

## Effects of integrated nutrient management on the yield and yield attributes of mustard varieties

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### ABSTRACT

An experiment was conducted during the period from November 2017 to February 2018 to evaluate the effect of integrated nutrient management on the yield and yield attributes of mustard varieties. Two varieties namely BARI Sarisha-14 ( $V_1$ ) and BARI Sarisha-16 ( $V_2$ ) were assigned to the main plot and six integrated nutrient managements (INM) viz., 75% RDF (Recommended dose of fertilizer) ( $T_1$ ), 75% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup> ( $T_2$ ), 100% RDF (90:27:32:15:1, N:P:K:S:Zn:B) - ( $T_3$ ), 100% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup> ( $T_4$ ), 125% RDF ( $T_5$ ) and 125% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup> ( $T_6$ ) to the sub-plot. Results revealed that most of the yield and yield attributes were significantly influenced by varieties and INM. The highest seed yield (1.82 t ha<sup>-1</sup>) was obtained from BARI Sarisha-16 and the lower seed yield (1.51 t ha<sup>-1</sup>) was observed in BARI Sarisha-14. Among the INM treatments, the highest seed yield (1.91 t ha<sup>-1</sup>) was recorded from 75% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup> ( $T_2$ ), which was statistically similar to 100% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup> ( $T_4$ ). Therefore, BARI Sarisha-16 should be grown with 75% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup> for obtaining higher yield.

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### Introduction

Mustard (*Brassica* sp.) is one of the most important oil seed crops of the world after soybean and groundnut (FAO, 2012). It is commonly known as “Sarisha” in Bangla and is being cultivated throughout the country during the winter season (November to March). It has a remarkable demand for edible oil in Bangladesh. It accounts for 59.4% of total oil seed production in the country and it covers the major portion of the total edible oil requirement of the country (AIS,

2010). Among the oil seed crops grown in Bangladesh, mustard tops the list in respect of both production and acreage (BBS, 2015). Mustard oil plays an important role as a fat substitute in our daily diet. This oil is widely used in cooking and as medical ingredients. Mustard is not only a rich source of energy (about 9 kcal g<sup>-1</sup>), but also rich in fat soluble vitamins like A, D, E and K. Mustard seeds contain 40-45% oil and 20-25% protein and mustard oilcake contains 40% protein that is used as nutritious animal feed and high quality manure for crop production. With increasing population, the demand of edible oil is increasing day by day. It is, therefore, highly accepted that the production of edible oil should be increased considerably to fulfill the demand. The area under mustard is declining due to late

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harvesting of high yielding *T. aman* rice and increased cultivation of *boro* rice. The decrease in an area of 104,000 hectare and production 68,000 tons of mustard and rapeseed in last ten years has been reported (Anonymous, 2006). The present area and production of mustard is 3.25 lac hectare and 3.59 lac metric ton respectively. The average yield of mustard in Bangladesh is very low (1.08 t/ha) (BBS, 2018) compared to other oilseeds growing countries of the world. Presently, on an average, 2.3 to 2.4 million tonnes of edible oils, both in oil and seeds form, are imported in the country (Alam, 2018). The internal production of edible oil can meet up only less than one-third of the annual requirement (Mondal and Wahhab, 2001). The major reasons for low yield of rapeseed-mustard in our country are due to lack of high yielding variety and proper management practices etc. There is a great scope of increasing yield of mustard by selecting high yielding varieties and improving management practices (Bhuiyan *et al.*, 2008).

Nutrient management is one of the most important agronomic factor that affects the mustard productivity. But application of all the needed fertilizer through chemical fertilizers had deleterious effect on soil fertility and unsustainable yields. In order to bring the soil well supplied with all the essential plant nutrients and also to maintain it in good health, it is necessary to use organic source like farmyard manure, vermicompost, neemcake and poultry manure which are good source of nutrients required by plants for quality produce. Vermicompost is a rich source of macro and micro nutrients, vitamins, enzymes, antibiotics, growth hormones and micro flora. Vermicompost application has been known to improve physical, chemical and biological properties of soil (Nagavallema *et al.*, 2004). Organic manures improve the physical and nutritional system of soil and also enhance the activity of soil microflora (Hadiyal *et al.*, 2017).

