



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(8): 85-88
Received: 13-05-2025
Accepted: 17-06-2025

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Impact of biofertilizers and fertility levels on growth and productivity of hybrid Indian mustard (*Brassica juncea* L.)

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DOI: <https://www.doi.org/10.33545/2618060X.2025.v8.i8b.3494>

Abstract

This field experiment investigated the effects of fertility levels, hybrid varieties, and biofertilizers on Indian mustard over two winter seasons (2021-22 and 2022-23) at the Agricultural Research Farm, Banaras Hindu University. The study employed a split-plot design with three replications, testing three fertility levels (75%, 100%, and 125% of recommended dose of fertilizer of nitrogen, phosphorus, potassium and sulphur) on two Indian mustard hybrids ('Pro Agro Hybrid Mustard-5222' and 'Pioneer Hybrid Mustard-45S46') with three biofertilizer seed treatments (Control, PSB+SDB, and NPK consortia). Results revealed that the fertility level (125% RDF NPKS) recorded higher plant height (cm), number of primary and secondary branches plant⁻¹. In-between varieties 'Pioneer Hybrid Mustard-45S46' yielded significantly highest seed yield (kg ha⁻¹). However, among biofertilizer application of NPK consortia biofertilizer recorded higher CGR (g m⁻² land area day⁻¹) and RGR (g g⁻¹ day⁻¹) and seed yield (kg ha⁻¹). This research contributes valuable insights into the synergistic effects of fertility levels, hybrid varieties, and biofertilizers on Indian hybrid mustard growth and productivity.

Keywords: Biofertilizers, fertility levels, growth parameters, hybrid, Indian mustard, yield

Introduction

Oilseeds hold a significant position in Indian agriculture, ranking behind cereals. They are among the most important crops in the country, offering high returns per unit area and demonstrating strong adaptability to diverse agroclimatic conditions. India has the fourth-largest vegetable oil economy globally, following the USA, China, and Brazil. In the Indian agricultural economy, oilseeds are the second-largest contributor after cereals. As the third-largest producer of rapeseed mustard (21.1%) after Canada and China, India plays a crucial role in the global rapeseed mustard industry (FAOSTAT, 2022) [4]. The country exported mustard seeds worth US\$ 45.4 million, with a total export volume of approximately 51.6 million kg. India is a key exporter of mustard oilseeds, meals, and flour, ranking as the third largest mustard seed exporter in 2022. Rapeseed mustard is a vital component of the Indian oilseed sector. In the 2023-24 period, it ranked first among oilseeds in terms of production, contributing 33.24% to India's total oilseed output. The overall oilseed production stood at 39.59 million metric tons, with rapeseed mustard accounting for 13.16 mt (ICAR-DRMR Bharatpur, 2024) [6]. The leading oil-producing states in India include Rajasthan, Madhya Pradesh, Gujarat, Maharashtra, Haryana, Uttar Pradesh, West Bengal, Karnataka, Tamil Nadu, and Telangana. Among these, Rajasthan, Madhya Pradesh, Haryana, and Uttar Pradesh are the top producers in 2021-22, contributing approximately 47%, 14%, 12%, and 9% of the total production, respectively (MoA&FW, GOI, 2023).

Mustard production in India varies owing to a multitude of influencing factors. As a significant oilseed crop, mustard is primarily cultivated for its oil content, which is extensively utilized in culinary and food production applications. Production levels are subject to fluctuations resulting from variables, such as climatic conditions, soil fertility status, nutrient recommendations, irrigation availability, pest infestations, and market prices. Recent initiatives have aimed to enhance mustard cultivation to decrease dependency on imports and satisfy domestic oil demand. Nutrient management plays a pivotal role in mustard production by directly affecting

the plant's growth, development, and yield. Nitrogen, phosphorus, potassium, and sulphur are essential for the growth and development of Indian mustard. The application of these nutrients significantly influences crop productivity, nutrient uptake, and soil health. Rana *et al.* (2018) found that different phosphorus fertilizers helped Indian mustard use phosphorus better and recover more nitrogen and potassium, leading to higher yields and better use of resources. Optimal application of N, P, K, and S is crucial for maximizing Indian mustard productivity. Integrated nutrient management, which combines organic and inorganic sources, has demonstrated promising results in enhancing soil fertility, microbial activity, and crop yield (Basak *et al.*, 2017) [2].

