**Original Research Article**

**Effect of Vermicompost on Growth and Yield attributing characteristic of Indian Mustard (*Brassica juncea L*.)**

**Abstract**

A field experiment was conducted during the Rabi season of 2023–2024 and 2024-25 at the NRM Block, Banda University of Agriculture and Technology, Banda (Uttar Pradesh), to investigate the “Effect of Vermicompost on Growth and Yield attributing characteristic of Indian Mustard (*Brassica juncea L*.)”. The experiment was laid out in a Randomized Block Design (RBD) with three replications. Vermicompost treatments—RDF100% (N:P:K:S-80:40:40:20), RDF100%+@ 2 tons Vermicompost ha⁻¹, RDF 75%+ @ 2 tons Vermicompost ha⁻¹, RDF 50% + @ 2 tons Vermicompost ha-1 were allotted, resulting in a total of 13 treatment combinations. The results indicated that the application of RDF 75% + vermicompost @ 2tons ha⁻¹ (V8) significantly enhanced yield attributes and seed yield 22.8 q ha⁻¹, 23.78 q ha⁻¹, and 24.40 q ha⁻¹, with corresponding gross returns of ₹136620.66 ha⁻¹, 148953.50 ha⁻¹, and142787.08 ha⁻¹, and net returns of ₹74746.467 ha⁻¹, 87079.30 ha⁻¹, and 80912.88 compared to the control in the year 2023-2024, 2024-25 and pooled data, respectively . Among fertility treatments, application of 100% RDF+ @vermicompost 2 tons (T₄) resulted in significantly greater seed yield 24.500 q ha⁻¹, 25.903 q ha⁻¹and 26.035 gross returns of ₹146127.00 ha⁻¹,161858.16 and 153992.58 net returns of ₹82710.20 ha⁻¹, 98441.36 and 90575.78 compared to the control (RDF 100%) in the year of 2023-24,2024-25 and also pooled data respectively. The combined application of 2 t ha⁻¹ vermicompost V4 with 100% RDF recorded the highest seed yield (24.500, 25.903 and 26.036 q ha⁻¹), gross return (₹146127,161858.16, and15399.58 ha⁻¹), and net return (₹82710.20, 98441.36 and 90575.78 ha⁻¹) in year 2023-24, 2024-25 and pooled data also, suggesting a synergistic effect on the growth and profitability of Indian mustard cultivation.

**Keywords:** Economics, Indian mustard, RDF, Vermicompost, Yield.

***Introduction***

India ranks among the leading global producers of oilseeds, utilizing approximately 16 % of the total arable land and contributing around 10% to the world’s overall oilseed output. Within the national agricultural landscape, oilseeds constitute the second most significant commodity after cereals. They occupy 13.33% of India’s gross cultivated area, account for nearly 3% of the gross national product, and represent approximately 10% of the total value of agricultural commodities. Mustard oil, derived from Brassica juncea L., is commonly employed in the tanning industry for its effectiveness in softening leather. Mustard seeds are a nutritionally dense oilseed crop, comprising approximately 37–49% oil and 25–32% protein, along with 7% ash content. They are also a valuable source of essential minerals, including calcium (0.6%), phosphorus (1.45%), magnesium (0.6%), and manganese (0.05%). Rich in vitamins and dietary fiber, mustard seeds contain notable concentrations of thiamine (5.2 mg/g), niacin (160 mg/g), riboflavin (3.7 mg/g), pantothenic acid, folic acid (9.5–2.3 mg/g), chlorine (6.7 mg/g), and tocopherols (1.5 mg/g). The residual mustard cake, a by-product of oil extraction, is particularly high in crude protein content (42%) and contains about 7% ash, making it an important supplementary feed and soil amendment **(Damodaram & Hedge, 2010)**. In addition to its industrial applications, this species is appreciated for its strong flavour profile and reputed medicinal properties. Primarily cultivated as an oilseed crop, Brassica juncea also serves as an excellent forage for pollinators, particularly bees **(Kumar, 2018).** Between 1950–51 and 2018–19, the area under rapeseed and mustard cultivation in India expanded significantly—from 0.76 million hectares to 6.65 million hectares. Over the same period, production rose by approximately 1.23 million tonnes, reaching an estimated total of 9.33 million tonnes. The national average yield for rapeseed and mustard during the 2018–19 season was reported at 1,499 kg per hectare **(Anonymous, 2020)**. India ranks third globally in rapeseed and mustard production, following China. Within the country, Rajasthan holds the leading position, with 2.632 million hectares under cultivation and a production volume of 4.108 million metric tonnes. Uttar Pradesh follows, with 0.793 million hectares sown, yielding 1.120 million metric tonnes and achieving a productivity rate of 1,412 kg per hectare **(Anonymous, 2020).**