Use of chemical fertilizers in combination with organic manure is essentially required to improve the soil health (Prasad *et al.* 2010). Chemical fertilizers/organic manures alone cannot sustain the desired levels of crop production under continuous farming. Integrated nutrient management is very essential which is not only sustains high crop production over the years (Verma *et al.* 2010) but also improves soil health and ensures safer environment (Vijaya *et al.* 2007). The nutrient supplied to crops through

IPNM not only restoring the soil fertility but also sustain desired level of production over the years (Pal and Pathak, 2016). Balanced nutrient management through conjunctive use of organic, inorganic and bio-fertilizers facilitate profitable and sustainable crop production and also maintain soil quality (Singh and Sinsinwar, 2006).

Keeping all the above facts in view, the present investigation was undertaken to study the effect of integrated nutrient management on the yield and yield attributes of mustard.

## Materials and Methods

### *Experimental site and soil*

The field experiment was conducted at the Agronomy Field Laboratory of the Rajshahi University, Rajshahi, during the period of November 2017 to February 2018 to study the effect of integrated nutrient management on the yield and yield attributes of mustard varieties. Geographically the experimental field is located at 24°17'-24°31' N latitude and 88°28'-88°43' E longitude with a height of 20m above the sea level. It belongs to High Ganges River Floodplain, which falls in Agro-ecological Zone-11(AEZ-11).The land was flat, well drained and above flood level. The soil of the experimental plot contained pH 7.56, organic matter 0.65%, total nitrogen (%) 0.09, available P (ppm) 17.67, available K (milimol/l) 0.23, available S( $\mu\text{g g}^{-1}$ ) 9.35, available Zn ( $\mu\text{g g}^{-1}$ ) 0.33 and available B (ppm) 25.45. During the experimental period, average maximum and minimum temperature, relative humidity and rainfall ranged from 24.8 to 35.7 °C, 13.5 to 24.9 °C and 76.03-90.60%, 2.17-51.5 mm.

### *Experimental design and treatment*

The experimental treatments included (a) two varieties and (b) 6 levels of integrated nutrient managements. The experiment was laid out in a split-plot design with three replications. Two varieties namely BARI Sarisha-14 ( $V_1$ ) and BARI Sarisha-16 ( $V_2$ ) were assigned to the main plots and six Integrated Nutrient Managements (INM) viz., 75% RDF ( $T_1$ ), 75% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup> ( $T_2$ ), 100% RDF (90:27:32:15:1, N:P:K:S:B) - ( $T_3$ ), 100% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup> ( $T_4$ ), 125% RDF ( $T_5$ ) and 125% RDF + Vermicompost (VC) @2.5 t ha<sup>-1</sup> ( $T_6$ ) to the sub-

plot. The unit plot size was 4 m x 2m having a spacing of 60cm, 50 cm and 30cm in between the blocks, main plots and unit plots, respectively.

### *Plant material*

BARI Sarisha-14 and BARI Sarisha-16, high yielding variety developed by the Bangladesh Agricultural Research Institute were used as the plant material in this study. BARI Sarisha-14, a short duration variety, plant height 75-85 cm, leaf light green, smooth, siliqua/plant 80-102, two chambers are present in pod but as like as four chambers. Seed/siliqua 22-26, seed color pink, 1000 seed weight 3.5-3.8 g, crop duration 75-80 days. BARI Sarisha-16, late planting potential, plant height 175-195 cm, siliqua/plant 180-200, two chamber are present in pod, seed/siliqua 9-11, seed color pink, 1000 seed weight 4.7-4.9 g, crop duration 105-115 days. Seeds of both the variety were collected from Pulse Research Centre, RARS, Bangladesh Agricultural Research Institute, Ishurdi, Pabna.