Biofertilizers play several vital roles in soil fertility, crop productivity, and agricultural production, as they are eco-friendly. However, they cannot replace chemical fertilizers, which are indispensable for achieving the maximum crop yields (Sharma *et al.*, 2018) [15]. Biofertilizers with phosphate-solubilizing bacteria (PSB) have proven to be very effective in helping plants grow better and absorb more nutrients in different crops, such as Indian mustard. PSB can convert insoluble phosphorus into plant-available forms, thereby increasing phosphorus availability in the soil (Aliyat *et al.*, 2022) [1].

Indian mustard (*Brassica juncea* L.) plays a crucial role in the agricultural sector as a valuable oilseed crop. Its significance lies not only in providing high-quality edible oil but also in its potential for improving farmers economic conditions. The cultivation of improved varieties, particularly hybrid strains, has become increasingly important in maximizing crop productivity. These advanced cultivars are specifically developed to withstand various environmental stresses, exhibit enhanced disease resistance, and produce higher yields compared to traditional varieties (Thakur *et al.*, 2021) [16]. The success of growing mustard relies on many factors, such as choosing the right types of mustard seeds, using the best planting methods, practicing good crop rotation, and managing pests and diseases effectively. Additionally, the availability of irrigation facilities and the ability to adapt to prevailing climatic conditions significantly influence crop performance. The development of conventional breeding programs has led to the introduction of varieties with improved yield potential and higher oil content, thereby expanding cultivation opportunities.

Materials and Methods

The study was conducted on Gangetic Alluvial soil (*Inceptisols*) characterized by a sandy clay loam texture, slight alkalinity, and low levels of organic carbon and nitrogen, at the Agricultural Research Farm, Banaras Hindu University, during the winters of 2021-22 and 2022-23. The experiment was conducted using a split-plot design to evaluate the effects of different fertility levels (Nitrogen, phosphorus, potassium and sulphur), Indian mustard hybrids, and biofertilizer applications on soil nutrient dynamics and plant performance. The main plot treatments consisted of a factorial combination of three fertility levels and two mustard hybrids. The fertility levels included F₁: 75% RDF (90, 45, 45, 30 kg NPKS ha⁻¹), F₂: 100% RDF (120, 60, 60, 40 kg NPKS ha⁻¹) and F₃: 125% RDF (150, 75, 75, 50 kg NPKS ha⁻¹). These were combined with two hybrids, H₁: 'Pro Agro Hybrid Mustard-5222' and H₂: 'Pioneer Hybrid Mustard-45S46' resulting in six main plot treatment combinations (3 fertility levels × 2 hybrids). Each main plot was further subdivided into three sub-plots to which different biofertilizer treatments were applied: B₁ (Control – no biofertilizer), B₂ (PSB + SDB, where PSB is phosphate solubilizing bacteria and SDB is sulphur

