Original Research Article

Growth and Yield Parameters of Black Mustard (*Brassica nigra L.*) under Organic Manures and Different Spacing

Abstract

A field experiment was conducted during *Rabi* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.36 %), available N (171.48 kg/ha), available P (15.2 kg/ha) and available K (232.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are T_1: FYM @ 10 t/ha + 20 x 10 cm, T_2: FYM @ 10 t/ha + 30 x 10 cm, T_3: FYM @ 10 t/ha + 40 x 10 cm, T_4: Poultry Manure @ 4 t/ha + 20 x 10 cm, T_5: Poultry Manure @ 4 t/ha + 30 x 10 cm, T_6: Poultry Manure @ 4 t/ha + 40 x 10 cm, T_7: Vermicompost @ 5 t/ha + 20 x 10 cm, T_8Vermicompost @ 5 t/ha + 30 x 10 cm, T_9: Vermicompost @ 5 t/ha + 40 x 10 cm. The results showed that application of Poultry Manure @ 4 t/ha + 30 x 10 cm recorded significantly higher plant height (134.04 cm), No. of Branches/plant (9.77), Plant dry weight (21.16 g/plant), Crop growth rate (5.16 g/m^2/day), Siliqae/plant (174.74), Seeds/siliquae (33.19), Test weight (3.22 g), Seed yield (1749.38 kg/ha), Stover yield (3209.05 kg/ha), gross returns (Rs.96215.90/ha), net return (Rs.65210.90/ha) and benefit cost ratio (2.10) as compared to other treatments.

Key words: FYM, Poultry manure, Vermicompost, Spacing, yield.

1.Introduction

Rapeseed mustard occupies about 24.7 percent of the total oilseeds area and contributes 22.9 percent to the oilseeds production of the country. The leaves of young plants are used as green vegetables, as they supply Sulphur and minerals in the diet **(Sondhiya *et al.*, 2019).** The estimated area, production and yield of rapeseed-mustard in the world was 36.59 million hectares (m ha), 72.37 million tonnes (mt) and 1980 kg / ha, respectively, during 2018-19. Globally, India accounts for 19.8 % and 9.8% of the total acreage and

production (USDA). India occupies the second position in area after China and third position in production in the world after China and Canada. Rapeseed and mustard are the major Rabi oilseed crops of India and stand next to groundnut in the oilseed economy. Rapeseed and mustard are one of the most important edible oils of northern and eastern parts of India. Various nutrients and micronutrients are required for oilseed production, but the nutrient which plays a multiple role in providing nutrition to oilseed crops, particularly those belonging to cruciferae family **(Chaurasia *et al.*, 2009).**

"Major mustard growing states in India Rajasthan (40.82%), Haryana (13.33%), Madhya Pradesh (11.76%), Uttar Pradesh (11.40%) and West Bengal (8.64%) according to 2018-19 year**.** The seeds are highly nutritive containing 38-57% erucic acid, 5-13% linoleic acid and 27% oleic acid. They are not only rich sources of energy and carriers of fat soluble vitamins A, D, E and K but they form the ingredients of foods and flavors, cosmetics and condiments, soap and detergents, lubricants and laxatives and also known for their medical and therapeutic use" **(Bhamdare *et al.*, 2020).**

In India, Mustard is mainly cultivated in sub-tropical climate, but recent stats prove that it thrives well in dry and cool climate. It requires the temperature from 10^0 to 25^0 C. The crop is highly susceptible to the frost conditions and it requires rainfall of 625- 1000 mm annual rainfall for its proper growth. It can be cultivated in both light to heavy loamy soils with 6-7.5 pH because of its deep root system. In the tropics, it is normally Intercropped with gram, wheat and lentils mostly in the spring seasons.

Organic manures like farmyard manure, Vermicompost and poultry manure are good source of nutrients required by plants for quality produce. They contains stable organic matter of up to sixty percent. Vermicompost helps to improve plants health, acts preventively against fungal diseases; scientific research conducted on the effects of Vermicompost has found 30-50% increase in nitrogen uptake, increase in root length, root numbers and shoot length. Organic farming is an eco-friendly system of farming which can maintain the soil fertility and productivity Repeated studies and observation have found that organic farming can withstand severe weather conditions better than conventional farming. However organic farms yield on average 10-15% less than conventional farming system, but the lower yields are balanced by the lower input cost such as fertilizer and pesticides and higher profit margin **(Bhagchand *et al.*, 2013).**

