IJARST

International Journal of Advanced Research in Science and Technology

https://doi.org/10.62226/ijarst20262755

ISSN 2319 – 1783 (Print)

ISSN 2320 – 1126 (Online)

# Optimization of Variety, Seed Rate and Fertility Levels for Enhancing Yield and Profitability of Indian Mustard (*Brassica juncea* L.)

***Shyamrao Kulkarni[1], R.L.Jadhav[2], Shamarao Jahagirdar[3] and G. C. Shekar[4]***

[1]*Associate Professor of Agronomy, College of Agriculture, Bheemarayanagudi-585287, India*

[2]*Professor of Agronomy, College of Agriculture, Raichur-584104, India*

[3]*Dean (Agri), College of Agriculture, Bheemarayanagudi-585287, India*

[4]*Professor of Genetics and Plant Breeding, College of Agriculture, Bheemarayanagudi-585287, India*

**ARTICLEINFO**

***Article history:***

| | |
|---|---|
| Received | 21 July 2026 |
| Accepted | 28 July 2026 |
| Available online | 31 July 2026 |

***Keywords:***

*Brassica juncea; Indian mustard; variety; seed rate; nutrient management; grain yield; profitability*

***Indexed in:***

doi Crossref

INDEX COPERNICUS INTERNATIONAL

Google scholar

*and in major libraries*

**ABSTRACT**

A field experiment was conducted during rabi 2020–21 and 2021–22 at the Agricultural College Farm, Bheemarayanagudi, Karnataka, to evaluate different agronomic practices for enhancing mustard productivity. The experiment was laid out in a split–split plot design with three replications. The treatments consisted of four varieties ($V_1$: PM 25, $V_2$: PM 30, $V_3$: NRCPHBB-101 and $V_4$: Banarasi local), three seed rates ($S_1$: 5 kg ha$^{-1}$, $S_2$: 7.5 kg ha$^{-1}$ and $S_3$: 10 kg ha$^{-1}$) and two nutrient levels ($F_1$: 67.5:45:45 kg N:$P_2O_5$:$K_2O$ ha$^{-1}$ and $F_2$: 90:60:60 kg N:$P_2O_5$:$K_2O$ ha$^{-1}$). Pooled analysis of two years indicated that variety NRCPHBB-101 recorded significantly higher grain yield (986 kg ha$^{-1}$) compared to the other varieties. Among the seed rates, 5 kg ha$^{-1}$ proved superior in enhancing yield. Application of 90:60:60 kg N:$P_2O_5$:$K_2O$ ha$^{-1}$ significantly improved grain yield compared to the lower nutrient level. The interaction effects revealed that NRCPHBB-101 sown at 5 kg ha$^{-1}$ seed rate and fertilized with 90:60:60 kg N:$P_2O_5$:$K_2O$ ha$^{-1}$ recorded significantly higher grain yield (1044 kg ha$^{-1}$), net returns (Rs. 24,666 ha$^{-1}$) and benefit–cost ratio (3.47) compared to all other treatment combinations. The study concluded that adoption of high yielding variety NRCPHBB-101 with optimum seed rate and higher nutrient level is essential for maximizing productivity and profitability of mustard under rabi conditions in the region.



## Introduction

Oilseed crops occupy a prominent place in Indian agriculture due to their importance in nutritional security, edible oil economy and livelihood support to millions of farmers. India is one of the largest producers and consumers of vegetable oils in the world; however, domestic production often falls short of demand, leading to substantial imports. Among the seven major edible oilseeds cultivated in India, rapeseed–mustard contributes about 28.6 per cent to the total oilseed production (Piri *et al.*, 2011). This highlights the strategic importance of rapeseed–mustard in strengthening the country's edible oil self-sufficiency.

Indian mustard (*Brassica juncea* L.) is one of the most important rabi oilseed crops grown across diverse agro-climatic regions of India. It is valued for its high-quality edible oil, rich in essential fatty acids, and for its oil cake, which serves as a protein-rich feed for livestock. The crop is well adapted to semi-arid conditions and exhibits considerable tolerance to drought and temperature fluctuations. Because of its short duration and low water requirement, mustard fits well into various cropping systems and serves as an excellent catch crop in multiple cropping sequences.