dissolving bacteria), and B₃ (NPK consortia comprising beneficial microbes that aid in nitrogen fixation, phosphorus solubilization, and potassium mobilization) Half of the nitrogen dose and full doses of phosphorus, potassium, and sulphur were applied as basal dressing, with the remaining nitrogen top-dressed at 30 and 55 DAS. During the first year, the mean maximum and minimum temperatures were 32.9 °C and 6.7 °C, respectively, with an average temperature of 19.8 °C. The total rainfall received was 69.2 mm, with an average relative humidity of 75.53%, wind speed of 1.76 km hr⁻¹, 5.92 sunshine hours day⁻¹, and evaporation rate of 1.89 mm day⁻¹. In the second year, slightly lower maximum temperature (32.3 °C), lower minimum temperature (4.8 °C), and average temperature (18.5 °C), relative humidity (69.89%) were recorded. Although rainfall (2.2 mm) and were lower than the previous year, sunshine hours (6.7 hours day⁻¹) and evaporation (2.12 mm day⁻¹) were marginally higher, along with wind speed (2.31 km hr⁻¹). Under assured irrigation, where moisture was not limiting, the improved sunshine duration, enhanced temperature amplitude, and lower humidity likely created a more conducive environment for photosynthesis, nutrient assimilation, and overall crop metabolism. These factors possibly contributed to the better growth and yield performance observed in the second year. Three irrigations were administered, adhering to standard crop management practices. Weather conditions in the second year were more conducive to mustard cultivation. Growth parameter such as plant height (cm), number of primary and secondary branches plant⁻¹, CGR, RGR at intervals of 30-60 DAS and 60-90 DAS and seed yield (kg ha⁻¹) were recorded during the 2-year experimentation. The collected data were subjected to statistical analysis as outlined by Gomez and Gomez (1984) [5]. The interpretation of treatment effects was conducted using Fisher's critical difference at the p=0.05 significance level.

$$\text{Crop growth rate (g cm}^2\text{day}^{-1}) = \frac{W_2 - W_1}{(t_2 - t_1) \times S (\text{m}^2)}$$

Where,

W₁ and W₂ are plant dry weight per plant at time t₁ and t₂, respectively.

S is the plant spacing in square meter

$$\text{Relative growth rate (g g}^{-1}\text{day}^{-1}) = \frac{\ln W_2 - \ln W_1}{(t_2 - t_1)}$$

Where, ln is the natural log

Results and Discussion

Fertility levels

The data showed that (Table 1.) application of 125% RDF (150, 75, 75, 50 kg NPKS ha⁻¹) recorded significantly higher plant height (183, 193 cm), number of primary branches plant⁻¹ (8.30, 8.85), number of secondary branches plant⁻¹ (14.9, 15.8) and seed yield (2710, 2824 kg ha⁻¹) over the 75% RDF NPKS during both years of the experiment (Fig 1.). Balanced nutrition especially N, P, K and S helps in regulating the cytokinin-auxin balance as well as homeostasis in plant, which promotes growth of lateral buds that ultimately, develop as branches. Formation of auxiliary and lateral branches is physiologically a case of tissue differentiation that is one of the main roles of nitrogen (Prasad *et al.*, 2022) [13]. These results are close conformity with (Kumar *et al.*, 2018; Mandal *et al.*, 2018) [7, 10]. Application of

125% RDF NPKS recorded highest CGR and RGR at intervals of 30-60 and 60-90 DAS (Table 2). Higher fertility level, the crop acquired greater shoot dry weight subsequently increased the CGR, AGR, RGR and NAR. This increase in these morpho-physiological characters might be due to the maintenance of higher levels of auxin in the plant tissues thereby greater synthesis of food in the leaves with better water relation (Majid and Simpson, 1997; Mondal *et al.*, 2017; Sahoo *et al.*, 2025)^[9, 12].

Hybrid varieties

As shown in (Table 1.) in-between hybrid varieties 'Pioneer Hybrid Mustard-45S46' recorded significantly higher plant height (cm), number of primary and secondary branches plant⁻¹, seed yield (kg ha⁻¹), CGR at 30-60 DAS over the 'Pro Agro Hybrid Mustard-5222' during both years of study. CGR at 60-90 DAS failed to touch the level of significance (Table 2.). However, RGR at 30-60 and 60-90 DAS failed to touch the level of significance similar trend was followed in second year. The varietal difference in plant height were also reported by Thakur *et al.* (2021)^[16] the findings of the experiment indicated that the growth parameters of the Indian mustard cv. '45S35' included plant height, primary branches per plant, dry weight, and crop

growth rate.

