UNDER PEER REVIEW

Original Research Article

TITLE:

INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND YIELD OF MUSTARD

(Brassica juncea L.)

ABSTRACT

The experiment was conducted during the *Rabi* season, 2021-22 at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, Uttar Pradesh, to study "Influence of Integrated Nutrient Management on Growth and Yield of Mustard *(Brassica juncea* L.)." The treatments consist of different levels of Nitrogen through urea (100%, 75%, 50%, 25%), Nitrogen through *Vermicompost* (100%, 75%, 50%, 25%), Nitrogen through FYM (100%, 75%,50%, 25%). The result reported that treatment 9 [75% Nitrogen through *vermicompost* + 25% Nitrogen through urea] significantly higher plant height (199.96 cm), maximum number of branches (12.27), number of siliquae/plant (272.42), number of seeds/siliqua (14.24) dry weight (28.40 g). It is also observed that the higher seed yield (2.19t/ha) and higher stover yield (3.34t/ha) was obtained with the application of 75% Nitrogen through *vermicompost* + 25% Nitrogen through urea. Higher Gross return (119619.5**)**, Net return (86,674)**,** Benefit cost ratio (2.63) was obtained under the use of 75% Nitrogen through *vermicompost* + 25% Nitrogen through urea.

Key words: Mustard, Nitrogen, *Vermicompost*, FYM, growth parameters, yield and economics.

Comment [A1]: Significantly influenced

INTRODUCTION

India is one of the largest producers of rapeseed and mustard in the world. India's contribution in the world's rapeseed and mustard production is the highest of any country. Mustard is a major rabi crop. Cultivation of mustard is taken up between October-November and February- March. Oil seeds are energy rich crops but these are cultivated under energy starvation condition that causes low production of these crops (Swaminathan, 1980).

Mustard has primary center of its origin in central Asia with secondary centers in central and western China, Eastern India, Burma and through Iran to near east cultivated for centuries in many parts of Eurasia. In India, rapeseed-mustard occupy 6.23million hectare area with production and productivity of 9.34 million tonnes and 1499 kg ha respectively (India starts, 2020-21). Major growing areas are Rajasthan, Uttar Pradesh, and Haryana. Rajasthan and Uttar Pradesh are the major mustard producing states in our country. Together, they contribute to about 50% of the total production. In Uttar Pradesh rapeseed and mustard is one of the major grown crops occupying 0.56 million hectares of area with production and productivity of 0.699 million tonnes and 1,248 kg/ha, respectively (GOI,2021).

Comment [A2]: INDIASTATS Reference missing

Continuous use of inorganic fertilizers alone on the soil physico-chemical properties and environment besides their higher cost affects the health of soil. In coming decades, a major issue in designing sustainable agriculture system will be soil organic matter management and the balanced use of organic and inorganic fertilizers which will check the plant nutrient depletion as well as maintain the soil health and ultimately improves the productivity of mustard crop (Bisht *et al.* 2018). INM improves the soil health and availability of nutrients which are responsible for better plant growth and development, hence yield of crop increases (Prasad *et al.*1991). Integration of chemical and organic sources and their efficient management have shown promising results not only in sustaining the productivity but also in maintaining the soil health (Pal and Pathak, 2016).

Nitrogen is the most important nutrient, and being a constituent of protoplasm and protein, it is involved in several metabolic processes that strongly influence growth, productivity and quality of crops (Kumar *et al*. 2000). Nitrogen is known to activate most of the metabolic activities and transformation of energy (Patel *et al*.2022). Vermicompost is rich source of nutrients containing 1.25% N, 0.30% P, 0.70 % K, 0.01 % Cu, 0.18% Fe, 0.005% Zn (Sinha et al. 2009). Besides these, vermicompost also improves soil aeration, reduction of soil erosion, reduces evaporation losses of water, accelerates the process of humification, stimulates the microbial activity, deodourification of obnoxious smell, destruction of pathogens, detoxification of pollutant in soil etc.

Farmyard manure (FYM) supplies N, P and K in available farm to the plant through biological decomposition along with NPK, Sulphur is an important secondary plant nutrient which is essential for proper growth and functioning of the plant. Mustard plant need Sulphur in a great amount because of

Sulphur containing amino acid like methionine, cistine. It also results in considerable amount of growth and yield of mustard along with an increase in the oil content of mustard varieties (Singh *et al.* 2014).

Nutrient management is one of the most important agronomic factors that affects the Indian mustard. But application of all the needed fertilizer through chemical fertilizers had deleterious effect of soil fertility, unsustainable yields. While integration with organic manures and bio-fertilizers would be able to maintain soil fertility and sustain crop productivity. The research work carried out on application of different levels of nitrogen through *vermicompost*, FYM, urea in addition to nutrients in mustard is lacking in India, and still meager in Uttar Pradesh. Keeping these points in view, the present study entitled **"Effect of integrated nutrient management on growth and yield of mustard *(Brassica juncea* L.)''**was conducted at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during *rabi* season of 2021-22.

