Integrated effects of vermicompost with chemical fertilizers on the yield of mustard

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Abstract

Field experiments were conducted in three Agroecological zones (AEZ) at Farmer’s field, Rangpur (AEZ-3), Farmer’s field, Ishurdi (AEZ-11) and BINA farm, Mymensingh (AEZ-9) to investigate the integrated effect of vermicompost and chemical fertilizers (CF) on Mustard (Brassica napus L.) during 2017-18 cropping season to reduce the usage of chemical fertilizer for mustard cultivation. The experiments were carried out with eight treatments and three replications in Randomized Complete Block Design. The treatments for the crops used in the experiments were T1: Native soil fertility, T2: 100% chemical fertilizer (CF), T3: 75% CF, T4: 75% CF + Vermicompost (VC) @ 4 t ha\(^{-1}\), T5: 85% CF, T6: 85% CF + VC @ 4 t ha\(^{-1}\), T7: 75% CF + VC @ 2 t ha\(^{-1}\) and T8: 85% CF + VC @ 2 t ha\(^{-1}\). Fertilizers applied on the basis of soil test (STB). Application of vermicompost with chemical fertilizer increased the yield attributes and yields of mustard. The treatment T6 (85% CF + VC @ 4 tha\(^{-1}\)) gave the tallest plant height, greatest number of pods plant\(^{-1}\) and silique pod\(^{-1}\) and maximum seed (1.82, 1.26 and 1.49 t ha\(^{-1}\) at Rangpur, Ishurdi and Mymensingh, respectively) and straw yields of mustard at all the location with the few exception. But the treatment T6 gave the identical results with the treatments T8, T4 and T2. Application of vermicompost also increased the N, P and K uptakes of mustard at all the location. The treatments T6, T8 and T4 gave statistically identical nutrients uptakes to the treatment T2 (100% CF). The results revealed that 75% CF with 4 t ha\(^{-1}\) vermicompost or 85% CF with 2 t ha\(^{-1}\) vermicompost almost equally effective to produce seed yield of mustard which was also comparable with the full dose (100%) of chemical fertilizers (NPKS) in all the location. Therefore 15-25% chemical fertilizer (NPKS) could be reduced either with the application of 75% CF with 4 t ha\(^{-1}\) vermicompost or 85% CF with 2 t ha\(^{-1}\) vermicompost for mustard cultivation.

Key words: Vermicompost, mustard, seed yields, nutrients uptakes, fertilizer save

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Introduction

Integrated application of fertilizers and manures is prime need for sustained crop productivity and soil fertility in Bangladesh. The use of chemical fertilizers as the supplemental source has been increasing steadily but these are not applied in balanced proportion in Bangladesh. Of the total fertilizer used in the country, urea alone constituted about 75% (FRG, 2012). Previous study indicated that about 60% cultivable land of Bangladesh is deficient in N, P and K (Miah et al., 2008). Moreover, organic matter content in country’s soils is low, the majority being below the thresh hold level (1.5%) and it was gradually depleted by 5 to 36% during the period of 1967-1995 (Ali et al., 1997). Islam (2008) mentioned that organic matter content in Bangladesh soils is generally around 1% in most and around 2% in few soils. Therefore, combined use of
different organic sources of nutrients with inorganic nutrients is congenial for soil health and sustainable for crop production (Dekhane et al., 2014). The various implications of commercial fertilizers particularly in decreasing the soil fertility and productivity and the ever increasing cost of chemical fertilizers compels one to think of the use of organic manures (Moral et al., 2009). Uses of only inorganic sources of fertilizers, unplanned disposal of wastes, use of pesticides and their run-off etc. are also detrimental for the ecosystem and create pollution to the environment (Hanif et al., 2020; Islam et al., 2020; Rahman et al., 2016; Uddin et al., 2015; Tinni et al., 2014).

Hence, integrated use of different organic and inorganic sources of plant nutrients might be good option for sustaining of crop productivity and soil fertility. All possible nutrients sources are considered in the integrated plant nutrient system (IPNS). So, this nutrients management preserves the environment friendly with the reduction of use of chemical fertilizers. The organic matter content as well as the soil fertility status of Bangladesh is decreasing day by day due to cultivation of high yielding crop varieties in a same piece of land repeatedly for meet up the food demand of ever rising population. Now it is well agreed that depleted soil fertility is a major constrain for higher crop production in Bangladesh and indeed, yield of several crops including mustard are declining in the different soils. Maintenance of soil fertility is a prerequisite for long term sustainable crop production and it is certain that organic manure like vermicompost could be played a vital role in the sustenance of soil fertility and crop productivity (Bejbaruah, 2013). Therefore, the present study was undertaken to investigate the integrated effect of vermicompost and chemical fertilizers (CF) on mustard to reduce the use of chemical fertilizer for mustard cultivation in Bangladesh.