### *Crop husbandry and data collection*

The land was opened by a power tiller, later on it was ploughed and cross ploughed with bullock drawn country plough followed by laddering to obtain a good tilth condition. The first ploughing was done on 26 October and final land preparations were done on 05 November 2017, respectively. Treatment wise fertilizer was applied in each unit plot. The experimental plots were fertilized with Urea, TSP, MoP, Gypsum and Borax fertilizers as per experimental treatment. The whole amount of all chemical fertilizers except urea was applied as a basal dose during final land preparation. The urea fertilizer was applied as two equal installments; as basal dose and before flowering. Vermicompost was applied before sowing in furrows as per treatments specification. Two hands weeding cum thinning were done for all the treatments at 15 and 25 days after sowing (DAS). Intercultural operations were done as and when necessary. The field was infested by different insects and diseases which were also controlled as and when necessary. The two varieties were harvested on different dates at full maturity. Before harvesting the whole plot, 10 plants were randomly selected from each plot for collecting data on yield attributes. The sample plants were uprooted prior to harvest and dried

properly in the sun and collected data from these plants. The seed and stover yields were measured from the plot after harvesting, cleaning and drying the plants from the whole plot.

### *Statistical analysis*

The recorded data on various plant characters were statistically analyzed to find out the significance of variation resulting from the experimental treatments. Analysis of variance (ANOVA) for each of the characters under study was done with the help of computer package MSTAT-C. The mean differences were compared with Duncan's New Multiple Range Test (Gomez & Gomez, 1984).

### **Results**

The results revealed that most of the yield and yield contributing characters were significantly influenced by varieties and integrated nutrient management. Significantly the tallest plant (93.24cm) was produced by BARI Sarisha-16 compared to that of variety BARI Sarisha-14 (70.45 cm) (Table 1). Numerically the T<sub>6</sub> (125% RDF + Vermicompost (VC) @2.5 t ha<sup>-1</sup>) treatment produced the tallest plant (86.19 cm) and smallest plant (75.26 cm) was found in T<sub>1</sub> (75% RDF) (Table 2). The interaction effect of variety and integrated nutrient management failed to exert any significant influence on plant height (Table 3). From the results it is evident that plant height increased with the increase in nutrient level and application of vermicompost. BARI Sarisha-16 statistically gave the highest number of branches plant<sup>-1</sup> (6.66) whereas the lowest value of branches plant<sup>-1</sup> (5.31) was found in BARI Sarisha-14. The maximum number of branches plant<sup>-1</sup> (6.57) was recorded from treatment T<sub>6</sub> (125% RDF + Vermicompost (VC) @2.5 t ha<sup>-1</sup>), which was statistically similar to T<sub>5</sub> (125% RDF) but the lowest number of branches plant<sup>-1</sup> (5.34) was obtained from T<sub>1</sub> (75% RDF) that is statistically at par with T<sub>2</sub> (75% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup>) (Table 1 & 2). The maximum number of branches plant<sup>-1</sup> (7.58) was observed from the interaction of V<sub>2</sub> x T<sub>6</sub> (BARI Sarisha-16 and with 125% RDF + Vermicompost (VC) @2.5 t ha<sup>-1</sup>) and the lowest (5.02) was found in the combination of V<sub>1</sub> x T<sub>1</sub> (BARI Sarisha-14 and 75% RDF) (Table 3). The longer siliqua (4.83 cm) was produced from the BARI Sarisha-14, but the shortest siliqua (4.23

**Table 1.** Effect of variety on the yield and yield attributes of mustard

Variety	Plant height (cm)	Number of branches plant <sup>-1</sup>	Siliqua length (cm)	Number of siliquae plant <sup>-1</sup>	Number of seeds siliqua <sup>-1</sup>	1000- seed weight(g)	Stover yield (t ha <sup>-1</sup> )	Harvest Index (%)
V <sub>1</sub>	70.45b	5.31b	4.83a	91.87b	17.50a	3.25b	4.07	27.03b
V <sub>2</sub>	93.24a	6.66a	4.23b	136.57a	12.58b	4.18a	4.18	30.26a
<b>Level of Significance</b>	0.01	0.05	0.01	0.01	0.01	0.01	NS	0.01
<b>CV(%)</b>	8.39	8.49	8.39	8.19	9.62	8.16	5.56	6.64

