590	25689	1.12
T ₂	100% RDN (120 kg. N/ha)	28992	80012	51020	1.76
T ₃	75% RDN	28800	67976	39176	1.36
T ₄	75% RDN + 25% Vermicompost (VC)	42875	92578	49703	1.16
T ₅	75% RDN + 25% Poultry Mannure (PM)	31652	96071	64419	2.03
T ₆	75% RDN + 25% Press Mud Compost (PMC)	34146	93622	59476	1.74
T ₇	75% RDN + 25% Through [VC , PM (1:1)]	37263	97204	59941	1.61
T ₈	75% RDN + 25% Through [VC, PMC (1:1)]	37319	103840	57715	1.55
T ₉	75% RDN + 25% Through [PM , PMC (1:1)]	33204	95034	70636	2.12
T ₁₀	75% RDN + 25% Through [VC , PM, PMC (1:1:1)]	35758	108211	72453	2.03
	SEm ±	-	-	-	-
	CD (P= 0.05)	-	-	-	-

Comment [H15]: Change name of the treatments and the mistakes as per comments in Table 1

The highest benefit cost ratio (2.12) was recorded in T₉ 75% RDN + 25% ~~t~~Through [PM, PMC (1:1)] and the lowest benefit cost ratio (1.12) -was found (~~1.12~~) in T₁ (control). Similar results have also been reported by Poornima *et al.* (2010), Tripathi *et al.* (2010), Verma *et al.* (2012) and Rohit *et al.* (2019).

Conclusion

On the basis of results obtained from the current study, it may be concluded that the application of only RDF fertilizers is not capable of exploiting the potential of the *Brassica juncea* L. in sustainable manner. Therefore, ~~in~~ addition of supplementary nutrients like Vermicompost, Poultry manure and Pressmud compost are essential to get ~~the~~ higher production and productivity. ~~Thus, the~~ In the present study, combination of 75% RDN + 25% ~~through~~ [VC , PM, PMC (1:1:1)] found to be more promising for boosting the productivity and profitability of mustard in sustainable way by Improving the physico-chemical condition of the soil. For the confirmation of present findings the experiment need to be repeated for few more years to draw definite conclusion.

Comment [H16]: Write the cultivar also

Comment [H17]: Sustenance can not be judged in one season. So better you can delete the highlight test. Further, if possible give the soil data, so that improvement in soil physic-chemical data can be observed.

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