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EFFECT OF INTEGRATED NUTRIENT MODULES ON PRODUCTIVITY AND PROFITABILITY OF MUSTARD

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ABSTRACT

A field experiment was conducted during the *rabi* season of 2022-23 to evaluate the effect of vermicompost and poultry manure in combination with recommended dose of fertilizers on the yield attributes, yield and profitability of mustard crop at Agronomy Research Farm of Nirwan University, Jaipur, Rajasthan. The experiment was laid out in randomized complete block design with ten treatments and three replications. The results revealed that combined application of chemical fertilizer (75% of recommended dose of nitrogen) and organic fertilizers (vermicompost, poultry manure and press mud) gave significantly higher yield attributes and yield for mustard crop. The integrated approach resulted in 56.7% and 31% increase in the seed yield as compared to control and sole application of chemical fertilizer, respectively. In economic terms, highest net returns of INR 72453 and INR 70636 were recorded under treatments where chemical fertilizers were applied along with organic fertilizers. The present study concludes that integrated fertilizer application improved the productivity and profitability of the mustard crop.
***Keywords*:** Integrated, manures, organic nutrient sources, oilseed.

Introduction

Rapeseed and mustard have great value at global level as edible oilseed being third most important after soybean and palm. At World level, rapeseed and mustard is cultivated over an area of 39.96 million hectares with a production of around 87.22 million tons (FAOSTAT, 2024). Similarly, Rapeseed and mustard is an important oilseeds crop in India. It secures unique position in Indian farming system with an impressive acreage next to food seeds. Despite having a wide area under cultivation with 7.99 million hectares and production of around 11.96 million tons, India is still facing a severe shortage of edible oil with average productivity lagging critically with productivity of around 1497 kg/ha against world average productively levels of 2182.4 kg/ha (FAOSTAT, 2024).

Generally, oilseed crops are raised under rainfed conditions with low input and poor management practices leading to lower productivity level. Moreover, worsening conditions due to climate change have presented a critical constraint to sustain crop productivity (Mrabet *et al.*, 2022; Mrabet *et al.*, 2023). Imbalanced nutrition is one of the important constraints toward higher mustard productivity, oil content and other quality parameters. In present agriculture scenario use of chemical fertilizer is increasing to boost up crop production (Sharma *et al.*, 2024). Simultaneously, cost of chemical fertilizer is increased constantly, besides these, indiscriminate use of inorganic fertilizers is injurious to soil health and soil productivity.

Application of chemical fertilizers along with organic manures are necessary to improve the soil health. The nutrients supply to crops through INM not only restores the soil fertility but also sustain desired level of production over the years. The key component of the INM is to decrease the enormous use of chemical fertilizers and accelerating a balance between fertilizer inputs and crop nutrient requirement, optimizing the level of yield, maximizing the profitability, and subsequently reducing the environmental pollutions (Chauhan *et al*., 2024). Yield potentials of the crop, can be maximized by balanced and efficient use of organic and inorganic sources of nutrient (Sharma *et al*., 2023).

Therefore, there is a great scope for increasing the production of mustard by enhancing mustard productivity with integrated application of organic manures (vermicompost) with balanced inorganic fertilization (Sharma *et al*., 2021; Sharma *et al*., 2024). Keeping in consideration the potential of integrated nutrient management practices in enhancing the productivity of mustard, the present field investigation was carried out with objectives to study the effect of integrated application of nutrient management modules on yield attributes, yield and profitability of mustard.

