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Short Communication

Effect of biofertilizers and fertility levels on phenology, agronomic efficiency and crop recovery efficiency of gobhi sarson (*Brassica napus* L.)

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Abstract

A field experiment was conducted during *rabi* 2022-23 at CSKHPKV Shivalik Agricultural Research and Extension Centre, Kangra (H.P.) to study the influence of fertility levels viz. control, 75% of recommended dose of fertilizer (RDF) and 100% RDF in main plots and seed inoculations with six liquid biofertilizers *viz. Azotobacter*, Phosphate solubilizing microorganism (PSMO), Potassium mobilizing biofertilizer (KMB), NPK consortia + Zinc solubilizing biofertilizer (ZSB), ZSB and control (no biofertilizer) as subplots of split plot design in gobhi sarson "GSC-7" on phenological stages and agronomic as well as crop recovery efficiency. Seed inoculation with liquid biofertilizers was done by soaking the seeds for 30 minutes in liquid biofertilizers procured from IFFCO. Application of 100% RDF recorded early flowering (79.6) and physiological maturity (165.5) being at par with 75% RDF compared to control. The higher values of agronomic efficiency and crop recovery efficiency were recorded in75% RDF and 100%RDF, respectively. Among biofertilizers, PSMO and *Azotobacter* recorded higher agronomic efficiency whereas crop recovery efficiency for total NPK was more with *Azotobacter* seed inoculation. The results indicated that seed inoculation with biofertilizers showed positive influence on phonological characteristics, agronomic as well as crop recovery efficiency. Amongst biofertilizers, *Azotobactor* was found to be the most efficient followed by PSMO. Thus, *gobhi sarson* seed treatment with liquid biofertilizer*Azotobacter*/PSMO and application of 120 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha is advisable.

Keywords: Agronomic efficiency, *Azotobacter*, Biofertilizers, Crop recovery efficiency, *Gobhi sarson*, Phenology

India's population is projected to be 1.48 billion in 2030. Moreover, per capita edible oil consumption is also increasing. India's demand for edible oil is expected to grow at an annual rate of 3.54% between 2011 and 2030, resulting in a projected increase in per capita consumption from 13.4 kg/annum to 23.1 kg/annum by 2030 (DRMR, 2011). During 2020-21 area, production and productivity of rapeseed-mustard in the world was 34.89 million hectares, 69.23 million tonnes and 1980 kg/ha while in India it was 6.69 million hectares,10.11 million tonnes and 1511 kg/ha, respectively. Globally, India account for 19.8 % and 9.8% of the total acreage and production. In Himachal Pradesh, the average productivity of rapeseed-mustard crop is 650 kg/ha (Anonymous 2019 and Anonymous 2021).

Rapeseed-mustard crops have high nutrient requirements, but they are mainly grown by small and marginal farmers who struggle to access necessary resources. These crops are generally grown on marginal and poor fertility soils. Consequently, the growth potential of rapeseed-mustard is constrained, despite its high nutrient demands. Integrated nutrient management is crucial for overcoming limitations and enhancing production in rapeseed-mustard crops (Shekhawat *et al.*2012; Kumar 2012).

Biofertilizers are the potential source for the supply of nutrients at low cost and may prove as an important component of Integrated Nutrient Management (INM) system in oilseed crops. Biofertilizers play a vital role

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in enhancing plant growth by converting unavailable plant nutrients into accessible forms through various mechanisms. They facilitate nitrogen supply through biological nitrogen fixation (BNF), solubilize micro and macro elements, mobilize nutrients and synthesize plant growth-promoting hormones (Sharma *et al* 2016). Moreover, they provide protection against soil-borne diseases. Due to their eco-friendly nature, lack of hazards and cost-effectiveness, biofertilizers have gained popularity as an excellent supplement to chemical fertilizers in modern agriculture (Kumawat 2017).

