International Journal of Plant & Soil Science

Volume 38, Issue 5, Page 460-465, 2026; Article no.IJPSS.137245
ISSN: 2320-7035

Studies of Integrated Nutrient Management on Growth, Yield Attributes and Yield of Mustard [*Brassica juncea* (L.) Czern & Cosson]

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijpss/2026/v38i56127

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/137245

Original Research Article

Received: 10/04/2025
Accepted: 04/06/2025
Published: 26/05/2026

Abstract

Demand for vegetable oil is increasing due to an increase in production and standard of living, increased industrialisation and diversion for bio-fuels as a result oilseed crops viz. groundnut, rapeseed and mustard, soybean, sesame, sunflower, safflower and niger (edible) and linseed and caster (non-edible) are cultivated in the country. The basic objective of the integrated nutrient management is to make as far as possible, a

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Cite as: *Singh, P., Kumar, D., Arvind, Verma, V. P., & Pal, S. (2026). Studies of Integrated Nutrient Management on Growth, Yield Attributes and Yield of Mustard [Brassica juncea (L.) Czern & Cosson]. International Journal of Plant & Soil Science, 38(5), 460–465. https://doi.org/10.9734/ijpss/2026/v38i56127*

balanced nutrient supply to the mustard crop that maintains and also improves the soil fertility health for sustained high productivity on a long-term basis. A field experiment was conducted to assess the effect of nutrient management on Mustard (variety Vardan) at the Student Instructional Farm (SIF) of C.S.A.U.A&T. Nababganj, Kanpur during Rabi season of 2012-13. The experiment consists of eight integrated nutrient management of organic and inorganic fertilisers. The experiment was laid out in randomised block design (RBD) with three replications. The results revealed that the treatment T4: RDF+VC @ 5 t ha-1 recorded higher growth parameter such as plant height and total no. of branches and yield attributes such as total no. of siliquae/plant (293.33), weight of siliquae/plant (125.63g), no. of seed/siliquae (15), test weight (4.53 g), grain yield (22.50 q ha-1) and stover yield (79.00 q ha-1) followed by T7 and T6. For obtaining maximum grain yield, growth and yield attributes characters in mustard crop could be made possible when the RDF dose is combined with Vermicompost 5t ha-1. The application of RDF+ Vermicompost @ 5t ha-1 was also found significantly higher in gross income (85275) and net income (30370.71) over the rest of the treatments.

Keywords: Mustard; yield; nutrient; sulphur; FYM; vermicompost.