Organic inputs have emerged as environmentally sustainable alternatives that enhance both agricultural productivity and long-term ecological balance. In current agricultural practices, there is a growing emphasis on integrating organic amendments with chemical fertilizers to develop cost-effective and eco-friendly nutrient management strategies. Among these, vermicompost a biologically derived organic fertilizer plays a vital role. It serves as both a nutrient-rich manure and a carbon sink in cropping systems, helping to reduce the dependency on synthetic fertilizers. Vermicompost is particularly valued for its high nutrient content, including nitrogen (1.7–2.5%), phosphorus (0.7–1.0%), potassium (1.1–1.4%), calcium (0.45%), magnesium (0.15%), sulphur (0.45%), zinc (25 ppm), and iron (175.2 ppm). Additionally, it contains beneficial vitamins and plant growth hormones that support enhanced plant development and stimulate microbial activity in the soil.

Notably, the combined use of vermicompost with synthetic fertilizers mitigates soil toxicity through buffering mechanisms, curtails soil degradation, and significantly improves overall soil fertility. This integrated approach aligns with sustainable agricultural practices aimed at promoting soil health and environmental safety. Organic fertilizers are primarily composed of organic matter derived from plant or animal sources that have undergone various forms of biological or mechanical processing. In contrast, inorganic fertilizers are synthesized through chemical, physical, or biological engineering methods and are typically produced as industrial products in fertilizer manufacturing facilities **(Anggaraini *et al*., 2021).**

***Material and Methods***

The experiment was laid out on the agriculture research farm, College of Agriculture, BUAT, Banda during the Rabi season of 2023-24 and 2024-25. The topography of the experimental area was uniform and plain. The site of the study lies between latitude 25.528259 °N and longitude 80.335688 °E with a mean sea level of 168 m**.**

The climate of the Bundelkhand region is semi-arid, characterized by the aridity of the atmosphere and scarcity of water with extreme temperatures during both summer and winter. The temperature in summer ranges between 28 to 46 0C, whereas in winter, the temperature falls to as low as 50C. The average annual rainfall of this region is varying between 650 to 850 mm, most of which is received in the rainy season from July to September. Ponds, canals, rivers and tube wells are the source and of irrigation and the water table is quite deep (about 35-45 meters). The agro-climatic zone VIII (Central Plateau and Hills region) tract is favorable to the pulses and oil seed productions and provides a safe long growing season for most of the oilseed crops, but frequent occurrences of heat may cause damage to crops. The periodic data for temperature, relative humidity, rainfall occurrences and evaporation for the period of experimentation viz., from November 2023 to March 2024 for the first year and from November 2024 to March 2025 for the second year were obtained from the meteorological observatory BUAT Banda.

***Experimental details.***

In accordance with the experimental objectives and to facilitate ease of agricultural operations, the study was structured using a Randomized block design comprising 13 treatment combinations. The Treatment combination details(Table.1): Control (RDF100%) T1 per hectare, 100% RDF + V1, V2, V3 and V4 @ 2 tonnes per hectare (T2-T5), 75% RDF+ V1, V2, V3 and V4 @ 2 tonnes per hectare (T6-T9), and 50% RDF + V1, V2, V3 and V4 @ 2 tonnes (T10-T13) per hectare. Where V1, V2, V3 and V4 is prepared vermicompost through Cow dung, Paddy straw, Moong straw and Carton straw respectively. And each treatment was replicated three times, and allocations within both the year 2023-24, 2024-25 were conducted using a randomized layout to ensure unbiased results. Mustard crop Variety name is DRMRIJ 31 (Giriraj) developing center Directorate of Rapeseed Mustard Research, Bharatpur (Rajasthan). maturity period is 137-153 days recommended for Rajasthan, Haryana, and Uttar Pradesh. The observations were recorded for number of siliquae/plants, number of seeds/siliquae, test weight, Biological yield, seed yield and Stover yield, harvex index, Gross return, Net return and B:C ratio.

