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

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**Authors’ contributions**

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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**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, low in organic carbon (0.42%) and available nitrogen (181.60 kg/ha), available phosphorus (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’, seeds siliqua’ and test weight), grain and stover yield (q ha ’). 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 enhance soil fertility which improve the productivity and productivity of mustard.

Keywords: 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 [1]. 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 [2]. 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 hectares 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 tonnes and productivity of 1141 kg/ha. [3]. 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. Nitrogen promotes flowering, setting of siliqua and increase the size of siliqua and yield [4]. Balanced combination of FYM, biofertilizers and chemical fertilizers facilitate profitable and sustainable production [5]. 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 applied in integrated manner to enhance the productivity of mustard crop [6]. 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 micronutrients [7].

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

2. MATERIALS AND METHODS

The field experiment was conducted at CRC farm of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (Uttar Pradesh), 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 34.4°C to 18.2°C, whereas the mean minimum temperature was between 5.9 °C to 20.7 °C. The area receives mean annual rainfall of 845 mm, of which more than 80% is 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, available phosphorus and potassium and slightly alkaline in reaction. The predominant soil at the experimental site is classified as Typic Ustochept with sandy-loam texture having pH 8.25, 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 recommended dose of nitrogen (120 kg N/ha), (T3) 75% RDN, (T4) 75% RDN + 25% through Vermicompost (VC), (T5) 75% RDN + 25% through Poultry Mannure (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, PM (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 and row to row spacing of 15 cm respectively. 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 crop 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 using t-test and calculating CD values.

3. RESULTS AND DISCUSSION

3.1 Yield Attributes

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

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).

Test weight ranged from 4.15 to 5.25 g under different treatments. T10 75% RDN + 25% through [VC, PM, PMC (1:1:1)] is significantly superior over rest of the treatments except T9 (75% RDN + 25% Through [PM, PMC (1:1:1)]). Similar results have also been reported by Mishra [8], Premi et al. [9] and Kumawat et al. [10].

3.2 Yield

The maximum seed yield (21.25 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 (1:1:1)]). The seed yield obtained in T10 treatments was 130.98 percent higher than T1, 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 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 minimum stover yield (39.40 q ha⁻¹) was noticed in T1 (control).
Table 1. Effect of Integrated Nutrient Management (INM) Modules on 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% through Vermicompost (VC)         | 5.06                   | 241.66                     | 9.86                | 4.63                  |
| $T_5$  | 75% RDN + 25% through 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% through [VC, PM (1:1)]            | 5.88                   | 309.83                     | 10.23               | 4.94                  |
| $T_8$  | 75% RDN + 25% through [VC, PMC (1:1:1)]         | 5.52                   | 285.50                     | 9.96                | 4.78                  |
| $T_9$  | 75% RDN + 25% through [PM, PMC (1:1:1)]         | 6.03                   | 315.69                     | 10.35               | 5.16                  |
| $T_{10}$ | 75% RDN + 25% through [VC, PM, PMC (1:1:1)]    | 6.15                   | 318.70                     | 11.40               | 5.25                  |

SEm ± CD (P= 0.05)

Table 2. Effect of Integrated Nutrient Management (INM) Modules on yield (q ha$^{-1}$) and harvest index (%) 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% through Vermicompost (VC)         | 17.95                    | 65.75                      | 83.70                         | 21.44             |
| $T_5$  | 75% RDN + 25% through Poultry Manure (PM)       | 18.72                    | 66.18                      | 84.90                         | 22.05             |
| $T_6$  | 75% RDN + 25% through 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 (1:1:1)]         | 18.45                    | 65.86                      | 84.31                         | 21.88             |
| $T_9$  | 75% RDN + 25% through [PM, PMC (1:1:1)]         | 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 ± CD (P= 0.05)

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). 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 (1:1:1)]. The treatments $T_9$, $T_7$ and $T_5$ were at par with $T_{10}$. 

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The minimum harvest index was noticed in T1 (control). Similar results have also been reported by Tripathi et al. [11], Kumar et al. [12], Singh et al. [13] and Neha et al. [14].