Biofertilizers

Two years of experiment revealed that application of NPK consortia resulted significantly higher plant height, number of secondary branches plant⁻¹, seed yield (kg ha⁻¹) it was followed by PSB+SDB. Number of secondary branches plant⁻¹ recorded highest with application of NPK consortia with percentage increment of (11.8%, 8.9%) over the control plot (Table 1.). However, CGR at intervals of 30-60 and 60-90 DAS resulted significantly higher with application of NPK consortia and it was statistically at par with PSB+SDB in first year of the experiment while in second year trial NPK consortia recorded highest over the control plot. Meanwhile RGR at intervals of 30-60 DAS recorded significantly higher with application of NPK consortia and it was followed by PSB + SDB during both years of the experiment and however intervals of 60-90 DAS failed to touch the level of significance during both years of the experiment (Table 2.). Kumar *et al.* (2017)^[8] reported that mustard seeds treated with *Azotobacter* and PSB showed faster emergence and stronger early growth due to improved nutrient mobilization at the root-soil interface.

Table 1: Effect of fertility levels and biofertilizers on growth parameters of hybrid Indian mustard

Treatments	Plant height (cm)		Number of primary branches plant ⁻¹		Number of secondary branches plant ⁻¹	
	Harvest		Harvest		Harvest	
	2021-2022	2022-2023	2021-2022	2022-2023	2021-2022	2022-2023
Fertility levels						
75% RDF (NPKS)	158	164	6.13	6.45	11.5	12.0
100% RDF (NPKS)	171	179	7.40	8.12	14.6	15.8
125% RDF (NPKS)	183	193	8.30	8.85	14.9	15.8
S.Em±	2.79	3.03	0.12	0.20	0.24	0.23
LSD (p=0.05)	8.78	9.53	0.38	0.63	0.76	0.72
Hybrids						
Pro Agro Hybrid Mustard-5222	167	175	6.96	7.37	12.9	13.8
Pioneer Hybrid Mustard-45S46	174	183	7.60	8.24	14.4	15.4
S.Em±	2.27	2.47	0.10	0.16	0.20	0.19
LSD (p=0.05)	7.17	7.78	0.31	0.52	0.62	0.58
Biofertilizers						
Control	160	167	6.89	7.52	12.4	13.2
PSB+SDB	174	183	7.25	7.72	14.1	15.0
NPK consortia	178	186	7.70	8.19	14.5	15.5
S.Em±	2.06	2.59	0.10	0.15	0.22	0.20
LSD (p=0.05)	6.01	7.56	0.30	0.45	0.65	0.58

RDF= Recommended dose of fertilizer, NPKS= Nitrogen, Phosphorus, Potassium, Sulphur, PSB= Phosphorus solubilizing bacteria, SDB= Sulphur dissolving bacteria, NS= non-significant

Table 2: Effect of fertility levels and biofertilizers on crop growth rate (CGR; g m⁻² land area day⁻¹) and relative growth rate (RGR; g g⁻¹ day⁻¹) of hybrid Indian mustard

Treatments	Crop Growth Rate (CGR; g m ⁻² land area day ⁻¹)				Relative Growth Rate (RGR; g g ⁻¹ day ⁻¹)			
	30-60 DAS		60-90 DAS		30-60 DAS		60-90 DAS	
	2021-2022	2022-2023	2021-2022	2022-2023	2021-2022	2022-2023	2021-2022	2022-2023
Fertility levels								
75% RDF (NPKS)	7.22	8.27	6.46	6.34	0.0429	0.0464	0.0167	0.0167
100% RDF (NPKS)	9.45	10.1	6.59	6.76	0.0508	0.0509	0.0145	0.0143
125% RDF (NPKS)	9.94	10.6	8.28	8.34	0.0520	0.0520	0.0173	0.0171
S.Em±	0.13	0.17	0.12	0.13	0.0007	0.0008	0.0003	0.0003
LSD (p=0.05)	0.42	0.52	0.39	0.41	0.0023	0.0026	0.0010	0.0010
Hybrids								
Pro Agro Hybrid Mustard-5222	8.58	9.32	7.07	7.01	0.0480	0.0493	0.0163	0.0159
Pioneer Hybrid Mustard-45S46	9.16	9.98	7.15	7.28	0.0491	0.0503	0.0161	0.0162
S.Em±	0.11	0.14	0.10	0.11	0.0006	0.0007	0.0002	0.0002
LSD(p=0.05)	0.34	0.43	NS	NS	NS	NS	NS	NS