**Table.1. The following treatments to be used for field experiment:**

|  |  |  |
| --- | --- | --- |
| **S.N.** | **Treatments Name** | **Treatments details** |
| 1. | T1 | 100% RDF (80 Kg N, 40 Kg P2O5 , 40 Kg K2O, 20 Kg S) |
| 2. | T2 | 100 % RDF (N:P:K:S) + (V1) @ 2 tonne ha -1 |
| 3. | T3 | 100 % RDF (N:P:K:S) + (V2) @2 tonne ha -1 |
| 4. | T4 | 100 % RDF (N:P:K:S) + (V3) @2 tonne ha -1 |
| 5. | T5 | 100 % RDF (N:P:K:S) +(V4) @2 tonne ha-1 |
| 6. | T6 | 75 % RDF (N:P:K:S) +(V1) @2 tonne ha-1 |
| 7. | T7 | 75 % RDF (N:P:K:S) +(V2) @2 tonne ha-1 |
| 8. | T8 | 75 % RDF (N:P:K:S) + (V3) @2 tonne ha-1 |
| 9. | T9 | 75 % RDF (N:P:K:S) +(V4) @2 tonne ha-1 |
| 10. | T10 | 50 % RDF (N:P:K:S) +(V1) @ 2 tonne ha-1 |
| 11. | T11 | 50 % RDF (N:P:K:S) +(V2) @ 2 tonne ha-1 |
| 12. | T12 | 50 % RDF (N:P:K:S) +(V3) @ 2 tonne ha-1 |
| 13. | T13 | 50 % RDF (N:P:K:S) +(V4) @ 2 tonne ha-1 |

***RESULTS AND DISCUSSION:***

***Yield attributes:***

The average values for siliquae per plant, seeds per siliqua, and test weight (1000-seed weight) presented in Table.2. were significantly influenced by varying doses of RDF + Vermicompost. The highest number of siliquae per plant was recorded with the application of RDF+ vermicompost V3 (, Moong Straw Vermicompost) @ 2 tonnes ha⁻¹ (T4), which was affected significantly greater than all other treatments.

The treatment T4 (RDF 100 %+ V3 @ 2 tons/ha)significantly influence siliquae per plant, which was statistically at par with T8. Similarly, the number of seeds per siliqua was maximum under T4 (RDF+V3@ 2 tons/ha) 264.14 of with a significant increase compared to other treatments.

T₄ (RDF 100% +V3@ 2 tons/ha) yielding the highest number of seeds per siliqua (16.95 seeds), which was statistically at par with T8 (75% RDF+ V3@ 2 tons/ha) and significantly superior to control T1 (RDF 100%).

The effect of treatment in test weight was affected non-significantly with higher test weight T₄ (RDF 100% +V3@ 2 tons/ha) 4.65 g and minimum test weight was found in T1(100%RDF).

Overall, vegetative growth traits positively contributed to yield attributes under favourable conditions established by various types of vermicompost applications and an optimal nutrient supply through Graded doses of recommended doses of fertilizers (RDF) during sowing and the vegetative growth phases. These conditions facilitated enhanced photosynthate translocation to developing plant organs, resulting in improved expression of yield-related characteristics **(Chaturvedi and Kumar, 2019).**

***Yield:***

Among the various Integrated Nutrient Management (INM) treatments evaluated (Table.2), the application of T4 (100% RDF + V3 at 2.0 t ha⁻¹ resulted in a significantly higher number of siliquae per plant, number of seeds per siliqua. This treatment was statistically comparable to the application of T8 (75% RDF+ V3 at 2.0 t ha⁻¹).

