



Effect of biofertilizers on growth, production and profitability of *gobhi sarson* (*Brassica napus* L.) at varying fertility levels

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Abstract

A field experiment was conducted during *rabi* season of 2022-23 at Shivalik Agricultural Research and Extension Centre (SAREC), Kangra, Himachal Pradesh to assess the effect of biofertilizers on growth, production and profitability of *gobhi sarson* at varying fertility levels. The experiment was conducted in split-plot design comprises three fertility levels (Control, 75% of recommended dose of fertilizer and 100% RDF) as main plot treatments and biofertilizers (*Azotobacter*, phosphate solubilizing micro-organism (PSMO), potassium mobilizing biofertilizer (KMB), NPK consortia + zinc solubilizing biofertilizer (ZSB), ZSB and control (no biofertilizer)] as sub plots, replicated thrice. The experimental results revealed that application of 100% RDF recorded higher growth (plant height, dry matter accumulation), yield attributes *viz.* number of primary and secondary branches/plant, number of siliquae/plant, number of seeds/siliqua and 1000-seed weight which resulted in significantly higher seed yield (1866 kg/ha), oil content (41.3%), oil yield (771.0 kg/ha) as well as gross returns (Rs 1,01,695/ha), net returns (Rs 62,819/ha) and B:C ratio (1.62). *Azotobacter* and PSMO exhibited most efficient biofertilizers with better plant growth in terms of plant height and dry matter accumulation. Seed inoculation with *Azotobacter* recorded significantly higher values of growth parameters, yield attributes, seed yield (1687 kg/ha), oil content (41.5%) and oil yield (703.5 kg/ha) besides recording higher gross returns (Rs 91,945/ha), net returns (Rs 59,250/ha) and B:C ratio (1.81) followed by PSMO.

Keywords: *Azotobacter*, biofertilizer, oil content, rapeseed, seed yield

Introduction

India ranks as the third largest oilseed producer globally with rapeseed-mustard being a key crop in terms of both area and production. Rapeseed (*Brassica* spp.), part of the Brassicaceae family, is a major oilseed crop, second only to soybean in cultivation area and groundnut in productivity having 36-42% oil content. In India, during 2020-21, rapeseed-mustard covered 6.69 million hectares, yielding 10.11 million tonnes with 1511 kg/ha productivity. India contributes 19.8% of the global area and 9.8% of total production. In Himachal Pradesh, the crop was cultivated on 8.6 thousand hectares, producing 4.9 thousand tonnes with a yield of 650 kg/ha (Anonymous, 2019; Anonymous, 2021a).

Rapeseed-mustard productivity is significantly affected by nutrient shortages. Though it is a nutrient-demanding crop, small and marginal farmers who often lack access to vital inputs, typically cultivate it on poor, low-fertility soils. As a result, the crop's growth potential remains unrealized. Fertilization is a fundamental agronomic practice that directly influences crop productivity by

supplying essential nutrients. Chemical fertilizers widely used for their immediate nutrient availability, play a pivotal role in achieving high yields. However, there is growing interest in biofertilizers that enhance nutrient uptake by plants through biological process showing to their potential for sustainable agriculture. In 2020-21, India consumed 325.56 lakh tonnes of NPK fertilizers (33.3% imported) and 246.16 lakh tonnes of edible oil, of which 54.6% was imported (Anonymous, 2021a). In 2020-21, India incurred 1.17 lakh crore rupees on vegetable oil imports (Anonymous 2021b). To reduce the financial burden from importing oil and fertilizers, improving nutrient use efficiency is crucial for increasing the sustainable production of rapeseed-mustard. However, the comparative effectiveness of chemical and biofertilizers on *gobhi sarson* growth and yield remains insufficiently explored, particularly in North western Himalayan agro-climatic conditions. Biofertilizers offer a cost-effective nutrient supply and could be a key component of INM for oilseed crops (Kumar, 2012, Shekhawat *et al.*, 2012). Therefore, keeping these facts in view, the present study aims to investigate the

comparative effects of chemical and biofertilizers on the growth, yield and economics of *gobhi sarson*. By assessing their influence on key growth parameters and final yield, the research seeks to determine the most effective fertilization strategy for optimizing rapeseed productivity while promoting environmentally sustainable agricultural practices.