MATERIALS AND METHODS

The experiment was conducted during the *Rabi* season of 2021-22, Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, Uttar Pradesh. which is located at 25°24' 42" N latitude, 81° 50' 56" E longitude and at an altitude of 98m above mean sea level (MSL). The experiment was conducted in Randomized Block Design with 9 treatments each replicated thrice. The plot size of each treatment was 3m x 3m. Treatments were given with different levels of nitrogen through urea (100%, 75%, 50%, 25%), nitrogen through *Vermicompost* (100%, 75%, 50%, 25%), nitrogen through FYM (100%, 75%, 50%, 25%). The mustard variety Varuna T-59 was sown on 27 October 2021 by maintaining a spacing of 30cm × 10cm. Harvesting was done taking $1m^2$ area from each plot. And from it three plants were randomly selected for recording growth and yield parameters. The treatment details are as follows, T_1 –(100% Nitrogen through urea), T_2 –(25% Nitrogen through FYM + 75% Nitrogen through urea), T_3 – (50% Nitrogen through FYM + 50% Nitrogen through urea), T_4-(75% Nitrogen through FYM + 25% Nitrogen through urea), T_5 -(100% Nitrogen through FYM), T_6 -(25% Nitrogen through *vermicompost* + 75% Nitrogen through urea), T_7 -(50% Nitrogen through *vermicompost* + 50% Nitrogen through urea), T_8 -(75% Nitrogen through *vermicompost* + 25% Nitrogen through urea), T_9 -(100% Nitrogen through *vermicompost*). The observations were recorded for plant height, number of branches/plants, dry weight, number of siliquae/plants, number of seeds/siliqua, seed yield and stover yield. The data were subjected to statistical analysis by analysis of variance method (Gomez and Gomez, 1976).

Comment [A3]: cysteine cystine

Comment [A4]: The treatment combinations can be given in a tabular column

RESULT AND DISCUSSION

Plant height: Significant and higher plant height (199.96 cm) was recorded in treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) However, treatment- 7 (50% Nitrogen through *vermicompost* + 50% Nitrogen through urea) was found to be statistically at par with treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) [Table 1]. The reason for better growth and development in the above treatments might be due to increased availability of nitrogen and phosphorus to the plant initially through organic manure and then through fertilizers in the cropping season. *Vermicompost* might have played an important role in better development of roots and increased microbial activity because of balanced nutritional environment probably both in soil rhizosphere and plant system results in better growth and development of mustard crop. These results were in conformity with those of **Singh *et al.* (2018)**.

Number of branches: Significantly higher number of branches/plant (12.27) was recorded in treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea). However, treatment- 6 (25% Nitrogen through *Vermicompost* + 75% Nitrogen through urea) was found to be statistically at par with treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) [Table 1]. Application of 75 % inorganic and 25 % organic fertilizers after soil test value might have increased the availability of nitrogen to the plant at early growth stages and nitrogen being an essential constituent of nucleic acid, protoplasm and protein, play a fundamental role in metabolism, growth, development, reproduction and transmission of heritable characters, so the number of secondary branches also increased by this condition. These results were in conformity with those **Singh *et al.* (2018).**

Dry weight: Significantly higher dry weight (28.40 g) was recorded in treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea). However, treatment- 7 (50% Nitrogen through *Vermicompost* + 50% Nitrogen through urea) was found to be statistically at par with treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) [Table 1]. Increase in dry weight due to the branches (primary and secondary) increased the total number of leaves per plant, hence the total accumulation of photosynthates and better growth of plants with combined application of inorganic fertilizers and organic manures. These findings were similar to **Lal and Dravid (1993)**.

Number of Siliquae/plants: Statistically higher number of siliquae per plant (279.05) treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea). However, treatment- 7 (50% Nitrogen through *Vermicompost* + 50% Nitrogen through urea) was found to be statistically at par with treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) [Table 2]. Significantly higher number of siliqua/plants was with the application of nitrogen fertilizer and vermicompost in integrated pattern which might have helped to supply sufficient nutrients throughout the growth period. These results are in conformity with the findings of **Patel *et al.* (2022).**

Number of seeds/siliqua: Statistically higher of was recorded maximum number of seed per siliqua (14.94) treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea). However, treatment- 7 (50% Nitrogen through *Vermicompost* + 50% Nitrogen through urea) was found to be statistically at par with treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) [Table 2]. Significant and maximum number of seeds/siliqua was with application of *Vermicompost* which may have cost improvement of overall growth of crop. Thus, greater availability of metabolic activity and nutrients to develop reproductive structures seems to have resulted in increased number of siliqua/plant and seeds/siliqua. The present findings are within the close proximity of **Singh *et al.* (2014).**

Seed yield: Significant and higher seed yield (2.39t/ha) treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea). However, treatment- 7 (50% Nitrogen through *Vermicompost* + 50% Nitrogen through urea) was found to be statistically at par with treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) [Table 2]. From this result it may be inferred that the positive influence of vermicompost was due to adequate supply of nutrient in root zone and plant system. The increased availability of those nutrients in the root zone coupled with increased metabolic activity at cellular levels might have synthesized more photosynthates and their accumulation in various plant parts. This result was corroborated by **Parihar *et al.* (2014).**