These results suggest that integrating inorganic fertilizers with vermicompost amendments enhances the plant framework conducive to higher yield and yield attributing characteristics of mustard crop. The findings corroborate the conclusions drawn in earlier studies conducted by **Tripathi *et al*. (2011), De and Sinha (2012), Pati and Mahapatra (2015), Bijarnia *et al*. (2017), Kumar *et al*. (2018), Singh *et al*. (2018), and Verma *et al*. (2021).**

**Table.2.** Effect of different treatments of vermicompost on number of siliqua/plants, number of seeds/siliqua and 1000 seed weight (g.) of mustard crop.

|  |  |  |
| --- | --- | --- |
| **T.****Symbol** | **Treatment details** | **Yield attributes** |
| **Number of siliqua/plants** | **Number of seeds/ siliquae** | **1000 seed weight (g.)** |
| **2023-24** | **2024-25** | **Pool data** | **2023-24** | **2024-25** | **Pool data** | **2023-24** | **2024-25** | **Pool data** |
| **T1** | 100% RDF (80 Kg N, 40 Kg P2O5, 40 Kg K2O, 20 Kg S) | 230.87 | 233.39 | 232.13 | 11.81 | 12.30 | 12.06 | 4.27 | 4.32 | 4.29 |
| **T2** | 100 % RDF (N:P:K:S) + (V1) @ 2 tonne ha -1 | 256.29 | 257.81 | 257.05 | 14.48 | 15.38 | 14.93 | 4.50 | 4.57 | 4.53 |
| **T3** | 100 % RDF (N:P:K:S) + (V2) @2 tonne ha -1 | 247.67 | 246.62 | 247.15 | 13.97 | 14.67 | 14.32 | 4.43 | 4.47 | 4.45 |
| **T4** | 100 % RDF (N:P:K:S) + (V3) @2 tonne ha -1 | 264.14 | 267.18 | 265.66 | 16.39 | 17.51 | 16.95 | 4.63 | 4.67 | 4.65 |
| **T5** | 100 % RDF (N:P:K:S) +(V4) @2 tonne ha-1 | 245.84 | 240.55 | 243.19 | 13.55 | 13.88 | 13.71 | 4.36 | 4.40 | 4.38 |
| **T6** | 75 % RDF (N:P:K:S) +(V1) @2 tonne ha-1 | 244.56 | 247.34 | 245.95 | 13.93 | 14.27 | 14.10 | 4.45 | 4.49 | 4.47 |
| **T7** | 75 % RDF (N:P:K:S) +(V2) @2 tonne ha-1 | 241.60 | 242.26 | 241.93 | 13.31 | 13.75 | 13.53 | 4.39 | 4.43 | 4.41 |
| **T8** | 75 % RDF (N:P:K:S) + (V3) @2 tonne ha-1 | 250.78 | 253.28 | 252.03 | 15.57 | 16.41 | 15.99 | 4.52 | 4.64 | 4.58 |
| **T9** | 75 % RDF (N:P:K:S) +(V4) @2 tonne ha-1 | 237.96 | 238.95 | 238.46 | 12.70 | 13.16 | 12.93 | 4.32 | 4.37 | 4.35 |
| **T10** | 50 % RDF (N:P:K:S) +(V1) @ 2 tonne ha-1 | 244.23 | 246.23 | 245.23 | 13.62 | 14.15 | 13.89 | 4.38 | 4.42 | 4.40 |
| **T11** | 50 % RDF (N:P:K:S) +(V2) @ 2 tonne ha-1 | 240.84 | 241.70 | 241.27 | 13.15 | 13.55 | 13.35 | 4.34 | 4.37 | 4.36 |
| **T12** | 50 % RDF (N:P:K:S) +(V3) @ 2 tonne ha-1 | 247.22 | 249.09 | 248.16 | 15.89 | 16.30 | 16.09 | 4.42 | 4.45 | 4.44 |
| **T13** | 50 % RDF (N:P:K:S) +(V4) @ 2 tonne ha-1 | 233.21 | 234.65 | 233.93 | 12.24 | 12.77 | 12.51 | 4.29 | 4.32 | 4.31 |
|  | SEm+ | 4.76 | 4.38 | 4.24 | 0.53 | 0.51 | 0.41 | 0.11 | 0.10 | 0.09 |
|  | CD (0.05) | 13.90 | 12.79 | 12.37 | 1.54 | 1.50 | 1.19 | NS | NS | NS |

**Fig.1.** Effect of different treatments of vermicompost on number of siliqua/plants, number of seeds/siliqua and 1000 seed weight (g.) of mustard crop.