In a column, the figure with same letter (s) or without a letter (s) does not differ significantly where as dissimilar letter differs significantly (as per DMRT) at 5% level of probability, NS= Not significant, CV= Coefficient of variation; V<sub>1</sub> = BARI Sarisha-14, V<sub>2</sub> = BARI Sarisha-16.

cm) was obtained from variety BARI Sarisha-16 (Table 1). Numerically the longest siliqua (4.67cm) was produced from T<sub>6</sub>(125% RDF + Vermicompost (VC) @2.5 t ha<sup>-1</sup>) treatment and the lowest (4.29 cm) was obtained from T<sub>1</sub>(75% RDF) treatment (Table 1 & 2). However, the tallest siliqua (5.00 cm) was produced by the treatment combination of V<sub>1</sub> x T<sub>6</sub> while the lowest value (3.99 cm) was found from treatment combination of V<sub>2</sub> x T<sub>1</sub>. Significantly higher number of siliquae plant<sup>-1</sup> (136.57) was found in the variety BARI Sarisha-16 and lower number of siliquae plant<sup>-1</sup> (91.87) was obtained from the variety BARI Sarisha-14 (Table 1). Number of siliqua plant<sup>-1</sup> of mustard showed a statistically significant variation for integrated nutrient management under the present trial (Table 2). The highest number of siliqua plant<sup>-1</sup> (126.30) was observed in T<sub>2</sub> which was statistically similar with T<sub>3</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub> while the lowest number of siliqua (99.35) was obtained from T<sub>1</sub>. There was no significant difference on number of siliqua plant<sup>-1</sup> due to the treatment combinations of variety and integrated nutrient management. Numerically the highest number of pod plant<sup>-1</sup> (151.15) was obtained from treatment combination of V<sub>2</sub>T<sub>2</sub> and the lowest (81.19) was found in the treatment combination of V<sub>1</sub> x T<sub>1</sub> (Table 3).

Significantly the higher number of seeds siliqua<sup>-1</sup> (17.50) was found in the variety BARI Sarisha-14 and lower number of seeds siliqua<sup>-1</sup> (12.58) was obtained from the variety BARI Sarisha-16 (Table 1). In case of INM, the maximum number of seeds siliqua<sup>-1</sup> (16.79) was observed in T<sub>2</sub> (Table 2) which was statistically similar with T<sub>3</sub>, T<sub>4</sub> and T<sub>6</sub> and the lowest number

of seeds siliqua<sup>-1</sup> (13.05) from T<sub>1</sub> which was statistically similar with T<sub>5</sub>. The highest number of seeds siliqua<sup>-1</sup> (19.48) was obtained from the interaction of V<sub>1</sub> x T<sub>2</sub> and the lowest (10.60) was found in V<sub>2</sub> x T<sub>1</sub> (Table 3). BARI Sarisha-16 significantly produced the highest 1000-seed weight (4.18 g) and the lowest 1000-seed weight (3.25 g) was produced by the BARI Sarisha-14. The highest weight of 1000 seed (4.18 g) was markedly noticed from T<sub>2</sub> (75% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup>) treatment and the lowest value (3.12 g) was produced by T<sub>1</sub> (75% RDF) (Table 1 & 2).

Numerically, the highest 1000 seed weight (4.63 g) was obtained from the interaction of V<sub>2</sub> x T<sub>2</sub> and the lowest (2.90 g) was found in V<sub>1</sub> x T<sub>1</sub>.

Variety and integrated nutrient management had a significant effect on seed yield of mustard but their interaction did not show any significant difference. The higher seed yield (1.82 t ha<sup>-1</sup>) was observed in BARI Sarisha-16 and the lower yield (1.51 t ha<sup>-1</sup>) was produced by BARI Sarisha-14 (Fig. 1). The maximum seed yield (1.91 t ha<sup>-1</sup>) was recorded from T<sub>2</sub> (75% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup>) treatment, which was statistically similar with the treatment T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub> and the lowest seed yield (1.42 t ha<sup>-1</sup>) was obtained from T<sub>1</sub> (75% RDF) (Fig. 2). Numerically, the highest seed yield (2.13 t ha<sup>-1</sup>) was observed in the interaction of V<sub>2</sub> x T<sub>2</sub> and the lower yield (1.32 t ha<sup>-1</sup>) was produced by interaction of V<sub>1</sub> x T<sub>1</sub> (Fig. 3). Numerically the higher stover yield (4.18 t ha<sup>-1</sup>) was found in BARI Sarisha-16 and lower stover yield (4.07 t ha<sup>-1</sup>) was obtained from the BARI