1. Introduction

Mustard is the second most important oilseed crop, cultivated during rabi under both rainfed and irrigated conditions (Ramakrishna et al., 2023). Oilseeds are grains grown primarily for the extraction of edible oils (Roasa et al., 2021). "It is the second largest agricultural commodity after cereals in India, playing a significant role in this country's agrarian economy, sharing 14% of the gross cropped area and accounting for nearly 1.5% of the gross national production and 8% of the value of all agricultural products. A range of oilseed crops viz. groundnut, rapeseed and mustard, soybean, sesame, sunflower, safflower and niger (edible) and linseed and caster (non edible) are cultivated in the country. Demand for vegetable oil is increasing due to an increase in production and standard of living, increased industrialisation and diversion for bio-fuels. Oilseed proteins and their derived peptides are also associated with many health benefits, including weight loss and reduced risks of diabetes, hypertension, metabolic syndrome and cardiovascular events" (Zhang et al., 2023). "The gap in supply is being met through huge imports costing more than Rs. 26000 crores during 2009-10" (Hegde & Sudhakara, 2011; Verma et al., 2020). "The average yield of rapeseed and mustard in the country is 1128 kg/ha **(**Religare Agri Research Department mustard crop survey report 2014-15). In India, Rajasthan ranks first both in area (29.27 lakh ha) and production (37.64 lakh metric tons). Gujarat state has the highest productivity (1680 kg. ha^{-1}) of rapeseed mustard. In Uttar Pradesh, mustard is grown on a 10.26 lakh hectare area with a production of 11.29 lakh tonnes and a productivity of 1100 Kg ha^{-1}" (Religare Agri Research Department Mustard Crop Survey Report, 2014-15). "Integrated Nutrient Management (INM) involves efficient and judicious use of all the major components of plant nutrients sources viz. chemical fertilizer in conjunction with animal manures, compost, green manures, legumes in cropping system, bio-fertilizers, crop residues or recyclable waste and other locally available nutrient sources for sustaining soil fertility, health and productivity. The effects of integrated nutrient management (INM) practices on soil quality are essential for sustaining agroecosystem productivity" (Sarkar, et al., 2024). "The integrated supply and use of plant nutrients from chemical fertiliser and organic manure has been found to produce higher crop yields than when each is applied alone. This increase in crop productivity results from their combined effect, the synergistic effect, which helps improve chemical, physical and biological properties of soil and consequently the soil organic matter and nutrient status to a large extent balance nutrient supply to crops of cropping systems and with no or minimal deleterious effect on the environment if any. The basic objective of the integrated nutrient management is to make as for as possible, balance nutrient supply to the crop that maintains and also improves the soil fertility health for sustained high productivity on a long-term basis. As plant nutrient sources differ markedly in their nutrient contents, release efficiency or fixation, positional availability, crop specificity, farmer's acceptability, etc., their appropriate combinations to a production system for optimum and balanced nutrient supply depend on the land use, ecological, sociological and economic conditions. Vermicompost is rich in NKP (nitrogen 2-3%, potassium 1.85-2.25% and phosphorus 1.55-2.25%), micronutrients, beneficial soil microbes and also contains 'plant growth hormones & respectively" (Sinha, et al., 2009; Chandan et al., 2018). "It is scientifically proven as a 'miracle growth promoter & also a plant protector from pests and diseases. I contrast to synthetic fertilisers, Vermicompost reduce soil toxicity by buffering action, prevents soil degradation and enhances soil fertility status. Farm Yard Manure (FYM) occupies an important position among the organic manures. The FYM seems to act directly by increasing crop yield either by acceleration of the respiratory process or by cell permeability,

or by hormonal growth action. It supplies N, P and K available to the plant through biological decomposition; it contains 0.5-1.5, 0.4-0.8 and 0.5-1.9 per cent N, P and K, respectively. Sulphur is an important secondary plant nutrient which is essential for the proper growth and functioning of the plant. It is observed as a divalent-sulfate ion. It is metabolised by roots only to the extent that they review it, and most of the observed sulfate is translocated unchanged to the shoots. It is incorporated into organic compounds and the most abundant products are sulphur-containing amino acids. These are incorporated into the proteins, which are so essential for plant structure and function; other important compounds containing sulphur include the respiratory compound co-enzyme and the vitamins, thiamine and biotin. Sulphur deficiencies are usually noted first in younger leaves" (Sarkar, et al., 2024).

- To find out the effect of inorganic fertiliser, Vermicompost and Farm Yard Manure (FYM) on the growth and yield of mustard.
- To find out a suitable dose of vermicompost and Farm Yard Manure (FYM) with inorganic fertilisers.
- To assess the economics of the treatments.

2. Materials and Methods

2.1 Plant Materials

The present field investigation entitled Studies on integrated nutrient management in mustard [*Brassica juncea* (L.) Czen & Cosson]. The experiment conducted during *rabi* 2012-13 at Student's Instructional Farm (SIF), Department of Agronomy, C.S. Azad University of Agiculture and technology, Kanpur in the alluvial tract of Gangatic plains in central part of U.P. 25.26 to 26.58 North latitude and 79.71 to 80.34 East longitude at an elevation of 125.9 meter from the sea level. The soil of the experimental site was sandy loam in texture, saline in reaction pH (7.8), high in organic carbon (0.45%), low in available N (145Kg ha^{-1}), medium in available P (16 Kg ha^{-1}) and available K (216 Kg ha^{-1}). The field was prepared after pre-sowing irrigation. At proper moisture conditions, first ploughing was done with tractor-drawn soil turning plough, followed by two cross-harrowings with cultivator to make fine tilth of soil. The crop was sown on 3rd November 2012 and harvested on 10th March 2013. Sowing of seed was done by manual labour by opening the furrows with the help of bullock-drawn wooden plough at a row distance of 45 cm. Certified seed of mustard (cv Vardan) was used for sowing. Well decomposed FYM and Vermicompost are applied by broadcasting and soil mixed properly by hand according to the particular treatment required, other than nitrogen, phosphorus, Potash and Sulphur, which are supplied through urea, DAP, MOP and elemental sulphur respectively. The remaining 50% dose of Nitrogen is applied as top dressing. Two irrigation regimes were applied at the peak vegetative stage and at the pod filling stage to maintain optimum soil moisture for plant growth in an experimental crop.