Stover yield: Significant and highest stover yields (3.45t/ha) treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea). However, treatment- 7 (50% Nitrogen through *Vermicompost* + 50% Nitrogen through urea) was found to be statistically at par with treatment-8(75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) [Table 2]. Significant and higher stover yield was with application 75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea. This might be due to the effect of organic and inorganic fertilizers combination to increasing growth attributes and production of more dry matter. These findings were similar to **Sharma (1994) and Jat *et al.* (2003).**

Comment [A5]: Missing reference

Gross returns (INR/ha): Higher gross returns (119619.5 INR/ha) was recorded in treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) as compared to other treatments [Table 3]

Net returns (INR/ha): Higher net returns (86,674 INR/ha) was recorded in treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) as compared to other treatments [Table 3]. The statistically higher net return was with application of 75% Nitrogen through *Vermicompost* with 25% Nitrogen through urea. The application of increasing rate of chemical fertilizers from 50 % to 75 % along with organic source increased the net return. These findings were similar to **Parampal Singh Gill and Rajneet Kaur (2014)** in potato.

Benefit Cost ratio (B: C): Higher benefit Cost ratio (2.63) was recorded in treatment-8 (75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea) as compared to other treatments [Table 3]. The statistically higher benefit cost ratio was with combination of inorganic fertilizer and organic manures.

The increase in yield also contributed to the higher benefit cost ratio. These findings were similar to **Singh *et al.* (2016**) in tomato.

CONCLUSION

It may be concluded that application of urea and *Vermicompost* performs positively and improves the growth parameters and yield attributes of mustard. Maximum seed yield, gross return, net return and benefit cost ratio was recorded with the application of 75% Nitrogen through *Vermicompost* with 25% Nitrogen through urea. These findings are based on one season therefore, further trails may be required for further confirmation.

Table 1: Effect of integrated nutrient management on Growth parameters of mustard

AT 1 0 DAS			
Treatments	**Plant height (cm)**	**Number of branches**	**Dry Weight (g)**
100% Nitrogen through urea	187.25	9.68	25.66
25% Nitrogen through FYM + 75% Nitrogen through urea	188.46	9.75	25.13
50% Nitrogen through FYM + 50% Nitrogen through urea	190.55	10.83	25.33
75% Nitrogen through FYM + 25% Nitrogen through urea	189.92	10.38	25.39
100% Nitrogen through FYM	190.42	10.94	25.88
25% Nitrogen through *Vermicompost* + 75% Nitrogen through urea	194.03	11.15	25.79
50% Nitrogen through *Vermicompost* + 50% Nitrogen through urea	198.06	11.71	27.33
75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea	199.96	12.27	28.40
100% Nitrogen through *Vermicompost*	193.20	11.45	25.73
F test	S	S	S
Sem (±)	0.66	0.32	0.37
CD (P=0.05)	1.99	0.97	1.42

Table 2: Effect of integrated nutrient management on yield attributes in mustard

	AT 100 DAS			
Treatments	**Number of siliquae/plants**	**Number of seeds/ siliqua**	**Grain yield (t/ha)**	**Stover yield (t/ha)**
100% Nitrogen through urea	250.17	11.52	1.51	2.84
25% Nitrogen through FYM + 75% Nitrogen through urea	256.47	11.58	1.81	2.82
50% Nitrogen through FYM + 50% Nitrogen through urea	260.65	12.19	1.92	2.90
75% Nitrogen through FYM + 25% Nitrogen through urea	255.87	11.39	1.85	2.87
100% Nitrogen through FYM	263.52	12.35	1.90	2.89
25% Nitrogen through *Vermicompost* + 75% Nitrogen through urea	268.61	13.29	2.01	3.02
50% Nitrogen through *Vermicompost* + 50% Nitrogen through urea	272.42	14.24	2.19	3.34
75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea	279.05	14.94	2.39	3.45
100% Nitrogen through *Vermicompost*	264.50	13.77	2.01	3.14
F test	S	S	S	S
Sem (±)	2.63	0.42	0.02	0,04
CD (P=0.05)	7.90	1.27	0.07	0.13

Table 3: Economics of different treatments in mustard

Treatments	**Gross return**	**Net return**	**B:C Ratio**
100% Nitrogen through urea	75575.5	46,930	1.64
25% Nitrogen through FYM + 75% Nitrogen through urea	90590.5	60,885	2.05
50% Nitrogen through FYM + 50% Nitrogen through urea	95895.8	65,120	2.12
75% Nitrogen through FYM + 25% Nitrogen through urea	92742.65	60,907	1.91
100% Nitrogen through FYM	94944.85	62,039	1.89
25% Nitrogen through *Vermicompost* + 75% Nitrogen through urea	100450.4	70,374	2.34
50% Nitrogen through *Vermicompost* + 50% Nitrogen through urea	109759.7	78,244	2.48
75% Nitrogen through *Vermicompost* + 25% Nitrogen through urea	119619.5	86,674	2.63
100% Nitrogen through *Vermicompost*	100750.7	66,345	1.93

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