**Table 2.** Effect of integrated nutrient management (INM) on the yield and yield attributes of mustard

Treatment	Plant height (cm)	Number of branches plant <sup>-1</sup>	Siliqua length (cm)	Number of siliquae plant <sup>-1</sup>	Number of seeds siliqua <sup>-1</sup>	1000-seed weight(g)	Stover yield (t ha <sup>-1</sup> )	Harvest Index (%)
T1	75.26	5.34b	4.29	99.35b	13.05c	3.12c	3.81b	27.07c
T2	79.98	5.52b	4.50	126.30a	16.79a	4.18a	4.14ab	31.43a
T3	82.59	5.99ab	4.59	112.40ab	15.02abc	3.72ab	4.20a	27.78bc
T4	83.45	6.14ab	4.59	119.00a	15.87ab	3.91ab	4.10ab	30.71ab
T5	83.62	6.37a	4.55	112.50ab	14.25bc	3.65b	4.41a	26.07c
T6	86.19	6.57a	4.67	115.9a	15.27abc	3.71ab	4.07ab	28.85abc
Level of Significance	NS	0.01	NS	0.01	0.01	0.01	0.01	0.01
LSD	-	0.8003	-	14.71	2.275	0.477	0.362	2.99
CV(%)	8.39	8.49	8.39	8.19	9.62	8.16	5.56	6.64

In a column, the figure with same letter (s) or without a letter (s) does not differ significantly where as dissimilar letter differs significantly (as per DMRT) at 5% level of probability, NS= Not significant, CV= Coefficient of variation, LSD=Least significant difference; T<sub>1</sub>=75% RDF, T<sub>2</sub>=75% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup>, T<sub>3</sub>=100% RDF (90:27:32:15:1, N:P:K:S:Zn:B), T<sub>4</sub>=100% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup>, T<sub>5</sub>=125% RDF and T<sub>6</sub>=125% RDF + Vermicompost (VC) @2.5 t ha<sup>-1</sup>.

Sarisha-14 (Table 1). Significantly, the highest stover yield (4.41 t ha<sup>-1</sup>) was produced by the treatment T<sub>5</sub> (125% RDF) which was statistically at par with the treatments T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>6</sub> whereas the lowest stover yield (3.81 t ha<sup>-1</sup>) was found in T<sub>1</sub> (Table 2). Numerically the higher stover yield (4.57 t ha<sup>-1</sup>) was observed the treatment combination of V<sub>2</sub> x T<sub>5</sub> and the lowest stover yield (3.80 t ha<sup>-1</sup>) was found in the combination of V<sub>2</sub> x T<sub>1</sub> (Table 3). Significantly the highest harvest index (30.26 %) was observed in BARI Sarisha-16 and the lower harvest index (27.03 %) was found in BARI Sarisha-14 (Table 1). The maximum harvest index (31.43 %) was recorded from T<sub>2</sub> (75% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup>), which was statistically similar to the treatment T<sub>4</sub> and the lowest harvest index (26.07 %) was obtained from T<sub>5</sub> (125% RDF) that was statistically at par with the treatment T<sub>1</sub> (75% RDF) (Table 2). Numerically, the highest harvest index (33.19%) was observed in the interaction of V<sub>2</sub> x T<sub>2</sub> and the lowest harvest index (25.70 %) was produced by interaction of V<sub>1</sub> x T<sub>1</sub> (Table 3).