Planting patterns play an important role in enhancing overall productivity of crops as They are likely to affect interception, absorption, penetration and utilization of incoming solar radiation. Plant density is another important aspect, which can be manipulated to attain the maximum production from per unit land area. The optimum plant density with proper geometry of planting is dependent on variety, its growth habit and agro-climatic conditions **(Sondhiya *et al.*, 2019).** "It is imperative to adjust plant population through planting method which may help in avoiding overcrowding. Higher plant population per unit area beyond an optimum limit results in competition among the plants for natural resources, Hence, weaker plant and may cause severe lodging" **(Jangir *et al.*, 2017).**

2.Materials and Methods

This experiment was carried out during *Rabi* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, UP, which is located at 25.28^{o}N latitude, 81.54^{o}E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Allahabad Rewa Road about 5 km away from Prayagraj city. All the facilities required for crop cultivation were met out from the department. The experiment was laid out in Randomized Block Design consisting of nine treatments which are T_1: FYM @ 10 t/ha + 20 x 10 cm, T_2: FYM @ 10 t/ha + 30 x 10 cm, T_3: FYM @ 10 t/ha + 40 x 10 cm, T_4: Poultry Manure @ 4 t/ha + 20 x 10 cm, T_5: Poultry Manure @ 4 t/ha + 30 x 10 cm, T_6: Poultry Manure @ 4 t/ha + 40 x 10 cm, T_7: Vermicompost @ 5 t/ha + 20 x 10 cm, T_8Vermicompost @ 5 t/ha + 30 x 10 cm,T_9: Vermicompost @ 5 t/ha + 40 x 10 cm were used. Nine treatments were replicated thrice in Randomized Block Design.

3.Experimental Design

The experiment laid out in Randomized Block Design which consisting of nine treatments which are T1: FYM @ 10 t/ha + 20 x 10 cm, T2: FYM @ 10 t/ha + 30 x 10 cm, T3: FYM @ 10 t/ha + 40 x 10 cm, T4: Poultry Manure @ 4 t/ha + 20 x 10 cm, T5: Poultry Manure @ 4 t/ha + 30 x 10 cm, T6: Poultry Manure @ 4 t/ha + 40 x 10 cm, T7: Vermicompost @ 5 t/ha + 20 x 10 cm, T8Vermicompost @ 5 t/ha + 30 x 10 cm,T9: Vermicompost @ 5 t/ha + 40 x 10 cm are used. Nine treatments were replicated thrice in Randomized Block Design.

Plant height (cm), Branches/plant, Plant dry weight (g/plant) and Yield attributes and Yield were measured.

3.1 Chemical Analysis of soil

Composite soil samples were collected before layout of the experiment to determine the initial soil properties. The soil samples were collected from 0-15 cm depth and were dried under shade, powdered with wooden pestle and mortar, passed through 2 mm sieve and were analyzed for organic carbon by rapid titration method by Nelson (1975). Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija (1956), available phosphorus by Olsen's method, available potassium was determined by using the flame photometer normal ammonium acetate solution and estimating by using flame photometer (ELICO Model) as outlined by Jackson (1973) and available $ZnSO_4$ was estimated by Atomic Absorption Spectrophotometer method.

3.2 Statistical Analysis

The data recorded where different characteristics were subjected to statistical analysis by adopting Fishers the method of analysis of variance (ANOVA) as described by Gomez and Gomez (2010). Critical difference (CD) values were calculated the 'F' test was found significant at level of 5%.

4. Results and Discussion

4.1 Plant height

Data in table 1 tabulated that significantly highest plant height (134.04 cm) was recorded in the treatment with Poultry Manure @ 4 t/ha + 30 x 10 cm over all the other treatments. However, the treatments with application of Poultry Manure @ 4 t/ha + 40 x 10 cm (133.72 cm) and Vermicompost @ 5 t/ha + 30 x 10 cm (133.17 cm) were found to be at par with treatment Poultry Manure @ 4 t/ha + 30 x 10 cm as compared to all the treatments.

The application of Poultry manure might have favoured better root proliferation, more solubility of phosphorous which consequently favoured higher biological nitrogen fixation and uptake of nutrients and availability of all plant nutrients during the crop growth period. Which resulted in the higher plant height.

The spacing practices had significant effects on plant height (cm); however, an increasing trend with optimum geometry level could be noticed. This may be due to the competition between the inter and intra plants for sun light, water, nutrients and space at closer spacing, whereas optimum spacing helped in significantly highest plant height. Significant results were obtained due to the optimum spacing of 30x10 cm and similar results were obtained by **Rameti *et al.*, (2017).**

4.2 Branches/plant

Treatment with Poultry Manure @ 4 t/ha + 30 x 10 cm recorded significantly highest No. of Branches /plant (9.77) over all the treatments. However, the treatments with Poultry Manure @ 4 t/ha + 40 x 10 cm (9.69) and Vermicompost @ 5 t/ha + 30 x 10 cm (9.62) were found to be statistically at par with Poultry Manure @ 4 t/ha + 30 x 10 cm.