Biofertilizers								
Control	8.20	8.87	6.64	6.74	0.0467	0.0482	0.0160	0.0158
PSB+SDB	9.09	9.78	7.29	7.19	0.0493	0.0499	0.0163	0.0164
NPK consortia	9.32	10.3	7.41	7.50	0.0496	0.0511	0.0161	0.0158
S.Em±	0.10	0.12	0.07	0.08	0.0006	0.0007	0.0002	0.0002
LSD (p=0.05)	0.30	0.36	0.22	0.24	0.0017	0.0019	NS	NS

RDF= Recommended dose of fertilizer, NPKS= Nitrogen, Phosphorus, Potassium, Sulphur, PSB= Phosphorus solubilizing bacteria, SDB= Sulphur dissolving bacteria, NS= non-significant

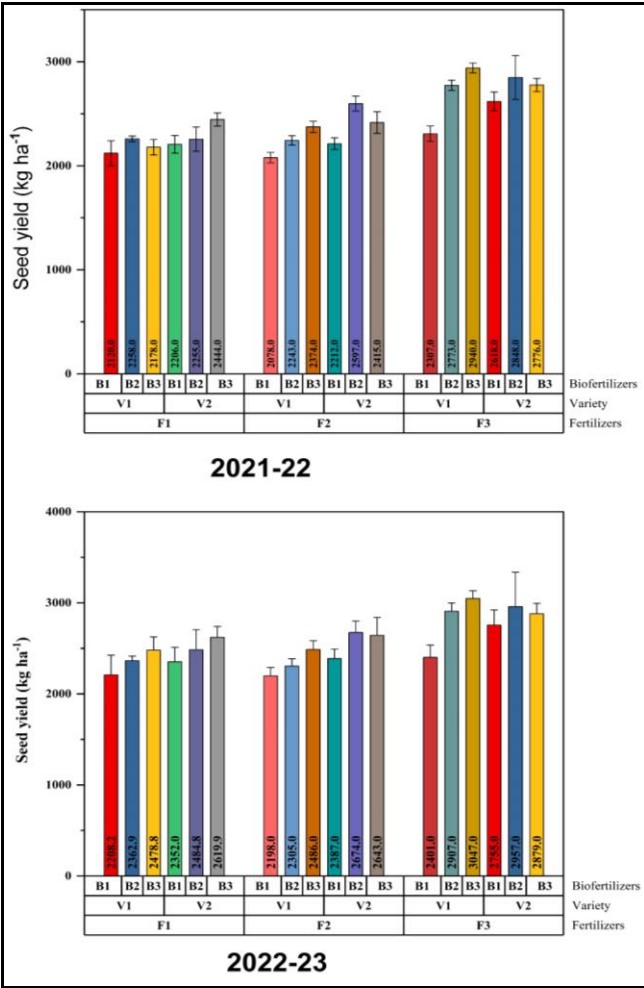


Fig 1: Effect of fertility levels and biofertilizers on seed yield (kg ha⁻¹) of hybrids Indian mustard during both the years
Foot note: {F1: 75% RDF (90, 45, 45, 30 kg NPKS ha⁻¹), F2: 100% RDF (120, 60, 60, 40 kg NPKS ha⁻¹), F3: 125% RDF (150, 75, 75, 50 kg NPKS ha⁻¹), H1: Pro Agro Hybrid Mustard-5222, H2: Pioneer Hybrid Mustard-45S46, B1-Control (No biofertilizers), B2-PSB+SDB, B3-NPK consortia}

Conclusion

The research indicates that applying a fertility level of 125% RDF NPKS, along with the use of 'Pioneer Hybrid Mustard-45S46' and biofertilizer treatment with NPK consortia, can substantially improve the growth, and yield of Indian mustard in the specific agro-climatic conditions of the Varanasi area.