A field experiment was conducted during *rabi* 2022-23 at CSKHPKV Shivalik Agricultural Research and Extension Centre (SAREC), Kangra, India. The soil of field experimentation was clay loam in texture having pH 5.61. The soil sample taken prior to experiment was low in available nitrogen (275.7 kg/ha) whereas medium in available phosphorus (18.3 kg/ha) and available potassium (227.4 kg/ha).The experiment was laid out in split plot design allocating fertility level in main plots, microbial consortia in subplots and replicated three times. The experiment consisted eighteen combinations of three main plot treatments *viz*. control, 75% recommended dose of fertilizer (RDF) and 100% RDF, and six subplot treatments (*Azotobacter*, Phosphate solubilizing microorganism (PSMO), Potassium mobilizing biofertilizer (KMB), Zinc solubilizing biofertilizer (ZSB), NPK consortia + ZSB and control). Seed inoculation with liquid biofertilizers was done by soaking the seeds for 30 minutes in liquid biofertilizers and then dried in shade for half an hour before sowing in field plots of gross plot area of 11.76 cm^2. The nitrogen was supplied by IFFCO (12:32:16) and urea whereas the source of potash was the 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 vegetative and flowering stage. The recommended dose of fertilizer was 120 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha. The manual sowing of the 'GSC-7' variety was conducted using the *kera* method, with row spacing of 30 cm and plant-plant spacing of 10 cm. The seed rate was 6 kg per hectare. The date on which 50 per cent plants in the net plot had at least one open flower was recorded and number of days taken to 50 per cent flowering was calculated from the date of sowing. Physiological maturity was considered when stem of selected plants turned yellow and siliquae were ripe from sowing to maturity. Agronomic efficiency indicates kg crop yield increase per kg nutrient applied. During study, agronomic efficiency calculated by adopting the following formula (López-Bellido and López-Bellido 2001) and mathematically this can be expressed as:

Agronomic efficiency

$$= \frac{\text{Yield (kg/ha) in fertilized soil - Yield (kg/ha) in unfertilized soil}}{\text{Quantity of fertilizer supplied (kg/ha)}}$$

Crop recovery efficiency indicates that kg increase in nutrient uptake per kg nutrient applied. It was calculated for each primary nutrient and computed by using following formula:

Crop recovery efficiency

$$= \frac{\text{Nutrient uptake (kg/ha) in fertilized soil - Nutrient uptake (kg/ha) in unfertilized soil}}{\text{Amount of nutrients applied (kg/ha)}}$$

The experimental data were analyzed by using the ANOVA (Analysis of variance) techniques as explained by Cochran and Cox (1957) using t-test at a significance level of 5%. The critical difference (CD) method was used to determine the significant difference between the treatments. Data analysis was undertaken in OPSTAT http://14.139.232.166/opstat/twofactor.html?flavor=Two+Factors+Analysis software.

The application of 100% recommended dose of fertilizer (RDF) hastened days to attain 50% flowering (79.6) and physiological maturity (165.5) being at par with 75% RDF compared to control (Table 1). The reason for early flowering and physiological maturity with100% RD Fmight be attributed to the adequate supply of essential nutrients, particularly N, P and K which play crucial roles in various physiological processes within the plant including cell division, flower bud initiation and overall plant development (Sharma *et al*. 2018). The results are in conformity with findings of Rana *et al*. (2021), Mankotia *et al*. (2022) and Shilpa *et al*. (2022).

Seed inoculation with Azotobacter showed earlier 50% flowering (79.1) and physiological maturity (165.1) being at par with PSMO treatment. Biofertilizers promote early physiological maturity in

Table 1: Effect of fertility levels and microbial consortia on phonological stages of *gobhi sarson*

	Treatment	Days to 50% flowering	Days taken to physiological maturity
Fertility levels			
F_1	Control (no fertilizer)	84.3	169.4
F_2	75% RDF	80.7	166.7
F_3	100% RDF	79.6	165.5
	SE m±	0.3	0.6
	CD (P=0.05)	1.4	2.6
Microbial consortia			
T_1	*Azotobacter*	79.1	165.1
T_2	PSMO	80.1	166.2
T_3	KMB	82.5	168.1
T_4	ZSB	82.5	168.0
T_5	NPK consortia + ZSB	81.3	166.9
T_6	Control (no biofertilizer)	83.6	168.7
	SE m±	0.4	0.6
	CD (P=0.05)	1.1	1.7