## Discussion

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. The results revealed that most of the yield and yield contributing characters were significantly influenced by varieties and integrated nutrient management (INM). Significantly the highest plant height was obtained from the variety BARI Sarisha-16 and the lowest in BARI Sarisha-14. It represents the varietal characteristics of a variety. The differences in plant height of different varieties might have been resulted from genetic makeup of the cultivars, but the environmental factors also influence a little. The results of the present experiment for plant height were in agreement with Ali *et al.* (1996) who also reported significant variation in plant height among the different varieties of mustard and rape. The plant height and number of branches plant<sup>-1</sup> increased with the increase of fertilizer level and addition of vermicompost. Improvement in these parameters like plant height and number of primary & secondary branches per plant due to vermicompost might be due to supply of plant nutrients including micronutrients, improvement in soil physical and biological properties and increased availability of nutrients. Thus, favourable influence of nutrients to produce larger cell with thinner cell wall and its contribution in

cell division and cell elongation which improved vegetative growth and ultimately increased plant height and number of primary & secondary branches per plant. The similar results were found by De and Sinha (2012), Yadav *et al.* (2013) and Kansotia *et al.* (2015). Results showed significant difference on siliqua length between two varieties.

that the napus group showed higher siliqua length than that of juncea group (BARI, 2001). Addition of vermicompost with chemical fertilizers gave the longest siliqua length. These results are in conformity with Pati and Mahapatra (2015). They also found longest siliqua from the treatment combination of organic and chemical fertilizer.

**Table 3.** Interaction effect of variety and integrated nutrient management (INM) on the yield and yield attributes of mustard

V x T	Plant height (cm)	Number of branches plant <sup>-1</sup>	Siliqua length (cm)	Number of siliquae plant <sup>-1</sup>	Number of seeds siliqua <sup>-1</sup>	1000-seed weight(g)	Stover yield (t ha <sup>-1</sup> )	Harvest index (%)
V <sub>1</sub> X T <sub>1</sub>	66.57	5.02c	4.59	81.19	15.50	2.90	3.82	25.70
V <sub>1</sub> X T <sub>2</sub>	67.62	5.24c	4.75	101.44	19.48	3.73	4.00	29.64
V <sub>1</sub> X T <sub>3</sub>	71.42	5.24c	4.86	89.03	17.33	3.17	4.17	26.44
V <sub>1</sub> X T <sub>4</sub>	71.92	5.47c	4.86	94.91	18.33	3.42	4.08	28.67
V <sub>1</sub> X T <sub>5</sub>	71.32	5.34c	4.93	91.28	16.50	3.10	4.25	24.78
V <sub>1</sub> X T <sub>6</sub>	73.83	5.55c	5.00	93.35	17.87	3.17	4.08	26.97
V <sub>2</sub> X T <sub>1</sub>	83.94	5.67c	3.99	117.52	10.60	3.33	3.80	28.44
V <sub>2</sub> X T <sub>2</sub>	92.33	5.79c	4.24	151.15	14.10	4.63	4.29	33.19
V <sub>2</sub> X T <sub>3</sub>	93.75	6.73b	4.31	135.68	12.70	4.27	4.23	29.13
V <sub>2</sub> X T <sub>4</sub>	94.97	6.80ab	4.32	143.03	13.40	4.40	4.11	32.73
V <sub>2</sub> X T <sub>5</sub>	95.92	7.41ab	4.17	133.69	12.00	4.20	4.57	27.36
V <sub>2</sub> X T <sub>6</sub>	98.55	7.58a	4.34	138.37	12.67	4.25	4.06	30.72
Level of Significance	NS	0.05	NS	NS	NS	NS	NS	NS
LSD	-	0.81	-	-	-	-	-	-
CV(%)	8.39	8.49	8.39	8.19	9.62	8.16	5.56	6.64

In a column, the figure with same letter (s) or without a letter (s) does not differ significantly whereas dissimilar letter differs significantly (as per DMRT) at 5% level of probability, NS= Not significant, CV= Coefficient of variation, LSD=Least significant difference; V<sub>1</sub> = BARI Sarisha-14, V<sub>2</sub> = BARI Sarisha-16; T<sub>1</sub>=75% RDF, T<sub>2</sub>=75% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup>, T<sub>3</sub>=100% RDF (90:27:32:15:1, N:P:K:S:Zn:B), T<sub>4</sub>=100% RDF + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup>, T<sub>5</sub>=125% RDF and T<sub>6</sub>=125% RDF + Vermicompost (VC) @2.5 t ha<sup>-1</sup>.