Material and Methods

The experiment was conducted during *Rabi* 2022-23 at Agronomy Farm, School of Agricultural Sciences, Nirwan University, Jaipur. The soils of experimental field were loamy sand, belonging to *chomu* series. Before initial of field experiment, a composite soil sample was collected from a soil depth of 0-15 cm using stainless steel auger to determine physio-chemical soil properties. Results of the physical and chemical analysis revealed that the soil of the experimental field was loamy sand in texture and slightly alkaline in reaction. The soil was poor in organic carbon, low in available nitrogen and phosphorus but medium in available potassium. The field preparation involving ploughing and harrowing was carried out on 12.10.2024 whereas the crop sowing was carried out on 20.10.2024. The present experiment was conducted in randomized complete block design with ten treatments (Table 1) which were replicated thrice. The treatments were randomly allocated in experimental plots having gross size of 5.1 X 4.5 m and net size of 4.10 m X 2.7 m. The crop was sown with a row spacing of 45 cm and plant spacing of 15 cm. The harvesting and threshing were carried out on 11.3. 2024 and 16.3.2024, respectively. The mustard variety used was "Pusa Vijay". The fertilizer application was carried out on 20.10.2024 wherein half dose of nitrogen, full doe of phosphorus, potassium and sulphur were applied as basal dose whereas the top dressing of nitrogen (50% of remaining nitrogen) was carried out on 25.11.2023. The yield attributes such as siliqua length, number of siliquae per plant, seeds per siliqua and test weight were recorded using randomly tagged plants for observations. The seed and stover were recorded using standard protocols whereas biological yield was derived as the sum of seed and stove yield. The profitability indicators such as gross, net returns and benefit cost ratio were derived using below given equations. The treatment details are given as:

Table 1: Details of treatment

Treatment	Notation
Control	T_1
100% RDN (120 kg N ha^{-1})	T_2
75% RDN (Recommended dose of Nitrogen)	T_3
75% RDN + 25% Vermicompost (VC)	T_4
75% RDN + 25% Poultry Manures (PM)	T_5
75% RDN + 25% Press Mud Compost (PMC)	T_6
75% RDN + 25% Through [VC, PM (1:1)]	T_7
75% RDN + 25% Through [VC, PMC (1:1)]	T_8
75% RDN + 25% Through [PM, PMC (1:1)]	T_9
75% RDN + 25% Through [VC, PM, PMC (1:1:1)]	T_{10}

Data analysis

The data presented in the present manuscript was analysed based on protocols prescribed by Gomez and Gomez in 1984 for analysis of variance (ANOVA) for randomized block design. The data was analysed at 5% level of least significant difference.

Results and Discussion

Siliqua length

The data on effect of integrated nutrient management practices on average length of siliqua (cm) of mustard is given in Table 1. A perusal of the data presented in Table 1 revealed that the length of siliqua was significantly affected by application of different sources of nutrients. The maximum length of siliqua (6.15 cm) was recorded in T_{10} (75% RDN + 25% Through [VC, PM, PMC (1:1:1)]) treatment, which remained statistically at par with T_9 (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 T_1 (control) treatments. Integrated application of nutrients through inorganic and organic sources of nutrients lead to considerable accumulation of carbohydrates in plant sink leading to considerable improvement in siliqua length of mustard. Similar findings were reported by Patel *et al.* (2023) wherein they reported considerable improvements in siliqua length of mustard with integrated application of organic and inorganic sources of nutrients.

Number of siliquae per plant

The data on effect of integrated nutrient management practices on average number of siliquae per plant of mustard is given in Table 2. The number of siliquae plant^{-1} were affected significantly by different treatments. Number of siliquae plant^{-1} ranged from 175.30 to 318.70 under different treatments. The maximum number of siliquae plant^{-1} 318.70 recorded in T_{10} (75% RDN + 25% Through [VC, PM, PMC (1:1:1)], which was significantly at par with T_9 but T_7 superior than rest of the treatments. The treatments T_{10} (318.70) recorded 81.80% more number of siliquae plant^{-1} than control was noticed in T_1 (control). Considerable improvement in number of siliquae per plant for mustard was attributed to substantial accumulation of carbohydrates in plant sink and optimized assimilation as increased siliquae number per plant under the influence of conjunctive application of organic and inorganic nutrient sources. Integrated application of organic and inorganic sources of nutrients was also found to be responsible for considerable improvement in number of siliquae per plant (Patel *et al*. 2024).