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 other treatments except treatment T7 and T9. The minimum oil content in grain (32.20%) was recorded in T1 (Control).

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)] than all other treatments except T1 and T9 respectively. The increment in protein content was 10.73 percent higher in T10 than T1. The minimum protein content in grain 16.78% was recorded in T1 (Control). Similar results have also been reported by Kumar et al. [15] and Singh et al. [13].

3.3 Economics

The maximum gross return (Rs. 108211) was obtained in T10 - 75% RDN + 25% through [VC , PM, PMC (1:1:1)] followed by T8 (Rs 103840).

| S.No. | Treatments | Oil content (%) | Protein content (%) |
|-------|------------|----------------|--------------------|
| T1    | Control    | 32.20          | 16.78              |
| T2    | 100% RDN (120 kg N/ha) | 37.45          | 17.18              |
| T3    | 75% RDN    | 34.50          | 17.00              |
| T4    | 75% RDN + 25% through Vermicompost (VC) | 37.60          | 17.35              |
| T5    | 75% RDN + 25% through Poultry Manure (PM) | 38.70          | 17.78              |
| T6    | 75% RDN + 25% through Press Mud Compost (PMC) | 38.10          | 17.43              |
| T7    | 75% RDN + 25% through [ VC , PM (1:1)] | 38.98          | 18.20              |
| T8    | 75% RDN + 25% through [VC, PMC (1:1)] | 38.42          | 17.56              |
| T9    | 75% RDN + 25% through [PM , PMC (1:1)] | 39.30          | 18.30              |
| T10   | 75% RDN + 25% through [VC , PM, PMC (1:1:1)] | 40.58          | 18.58              |
|       | Control    | 0.58           | 0.26               |
|       | 100% RDN (120 kg N/ha) | 1.74           | 0.77               |

| S.No. | Treatments | Cost of cultivation (Rs. ha⁻¹) | Gross returns (Rs. ha⁻¹) | Net return (Rs. ha⁻¹) | B: C ratio |
|-------|------------|-------------------------------|--------------------------|----------------------|------------|
| T1    | Control    | 22901                         | 48590                    | 25689                | 1.12       |
| T2    | 100% RDN (120 kg N/ha) | 28992          | 80012                    | 51020                | 1.76       |
| T3    | 75% RDN    | 28800                         | 67976                    | 39176                | 1.36       |
| T4    | 75% RDN + 25% through Vermicompost (VC) | 42875          | 92578                    | 49703                | 1.16       |
| T5    | 75% RDN + 25% through Poultry Manure (PM) | 31652          | 96071                    | 64419                | 2.03       |
| T6    | 75% RDN + 25% through Press Mud Compost (PMC) | 34146          | 93622                    | 59476                | 1.74       |
| T7    | 75% RDN + 25% through [ VC , PM (1:1)] | 37263          | 97204                    | 59941                | 1.61       |
| T8    | 75% RDN + 25% through [VC, PMC (1:1)] | 37319          | 103840                   | 57715                | 1.55       |
| T9    | 75% RDN + 25% through [PM , PMC (1:1)] | 33204          | 95034                    | 70636                | 2.12       |
| T10   | 75% RDN + 25% through [VC , PM, PMC (1:1:1)] | 35758          | 108211                   | 72453                | 2.03       |
|       |             | SEM ±                         | CD (P= 0.05)             | -                    | -          |
The minimum gross return (Rs. 48590) was found in $T_1$ (control plot). The maximum net return (Rs. 72453) was obtained in $T_{10}$ -75% RDN + 25% through [VC, PM, PMC (1:1:1)] followed by $T_9$ (Rs. 70636). The minimum net return (Rs. 25689) was found in $T_1$ (control plot).

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 (1.12) was found in $T_1$ (control). Similar results have also been reported by Poonima et al. [16], Tripathi et al. [11], Verma et al. [17] and Rohit et al. [18].

4. 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, addition of supplementary nutrients like Vermicompost, Poultry manure and Pressmud compost are essential to get higher production and productivity. In the present study, the 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. For the confirmation of present findings the experiment need to be repeated for few more years to draw definite conclusion.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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