This result was in conformity to the finding of Akhter (2005) who pointed out that variations in siliqua length among the varieties were statistically significant. Hossain *et al.* (1996) also reported that the varieties differed significantly in respect of siliqua length. It has been also reported

The results indicated the variation of number of siliqua plant<sup>-1</sup> between two mustard varieties. These differences were mostly due to their variation of morphological characters and genetic makeup of two varieties. Biswas *et al.* (2019), Mamun *et al.* (2014), Akhter (2005) and Roy

(2008) also reported similar observations that the number of siliqua plant<sup>-1</sup> of rapeseed mustard was significantly affected by the varieties.

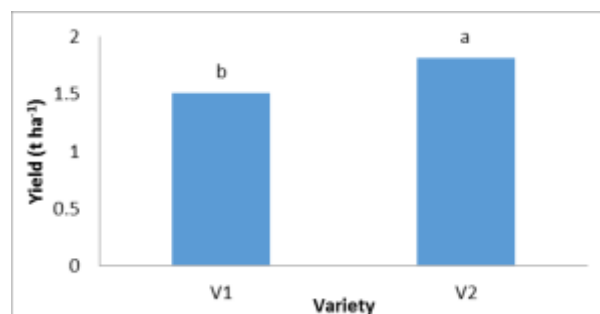


Fig. 1. Effect of variety on the yield and yield attributes of mustard

The number of siliqua plant<sup>-1</sup> was significantly influenced by the application of vermicompost. The increase in siliqua plant<sup>-1</sup> due to the application of vermicompost might be due to the fact that application of organic manure favorably improved the nutritional environment thereby resulting in better growth and development leading to higher yield attributes and yield. These results are in close agreement to Singh *et al.* (2013), Yadav *et al.* (2013) and Lepcha *et al.* (2015). It was observed that variety exerted significant variation on seeds siliqua<sup>-1</sup> between two varieties. Varietal variation regarding the number of seeds siliqua<sup>-1</sup> might be due to their variation in genetic constitutions and also due to variation in photosynthetic assimilate accumulation. It was in conformity with Biswas *et al.* (2019) and Mamun *et al.* (2014), who found the highest seeds siliqua<sup>-1</sup> in BARI Sarisha-13 and the lowest seeds siliqua<sup>-1</sup> in BARI Sarisha-16. This result supports the findings of Jahan and Zakaria (1997) and Gurjar and Chauhan (1997). Variation in seeds siliqua<sup>-1</sup> among the varieties was also in conformity with Islam *et al.* (1994) who found a significant variation in number of seeds siliqua<sup>-1</sup> among different varieties of mustard and rapeseed. Variety showed statistically significant differences for 1000 seed weight of mustard under the present study. The variation in 1000-grain weight might be due to differences of size of the grains that were partly controlled by genetic makeup of the variety under study. Biswas *et al.* (2019) and Mamun *et al.* (2014) also observed the variation of 1000- seed weight among the mustard varieties. The results indicated that 1000-seed weight increased with the addition of vermicompost. These findings clearly indicate

that optimum supplied of fertilizers combined with organics which provide opportunity for seeds to grow their full potential, with an obvious increase in 1000-seed weight as observed in the study.

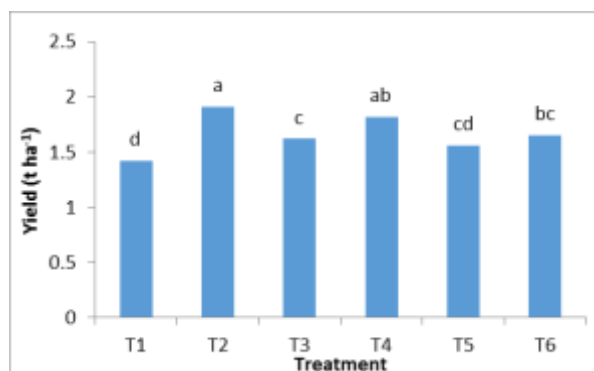


Fig. 2. Effect of integrated nutrient management (INM) on the yield and yield attributes of mustard