**Seed, Stover and biological yield.**

The analysis of seed, Stover, and biological yield revealed significant variation among the different treatment combinations (Table.3). Notably, the application of T4 (100 % +V3 @ 2 tons/ha) resulted in markedly higher seed yield (26.035 q/ha), Stover yield (57.482 q/ha), and total biological yield (83.658 q/ha) in the both year same trend and pooled data also. These results were statistically comparable to those observed under T8 (75% RDF +V3 at 2 t ha⁻¹) and 100% RDF, except in terms of Seed yield, where T4 was superior.

Mustard cultivation responded positively to the integrated application of organic and inorganic fertilizers, as evidenced by enhanced root development. This more extensive root system improved the uptake of moisture and nutrients from the soil, thereby facilitating greater dry matter accumulation. The efficient translocation of photosynthates from the leaves to the siliquae supported the formation of well-developed seeds. The increase in seed size may be attributed to the greater availability of carbohydrates and enhanced metabolic processes associated with an integrated nutrient supply. The synergistic interaction between organic and inorganic nutrient sources thus plays a crucial role in achieving higher seed yield. These findings align with the reports of **Mandal and Sinhala (2004), Tripathi *et al*. (2011), De and Sinha (2012), Pati and Mahapatra (2015), Bijarnia *et al*. (2017), Kumar *et al*. (2018), Singh *et al*. (2018), Varma *et al*. (2021), and Tyagi *et al*. (2022).**

**Table.3. Effect of different treatments of vermicompost on grain yield (qt/ha) mustard crop.**

|  |  |  |
| --- | --- | --- |
| **T.****Symbol** | **Treatment details** | **Yields** |
| **Seed yield (q/ha.)** | **Stover yield (q/ha.)** | **Biological yield (q/ha.)** | **Harvest index (%)** |
| **2023-24** | **2024-25** | **Average data** | **2023-24** | **2024-25** | **Average data** | **2023-24** | **2024-25** | **Average data** | **2023-24** | **2024-25** | **Average data** |
| **T1** | 100% RDF (80 Kg N, 40 Kg P2O5, 40 Kg K2O, 20 Kg S) | 19.567 | 20.100 | 19.833 | 51.550 | 52.450 | 52.000 | 71.117 | 72.550 | 71.833 | 27.514 | 27.705 | 27.610 |
| **T2** | 100 % RDF (N:P:K:S) + (V1) @ 2 tonne ha -1 | 24.307 | 23.033 | 23.670 | 55.557 | 57.800 | 56.678 | 79.863 | 80.183 | 80.023 | 30.442 | 28.723 | 29.583 |
| **T3** | 100 % RDF (N:P:K:S) + (V2) @2 tonne ha -1 | 22.740 | 21.990 | 22.365 | 54.767 | 56.550 | 55.658 | 77.507 | 78.450 | 77.978 | 29.355 | 28.013 | 28.684 |
| **T4** | 100 % RDF (N:P:K:S) + (V3) @2 tonne ha -1 | 24.500 | 25.903 | 26.035 | 56.770 | 58.193 | 57.482 | 83.937 | 83.380 | 83.658 | 32.356 | 29.877 | 31.117 |
| **T5** | 100 % RDF (N:P:K:S) +(V4) @2 tonne ha-1 | 21.747 | 21.197 | 21.472 | 54.020 | 55.393 | 54.707 | 75.767 | 76.190 | 75.978 | 28.704 | 27.812 | 28.258 |
| **T6** | 75 % RDF (N:P:K:S) +(V1) @2 tonne ha-1 | 21.490 | 21.177 | 22.083 | 53.073 | 54.473 | 53.773 | 74.897 | 76.817 | 75.857 | 29.103 | 29.086 | 29.095 |
| **T7** | 75 % RDF (N:P:K:S) +(V2) @2 tonne ha-1 | 20.910 | 21.133 | 21.303 | 52.410 | 53.683 | 53.047 | 73.320 | 75.380 | 74.350 | 28.549 | 28.749 | 28.649 |
| **T8** | 75 % RDF (N:P:K:S) + (V3) @2 tonne ha-1 | 22.867 | 23.783 | 24.408 | 55.213 | 55.480 | 55.347 | 80.247 | 79.263 | 79.755 | 31.177 | 30.005 | 30.591 |
| **T9** | 75 % RDF (N:P:K:S) +(V4) @2 tonne ha-1 | 20.590 | 20.643 | 20.617 | 54.563 | 54.523 | 54.543 | 75.153 | 75.167 | 75.160 | 27.399 | 27.429 | 27.414 |
| **T10** | 50 % RDF (N:P:K:S) +(V1) @ 2 tonne ha-1 | 20.700 | 20.567 | 21.700 | 53.417 | 54.453 | 53.935 | 75.117 | 76.153 | 75.635 | 28.887 | 28.482 | 28.684 |
| **T11** | 50 % RDF (N:P:K:S) +(V2) @ 2 tonne ha-1 | 20.697 | 20.543 | 21.282 | 52.697 | 53.803 | 53.250 | 73.793 | 75.270 | 74.532 | 28.597 | 28.504 | 28.550 |
| **T12** | 50 % RDF (N:P:K:S) +(V3) @ 2 tonne ha-1 | 21.723 | 22.703 | 23.637 | 53.797 | 54.930 | 54.363 | 77.187 | 78.813 | 78.000 | 30.301 | 30.306 | 30.303 |
| **T13** | 50 % RDF (N:P:K:S) +(V4) @ 2 tonne ha-1 | 20.283 | 21.050 | 21.000 | 53.280 | 53.733 | 53.507 | 74.230 | 74.783 | 74.507 | 28.210 | 28.144 | 28.177 |
|  | SEm+ | 0.52 | 0.15 | 0.51 | 0.90 | 0.82 | 0.71 | 1.15 | 1.17 | 0.95 | 0.72 | 0.61 | 0.48 |
|  | CD (0.05) | 1.51 | 1.55 | 1.49 | 2.62 | 2.38 | 2.07 | 3.36 | 3.41 | 2.77 | 2.11 | 1.79 | 1.39 |