RDF: Recommended dose of fertilizer; PSMO: Phosphate solubilizing microorganism; KMB: Potassium mobilizing biofertilizer; ZSB: Zinc solubilizing

plants by enhancing nitrogen fixation (*Azotobacter*), phosphorus solubilization (PSMO), hormonal regulation and nutrient uptake efficiency. These beneficial effects contribute to accelerated growth, development and reproductive processes, ultimately leading to early maturation of the plants. Rekha (2020) also reported that early physiological maturity was observed in biofertilizer treatments over control (no biofertilizer).

Agronomic efficiency at 100% RDF (8.5 kg seed/kg N, 17.1 kg seed/kgP, 25.6 kg seed/kg K applied) was significantly less than that at 75% RDF which can be ascribed to the law of diminishing returns *i.e.* less response at higher level (Chandel *et al*. 2023). Similar results were found by Karim and Ramasamy (2002). Among different biofertilizers,

Table 2: Effect of fertility levels and microbial consortia on agronomic efficiency of gobhi sarson

	Treatment	Agronomic efficiency (kg/kg)			
		Nitrogen	Phosphorus	Potassium	Total NPK
Fertility levels					
F_1	75 % RDF	10.17	20.34	30.51	5.55
F_2	100 % RDF	8.54	17.07	25.61	4.66
	SE m±	0.10	0.18	0.27	0.05
	CD (P=0.05)	0.60	1.18	1.77	0.32
Microbial consortia					
T_1	Azotobacter	9.48	18.96	28.44	5.17
T_2	PSMO	10.12	20.25	30.37	5.52
T_3	KMB	9.01	18.03	27.04	4.92
T_4	ZSB	9.00	18.00	27.00	4.91
T_5	NPK consortia + ZSB	9.21	17.42	27.63	5.02
T_6	Control (no biofertilizer)	9.30	18.60	27.90	5.07
SE m±	0.38	0.75	1.13	0.20	
CD (P=0.05)	NS	NS	NS	NS	

RDF: Recommended dose of fertilizer; PSMO: Phosphate solubilizing microorganism; KMB: Potassium mobilizing biofertilizer; ZSB: Zinc solubilizing biofertilizer