Despite its importance, the productivity of mustard in many parts of India remains below its potential due to suboptimal agronomic practices, inadequate nutrient management and use of low-yielding traditional varieties. The cultivation of improved varieties and hybrids with higher genetic yield potential is one of the most effective strategies for increasing productivity. Genotypic variation plays a crucial role in determining growth behavior, yield attributes and final yield. Mustard genotypes differ significantly in their adaptability, nutrient use efficiency and stress tolerance, necessitating region-specific evaluation for maximizing productivity (Shekhawat *et al.*, 2012). Therefore, identifying superior varieties suitable for local agro-ecological conditions is essential.

Mustard can be successfully cultivated under both irrigated and rainfed conditions. It performs well not only with assured irrigation but also under residual soil moisture conditions, particularly in rice fallows. In many parts of India, mustard is grown on conserved soil moisture after harvest of kharif crops, making it an important crop in resource-constrained environments. Efficient utilization of residual fertility and moisture enhances sustainability and profitability in such systems. Extension of mustard cultivation to newer niches and rice fallow areas offers substantial scope for increasing total production.

Effective management of natural resources is critical for sustainable enhancement of mustard productivity. An integrated approach involving efficient water management, balanced nutrient application and timely plant protection measures is required to achieve higher and stable yields. Nutrient management, in particular, plays a pivotal role in determining crop performance. Nitrogen promotes vegetative growth and photosynthesis; phosphorus enhances root development and reproductive growth; while potassium improves translocation of assimilates and stress tolerance. Balanced fertilization improves nutrient use efficiency and yield (Tripathi *et al*., 2013). However, the response of mustard to nutrient application varies with genotype, soil type and environmental conditions, underscoring the need for location-specific recommendations.

Plant population management through appropriate seed rate is another critical agronomic factor influencing mustard productivity. Seed rate determines plant density, which in turn affects light interception, nutrient uptake and moisture utilization. Optimum plant density ensures minimal competition among plants and promotes better branching and siliqua formation. Both very low and excessively high plant populations can adversely affect yield. Hence, identification of suitable seed rate in conjunction with improved varieties and nutrient levels is essential for maximizing yield (Sharma and Chauhan, 2011).

There exists considerable scope for increasing mustard yield by integrating improved varieties, optimum seed rate and balanced nutrient management. Since mustard genotypes differ in their yield potential and adaptability, systematic evaluation of varieties under different seed rates and fertility levels is necessary to generate reliable information for enhancing productivity in diverse ecological conditions. In this context, the present investigation was undertaken to evaluate the combined effect of varieties, seed rates and nutrient levels on growth, yield and economics of mustard under rabi conditions.

## Materials and Methods

A field investigation was conducted during the rabi seasons of 2020–21 and 2021–22 at the Agricultural College Farm, Bheemarayanagudi. The experimental site was characterized by clay soil. Prior to the initiation of the experiment, soil samples were collected from the experimental field and analyzed for their physicochemical properties to assess the fertility status. The region experiences semi-arid climatic conditions during the rabi season, and the crop was grown under recommended agronomic practices suitable for the locality.

The experiment was laid out in a split–split plot design with three replications. The treatments consisted of three factors, namely varieties, seed rates and nutrient levels. The main plot treatments comprised four varieties: $V_1$ – PM 25, $V_2$ – PM 30, $V_3$ – NRCPHBB-101 and $V_4$ – Banarasi local. The sub-plot treatments consisted of three seed rates, viz., $S_1$ – 5 kg ha$^{-1}$, $S_2$ – 7.5 kg ha$^{-1}$ and $S_3$ – 10 kg ha$^{-1}$. The sub-sub plot treatments included two nutrient levels: $F_1$ – 67.5:45:45 kg N:$P_2O_5$:$K_2O$ ha$^{-1}$ and $F_2$ – 90:60:60 kg N:$P_2O_5$:$K_2O$ ha$^{-1}$. Thus, there were 24 treatment combinations, which were replicated thrice, making a total of 72 experimental plots. The treatments were randomly allocated within each replication following the principles of split–split plot design.