**Materials and Methods**

Field experiments were conducted to investigate the integrated effect of vermicompost and chemical fertilizers (CF) on Mustard during 2017-18 cropping season to reduce the use of chemical fertilizer for mustard cultivation. The experiments were carried out with eight treatments and three replications in Randomized Complete Block Design. The treatments for the crops used in the experiments were T1: Native soil fertility, T2:100% chemical fertilizer (CF), T3: 75% CF, T4: 75% CF + Vermicompost (VC) @ 4 tha
-1, T5: 85% CF, T6: 85% CF + VC @ 4 tha
-1, T7: 75% CF +VC @ 2 tha
-1 and T8: 85% CF+VC @ 2 tha
-1. The experiments conducted at three locations viz. i) BINA farm Mymensingh (AEZ-9) ii) Farmer’s field at Khoddo Tampat, Rangpur sadar (AEZ-3) and iii) Farmer’s field, at Ista, Ishurdi, Pabna (AEZ-11). The properties of initial soil have been given in the Table 1.

**Table 1.** Physico-chemical characteristics of initial soils in the different experimental fields.

| Soil characteristics | BINA farm Mymensingh | Rangpur sadar (Farmer’s field) | Ishurdi, Pabna (Farmer’s field) |
|---------------------|-----------------------|-------------------------------|-------------------------------|
| Soil texture        | Silt loam             | Silt loam                     | Silty clay loam               |
| Ph                  | 6.85                  | 5.9                           | 7.1                           |
| Organic carbon(%)   | 0.93                  | 0.91                          | 0.84                          |
| Total N(%)          | 0.1                   | 0.09                          | 0.1                           |
| Available P (mg kg
-1 soil) | 15.0                 | 13.0                          | 14.0                          |
| Exchangeable K (cmolkg
-1) | 0.151               | 0.141                         | 0.171                         |
| Available S (mg kg
-1 soil) | 15.0                 | 14.0                          | 13.0                          |
Fertilizer was applied (Table 2) on the basis of soil test (STB). Nutrient content of applied vermicompost was 1.3% N, 0.6 %P, 1.4 %K and 0.38 %S. Mustard was sown on 23, 20 and 27 Nov. at Mymensingh, Rangpur and Ishurdi, respectively and harvested on 8, 11 and 21 Feb. 2018 at Mymensingh, Rangpur and Ishurdi, respectively. Yields and yield contributing characters of mustard were recorded during the harvest.

**Table 2.** Full (100%) fertilizer rates (kg ha⁻¹) for mustard.

| Location                        | N  | P  | K  | S  |
|---------------------------------|----|----|----|----|
| i. BINA farm, Mymensingh       | 87 | 18 | 47 | 10 |
| ii. Khoddo Tampat, Rangpur sadar (Farmer’s field) | 120 | 20 | 49 | 11 |
| iii. Ista, Ishurdi, Pabna (Farmer’s field) | 87 | 19 | 49 | 12 |

**Physicochemical analyses of soil**

*Textural class:* Particle size analysis was carried out by hydrometer method (Black, 1965) and finally textural class was determined by fitting the %sand, % for silt and % clay to the Marshall's Triangular Coordinates following USDA system.

*Soil pH and EC:* Soil pH and EC were measured by a glass electrode pH and EC meter using soil: water suspension of 1:2.5 (10 g soil and 25 ml distilled water) as described by Jackson (1967).

*Organic matter:* Organic carbon was determined by wet oxidation method as described by Black (1965). The underlying principle was used to oxidize the organic matter with an excess of 1N K₂Cr₂O₇ in presence of conc. H₂SO₄ and conc. H₃PO₄ and to titrate the excess K₂Cr₂O₇ solution with 1N FeSO₄. To obtain the organic matter content the amounts of organic carbon were multiplied by Van Bemmelen factor 1.73. The results were expressed in percentage (Page et al., 1989).