2.2 Statistical Analyses

The experiment was conducted during 2012-13, had eight treatments laid out in a randomised block design with three replications. Eight integrated nutrient management treatments, viz. T_1-RDF, T_2-RDF + Vermicompost @ 2.0 t ha^{-1}, T_3-RDF+Vermicompost@3.0 t ha^{-1}, T_4-RDF+Vermicompost@5 t ha^{-1}, T_5-RDF+vermicompost@2 t ha^{-1} + FYM @ 3 t ha^{-1}, T_6-RDF + Vermicompost @ 2 t ha^{-1} + FYM @ 4 t ha^{-1}, T_7-RDF + Vermicompost @ 2 t ha^{-1} + FYM @ 5 t ha^{-1} and T_8-RDF + FYM @ 6.0 t ha^{-1}. The yield parameters and yields were recorded and analysed as per Gomez and Gomez (1984). The treatment comparisons were made using a t-test at a 5% level of significance.

3. Results and Discussion

3.1 Plant Height

The treatment of T_4 (RDF + Vermicompost @ 5.0 t ha^{-1}) was found significantly superior at the flowering stage (60 DAS) and maturity stage (110 DAS) over the rest treatments, RDF (NPKS). Respectively, the reason behind the higher height of the plant in more translocation of nutrients through Vermicompost. These results are supported by Premi, et al. (2005) and Singh et al. (2011).

3.2 Yield Attribute

It is clear from Table 1 that the total number of branches per plant was significantly influenced by the use of different sources of nutrients. The maximum number of total branches, 19.66 per plant, was recorded in RDF + Vermicompost @ 5 t/ha, followed by RDF + Vermicompost @ 2.0 t/ha + FYM @ 5 t/ha (17.66). The number of primary branches, secondary branches, tertiary branches and total branches per plant at flowering and maturity stages was significantly increased with the use of nutrients in treatment (RDF + Vermicompost @ 5.0 t ha^{-1}) over all rest treatments, respectively. "This may be due to better establishment of the plant under this treatment compared to other remaining treatments, and it might also be due to improvement in nutrient availability, particularly those of Vermicompost and NPKS", by same reported by Singh, et al., (2011). A perusal of the data presented in the table revealed that the reason recommended dose of fertilisers, RDF + Vermicompost @ 5t $ha^{-1,}$ were significantly superior in respect to the number of siliqua on primary branches, secondary branches, siliquae/plant than the remaining treatments respectively. This results in more translocation of nutrients through Vermicompost toward sink development by Mandal and Singha (2004) and Singh, et al*.,* (2011). **"**The maximum production of siliquae length, siliquae weight per plant, seed per siliquae and siliqua girth were recorded in RDF with Vermicompost @ 5 t ha^{-1} than the remaining treatments, respectively. The use of organic manure consequently has more siliqua length, siliquae weight, seed per siliqua and siliqua and siliqua girth" has also been reported by Singh and Singh (2006) and Kashved et al. (2010) significantly highest seed weight per plant, no of seed per plant and test weight were noted in RDF with Vermicompost @ 5 t ha^{-1} over all remaining treatments, while RDF+ Vermicompost @ 3.0 t ha^{-1} and RDF + Vermicompost @ 2.0 t / ha^{-1} +FYM @ 3.0 t ha^{-1} at equal to each other and RDF + Vermicompost @ 2.0 t ha^{-1} + FYM @ 4.0 t ha^{-1} and RDF + Vermicompost @ 2.0 t ha^{-1} +FYM @ 5.0 t ha^{-1} equal to each other since the plant has larger vegetative growth on account of better root development and conserving moisture situations the seeds size must have been increase due to more carbohydrate, photosynthesis process, consumptive use etc. water integrated nutrient supply by Mandal and Singha (2004) and Kashved et al. (2010).