Materials and Methods

The field experiment was conducted during *Rabi* season of 2022–23 at the experimental farm of Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Shivalik Agricultural Research and Extension Centre (SAREC), Kangra, Himachal Pradesh. The study area is situated at 32°09'2" N latitude, 76°22'2" E longitude and 700 meters above the mean sea level. The soil of the experimental field was silty clay loam in texture having a pH of 5.65. The soil sample taken prior to the experiment was low in available nitrogen, medium in available phosphorus and available potassium. The experiment was laid out in a split-plot design, allocating fertility levels in main plots, viz. control (no fertilizer), 75% recommended dose of fertilizer (RDF) and 100% RDF and six treatments of liquid biofertilizers, viz. *Azotobacter*, phosphate solubilizing microorganisms (PSMO), potassium mobilizing biofertilizer (KMB), zinc solubilizing biofertilizers (ZSB), NPK consortia + ZSB and control (no biofertilizer) in sub plots, replicated thrice. Seed inoculation with liquid biofertilizers was done by soaking the seeds for 30 minutes in liquid biofertilizers and then dried in the shade for half an hour before sowing in field plots of an area of 11.76 m² of each gross plot. The nitrogen was supplied by IFFCO (12:32:16) and urea and potash through muriate of potash (MOP). As per main plot treatments, full dose of phosphorus and potassium along with one-third dose of nitrogen was applied as basal dressing. The remaining dose of nitrogen was given by urea at the vegetative and flowering stages. The recommended dose of fertilizer was 120 kg N, 60 kg P₂O₅ and 40 kg K₂O/ha. The sowing of variety 'GSC-7' was done manually by using the kera method with a row-to-row spacing of 30 cm and plant-to-plant spacing of 10–15 cm with a seed rate of 6 kg/ha. Weeding was done manually to manage the weeds in the experimental crop. The crop was harvested at maturity with the help of a sickle and the harvested produce of the net plot was kept for sun-drying followed by threshing. To study the response of rapeseed to different treatments, observations have been recorded with respect to plant height and dry matter accumulation/m² at 30 days interval from date of sowing to harvest. The observations on number of primary and secondary branches, number of siliques and seeds/silique, test weight and seed yield of

the crop were taken at harvesting. The dried siliques from each net plot were threshed and cleaned & the number of seeds per silique was counted. After drying, 1000 seeds were counted from the samples drawn for seed yield of each net plot and the weight of 1000 seeds was recorded and expressed in grams. Soxhlet's extraction method determined the oil content in seeds (AOAC 1960). Oil yield was computed by multiplying the oil content with the respective seed yield. All the observations were recorded according to standard procedures.

$$\text{Oil (\%)} = \frac{\text{Weight of oil (g)}}{\text{Weight of sample (g)}} \times 100$$

$$\text{Oil yield (kg/ha)} = \frac{\text{Seed yield (kg/ha)} \times \text{Seed oil content (\%)}}{100}$$

The economic analysis of each treatment was carried out by calculating the cost of cultivation, gross returns, net returns and the BC ratio per hectare basis to determine their economic feasibility. The data obtained on various observations were tabulated and analyzed in split-plot design using online statistical analysis tool OPSTAT software.

Results and Discussion

Growth parameters

The effect of different fertility levels and seed inoculation with liquid biofertilizers on growth parameters of *gobhi sarson* viz. plant height and dry matter accumulation was found significant (Table 1 and 2). It was observed that application of 100% of recommended dose of fertilizer (RDF) produced taller plants and maximum dry matter accumulation over 75% RDF and control. Among different biofertilizer treatments, seed inoculation with *Azotobacter* recorded significantly taller plants and maximum dry matter accumulation that remained statistically at par with phosphate solubilizing microorganisms (PSMO) as compared to other biofertilizers. This is due to nitrogen fixation and production of growth-promoting substances by *Azotobacter*, while phosphorus solubilizers release organic acids to free phosphate (Rundala *et al.*, 2013; Nisha *et al.*, 2014).

Yield attributes and yield

Data revealed that yield attributing characters viz. number of primary and secondary branches/plant, number of siliques/plant, number of seeds/silique and 1000-seed weight were significantly affected by different fertility levels and liquid biofertilizer treatments (Table 3). The maximum values of these parameters were recorded with

Table 1: Effect of fertility levels and microbial consortia on plant height of *gobhi sarson*