References

1. Aliyat F, Kumar S, Sharma R, Gupta P. Effect of phosphate-solubilizing bacteria on phosphorus availability, plant growth, and nutrient uptake in Indian mustard (*Brassica juncea* L.). *Journal of Soil Biology and Fertility*. 2022;18(2):145-160.

2. Basak N, Mandal B, Datta A, Mitran T, Biswas S, Dhar D,

et al. Impact of long-term application of organics, biological, and inorganic fertilizers on microbial activities in rice-based cropping system. *Communications in Soil Science and Plant Analysis*. 2017;48(20):2390-2401.

3. Chaudhary AK, Rana DS, Rajanna GA, Dass A. Fertilizer phosphorus solubility effects on Indian mustard-maize and wheat-soybean cropping systems productivity. *Agronomy Journal*. 2018;110(6):2608-2618.

4. Food and Agriculture Organization of the United Nations (FAO). FAOSTAT. Statistics Database. Rome: FAO; 2022.

5. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd ed. New York: John Wiley and Sons; 1984.

6. ICAR-Directorate of Rapeseed-Mustard Research (DRMR). Annual Report 2024. Bharatpur: DRMR; 2024.

7. Kumar D, Singh JK, Nanda G. Effect of levels and sources of sulphur on growth, yield, nutrient removal and relative economies of Indian mustard (*Brassica juncea* L.) varieties under irrigated conditions. *SKUAST Journal of Research*. 2018;20(1):53-57.

8. Kumar V, Tyagi S, Choudhary SK. Growth, yield and quality of Indian mustard (*Brassica juncea* L.) with doses and different sources of sulphur. *Indian Journal of Ecology*. 2017;44(5):422-426.

9. Majid A, Simpson C. Growth relationships of mustard under irrigated conditions. *Pakistan Journal of Botany*. 1997;29(1):125-134.

10. Mandal M, Naik SK, Das DK. Effect of boron and sulfur interaction on some important biological indices in an Inceptisol. *Journal of Plant Nutrition*. 2018;41(2):197-209.

11. Ministry of Agriculture and Farmers Welfare, Government of India. Annual Report 2023. New Delhi: MoAFW; 2023.

12. Mondal T, Datta JK, Mondal NK. Chemical fertilizer in conjunction with biofertilizer and vermicompost induced changes in morpho-physiological and biochemical traits of mustard crop. *Journal of the Saudi Society of Agricultural Sciences*. 2017;16:135-144.

13. Prasad S, Mahapatra BS, Singh SP, Kumar A, Negi MS, Verma G. Effect of INM practices on productivity, profitability and quality of Indian mustard. *Indian Journal of Agricultural Sciences*. 2021;91(5):789-791.

14. Sahoo S, Jena S, Dash R, Mohapatra KK, Barla S. Effect of weed management practices and fertility levels on growth, nutrient uptake and yield of groundnut (*Arachis hypogaea* L.). *Plant Science Today*. 2025;12(2):1-8.

15. Sharma V, Sharma BL, Sharma GD, Porte SS, Dubey A. Studies on impact of sulphur with and without FYM on yield, uptake and methionine content in mustard. *International Journal of Current Microbiology and Applied Sciences*. 2018;7:723-731.

16. Thakur T, Singh V, Kumar S, Tiwari D, Thakur MP. Agronomic evaluation of mustard (*Brassica juncea* L.) hybrids under agroclimatic conditions of Prayagraj (U.P.) in Rabi-2019-2020. *International Journal of Current Microbiology and Applied Sciences*. 2021;10(1):347-351.