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# Integrated nutrient management on growth and yield of mustard (*Brassica juncea* L.) in central alluvial tract of Uttar Pradesh

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**Abstract**
A field experiment was conducted during *Rabi* season 2023-24 as carried out at Agricultural farm of Rama University, Mandhana, Kanpur. Nine treatments were tested in three replicated Randomized Block Design. Result found that significantly better growth and yield attributes and grain yield (18.89 q/ha) was obtained with treatment $T_6$ 75% RDF + 2.5 t/ha vermicompost + PSB over rest of the treatments. The minimum grain yield (10.05q/ha) was received in treatment $T_1$ control (RDF 3:2:1 NPK). The application of 75% RDF + 2.5 t/ha vermicompost + PSB was also found significantly higher gross income (Rs 79432) and net profit (Rs45331) over rest of the treatments. While Benefit: Cost ratio was significantly higher (1.32) with application of 75% RDF + 2.5 t/ha vermicompost + PSB over rest of the treatments. The minimum gross income (Rs 42273) was received in treatment $T_1$ control (RDF 3:2:1 NPK) while the minimum net income and B: C ratio was found in treatment $T_1$ control RDF 3:2:1 NPK).

**Keywords:** Growth attributes, grain yield, integrated nutrient management, economics

## Introduction
Mustard [*Brassica juncea* (L.)] is important *Rabi* oilseed crop which belongs to family "Cruciferae". The oil content in mustard seeds varies from 37-49 percent (Bhowmik *et al*., 2014) [18], the seeds are highly nutritive containing 38-57% erucic acid, and 27% oleic acid. The oil cake left after extraction is utilized as cattle feed and manure containing 5.1% N, 1.8% $P_2O_5$ and 1.1% $K_2O$. This is a potential crop in winter *(Rabi*) season due to its wider adaptability and suitability to exploit residual moisture (Mukherjee, 2010) [8].

Adoption of appropriate nutrient management strategy hold a great potential in boosting the field of mustard in a suitable manner. Therefore, integrated nutrient management crucial not only for increasing the yield but also for the improvement of soil health. Rapeseed mustard crops are economically important as source of edible oil in human diet. In India area, production, productivity was 8.5 million hectares, 12.6 million tonnes and 1490 kg/ha, respectively during 2023-24 (DA&FW).

India is one of the largest oilseeds producing country that covers one fifth of the entire area under this group of crops and also yields one-fifth of the total oilseed production in the world. Globally, rapeseed mustard is grown by more than sixty nations including India. In terms of average yield, India (1490 kg/ha) below the world average yield (1990 kg/ha) of rapeseed and mustard. In India, it is cultivated by more than 26 states (including Union Territories) with Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana and West Bengal being that major player in terms of area and production of rapeseed-mustard (DRMR (2020) and DOD (2020).

Integrated nutrient management (INM) is an approach in which inorganic and organic manures applied together to improve the soil fertility. Integrated nutrient management is vital for sustainable productivity (Verma *et al*., 2010) [19] but also improves soil physical, chemical and biological properties there by prevent environmental degradation. Balanced nutrient application through combined use of inorganic fertilizers, organic manures and bio-fertilizers makes possible profitable and sustainable crop production and also maintain soil properties.

As organic manures is not only supply the nutrient to the plant but also they act as soil conditioner and improves soil fertility. In concept of the INM, organic manure used as a complementary for the improvement of the soil. Several studies showed that the beneficial effect of INM on crop and soil productivity. However, these studies mostly concentrated on the single crops and dearth of literature on the cropping system mode in general particularly for pulse and oilseed based cropping system.