3.3 Yield Economics

The recommended dose of fertilizers with 5.0 t ha^{-1} Vermicompost were significantly maximum produce in respect to grain yield, stover yield and biological yield compared to all remaining treatments but Harvest index of mustard enhance with the increasing different sources of nutrient. The maximum Harvest index was significantly recorded in recommended dose of fertilizer and RDF+FYM @ 6.0 t ha^{-1} the probable reason for this phenomenon may be longer plant and increased dry matter, were vegetative growth under organic and inorganic nutrient supply. This weight have resulted to increased stover yield, grain yield and total biomass production by Premi, et al. (2005) reported similer result as yields. The recommended dose of fertilizers with 5 t ha^{-1} Vermicompost were found significantly superior in respect to gross income, net income and benefit cost ratio than other remaining treatments, respectively organic and inorganic combined nutrient supply with have favorable effect on development photosynthetic organ and rate of accumulation of growth characters, yield characters, and yields. The findings are in close conformity with Kumpawat et al. (2004) and Ramesh et al. (2009).

Table 1. Effect of integrated nutrient management on growth, yield attributes and yield of mustard.

Treatment	Plant height	Total No. of branches	Total No. of siliquae/Plant	Weight of siliquae/Plant (g)	No. of seed/siliquae	Test weight (g)	Grain yield (q/ha)	Stover yield (q/ha)
T_1	126.11	7.99	226.30	78.27	9.00	3.30	19.20	57.00
T_2	133.18	10.66	224.32	86.74	12.00	3.50	20.00	64.00
T_3	134.33	11.98	252.65	93.30	13.00	3.60	20.52	68.00
T_4	145.20	20.00	293.33	125.63	15.00	4.53	22.50	79.00
T_5	140.57	14.32	258.33	96.64	13.33	3.63	21.00	71.00
T_6	140.66	15.99	263.99	113.09	13.66	4.00	21.50	73.00
T_7	143.43	17.33	279.99	116.77	14.00	4.20	21.75	76.00
T_8	132.48	9.66	234.65	82.53	9.33	3.40	19.90	61.00
S.E. (d)	1.372	0.66	3.92	1.84	0.52	0.19	0.46	0.89
C.D. at 5%	2.97	1.43	8.49	4.00	1.12	0.42	1.02	1.93

4. Conclusion

Significantly better growth, yield contribute characters and yield (22.50 q ha^{-1}) were obtained with the combined application of RDF+Vermicompost 5 t $ha^{-1,}$ followed by RDF+Vermicompost 2t ha^{-1}+FYM 5t ha^{-1}. combined use of RDF+Vermicompost 5t ha^{-1} followed by RDF+Vermicompost 2t ha^{-1}+FYM 5t ha^{-1}. The combined use of RDF+ Vermicompost 5t ha^{-1} gave (14.66%) higher grain yield than the control. For obtaining maximum grain yield, growth and yield attributes characters in mustard crop could be made possible when the RDF dose is combined with Vermicompost 5t ha^{-1}. The application of RDF+ Vermicompost @ 5t ha^{-1} was also found significantly higher in gross income (85275) and net income (30370.71) over the rest of the treatments. While the benefit cost ratio was significantly higher with application of RDF(NPKS 1.58) over remaining treatments, except RDF+Vermicompost @2.0t ha^{-1}, RDF+Vermicompost @5t ha^{-1} and RDF+Vermicompost @ 2.0 t ha^{-1}+FYM @ 4.0 t $ha^{-1,}$ being at par to each other.

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Competing Interests

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://pr.sdiarticle5.com/review-history/137245