**Total nitrogen:** Total N content was determined following micro-Kjeldahl method as described by Jackson (1967). Soil sample was digested with H₂O₂, conc. H₂SO₄ and catalyst mixture (K₂SO₄:CuSO₄.5H₂O:Se in the ratio of 100:10:1). After completion of digestion, made the volume to 100 ml. Distillation was performed with adding of 40% NaOH into the digest. The distillate was received in 2% boric acid (H₃BO₃) solution and 4 drops of mixed indicator of bromocresol green and methyl red solution. Finally, the distillate was titrated with standard H₂SO₄ (0.01N) until the color changed from green to pink. Then amount of N was calculated.

**Available phosphorus:** Available phosphorus was extracted from the soil samples by shaking with 0.5 M NaHCO₃ solutions at pH 8.5 following the method of Olsen and Sommers (1982). The extracted phosphorus was determined by developing blue color by SnCl₂ reduction of phosphomolydate complex and measuring the intensity of color calorimetrically at 660 nm wavelength and the readings were calibrated to the standard P curve.

**Exchangeable K:** Exchangeable K was extracted from the soil samples with 1N NH₄OAC (pH 7) and cations were determined from the extract by flame photometer (Black, 1965) and calibrated with a standard curve.

**Available sulphur:** Available S content was determined by extracting with 0.15% CaCl₂ solution (1:5 soil extractant ratio) and estimated by turbidimetric method using spectrophotometer at 535 nm wavelength (Williams and Steinbergs, 1959).

**Chemical analysis of plant samples**

The representative grain and straw samples were dried in an oven at 65°C for about 72 hours before they were ground by a grinding machine. The prepared samples
were then stored in paper bags and finally they were kept into a desiccator until analysis.

**Determination of total N content in plant samples:**
Total N was analysed using micro Kjeldhal method as described in case of soil analysis.

**Determination of P and K content in plant samples:**
About 0.5 g of plant samples (seeds or straw) were transferred into dry clean 100 ml kjeldahl flasks. 10 ml of diacid mixture (HNO₃:HClO₄ = 2:1) were added into the flask. After leaving for a while the flasks were heated at temperature slowly raised to 200°C. The contents of the flasks were boiled until they became sufficiently clear and colorless. After cooling the digests were transferred into 100ml volumetric flasks and the volumes were made up to the mark with distilled water. Phosphorus was determined from the aliquot by calorimetrically as described in case of soil analysis. Potassium was determined from the aliquot with the help of flame photometer as described in case of soil analysis (Jackson (1967).

**Calculation of nutrient uptakes by crops**
After chemical analysis of straw and grain samples, the N, P and K contents were used for the determination nutrient uptakes of grain and straw with the following formula of Jackson (1967)

\[
\text{Nutrient uptake by seed or straw (kg ha}^{-1}\text{)} = \text{nutrient content} \times \text{yield (kg ha}^{-1}\text{)} / 100
\]

**Results and Discussion**

**Effects of vermicompost on yield attributes of mustard:**
Yield attributes of mustard vizs. plant height, siliqua plant⁻¹ and seeds siliqua⁻¹ were increased due to application of vermicompost with chemical fertilizers (Table 3). The treatments T₄, T₆ and T₈ showed better performance in the growth and development of yield attributes of mustard which was very comparable with the treatment T₂ (100% CF) at all the location. But the treatments T₂, T₄, T₆ and T₈ did not differ significantly in respect of yield attributes of mustard at all the location.