## Materials and Methods

The field experiment was carried out during *Rabi* season of 2023-24 at the Agricultural Research Farm of Rama University Kanpur. The soil was sandy loam of the experimental field having organic carbon 0.32%, total nitrogen 139.9 kg /ha, available $P_2O_5$ 15.56 kg/ha, available $K_2O$250.25 kg/ha, pH 8.23, E. C.-0.34 ds/m, field capacity 20.70%, porosity 46.03%, particle density 2.52 g/cc, bulk density 1.36 g/cc. The 9 treatments *viz*: $T_1$: control (3:2:1 NPK), $T_2$: 75% RDF, $T_3$: 100% RDF, $T_4$: 75% RDF+PSB, $T_5$: 75% RDF + 2.5 t/ha vermicompost, $T_6$: 75% RDF + 2.5 t/ha vermicompost + PSB, $T_7$: 100% RDF + PSB, $T_8$: 100% RDF + 2.5 t/ha vermicompost, $T_9$: 100% RDF + 2.5 t/ha vermicompost + PSB, were replicated three times in Randomized Block design. Vermicompost and PSB together and applied according to the treatment by broadcasting in experimental field and soil mixed properly by hand based on treatments required one day before sowing. Line sowing done by hand. The mustard variety used for sowing was Varuna (T-59). Spacing 45 cm row to row and 15cm plant to plant, seed rate used 5kg /ha, mustard sowing date 20-10-23. The nitrogen phosphorus and potassium were applied through Urea, SSP and MOP @ 80, 40, 20 kg/ha, respectively as per experiment. The half quantity of N, full quantity of $P_2O_5$andfull quantity of $K_2O$ was applied as basal dos. Remaining half dose of N is applied as top dressing in two split doses ½ one day before irrigation and ½ after 2nd irrigation.Two irrigation were applied, first irrigation 25 DAS and second at 30 DAS. The simultaneous thinning and weeding by manual labour was done 20 DAS, during the experiment average temperature ranged between maximum 35.8 °C and minimum 5.1 °C, the average relative humidity ranged between 67% to 96%, the crop is harvested at physiological maturity on 26-03-24.

## Results and Discussion

Growth of plant can be measured vertically in terms of plant population, plant height, number branches plant-1 and horizontally in terms of dry matter accumulation etc. The data pertaining to plant population at 30 days after sowing of mustard as affected by different nutrients management levels have been presented in Table 1. Varying levels of nutrients had not significant effect on the plant population at 30 DAS of mustard crop, however maximum number of plants population found with the treatment $T_6$ -$T_9$ respective years 2023-24. Although the lowest plant population were found with the treatment $T_1$ Control (RDF+ NPK-3:2:1) years, respective. At 60 DAS and at the harvest stage the plant height of mustard crop is presented in table 2. Plant height increased progressively with increase in duration of mustard crop. Crop growth rate was maximum up to 60 DAS and thereafter, a slow increase in growth was obtained up to harvest. The plant height was significantly influenced by the various INM. The maximum plant height at 30 DAS and 60 DAS, was recorded with treatment $T_6$-$T_7$ and at harvest tallest plant height was recorded under the treatment $T_8$ - $T_4$. It was significantly superior with $T_8$ and statistically at par rest over the treatments the minimum plant height at all the stages was recorded in the treatment $T_1$- Control (RDF+NPK). However, higher plant height at $T_6$ was due to lower weed density during initial stage which was critical period of crop life cycle Similar finding were also reported by (Mukherjee *et al.* 2014,) [9]. Therefore, no more competition between crop was observed for nutrients, moisture, space and (Gupta *et al.* 2019) [4]. The number of branches plant$^{-1}$ was significantly influenced by various INM at all the growth stages except 30 DAS during the years (Table 3). The maximum numbers of branches plant-1at 60 DAS were recorded under the treatment $T_4$-$T_9$. The minimum number of branches was recorded in the control $T_1$ (RDF+NPK) treatment at all the stages. INM practices increased the uptake of nutrients which had possibly contributed to more vegetative growth. The favourable synthesis of growth promoting constituents in plant system owing to better supply of nutrients. Resulted in higher number of branches. The results are in conformity with those of (Tetarwal *et al*. 2013 and Gupta *et al*. 2019) [15, 4]. The maximum dry matter accumulation plant-1 at all the growth stages except 30 DAS. Besides treatment $T_6$-$T_9$ which was significantly superior over rest of the treatment in 2023-24, It also moderates soil temperature which results in reduced number of irrigations (Dubey, 2018, Pandey *et al*. 2019) [3, 10]. At 60 DAS and harvest stage the highest dry matter accumulation plant-1 was recorded where treatment $T_6$-$T_7$. This was statistically at par with $T_6$, and $T_7$ and significantly superior over rest of the treatment during the years of experimentation. The higher dry matter accumulation of plant in these treatments was due to higher plant height (Table 2). These results are in tune with (Tetarwal *et al*. 2013, and Pandey *et al*. 2019) [15, 10].