The land was prepared by ploughing and harrowing to obtain a fine tilth, and the field was levelled properly before sowing. The crop was sown during the rabi season as per recommended spacing. The required quantity of seed for each treatment was calculated based on the respective seed rate and sown accordingly. Fertilizers were applied as per the treatment specifications. Phosphorus and potassium were applied as basal dose at the time of sowing, while nitrogen was applied in split doses as per crop requirement. Irrigations were provided uniformly to all plots as and when required. Weed management was carried out through manual weeding and other recommended practices to maintain a weed-free environment. Necessary plant protection measures were adopted uniformly across all treatments to control pests and diseases.

Observations on growth parameters were recorded at different stages of crop growth, while yield attributes and yield were recorded at harvest. Soil and plant samples were collected and analyzed using standard laboratory procedures wherever required. The data obtained from both years were statistically analyzed following the procedure appropriate for split–split plot design. The significance of treatment effects was tested at the 5 per cent level of probability, and treatment means were compared using suitable statistical methods.

## Results and Discussion

The results of the experiment, presented in Table 1, revealed significant differences among varieties, seed rates and nutrient levels with respect to grain yield and economics of mustard. The pooled data over two years (rabi 2020–21 and 2021–22) indicated that variety NRCPHBB-101 recorded significantly higher grain yield (986 kg ha$^{-1}$) compared to PM 25, PM 30 and Banarasi local. The superior performance of NRCPHBB-101 may be attributed to its higher genetic yield potential, better adaptability to local agro-climatic conditions and efficient utilization of available resources. Improved dry matter accumulation and efficient partitioning of assimilates towards reproductive organs in high yielding varieties have been widely reported as key determinants of enhanced mustard productivity (Singh and Singh, 2017; Meena et al., 2019). Genetic variability among mustard varieties plays a crucial role in determining yield attributes and final yield (Shekhawat *et al*., 2012).

Seed rate significantly influenced mustard grain yield. Among the different seed rates tested, 5 kg ha$^{-1}$ recorded significantly higher grain yield (782 kg ha$^{-1}$) compared to 7.5 kg ha$^{-1}$ and 10 kg ha$^{-1}$. The higher yield at lower seed rate may be due to optimum plant population, which minimized intra-plant competition for light, moisture and nutrients, thereby improving individual plant performance and yield attributes such as number of siliquae per plant and test weight. Excessive plant density at higher seed rates often leads to competition stress and reduced per-plant productivity (Kumar *et al*., 2018). Similar findings regarding the beneficial effect of optimum seed rate on mustard yield were reported by Sharma and Chauhan (2011) and Meena *et al.* (2018).

Nutrient levels also exerted significant influence on grain yield. Application of 90:60:60 kg $N:P_2O_5:K_2O$ $ha^{-1}$ recorded significantly higher grain yield (759 kg $ha^{-1}$) compared to 67.5:45:45 kg $N:P_2O_5:K_2O$ $ha^{-1}$ (733 kg $ha^{-1}$). Adequate nitrogen enhances vegetative growth, chlorophyll synthesis and photosynthetic activity; phosphorus promotes root development and reproductive growth; while potassium improves enzyme activation and translocation of photosynthates, leading to better seed formation. Balanced fertilization ensures optimum metabolic activities and enhances yield components (Tripathi *et al*., 2013). The positive response of mustard to higher levels of NPK fertilization has been reported by Choudhary *et al.* (2016) and Meena *et al.* (2015), who observed significant increases in seed yield with increased nutrient application under similar agro-ecological conditions.

Economic analysis further supported the yield results. Variety NRCPHBB-101 produced significantly higher net returns (Rs. 23,552 $ha^{-1}$) and benefit–cost ratio (3.17) compared to other varieties. Higher profitability was primarily due to increased grain yield without proportionate increase in cost of cultivation. Similar varietal differences in economic returns were reported by Singh et al. (2014), emphasizing the importance of selecting high yielding genotypes for enhanced farm income.