| Treatments | Rangpur |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|------------|---------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|            | Plant height (cm) | Siliqua plant⁻¹ (no.) | Seeds siliqua⁻¹ (no.) | Plant height (cm) | Siliqua plant⁻¹ (no.) | Seeds siliqua⁻¹ (no.) | Plant height (cm) | Siliqua plant⁻¹ (no.) | Seeds siliqua⁻¹ (no.) | Plant height (cm) | Siliqua plant⁻¹ (no.) | Seeds siliqua⁻¹ (no.) | Plant height (cm) | Siliqua plant⁻¹ (no.) | Seeds siliqua⁻¹ (no.) | Plant height (cm) | Siliqua plant⁻¹ (no.) | Seeds siliqua⁻¹ (no.) |
| T₁         | 65.5b   | 31.9d | 11.97c | 52.6b | 18.3b | 11.2b | 29.8d | 11.5c | 9.3c | 29.8d | 11.5c | 9.3c | 29.8d | 11.5c | 9.3c | 29.8d | 11.5c | 9.3c |
| T₂         | 97.4a   | 102.4ab | 15.6a | 83.8a | 62.4a | 15.4a | 91.2a | 76.7ab | 15.9a | 91.2a | 76.7ab | 15.9a | 91.2a | 76.7ab | 15.9a | 91.2a | 76.7ab | 15.9a |
| T₃         | 93.0a   | 72.7bc | 13.0bc | 81.2a | 56.3a | 14.5a | 80.1a | 66.8b | 12.1b | 80.1a | 66.8b | 12.1b | 80.1a | 66.8b | 12.1b | 80.1a | 66.8b | 12.1b |
| T₄         | 98.5a   | 101.3ab | 15.3a | 83.5a | 63.0a | 15.4a | 80.7a | 80.2ab | 15.8a | 80.7a | 80.2ab | 15.8a | 80.7a | 80.2ab | 15.8a | 80.7a | 80.2ab | 15.8a |
| T₅         | 93.6a   | 82.2abc | 14.5ab | 83.3a | 59.0a | 15.0a | 80.0a | 74.8ab | 14.8a | 80.0a | 74.8ab | 14.8a | 80.0a | 74.8ab | 14.8a | 80.0a | 74.8ab | 14.8a |
| T₆         | 98.7a   | 106.3a | 16.1a | 86.1a | 64.0a | 15.8a | 86.3a | 86.7a | 16.0a | 86.3a | 86.7a | 16.0a | 86.3a | 86.7a | 16.0a | 86.3a | 86.7a | 16.0a |
| T₇         | 98.3a   | 88.2c | 14.5ab | 83.1a | 60.0a | 15.2a | 80.3a | 75.0ab | 15.5a | 80.3a | 75.0ab | 15.5a | 80.3a | 75.0ab | 15.5a | 80.3a | 75.0ab | 15.5a |
| T₈         | 99.3a   | 105.2a | 15.8a | 83.1a | 64.6a | 15.6a | 81.6a | 83.0a | 15.9a | 81.6a | 83.0a | 15.9a | 81.6a | 83.0a | 15.9a | 81.6a | 83.0a | 15.9a |
| CV(%)      | 4.68    | 19.92 | 5.86 | 6.00 | 9.67 | 9.05 | 8.62 | 12.28 | 7.71 | 8.62 | 12.28 | 7.71 | 8.62 | 12.28 | 7.71 | 8.62 | 12.28 | 7.71 |

Same letter in a column do not differ significantly at 5% level of significance as per DMRT. Note: T₁: Native soil fertility, T₂:100% chemical fertilizer (CF), T₃: 75% CF, T₄: 75% CF + Vermicompost (VC) @ 4 tha⁻¹, T₅:85%CF, T₆: 85% CF + VC @ 4 tha⁻¹, T₇: 75%CF+VC @ 2 tha⁻¹, T₈: 85%CF+VC @ 2 tha⁻¹.
The least growth and development was observed in the control treatment T1 at all the location. The results indicated that the application of 2 or 4 t ha\(^{-1}\) vermicompost either with 75% or 85% chemical fertilizer gave better performance in the growth and development of mustard. These results are in agreement with the findings of Kansotia \textit{et al.} (2015) and Reddy and Ohkura (2004).

**Effect of vermicompost on seed and straw yields of mustard:** Seed yield of mustard (Binasharisha 10) was significantly influenced with the different treatments at Rangpur, Ishurdi and Mymensingh (Table 4). Maximum seed yield was observed with the treatment T6 (1.82, 1.26 and 1.49 t ha\(^{-1}\) at Rangpur, Ishurdi and Mymensingh, respectively) in all the location followed by the treatment T8 (1.80, 1.23 and 1.46 t ha\(^{-1}\) at Rangpur, Ishurdi and Mymensingh, respectively but they were identical with the treatments T4 and T2 for producing of seed yield of mustard. The treatment T6 gave identical seed yield with the treatment T2, T4 and T8 at Rangpur and Mymensingh. The treatments T4, T6 and T8 did not differ significantly in case of seed yield of mustard which were also comparable to the treatment T2 (100% chemical fertilizer). The lowest seed yield of mustard was observed with the treatment T1 at all the location. Kansotia \textit{et al.} (2015) reported that application of vermicompost with inorganic fertilizer increased the yield of indian mustard. Desai \textit{et al.} (1999) evaluated the efficiency of vermicompost in field condition and stated that vermicompost along with fertilizer N gave higher dry matter and grain yield of wheat.