Number of seeds siliqua^{-1}

The data on effect of integrated nutrient management practices on average number of seeds per siliqua of mustard is given in Table 2. Number of seed siliqua^{-1} were affected significantly by different treatments. Number of seeds siliqua^{-1} ranged from 7.50 to 11.40 number different treatments. The maximum number of seeds siliqua^{-1} (11.40) were found in T_{10} (75% RDN + 25% Through [VC, PM, PMC (1:1:1)], which was significantly superior than rest of the treatments. The treatment T_{10} (11.40) recorded 52.00% more number of seeds siliqua^{-1}. Minimum number of seed siliqua^{-1} was noticed in T_1 (control). Increased number of seeds per siliqua can be attributed can be attributed to optimized supply of nutrients through inorganic and organic sources (Patel *et al*., 2024). Considerable improvements in number of seeds per siliqua with combined application of organic and inorganic nutrient sources was also reported by Patel *et al*. (2024).

Test weight

The data on effect of integrated nutrient management practices on test weight of mustard is given in Table 2. The test weight was affected significantly by different treatments. Test weight ranged from 4.15 to 5.25 g under different treatments. The maximum test weight (5.25 g) was recorded in T_{10} (75% RDN + 25% Through [VC, PM, PMC (1:1:1)]), which was statistically at par with T_9 (75% RDN + 25% Through [PM, PMC (1:1)] but T_{10} 75% RDN + 25% Through [VC, PM, PMC (1:1:1)] is significantly superior over rest of the treatments except T_9.

Table 2 : Effect of Integrated Nutrient Management (INM) modules on yield attributes of mustard

Treatments	Length of siliqua (cm)	No. of siliquae plant^{-1}	Seeds siliqua^{-1}	1000 seed weight (g)
T1	4.21	175.30	7.50	4.15
T2	4.85	209.89	9.65	4.55
T3	4.56	205.10	8.75	4.25
T4	5.06	241.66	9.86	4.63
T5	5.65	296.60	10.11	4.90
T6	5.36	262.40	9.90	4.72
T7	5.88	309.83	10.23	4.94
T8	5.52	285.50	9.96	4.78
T9	6.03	315.69	10.35	5.16
T10	6.15	318.70	11.40	5.25
SEm±	0.08	3.51	0.11	0.06
LSD	0.25	10.51	0.32	0.18

Seed yield

The data on effect of integrated nutrient management practices on mustard seed yield is given in Table 3. The seed yield of mustard differed significantly under the influence of different treatments. The maximum seed yield (21.25 q ha^{-1}) was recorded in T_{10} (75% RDN + 25% Through [VC, PM, PMC (1:1:1)]) followed by T_9 (75% RDN + 25% Through [PM, PMC (1:1)]. The seed yield obtained in T_{10} treatments was 130.98 percent higher than T_1. Significantly higher seed yield of mustard with the integrated application of 75% recommended dose of nitrogen and 25% based on vermicompost, poultry manure and press mud compost can be attributed to considerably higher number of siliquae per length, seeds per siliqua and siliqua length under the influence of the particular treatment. Various researchers have advocated integrated nutrient management practices to be responsible for enhancing seed yield of mustard (Ajnar and Namdeo 2021; Patel *et al.* 2024).

Stover yield

The data on effect of integrated nutrient management practices on mustard stover yield is given in Table 3. Stover yield ranged from 39.40 to 70.90 q ha^{-1} under different treatments. The maximum Stover yield 70.90 q ha^{-1} was recorded in T_{10} (75% RDN + 25% Through [VC, PM, PMC (1:1:1)]) followed by T_9 (75% RDN + 25% Through [PM, PMC (1:1)]) which was 79.95 percent higher than T_1. Minimum Stover yield 39.40 q ha^{-1} was noticed in T_1 (control). Substantially higher stover yield can be attributed to considerably higher dry matter accumulated under the influence of integrated application of organic and inorganic sources of nutrients (Ajnar and Namdeo 2021; Patel *et al*., 2024). Improved stover yield of mustard was also reported by Sharma and Singh in 2024 wherein they observed benign effect of integrated application of organic and inorganic nutrient sources over mustard stover yield.