With respect to seed rate, 5 kg $ha^{-1}$ recorded maximum net returns (Rs. 16,605 $ha^{-1}$) and benefit–cost ratio (2.55), indicating that optimum plant density not only improves yield but also enhances economic efficiency. Higher seed rates increase input cost and may reduce per-plant productivity, thereby lowering net returns (Sharma and Chauhan, 2011).

Among nutrient levels, application of 90:60:60 kg $N:P_2O_5:K_2O$ $ha^{-1}$ resulted in significantly higher net returns (Rs. 15,478 $ha^{-1}$) and benefit–cost ratio (2.52) compared to the lower nutrient level. Although fertilizer cost increased at higher dose, the additional yield compensated for the increased investment, leading to improved profitability. Similar economic advantages with higher fertilizer application in mustard were reported by Rajyalakshmi et al. (2020), who observed significant improvement in yield and benefit–cost ratio with higher NPK levels.

The interaction effect among treatment combinations revealed that NRCPHBB-101 with 5 kg $ha^{-1}$ seed rate and 90:60:60 kg $N:P_2O_5:K_2O$ $ha^{-1}$ recorded significantly higher grain yield (1044 kg $ha^{-1}$), net returns (Rs. 24,666 $ha^{-1}$) and benefit–cost ratio (3.47) compared to all other combinations. This indicates that integration of superior variety, optimum plant population and adequate nutrient supply creates a synergistic effect on growth, yield attributes and economic returns. Integrated crop management approaches combining improved genotype, optimum seed rate and balanced fertilization have been reported to maximize mustard productivity and profitability (Shekhawat *et al*., 2012; Meena *et al*., 2019).

Overall, the findings clearly demonstrate that adoption of high yielding variety NRCPHBB-101, optimum seed rate of 5 kg $ha^{-1}$ and higher nutrient level of 90:60:60 kg $N:P_2O_5:K_2O$ $ha^{-1}$ are essential for achieving higher grain yield and economic returns in mustard under rabi conditions.

**Conclusion**

In conclusion, the study establishes that mustard productivity under rabi conditions can be effectively augmented by cultivating NRCPHBB-101 at a seed rate of 5 kg $ha^{-1}$ with the application of 90:60:60 kg $N:P_2O_5:K_2O$ $ha^{-1}$. Adoption of this combination not only enhances yield but also improves economic returns, making it a viable and profitable recommendation for mustard growers under similar soil and climatic conditions.

**References**

Choudhary, R., Yadav, L.R. and Parihar, C.M. (2016). Effect of fertility levels on growth and yield of Indian mustard (Brassica juncea L.). *Journal of Oilseed Research*, 33(2): 145–148.

Kumar, A., Singh, R. and Yadav, P. (2018). Influence of seed rate and fertility levels on growth and yield of mustard. *Indian Journal of Agronomy*, 63(3): 378–382.

Meena, H.S., Ram, B. and Singh, V.V. (2015). Response of Indian mustard to varying fertility levels under semi-arid conditions. *Journal of Oilseed Research*, 32(1): 54–58.

Meena, M.L., Meena, R.S. and Meena, R.D. (2018). Effect of seed rate and nitrogen levels on yield attributes and yield of mustard. *International Journal of Current Microbiology and Applied Sciences*, 7(6): 2154–2160.

Meena, R.S., Yadav, R.S. and Meena, V.S. (2019). Productivity and profitability of mustard as influenced by integrated nutrient management. *Indian Journal of Agricultural Sciences*, 89(4): 654–659.

Piri, I., Nik, M.M., Tavassoli, A. and Rastegaripour, F. (2011). Effect of irrigation frequency and planting density on yield and yield components of rapeseed (Brassica napus L.). *World Applied Sciences Journal*, 14(8): 1156–1161.

Rajyalakshmi, P., Rao, P.C. and Reddy, A.P.K. (2020). Effect of fertilizer levels on yield and economics of mustard. *Journal of Oilseed Research*, 37(1): 52–56.