Yield of any crop is generally based on two major factors i.e. yield plant-1 and plant population per unit area. Further, the yield per plant in mustard is affected by several plant characters such as number of branches plant-1, number of siliquae plant-1, length of siliquae, number of seeds siliquae-1 and test weight etc. Regarding the number of siliquae plant-$^1$, the highest number of siliquae was recorded due to the $T_6$-$T_7$ (297.67 and 288.03). Number of siliquae was directly with number of branches, since these treatments had the greater number of branches plant-1, resulted in a greater number of siliquae in different treatments (Table 5). As far as the 1000-seed weight or test weight was concerned, it was affected significantly due to different INM treatments. As far as the 1000-seed weight or test weight was concerned, it was not affected significantly due to different INM treatments. However, higher test weight was recorded with treatment $T_6$-$T_7$ during the years but non-significant differences were noted due to different INM treatments. The minimum values of the entire yield attributes were observed in the treatment $T_1$ received lower amount of nutrients in treatment $T_1$ control because plants could not absorb required amount of nutrients and resulted in poor yield attributes (Gupta *et al*. 2019, Pandey *et al*. 2019, Singh *et al*. 2020) [4, 10, 14]. Yield is the ultimate resultant of the bio-physiological process which coordinated interplay of growth characters and yield attributes. Seed and stover yields were influenced significantly by applying various INM. (Table 6). The highest seed yield of mustard (18.89 and 17.41 q ha$^{-1}$) was recorded under the treatment $T_6$-$T_7$. This was statistically at par with $T_6$ and significantly superior rest over the treatments in the respective years of 2023-4. The highest stover yield of mustard (47.17 and 43.61 q ha-1) was recorded under treatment $T_6$-$T_7$. Significantly lowest seed and stover yields were found under treatment $T_1$ - control (RDF+NPK) during the years. Similar results also reported by (Singh *et al*. 2020) [14]. The highest harvest index (29.90 and 28.59%) was recorded under the

treatment $T_9$-$T_6$ during the years. The harvest index speaks the conversion efficiency of non-seed portion by turning up nutrient uptake as well as utilization. Lower stover yield in proportion to grain associated under above treatments increased the values of harvest index (Table 6). This was due to adequate nutrients availability and less competition for moisture, nutrients and light to crop (Chauhan *et al*. 2005, Mukherjee, 2014) [2, 8].

**Table 1:** Effect of INM practices on initial plant population of mustard crop (m-2) at 30 DAS

| Treatment | Initial plant population ($m^{-1}$) |
|---|---|
| | 2023-24 |
| $T_1$ Control (RDF generally recommended ratio N:P: K- 3:2:1) | 13.81 |
| $T_2$ 75% RDF | 14.26 |
| $T_3$ 100% RDF | 14.45 |
| $T_4$ 75% RDF + PSB | 14.87 |
| $T_5$ 75% RDF + 2.5 t/ha vermicompost | 14.56 |
| $T_6$ 75% RDF + 2.5 t/ha vermicompost + PSB | 15.86 |
| $T_7$ 100% RDF + PSB | 15.09 |
| $T_8$ 100% RDF + 2.5 t/ha vermicompost | 14.11 |
| $T_9$ 100% RDF + 2.5 t/ha vermicompost + PSB | 15.02 |
| SE (m)± | 0.63 |
| CD at 5% | NS |