The higher number of branches due to the application of poultry manure might be due to the availability of desired and required quantity of nutrients for longer period in root zone of growing plants which helped plant cells to divide.

"The optimum (increased) plant spacing between plants resulted in enhanced space, sun-light, nutrients and soil moisture for increased photosynthesis, metabolic activities, growth and development which lead to higher number of branches" **Gadade *et al.*, (201**

4.3 Plant dry weight (g/plant)

Treatment with Poultry Manure @ 4 t/ha + 30 x 10 cm recorded significantly maximum dry weight (21.16 g/plant) over all the treatments. However, the treatments Poultry Manure @ 4 t/ha + 40 x 10 cm (20.92 g/plant) and Vermicompost @ 5 t/ha + 30 x 10 cm (20.78 g/plant) were found to be statistically at par with Poultry Manure @ 4 t/ha + 30 x 10 cm.

The increase in the total dry matter production may be due to better source and sink capacity developed due to better dry matter production with the application of PM and its accumulation in assimilatory surface area and increase in the photosynthetic efficiency and thus increased the production of photosynthates reflected in better growth and ultimately in higher dry accumulation.

Higher dry matter production was observed in 30 x10 cm spacing, because of better photosynthetic activity due to greater exposure of light and increased availability of nutrients to plants, the treatment showed the increasing trend in dry weight up to harvest stage, **Rameti *et al.*, (2017)** also reported similar res

Table 1 Effect of different levels Organic Manures and Spacing on Growth Parameters of Black Mustard.

Treatments	Plant height (cm)	Branches/plant	Dry weight (g)
1. FYM @ 10 t/ha + 20 x 10 cm	130.06	8.70	19.50
2. FYM @ 10 t/ha + 30 x 10 cm	131.77	9.14	19.99
3. FYM @ 10 t/ha + 40 x 10 cm	130.47	8.85	19.65
4. Poultry Manure @ 4 t/ha + 20 x 10 cm	132.74	9.50	20.48
5. Poultry Manure @ 4 t/ha + 30 x 10 cm	134.04	9.77	21.16
6. Poultry Manure @ 4 t/ha + 40 x 10 cm	133.72	9.69	20.92
7. Vermicompost @ 5 t/ha + 20 x 10 cm	131.01	9.00	19.72
8. Vermicompost @ 5 t/ha + 30 x 10 cm	133.17	9.62	20.78
9. Vermicompost @ 5 t/ha + 40 x 10 cm	132.39	9.33	20.22
F test	S	S	S
S. Em (±)	0.30	0.05	0.21
CD (P = 0.05)	0.89	0.15	0.63

4.4 Yield attributes and Yield

Significantly Maximum Number of Siliquae/plant (174.75) was recorded with the treatment of application of Poultry Manure @ 4 t/ha + 30 x 10 cm over all the treatments. However, the treatments Poultry Manure @ 4 t/ha + 40 x 10 cm (173.06) and Vermicompost @ 5 t/ha + 30 x 10 cm (172.12) were found to be statistically at par with Poultry Manure @ 4 t/ha + 30 x 10 cm.

Higher number of Siliquae/plant might have been possible due to more vigour and strength attained by the plants as a result of better photosynthetic activities with sufficient availability of light, and supply of nutrients in balanced quantity of the plants at growing stages.

Significantly Maximum Number of Seeds/Siliquae (33.19) was recorded with the application of Poultry Manure @ 4 t/ha + 30 x 10 cm over all the treatments. However, the treatments Poultry Manure @ 4 t/ha + 40 x 10 cm (32.93) and Vermicompost @ 5 t/ha + 30 x 10 cm (32.27) were found to be statistically at par with Poultry Manure @ 4 t/ha + 30 x 10 cm.

The greater photosynthesis production of metabolites and enzymatic activities due to the Poultry manure application might have influenced increased and extensive root system and the greater production of metabolites and their translocation to various sinks especially the productive structures (Siliqua and seeds) could have helped to increase into the number of Siliqua per plant besides increasing the overall growth.