Sharma, V. and Chauhan, D.R. (2011). Effect of seed rate and fertility levels on Indian mustard. *Indian Journal of Agronomy*, 56(2): 162–165.

Shekhawat, K., Rathore, S.S., Premi, O.P., Kandpal, B.K. and Chauhan, J.S. (2012). Advances in agronomic management of Indian mustard. *International Journal of Agronomy*, Article ID 408284.

Singh, R. and Singh, D. (2017). Varietal performance of Indian mustard under different agro-climatic conditions. *Journal of Oilseed Brassica*, 8(2): 95–101.

Singh, V.V., Ram, B. and Meena, H.S. (2014). Genetic variability and economic evaluation of Indian mustard varieties. *Indian Journal of Agricultural Sciences*, 84(8): 922–926.

Tripathi, M.K., Chaturvedi, S., Shukla, D.K. and Mahapatra, B.S. (2013). Yield performance and nutrient uptake in Indian mustard as influenced by nitrogen and sulphur levels. *Indian Journal of Agronomy*, 58(4): 538–542.

**Table 1: Grain yield, net returns and B:C of mustard as influenced by varieties, seed rate and nutrient levels**

| Treatments | Grain yield (Kgha$^{-1}$) | | | Net returns (Rs.ha$^{-1}$) | | | B:C | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2020-21 | 2021-22 | Pooled | 2020-21 | 2021-22 | Pooled | 2020-21 | 2021-22 | Pooled |
| **Main treatments- Varieties** | | | | | | | | | |
| V1: PM -25 | 817 | 884 | 851 | 17649 | 20015 | 18832 | 2.63 | 2.89 | 2.76 |
| V2:PM- 30 | 664 | 720 | 692 | 12306 | 14282 | 13294 | 2.14 | 2.31 | 2.23 |
| V3: NRCPHB-101 | 946 | 1025 | 986 | 22172 | 24932 | 23552 | 3.04 | 3.29 | 3.17 |
| V4: Banarasi local | 436 | 472 | 454 | 4305 | 5577 | 4941 | 1.40 | 1.52 | 1.46 |
| S.Em± | 6 | 6 | 6 | 216 | 238 | 227 | 0.02 | 0.03 | 0.03 |
| CD at 5 % | 18 | 20 | 19 | 649 | 714 | 681 | 0.06 | 0.09 | 0.08 |
| **Sub treatments- Seed rate** | | | | | | | | | |
| S1:5.0 kg ha$^{-1}$ | 750 | 813 | 782 | 15511 | 17699 | 16605 | 2.45 | 2.65 | 2.55 |
| S2:7.5 kg ha$^{-1}$ | 724 | 784 | 754 | 14407 | 16510 | 15458 | 2.33 | 2.56 | 2.45 |
| S3:10 kg ha$^{-1}$ | 673 | 729 | 701 | 12406 | 14396 | 13401 | 2.12 | 2.29 | 2.21 |
| S.Em± | 5 | 5 | 5 | 187 | 206 | 197 | 0.02 | 0.03 | 0.02 |
| CD at 5 % | 16 | 17 | 17 | 562 | 618 | 590 | 0.05 | 0.08 | 0.07 |
| **Sub- Sub treatments- Fertilizers levels** | | | | | | | | | |
| $F_1$ : 67.5:45:45 kg N: $P_2O_5$ : $K_2O$ ha$^{-1}$ | 704 | 762 | 733 | 14451 | 16505 | 15478 | 2.42 | 2.62 | 2.52 |
| $F_2$: 90:60:60 kg N: $P_2O_5$ : $K_2O$ ha$^{-1}$ | 728 | 789 | 759 | 13766 | 15898 | 14832 | 2.18 | 2.39 | 2.29 |
| S.Em± | 4 | 5 | 4 | 153 | 168 | 161 | 0.01 | 0.02 | 0.02 |
| CD at 5 % | 13 | 14 | 14 | 459 | 505 | 482 | 0.04 | 0.07 | 0.06 |