Biological yield

The data on effect of integrated nutrient management practices on mustard biological yield is given in Table 3. The data revealed that biological yield was affected significantly by different treatments and ranged from 48.40 to 92.15 q ha^{-1} under different treatments. The maximum biological yield (92.15 q ha^{-1}) was recorded in T_{10} 75% RDN + 25% Through [VC, PM, PMC (1:1:1)], which was 90.39 percent higher than T_1. The Minimum biological yield 38.69 q ha^{-1} was found in T_1 (control). Considerably higher biological yield under the influence of the particular treatment can be attributed to significantly higher seed and stover yield for the treatment (Ajnar and Namdeo 2021; Patel *et al*., 2024; Sharma and Singh, 2024).

Harvest Index

The data on effect of integrated nutrient management practices on harvest index of mustard is given in Table 3. A perusal of the data presented in table 1 showed that the maximum harvest index recorded was in the treatment T_{10} 75% RDN + 25% Through [VC, PM, PMC (1:1:1)] followed by treatment T_9 75% RDN + 25% Through [PM, PMC (1:1)]. All these Treatment T_9, T_7 and T_5 Significantly at par as compare to T_{10}. Minimum harvest index per cent noticed in T_1 (control).

Table 3 : Effect of Integrated Nutrient Management (INM) modules on yield levels of mustard

Treatments	Seed Yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest Index (%)
T1	9.20	39.40	48.40	19.01
T2	14.65	57.93	72.58	20.65
T3	12.96	53.14	66.10	19.61
T4	17.95	65.75	83.70	21.44
T5	18.72	66.18	84.90	22.05
T6	18.32	62.78	84.10	20.78
T7	18.98	66.09	85.07	22.31
T8	18.45	65.86	84.31	21.88
T9	20.40	67.85	89.10	22.89
T10	21.25	70.90	92.15	23.06
SEm±	0.20	0.96	0.85	0.37
LSD	0.61	2.88	2.54	1.10

Gross returns

The data on effect of integrated nutrient management practices on mustard gross returns is given in Table 4. The gross return of mustard differs significantly owing to different nutrient management treatments. The maximum gross return (Rs. 108211) obtained in T_{10} - 75% RDN + 25% Through [VC, PM, PMC (1:1:1)] followed by T_8 (Rs 103840). The minimum gross return was found (Rs. 48590) in T_1 control plot.

Net returns

The data on effect of integrated nutrient management practices on mustard net return is given in Table 4. The maximum net return (Rs. 72453) obtained in T_{10} -75% RDN + 25% Through [VC, PM, PMC

(1:1:1)] followed by T_9 (Rs. 70636). The minimum net return was found (Rs. 25689) in T_1 control plot.

Benefit cost ratio

The data on effect of integrated nutrient management practices on mustard benefit cost ratio is given in Table 4. The highest benefit cost ratio (2.12) was recorded in T_9 75% RDN + 25% Through [PM, PMC (1:1)] and the lowest benefit cost ratio was found (1.12) in T_1 (control).

Table 4 : Effect of Integrated Nutrient Management (INM) modules on crop profitability

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B: C ratio
T1	22901	48590	25689	1.12
T2	28992	80012	51020	1.76
T3	28800	67976	39176	1.36
T4	42875	92578	49703	1.16
T5	31652	96071	64419	2.03
T6	34146	93622	59476	1.74
T7	37263	97204	59941	1.61
T8	37319	103840	57715	1.55
T9	33204	95034	70636	2.12
T10	35758	108211	72453	2.03

Conclusion

Based on the present field study, it was concluded that integrated application based on 75% recommended dose of nitrogen as inorganic sources and rest 25% as vermicompost, press mud compost and poultry manure can significantly improve the yield attributes, yield and profitability in a significant manner.

Conflict of interest

There is no conflict of interest among authors.

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