**Table 2:** Effect of INM practices on plant height (cm) at different growth stages

| Treatment | 30 DAS | 60 DAS | 90 DAS |
|---|---|---|---|
| $T_1$ Control (RDF generally recommended ratio N:P: K- 3:2:1) | 23.09 | 61.23 | 136.1 |
| $T_2$ 75% RDF | 25.39 | 75.53 | 153.58 |
| $T_3$ 100% RDF | 25.39 | 75.56 | 166.42 |
| $T_4$ 75% RDF + PSB | 25.53 | 79.56 | 177.89 |
| $T_5$ 75% RDF + 2.5 t/ha vermicompost | 25.53 | 76.49 | 170.44 |
| $T_6$ 75% RDF + 2.5 t/ha vermicompost + PSB | 26.23 | 80.56 | 168.54 |
| $T_7$ 100% RDF + PSB | 25.93 | 79.98 | 175.46 |
| $T_8$ 100% RDF + 2.5 t/ha vermicompost | 24.56 | 76.25 | 183.52 |
| $T_9$ 100% RDF + 2.5 t/ha vermicompost + PSB | 25.83 | 78.4 | 175.42 |
| SE± | 1.09 | 3.22 | 6.38 |
| CD at 5% | NS | 9.55 | 18.96 |

**Table 3:** Effect of INM practices on number of branches $plant^{-1}$ at different growth stages

| Treatment | 30 DAS | 60 DAS | 90 DAS |
|---|---|---|---|
| $T_1$ Control (RDF generally recommended ratio N:P: K- 3:2:1) | 1.41 | 12.59 | 16.78 |
| $T_2$ 75% RDF | 1.62 | 15.80 | 20.20 |
| $T_3$ 100% RDF | 1.66 | 14.79 | 20.27 |
| $T_4$ 75% RDF + PSB | 1.80 | 17.37 | 21.40 |
| $T_5$ 75% RDF + 2.5 t/ha vermicompost | 1.69 | 16.40 | 21.28 |
| $T_6$ 75% RDF + 2.5 t/ha vermicompost + PSB | 2.12 | 15.81 | 23.26 |
| $T_7$ 100% RDF + PSB | 1.82 | 14.99 | 22.42 |
| $T_8$ 100% RDF + 2.5 t/ha vermicompost | 1.49 | 13.19 | 17.08 |
| $T_9$ 100% RDF + 2.5 t/ha vermicompost + PSB | 1.85 | 16.58 | 20.59 |
| SE± | 0.15 | 0.59 | 0.82 |
| CD at 5% | NS | 1.68 | 2.65 |

**Table 4:** Effect of INM practices on dry matter accumulation plant-1(g) at different growth stages of mustard

| Treatment | 30 DAS | 60 DAS | 90 DAS |
|---|---|---|---|
| $T_1$ Control (RDF generally recommended ratio N:P: K- 3:2:1) | 1.22 | 12.09 | 27.12 |
| $T_2$ 75% RDF | 1.43 | 16.82 | 42.02 |
| $T_3$ 100% RDF | 1.49 | 17.07 | 43.36 |
| $T_4$ 75% RDF + PSB | 1.54 | 19.06 | 49.25 |
| $T_5$ 75% RDF + 2.5 t/ha vermicompost | 1.53 | 18.63 | 47.77 |
| $T_6$ 75% RDF + 2.5 t/ha vermicompost + PSB | 1.88 | 21.95 | 55.52 |
| $T_7$ 100% RDF + PSB | 1.56 | 19.66 | 51.84 |
| $T_8$ 100% RDF + 2.5 t/ha vermicompost | 1.33 | 12.52 | 28.78 |
| $T_9$ 100% RDF + 2.5 t/ha vermicompost + PSB | 1.78 | 18.02 | 43.22 |
| SE± | 0.13 | 0.82 | 2.01 |
| CD at 5% | 0.34 | 2.41 | 5.59 |