| Treatments | Rangpur | | Ishurdi | | Mymensingh |
|------------|---------|--------|---------|--------|---------|
| Seed yield | Straw yield | Seed yield | Straw yield | Seed yield | Straw yield |
| T1 | 0.58c | 2.22b | 0.29c | 0.83b | 0.26d | 1.41b |
| T2 | 1.72a | 4.47a | 1.22a | 3.78a | 1.43ab | 3.23a |
| T3 | 1.42b | 4.36a | 0.81b | 3.27a | 0.88c | 3.03a |
| T4 | 1.76b | 4.51a | 1.20a | 3.73a | 1.44ab | 3.37a |
| T5 | 1.53b | 4.44a | 1.07a | 3.43a | 1.03c | 3.10a |
| T6 | 1.82b | 4.55a | 1.26a | 3.91a | 1.49a | 3.40a |
| T7 | 1.54b | 4.45a | 1.13a | 3.63a | 1.34b | 3.33a |
| T8 | 1.80a | 4.71a | 1.23a | 3.85a | 1.46ab | 3.32a |
| CV(%) | 6.25 | 5.50 | 12.26 | 10.50 | 7.09 | 8.00 |

Same letter in a column do not differ significantly at 5% level of significance as per DMRT. Note: T1: Native soil fertility, T2:100% chemical fertilizer (CF), T3: 75% CF, T4: 75% CF + Vermicompost (VC) @ 4 tha\(^{-1}\), T5:85%CF, T6: 85% CF + VC @ 4 tha\(^{-1}\), T7: 75%CF+VC @ 2 tha\(^{-1}\), T8: 85%CF+VC @ 2 tha\(^{-1}\).

Similarly, a positive response was obtained with the application of vermicompost to other field crops such as sorghum (Patil and Sheelavantar 2000) and sunflower (Devi and Agarwal 199; Devi \textit{et al.} 1998). The results of the present study are in agreement with those findings. Similar trends were also observed in case of straw yield of mustard at all the location. The results indicated that 75% chemical fertilizer (CF) with 4 t ha\(^{-1}\) vermicompost or 85% CF with 2 t ha\(^{-1}\) vermicompost almost equally effective to produce seed yield of mustard (Binasharisha 10) which was also comparable with the full dose chemical fertilizer (100% CF). Therefore, 15-25% chemical fertilizer (NPKS) could be saved either with the application of
75% CF with 4 t ha\(^{-1}\) vermicompost or 85% CF with 2 t ha\(^{-1}\) vermicompost for mustard cultivation in Bangladesh.

**Nutrients uptake of mustard:** Total N, P and K uptakes of mustard were significantly affected with the integrated application of vermicompost with chemical fertilizers at all the location (Table 5). Maximum total N uptake was observed in the treatment T\(_8\) (85%CF+VC @ 2 tha\(^{-1}\)) at Rangpur (97.3 N kg ha\(^{-1}\)) and Mymensingh (74.7 N kg ha\(^{-1}\)) whereas the treatment T\(_6\) (85% CF + VC @ 4 tha\(^{-1}\)) showed maximum N uptake at Mymensingh (96.9 N kg ha\(^{-1}\)).