**Fig 2. Effect of different treatments of vermicompost on grain yield (qt/ha) mustard crop.**

**Economics:**

According to the economic analysis presented in Table 2, the application of T4 (100% RDF +V3 at 2.0 t ha⁻¹) yielded the highest gross returns (`153992.58 ha-1) and net returns (90575.78 ha⁻¹) from mustard cultivation. This treatment was closely followed by T8 (75% RDF +V3 2 t ha⁻¹) in terms of economic performance.

The highest benefit-cost (B:C) ratio of 2.42 was recorded under T4 (100% RDF+V3), with T8 also demonstrating a favourable return on investment. The superior economic returns under these treatments are likely attributed to their positive influence on crop yield.

These findings are consistent with the earlier observations reported by **Tripathi *et al*. (2011),** **Singh et al. (2018), Maurya *et al*. (2020),** **Annapoorna and Chandra Nath (2021)**, and **Varma *et al*. (2021)**, who also noted enhanced profitability with integrated nutrient management practices in mustard cultivation.

**Conclusion:**

Based on the two-year field experiment, it can be concluded that the application Graded doses (100 %, 75%, 50%) of RDF (Recommended Dose of Fertilizer) comprising 80 kg N, 40 kg P₂O₅, 40 kg K₂O and 20 kg Sulphur/ha in combination with V1 (cow dung Vermicompost), V2 (Paddy Straw vermicompost), V3 (moong Straw vermicompost) and V4 (Carton vermicompost) @ 2.0 t ha⁻¹, significantly enhanced mustard seed yield and to the other treatment combinations. This integrated nutrient management practice also contributed to an improvement in post-harvest soil nutrient availability.

From an economic standpoint, treatment T4 (100% RDF + V3 @ 2 t/ha) generated the highest gross returns (153992.58 ha⁻¹) net returns (90575.78 ha⁻¹) and highest benefit-cost (B:C) ratio of 2.42 was recorded. Despite this, the combination of T8 (75% RDF + V3 @ 2 t/ha) emerged as the most effective strategy for maximizing both crop productivity and farm profitability in mustard cultivation.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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