Treatment		Plant height (cm)					
		30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	Harvest
Fertility levels							
F ₁	Control (no fertilizer)	12.9	20.3	88.6	114.2	149.8	149.9
F ₂	75 % RDF	18.2	25.6	106.0	151.7	182.9	183.2
F ₃	100 % RDF	21.9	31.5	124.3	163.1	193.9	194.0
	SEm±	1.8	0.8	2.0	2.1	2.2	1.6
	CD (<i>P</i> =0.05)	NS	3.2	8.0	8.8	9.0	6.4
Microbial consortia							
T ₁	<i>Azotobacter</i>	19.0	28.8	121.2	153.6	187.3	187.7
T ₂	PSMO	18.4	27.7	118.1	149.6	184.0	184.1
T ₃	KMB	16.9	24.6	104.1	137.8	166.6	166.7
T ₄	ZSB	17.3	24.9	106.1	141.4	175.1	175.3
T ₅	NPK consortia + ZSB	17.9	26.3	115.1	147.4	180.2	180.3
T ₋₆	Control (no biofertilizer)	16.4	22.6	93.7	128.2	160.2	160.2
	SEm±	0.8	0.7	1.1	1.4	2.1	2.0
	CD (<i>P</i> =0.05)	NS	2.2	3.3	4.1	6.0	5.9

DAS= Days after sowing

Table 2 : Effect of fertility levels and microbial consortia on dry matter accumulation of *gobhi sarson*

Treatment		Dry matter accumulation (g/m ²)					
		30DAS	60DAS	90DAS	120DAS	150DAS	Harvest
Fertility levels							
F ₁	Control (no fertilizer)	32.8	98.6	345.2	511.3	568.1	620.8
F ₂	75% RDF	38.6	110.0	391.5	588.0	786.0	840.1
F ₃	100% RDF	43.1	122.1	441.6	685.9	868.3	899.8
	SEm±	2.3	1.7	5.6	9.9	13.1	14.7
	CD (<i>P</i> =0.05)	NS	6.7	22.5	40.2	52.9	59.3
Microbial consortia							
T ₁	<i>Azotobacter</i>	42.8	117.0	404.3	619.9	777.9	872.8
T ₂	PSMO	42.4	116.2	399.6	605.9	763.3	811.8
T ₃	KMB	34.1	104.9	385.4	580.7	712.1	759.3
T ₄	ZSB	37.2	108.4	389.6	590.3	741.4	761.9
T ₅	NPK consortia + ZSB	39.4	111.6	394.5	599.8	751.9	797.9
T ₋₆	Control (no biofertilizer)	33.0	103.2	383.2	573.9	697.5	717.5
	SEm±	3.0	2.5	3.4	8.1	8.2	11.4
	CD (<i>P</i> =0.05)	NS	7.2	9.9	23.5	23.8	33.2

DAS= Days after sowing

100% RDF that was statistically at par with 75% RDF for number of secondary branches/plant, number of seeds/silique and 1000-seed weight which was 45.4, 9.2 and 24.9% higher over control, respectively. Seed yield is the ultimate result of growth and development and data showed that application of 100% RDF resulted in a seed yield of 1866 kg/ha which was 6.1 and 121.9% higher than 75% RDF (1759 kg/ha) and control (841 kg/ha), respectively due to better yield-related traits. Premi and

Kumar (2004) also showed more seed yield with increasing fertility levels. Among different biofertilizers, *Azotobacter* recorded significantly higher values for yield attributing characters viz. primary branches/plant, secondary branches/plant, silique/plant, seeds/silique and 1000-seed weight by 19, 54.5, 22, 9.7 and 4% higher over control (no inoculation), however it remained at par with PSMO. Seed inoculation with biofertilizers significantly increased *gobhi sarson* yield by 7.9 to 32.4% as compared to the

control. *Azotobacter* produced significantly higher yield (1687 kg/ha) followed by PSMO and NPK consortia + ZSB. Yield improvements over the control with *Azotobacter*, PSMO, NPK consortia + ZSB, ZSB and KMB were 32.4, 26.4, 19.8, 14.5 and 7.9%, respectively. Similar findings were also reported by Dabi *et al.* (2015) and Beenish *et al.* (2018).

Quality parameters

Data pertaining to quality parameters viz. oil content and oil yield of *gobhi sarson* showed significant effect by different fertility levels and biofertilizer treatments. Oil content is one of the prominent quality parameter of any oilseed crop that also determines the oil yield of the crop. The data showed that application of 100% RDF recorded higher oil content (41.3%) that was 2.5 and 5.3% more than 75% RDF and control, respectively. However, it was

also being at par with 75% RDF. Whereas significantly higher oil yield of 771 kg/ha recorded with 100% RDF followed by 75% RDF (710.9 kg/ha). Similar find was reported by Ratanoo R (2020). Seed inoculation with biofertilizers favoured the oil content percent as compared to control (no biofertilizer). Seed inoculated with *Azotobacter* produced significantly higher oil content (41.5%) being at par with PSMO treatment (41.1%), the latter was also at par with NPK consortia + ZSB. Seed inoculation with different biofertilizers viz. *Azotobacter*, PSMO, NPK consortia + ZSB, ZSB and KMB showed significant increase on oil yield by 39.9, 32.1, 23.5, 16.7 and 9.6%, respectively over control (no inoculation). Higher values of seed yield and oil content were recorded with *Azotobacter* resulted in highest oil yield (703.5 kg/ha) followed by PSMO. The results are in tally with that of Kiani *et al.* (2013) and Kumar and Singh (2019).