**Table 5.** Total N, P, and K uptakes (kg ha\(^{-1}\)) by mustard as affected by different treatments.

| Treatment | Rangpur N | Rangpur P | Rangpur K | I shurdi N | I shurdi P | I shurdi K | Mymensingh N | Mymensingh P | Mymensingh K |
|-----------|-----------|-----------|-----------|------------|-----------|-----------|-------------|-------------|-------------|
| T\(_1\)    | 28.8e     | 7.3e      | 34.8e     | 11.5d      | 3.0f      | 13.7f     | 14.8e       | 4.0f        | 22.0e       |
| T\(_2\)    | 91.6b     | 25.2b     | 81.9b     | 65.1ab     | 18.5b     | 66.4b     | 72.6b       | 20.8c       | 63.0b       |
| T\(_3\)    | 72.9d     | 19.1d     | 75.0d     | 44.4c      | 11.4e     | 53.4e     | 46.4d       | 13.0e       | 50.8d       |
| T\(_4\)    | 93.8ab    | 25.6b     | 82.5b     | 52.8bc     | 18.1b     | 65.1b     | 73.9ab      | 21.5b       | 64.7a       |
| T\(_5\)    | 82.2c     | 22.9c     | 77.2cd    | 57.5abc    | 16.1d     | 59.2d     | 55.1c       | 15.7d       | 55.7c       |
| T\(_6\)    | 96.9a     | 27.3a     | 84.3ab    | 68.4a      | 19.6a     | 69.1a     | 76.4a       | 22.5a       | 64.6a       |
| T\(_7\)    | 85.9c     | 24.0c     | 79.3c     | 63.2ab     | 17.6c     | 62.3c     | 70.9b       | 20.0c       | 62.5b       |
| T\(_8\)    | 97.3a     | 26.5ab    | 85.1a     | 68.3a      | 18.6b     | 67.0ab    | 74.7ab      | 21.5b       | 63.9b       |
| SE         | 1.33      | 0.50      | 0.74      | 4.36       | 0.32      | 0.65      | 1.19        | 0.28        | 0.83        |
| CV(%)      | 7.54      | 6.78      | 7.96      | 14.02      | 5.94      | 9.45      | 8.23        | 7.52        | 6.87        |

Same letter in a column do not differ significantly at 5% level of significance as per DMRT. Note: T\(_1\): Native soil fertility, T\(_2\):100% chemical fertilizer (CF), T\(_3\): 75% CF, T\(_4\): 75% CF + Vermicompost (VC) @ 4 tha\(^{-1}\), T\(_5\):85%CF, T\(_6\):85% CF + VC @ 4 tha\(^{-1}\), T\(_7\): 75%CF +VC @ 2 tha\(^{-1}\), T\(_8\): 85%CF+VC @ 2 tha\(^{-1}\).

Total N uptake by mustard observed identical in the treatment T\(_8\), T\(_6\), and T\(_4\) at all the location. The lowest Total N uptake was observed with the control treatment T\(_1\) (Native soil fertility) at all the location. Total N uptake of mustard increased might be due to vermicompost provides all nutrients in readily available form and also enhances uptake of nutrients by the crops. Sreenivas \textit{et al.} (2000) studied integrated effect of fertilizer and vermicompost on soil available N and uptake of ridge gourd (\textit{Luffa acutangula}) and stated that increasing levels of vermicompost gave the highest N uptake.

The highest Total P uptake (27.3, 19.6 and 22.5 kg P ha\(^{-1}\) at Rangpur, Ishurdi and Mymensingh, respectively) was observed in the treatment T\(_6\) (85% CF + VC @ 4 tha\(^{-1}\)) at all the location followed by the treatment T\(_8\) (Table 5). The results indicated that more P uptake of mustard was recorded where vermicompost was applied with the chemical fertilizers. Total P uptake by the crop was highest when fertilizer was applied in combination with vermicompost (Jadhav \textit{et al.} 1997). The results of present study are also in line with the findings of Kansotia \textit{et al.} (2015).

The highest Total K uptake of mustard (Table 5) was obtained with the treatment T\(_8\) (85% CF + VC @ 4 tha\(^{-1}\)) at Ishurdi (69.1 kg K ha\(^{-1}\)) and Mymensingh (66.4 kg K ha\(^{-1}\)) whereas the treatment T\(_6\) showed maximum total K uptake at Rangpur (85.1 kg K ha\(^{-1}\)). Nurtient uptakes varied in the different location might be due to
the variation of yield of crops due to the application of vermicompost with fertilizers. The results indicated that application of vermicompost with chemical fertilizer (CF) increased the nutrients uptake by mustard than only sole application of CF. Application of organic manure along with chemical fertilizer accelerates the microbial activity (Rani and Srivastava, 1997), increases nutrients use efficiency (Narwal and Chaudhary, 2006) and enhances the availability of the native nutrients to the crops resulting higher nutrients uptake (Bhandari et al., 1992).

**Conclusion**

The results indicated that 75% CF with 4 t ha\(^{-1}\) vermicompost or 85% CF with 2 t ha\(^{-1}\) vermicompost almost equally effective to produce seed yield of mustard which was also comparable with the full dose (100%) of chemical fertilizers (NPKS) at all the location. Therefore 15-25% chemical fertilizer (NPKS) could be saved either with the application of 75% CF with 4 t ha\(^{-1}\) vermicompost or 85% CF with 2 t ha\(^{-1}\) vermicompost for mustard cultivation.

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