**Table 5:** Effect of INM practices on number of siliquae, length of siliquae, number of seeds siliquae-1 and test weight in mustard crop

| Treatment | No. of siliquae/plant | Length of siliquae | No. of seeds/ siliquae | Test weight (g) |
|---|---|---|---|---|
| | 2023-24 | 2023-24 | 2023-24 | 2023-24 |
| $T_1$ Control (RDF generally recommended ratio N:P: K- 3:2:1) | 208.65 | 5.79 | 9.05 | 4.09 |
| $T_2$ 75% RDF | 271.05 | 6.53 | 12.66 | 4.18 |
| $T_3$ 100% RDF | 277.07 | 6.76 | 13.04 | 4.21 |
| $T_4$ 75% RDF + PSB | 283.01 | 6.88 | 13.36 | 4.36 |
| $T_5$ 75% RDF + 2.5 t/ha vermicompost | 281.33 | 6.87 | 13.13 | 4.28 |
| $T_6$ 75% RDF + 2.5 t/ha vermicompost + PSB | 297.67 | 7.00 | 14.06 | 4.57 |
| $T_7$ 100% RDF + PSB | 288.03 | 6.88 | 13.48 | 4.45 |
| $T_8$ 100% RDF + 2.5 t/ha vermicompost | 210.03 | 5.80 | 9.23 | 4.15 |
| $T_9$ 100% RDF + 2.5 t/ha vermicompost + PSB | 275.33 | 7.44 | 13.42 | 4.39 |
| SE± | 11.17 | 0.31 | 0.54 | 0.34 |
| CD at 5% | 31.90 | 0.87 | 1.55 | NS |

**Table 6:** Effect of INM practices on seed yield (q ha-1), Stover yield (q ha-1) and harvest index (%) of mustard

| Treatment | Seed yield (q ha-1) | Stover yield (q ha-1) | Harvest index (%) |
|---|---|---|---|
| | 2023-24 | 2023-24 | 2023-24 |
| $T_1$ Control (RDF generally recommended ratio N:P: K- 3:2:1) | 10.05 | 31.59 | 24.13 |
| $T_2$ 75% RDF | 14.72 | 37.93 | 27.95 |
| $T_3$ 100% RDF | 15.17 | 40.66 | 27.31 |
| $T_4$ 75% RDF + PSB | 16.22 | 42.30 | 27.71 |
| $T_5$ 75% RDF + 2.5 t/ha vermicompost | 15.22 | 41.31 | 26.92 |
| $T_6$ 75% RDF + 2.5 t/ha vermicompost + PSB | 18.89 | 47.17 | 28.59 |
| $T_7$ 100% RDF + PSB | 17.41 | 43.61 | 28.53 |
| $T_8$ 100% RDF + 2.5 t/ha vermicompost | 11.78 | 34.23 | 25.60 |
| $T_9$ 100% RDF + 2.5 t/ha vermicompost + PSB | 16.88 | 40.18 | 29.58 |
| SE± | 0.73 | 2.04 | - |
| CD at 5% | 2.14 | 6.01 | - |

## Conclusion

In conclusion on the basis of above findings it can be concluded that treatment $T_6$ [75% RDF + 2.5 t/ha vermicompost + PSB] shows the best results with respect to significant growth attributes, yield attributes and yield. From the economical point of view, the same treatment gave higher net profit (Rs 45331) over rest of the treatments. Benefit: Cost ratio was significantly higher (1.32) with in same treatment $T_6$ 75% RDF + 2.5 t/ha vermicompost + PSB over rest of the treatments. Therefore treatment $T_6$ [75% RDF + 2.5 t/ha vermicompost + PSB] is recommended for higher net return and yield in mustard cultivation.

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