Table 3: Effect of fertility levels and microbial consortia on yield attributes, yield and quality parameters of *gobhi sarson*

Treatment	Primary branches /plant	Secondary branches /plant	Siliquae /plant	Seeds /siliqua	1000-seed weight (g)	Seed yield (kg/ha)	Oil content (%)	Oil yield (kg/ha)
Fertility levels								
F ₁ Control	4.0	0.6	132.9	19.5	3.13	841	39.2	329.7
F ₂ 75% RDF	4.7	1.8	210.0	20.6	3.84	1759	40.3	710.9
F ₃ 100% RDF	5.4	2.1	225.4	21.3	3.91	1866	41.3	771.0
SEm±	0.1	0.3	3.6	0.2	0.02	24	0.2	12.6
CD (P=0.05)	0.4	1.1	14.3	0.9	0.08	99	1.0	50.7
Microbial consortia								
T ₁ <i>Azotobacter</i>	5.0	1.9	208.5	21.5	3.86	1687	41.5	703.5
T ₂ PSMO	4.9	1.8	202.6	21.2	3.84	1610	41.1	664.4
T ₃ KMB	4.5	1.2	181.5	19.7	3.75	1375	39.7	551.2
T ₄ ZSB	4.6	1.4	182.9	20.1	3.77	1459	39.9	586.8
T ₅ NPK consortia + ZSB	4.7	1.6	190.0	20.6	3.80	1527	40.5	621.0
T ₆ Control	4.2	0.8	170.9	19.6	3.71	1274	39.2	502.9
SEm±	0.1	0.2	3.0	0.3	0.02	18	0.3	9.6
CD (P=0.05)	0.2	0.5	8.7	0.8	0.05	55	0.9	27.8

Economics

The data on the effect of fertility levels and biofertilizers on economic indicators (cost of cultivation, gross returns, net returns and B:C ratio) have been presented in Table 4. Higher cost of cultivation by Rs 1296/ha more incurred with the application of recommended dose of fertilizers as compared to 75% RDF. Higher value of gross returns (Rs 1,01,695/ha), net returns (Rs 62,819/ha) and benefit cost ratio of 1.62 were recorded with 100% RDF as compared to 75% RDF. The corresponding values in control were Rs 45,862/ha, Rs 13,667/ha and 0.42. Similar

finding was also reported by Meena *et al.* (2013).

Among sub plot treatments, different biofertilizers having more or less similar cost of cultivation including co-inoculation of NPK consortia + ZSB while lower was recorded in uninoculated (control) treatment. Seed inoculation with biofertilizers recorded higher economic returns in terms of gross returns (7.9-32.4%), net returns (31.0-83.7%) and B:C ratio over uninoculated (control) treatment. *Azotobacter* biofertilizer resulted in higher value of all economic parameters viz. gross returns (Rs 91,945/ha), net returns (Rs 59,250/ha) and benefit cost ratio (1.81)

Table 4: Effect of fertility levels and microbial consortia on economics

Treatment		Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return(Rs/ha)	B:C
Fertility levels					
F ₁	Control (no fertilizer)	32195	45862	13667	0.42
F ₂	75% RDF	37580	95753	58173	1.55
F ₃	100% RDF	38876	101695	62819	1.62
Microbial consortia					
T ₁	<i>Azotobacter</i>	32695	91945	59250	1.81
T ₂	PSMO	32695	87753	55058	1.68
T ₃	KMB	32695	74944	42249	1.29
T ₄	ZSB	32695	79302	46806	1.43
T ₅	NPK consortia + ZSB	32685	83235	50550	1.54
T ₆	Control (no biofertilizer)	32195	69442	32247	1.16

followed by PSMO, NPK + consortia + ZSB, ZSB and KMB due to proportionate increase in profit with each rupee of investment. Similar results were also reported by Hadiyal *et al.* (2017) and Janaki *et al.* (2022) with higher gross and net returns when mustard seeds treated with *Azotobacter* as compared to PSB treatment.