Production of higher seed yield by the variety of BARI Sarisha-16 might be due to the contribution of the cumulative favorable effects of the crop characters viz. number of branches plant<sup>-1</sup>, siliqua plant<sup>-1</sup> and weight of 1000 seeds. This result is in conformity with the findings of Biswas *et al.* (2019), Rahman (2002) and BARI (2001) who reported that seed yield of rape and mustard were varied with different varieties. The balanced nutrient management practices contributed to a great extent influencing the seed yield of mustard. Results revealed that the combination of recommended inorganic fertilizer with vermicompost resulted in comparable better seed yield in mustard. The increase in seed yield due to application of vermicompost might be due to the fact that application of organic manure favorably improved the nutritional environment thereby resulting in better growth and development leading to higher yield attributes and yield. These results are in close agreement to Singh *et al.* (2013), Yadav *et al.* (2013), Lepcha *et al.* (2015), Dhaka and Satish (2003) and Thanki (2004). This improvement in seed yield is might be due to improvement of soil pH, physicochemical properties of soil due to application of organic fertilizer and instant availability of nutrients from inorganic fertilizers. The increment in supply of essential nutrients to mustard, their availability, acquisition, mobilization and influx into the plant tissue increasing and thus improved yield components and finally the yield. These results are in conformity with those of Singh and Sinsinwar (2006) and Datta *et al.* (2009).

Significantly higher stover yield was produced by Sarisha-16 and BARI BARI Sarisha-14 produced lower stover yield. The cause of increase in stover yield might be due to increasing branches number and plant height of mustard variety BARI Sarisha-16.

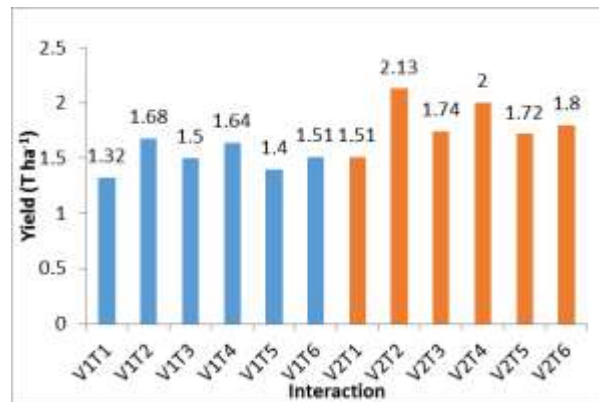


Fig. 3. Interaction effect of variety and integrated nutrient management (INM) on the yield and yield attributes of mustard

This result is in agreement with Islam (1994) and Chakraborty *et al.* (1991) who reported that dry matter production in crops is importantly determined by varietal characteristics. The stover yield increased with the increasing fertility levels. Addition of chemical fertilizers and their integration with vermicompost increased the stover yield. The stover yield of mustard was significantly increased with increased levels of fertility upto 125% RDF, it gave more stover. In general vermicompost affected the harvest index of the crop. Lepcha *et al.* (2015) observed similar results in case of harvesting index.

## Conclusion

Present study confirms that vermicompost increases soil organic matter status, which act as a reservoir for nutrients and hence improve soil physicochemical attributes for yield. This study indicates that combined application of manure (Vermicompost) and inorganic fertilizers help to increase crop productivity by improving soil fertility and soil quality. Our present investigation will be useful to farmers; agronomist, researchers and environmentalists as it will provide information in maintaining long term soil fertility; sustained higher productivity of crop and lessen the harm caused to the soil by the use of fertilizers. It is clear that mustard varieties and integrated nutrient management (INM) practices have significant influences on the yield

contributing characters and yield of mustard. Application of 75 % RDF (recommended dose of fertilizer) + Vermicompost (VC) @ 2.5 t ha<sup>-1</sup> with BARI Sarisha-16 was the best treatment for higher mustard yield. However, to arrive a definite conclusion and recommendation more research work on wider range of nutrient management practices and varieties should be tested over all different Agro-ecological Zones (AEZ) of the country.

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