Significantly highest Test weight (3.22 g) was recorded with the treatment of application of Poultry Manure @ 4 t/ha + 30 x 10 cm over all the treatments. However, the treatments Poultry Manure @ 4 t/ha + 40 x 10 cm (3.13 g) and Vermicompost @ 5 t/ha + 30 x 10 cm (3.01 g) which were found to be statistically at par with Poultry Manure @ 4 t/ha + 30 x 10 cm.

Better availability of moisture and moderation of soil temperature which led to greater uptake of nutrients and reduced number of days taken to meet the required heat units for proper growth and development of plants and ultimately the yield attributes. The results were recorded similar with research of **Patil *et al.*, (2007).**

Significantly highest Seed yield (1749.38 kg/ha) was recorded with the treatment application of Poultry Manure @ 4 t/ha + 30 x 10 cm over all the treatments. However, the treatments with (1708.23 kg/ha) in Poultry Manure @ 4 t/ha + 40 x 10 cm and with (1694.97 kg/ha) in Vermicompost @ 5 t/ha + 30 x 10 cm which were found to be statistically at par with Poultry Manure @ 4 t/ha + 30 x 10 cm.

The higher increase in the yield has been reported to be associated with the release of macro and micro nutrients during the course of microbial decomposition. Organic matter also functions as source of energy for soil micro flora which brings about the transformation of other nutrients held in soil or applied through other means, in a form that is readily utilized by growing plants which helped in increase of seed yield.

The optimum spacing 30 x 15 cm helped plant to receive sufficient amount of heat, water and nutrients from soil which increased number of siliqua/plant, seeds/siliqua and test weight which directly helped in increase of seed yield in mustard. The results were similar to **Chandrasekaran *et al.*, (2007).**

Significantly highest Stover yield (3209.05 kg/ha) was recorded with the treatment application of Poultry Manure @ 4 t/ha + 30 x 10 cm over all the treatments. However, the treatments with (3121.27 kg/ha) in Poultry Manure @ 4 t/ha + 40 x 10 cm and with (3078.68 kg/ha) in Vermicompost @ 5 t/ha + 30 x 10 cm which were found to be statistically at par with Poultry Manure @ 4 t/ha + 30 x 10 cm.

The beneficial response of poultry manure to stover yield might also be attributed to the availability of sufficient amounts of easily utilizable from of plant nutrients throughout the growth period and especially at critical growth periods of crop resulting in better uptake, plant vigour and superior yield attributes. The results were found to be similar with **Jagadeesha *et al.*, (2010).**

At Harvest index there was no significant difference among the treatments. However, highest Harvest index (35.68 %) was recorded with the treatments Vermicompost @ 5 t/ha + 20 x 10 cm whereas, minimum Harvest index (35.03 %) was recorded with Poultry Manure @ 4 t/ha + 20 x 10 cm.

Table 2. Effect of different levels of Organic manures and Spacing on Yield attributes and Yield of Black mustard.

Treatments	Siliquae/plant	Seeds/siliquae	Test Weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)
10. FYM @ 10 t/ha + 20 x 10 cm	165.55	29.62	2.56	1439.73	2622.33	35.44
11. FYM @ 10 t/ha + 30 x 10 cm	168.25	31.31	2.77	1544.62	2872.86	34.96
12. FYM @ 10 t/ha + 40 x 10 cm	165.64	29.89	2.62	1467.01	2705.98	35.15
13. Poultry Manure @ 4 t/ha + 20 x 10 cm	170.97	31.86	2.92	1630.59	3023.87	35.03
14. Poultry Manure @ 4 t/ha + 30 x 10 cm	174.75	33.19	3.22	1749.38	3209.05	35.28
15. Poultry Manure @ 4 t/ha + 40 x 10 cm	173.06	32.93	3.13	1708.23	3121.27	35.36
16. Vermicompost @ 5 t/ha + 20 x 10 cm	166.58	30.53	2.68	1515.31	2731.12	35.68
17. Vermicompost @ 5 t/ha + 30 x 10 cm	172.12	32.27	3.01	1694.97	3078.68	35.50
18. Vermicompost @ 5 t/ha + 40 x 10 cm	169.75	31.58	2.81	1597.37	2947.96	35.15
F test	**S**	**S**	**S**	**S**	**S**	**NS**
S. EM (±)	0.96	0.37	0.07	18.27	43.73	0.26
CD (P = 0.05)	2.88	1.11	0.21	54.79	131.10	-

5. CONCLUSION

It is concluded that application of treatment Poultry Manure @ 4 t/ha + 30 x 10 cm recorded significantly higher yield (1749.38kg/ha), higher gross returns (Rs.96215.90/ha), net returns (Rs.65215.90/ha) and benefit cost ratio (2.10) as compared to other treatments.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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