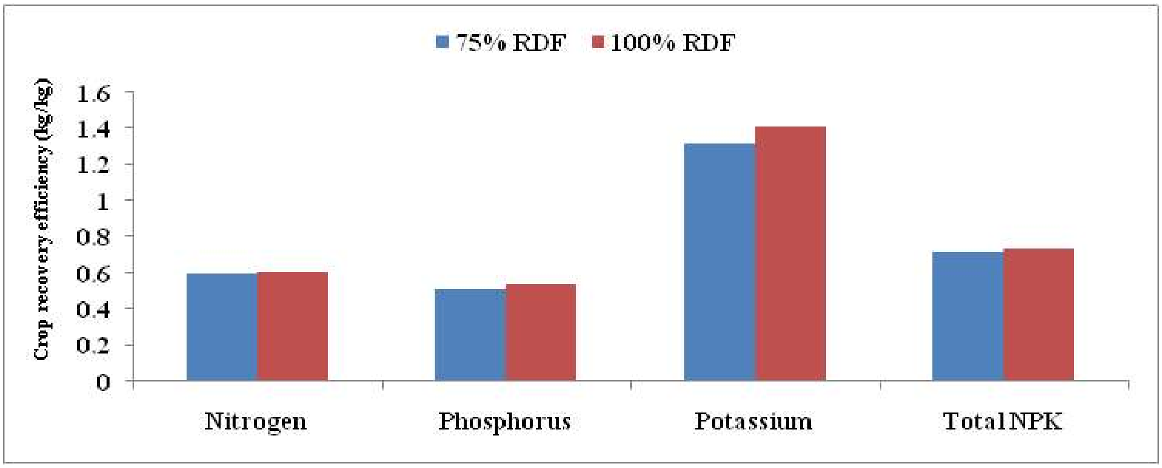

Fig. 1: Effect of fertility levels on crop recovery efficiency

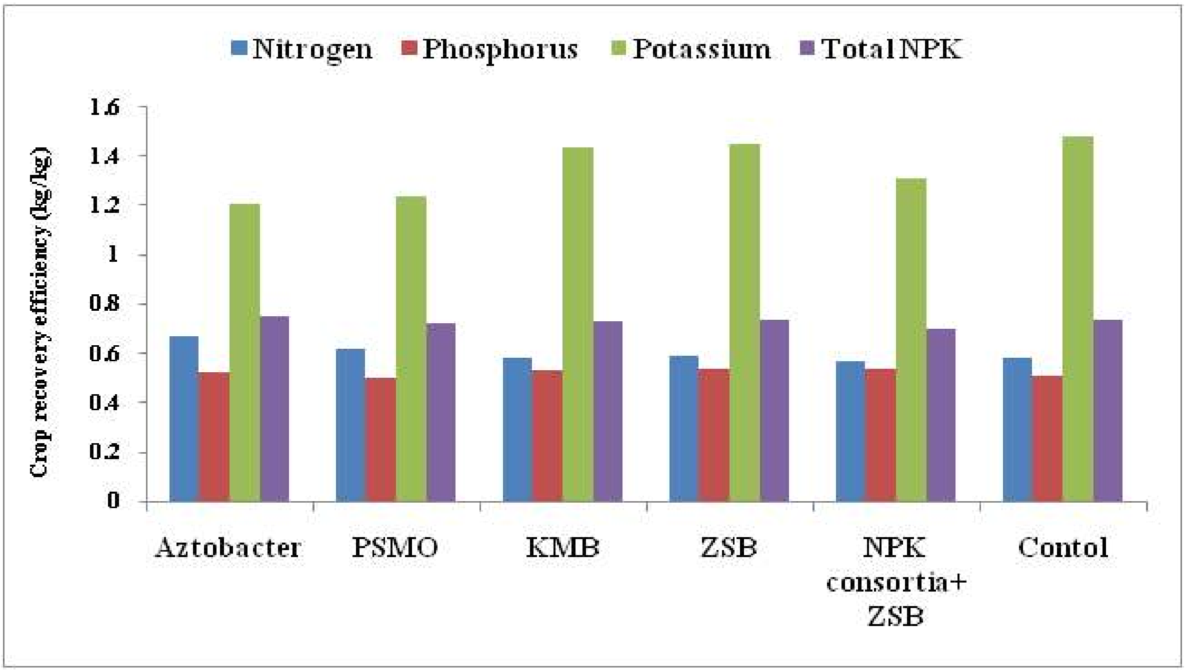

Fig. 2: Effect of fertility levels and microbial

Azotobacter and PSMO recorded numerically higher values of Agronomic efficiency than that in control (no inoculation) indicating their better efficiency in fertilized plots.

Crop recovery efficiency in plants refers to the ability of a crop to effectively utilize applied nutrients, particularly fertilizer nutrients, for optimal growth and yield production. Their higher values were observed with 100% RDF than 75% RDF. In biofertilizer treatments, the value ranged for nitrogen between 0.57-0.67 and phosphorus 0.50-0.54 whereas for total NPK, value ranged between 0.70-0.75.

Based on the findings of the investigation it may be concluded that application of 100% RDF took less days to achieve 50% flowering, physiological maturity and numerically higher crop recovery efficiency where as agronomic efficiency with 100% RDF was lower than 75% RDF. Seed inoculation with biofertilizers recorded earlier flowering & physiological maturity of *gobhi sarson* where as, no significant influence on agronomic as well as crop recovery efficiency. Among biofertilizers, *Azotobacter* and PSMO were found to be most efficient. Hence, application of *Azotobacter* (biofertilizer) along with 100% RDF may be more preferable and can be recommended.

Conflict of interest: There is no conflict of interest in this research paper.

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