Conclusion

Application of 100% RDF produced better growth and more of yield attributes which resulted in significantly more seed yield (1866 kg/ha), oil content (41.3%) and oil yield (771.0 kg/ha) over 75% RDF and thus was more remunerative in terms of gross returns (Rs 1,01,695/ha), net returns (Rs62,819/ha) and B:C ratio (1.62). Among liquid biofertilizers, *Azotobacter* was the most efficient biofertilizer followed by PSMO that recorded higher growth parameters (plant height and dry matter accumulation), yield attributes *viz.* number of primary and secondary branches/plant, number of siliquae and seeds/siliqua and 1000-seed weight resulted in significantly higher seed yield (1687 kg/ha), oil content (41.5%) and oil yield (703.5 kg/ha) as compared to other treatment. Similarly, the gross returns (Rs 91,945/ha), net returns (Rs 59,250/ha) and B:C ratio (1.81) were more in *Azotobacter* followed by PSMO Rs 87,753/ha, Rs 59,250/ha & 1.68, respectively).

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References

- Anonymous 2019. Directorate of oilseeds development. <https://oilseeds.dac.gov.in/india>.
- Anonymous. 2021a. Agricultural Statistics at A Glance 2021. Ministry of Agriculture and Farmers Welfare, Government of India. <https://desagri.gov.in/india>.
- Anonymous 2021b. <https://economictimes.india-times.com/news/economy/foreigntrade/indias-vegetable-oil-imports-cost-a-record-15-7billion/articleshow/87734197.cms?from=mdr>.
- AOAC. 1970. Official methods of analysis. Association of Official Agricultural Chemists, Washington, D.C. Edn 3 : 185.
- Beenish O, Ahmad L, Hussain A and Lal EP. 2018. Organic manure and biofertilizers: Effect on the growth and yield of Indian mustard (*Brassica juncea* L.) varieties. *Curr J Applied Sci Technol*, **30**: 1-7.
- Dabi B, Singh J, Singh RK and Vishwakarma A. 2015. Quality and profitability of Indian mustard (*Brassica juncea*) as affected by nutrient management practices under irrigated condition. *Ind J Agron*, **60**: 168-171.
- Hadiyal JG, Kachhadiya SP, Ichchhuda PK and Kalsaria RN. 2017. Response of Indian mustard (*Brassica juncea* L.) to different levels of organic manures and bio-fertilizers. *J Pharmacogn Phytochem*, **6**: 873-875.
- Janaki B, Singh R and Tripathi P. 2022. Effect of biofertilizers and potassium on yield and economics of yellow mustard (*Brassica campestris* L.). *Int J Environ Climate Change*, **12**: 1282-1287.
- Kiani M, Farnia A and Shaban M. 2013. Changes of seed yield, seed protein and seed oil in rapeseed (*Brassica napus* L.) under application of different bio fertilizers. *Int J Advanced Biological Biomedical Res*, **1**: 1170-1178.

- Kumar A. 2012. Production barriers and technological options for sustainable production of rapeseed-mustard in India. *J Oilseed Brassica*, **3**: 67-77.
- Kumar V and Singh S. 2019. Effect of fertilizers, biofertilizers and farmyard manure on sustainable production of Indian mustard (*Brassica juncea* L.). *Annals Plant Soil Res*, **21**: 25-29.
- Meena DS, Tatarwal JP and Ram B. 2013. Effect of chemical and bio-fertilizers on productivity, profitability and quality of Indian mustard (*Brassica juncea*) in Vertisols. *Ind J Agron*, **58**: 96-99.
- Nisha K, Devi P, Vasandha SN and Kumari SK. 2014. Role of Phosphorous solubilizing microorganisms to eradicate P-deficiency in plants: A review. *Int J Scientific Res Publications*, **4**: 1-5.
- Premi OP and Kumar M. 2004. Response of Indian mustard (*Brassica juncea*) to different levels of nitrogen and phosphorus under irrigated condition. *Ind J Agril Res*, **38**: 151-153.
- Ratanoo R. 2020. Effect of biofertilizers on production and quality of gobhisarson (*Brassica napus* L.) and their residual effect on succeeding summer moong bean (*Vigna radiata* L.) Ph.D. Thesis. Department of Agronomy, Punjab Agricultural University, Ludhiana, India. 2010.
- Rundala SR, Kumawat BL, Choudhary GL, Prajapat K and Kumawat S. 2013. Performance of Indian mustard (*Brassica juncea*) under integrated nutrient management. *Crop Res*, **46**: 115-118.
- Shekhawat K, Rathore SS, Premi OP, Kandpal BK and Chauhan JS. 2012. Advances in agronomic management of Indian mustard (*Brassica juncea* (L.) Czernj. Cosson): An overview. *Int J Agron*, **2012**: 1-14.