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**Anubhav Raj**
Assistant Professor, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj Uttar Pradesh, India

**Corresponding Author:**
**Anubhav Raj**
Assistant Professor, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj Uttar Pradesh, India

# Effect of biofertilizer and sulphur on growth and yield of rapeseed (*Brassica napus* L.)

**Anubhav Raj**

**Abstract**
A field experiment was conducted during *Rabi* 2021-22 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.30%), available N (171.47 kg/ha), available P (14.2 kg/ha) and available K (242.5 kg/ha). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. The treatments which are $T_1$: Azotobacter 20g/kg + Sulphur 0kg/ha, $T_2$: Azotobacter 20g/kg + Sulphur 20kg/ha, $T_3$: Azotobacter 20g/kg + Sulphur 40kg/ha, $T_4$: PSB 20g/kg + Sulphur 0kg/ha, $T_5$: PSB 20g/kg + Sulphur 20kg/ha, $T_6$: PSB 20g/kg + Sulphur 40kg/ha, $T_7$: Azotobacter+PSB 20g/kg + Sulphur 0kg/ha, $T_8$: Azotobacter+PSB 20g/kg + Sulphur 20kg/ha, $T_9$: Azotobacter+PSB 20g/kg + Sulphur 40kg/ha are used. The results showed that application of Azotobacter +PSB 20g/kg +Sulphur 40kg/ha was recorded significantly higher plant height, No. of Branches/plant, Plant dry weight, Siliuae/plant, Seeds/siliquae, Days to maturity, Test weight, Seed yield, gross returns, net return and benefit cost ratio. However, significantly highest Crop growth rate was recorded with the treatment Azotobacter +PSB 20g/kg +Sulphur 40kg/ha as compared to other treatments.

**Keywords:** Azotobacter, PSB, sulphur, growth, yield

## Introduction

Rapeseed (*Brassica napus* var. toria) commonly known as raya, rai or lahi is an important oilseed crop among the Brassica group of oilseed in India. It's the second most important edible oilseed crop in India after groundnut and accounts for nearly 30% of the total oilseeds produced in the country. Rapeseed-mustard is an important group of edible oil seed crops and contributes around 26.1% of the total oil seed production and contributes about 85% of the total rapeseed–mustard produced in India (Meena *et al*., 2011). The first position in area and second position in Production after China (Anonymous, 2009). Rapeseed and mustard crops are being cultivated in 53 countries spreading over the six continents across the globe covering an area of 24.2 million hectare. Indians contribution to world hectare and production is 28.3 and 19.8 percent respectively (Kumar *et al*, 2018).

Biofertilizer is an organic source of nutrients. It has long been known that bio-fertilizers have the potential to boost oilseed crop output. In addition to preserving the health of the soil and lowering environmental pollution, the Microbial inoculants created specifically for these crops can increase crop production. Tropical and subtropical climates typically favour higher photosynthetic rates in plants, which results in greater excretion of root exudates, which favours the growth and increased activity of certain rhizospheric bacteria (0du, 1977). Azotobacter is a biofertilizer that is often employed in any crop that is not a legume. The preparation has a very high population of aerobic, free-living nitrogen-fixing bacteria called Azotobacter. When treated as a soil application, seed treatment, or seedling root dip, they multiply quickly and form a dense population in the rhizosphere. They obtain nourishment from the organic materials in the soil, root exudates, and air nitrogen fixation. Chemical fertilisers may not be as necessary when azotobacter and phosphorus solubilizing bacteria (PSB) are used.

Sulphur (S) is one of four major macro elements, after nitrogen, phosphorus and potassium, which Is considered as indispensable as far as appropriate plant growth and development are concerned (Anjum *et al*. 2012) [2]. In the regions of intensive Rapeseed production, a significant negative balance of this component was observed. Plant malnutrition due to sulphur deficit has become one of the Important problems in modern agriculture, especially in the Northern European countries and many Other countries all over the world.

The data by the Sulphur Institute, Washington, indicate that in 2000 global sulphur deficit reached 7.5 million tons Per year (Scherer 2001). According to the Sulphur Institute (TSL), plant nutrient sulphur deficit in 2010 (in tons) was 5.8 mln in Asia, 1.5 mln in North America, 1.5 mln in Africa, 0.9 mln in Latin America and 1.0 mln in Europe. It is estimated that in 2015. The mentioned deficit will amount 12.5 million Tons per year (Messick 2013). These forecasts Result mainly from considerable reduction in sulphur compounds emission to the atmosphere, and therefore, in diminished sulphur deposition on the Areas of agricultural production.

## Materials and Methods

The experiment was conducted during *Rabi* season of 2021-22. The experiment was conducted in Randomized Block Design consisting of nine treatment combinations with three replications and was laid out with the different treatments allocated randomly in each replication. The soil of the experimental field was sandy loam in texture, slightly alkaline reaction (pH 7.1) with low level of organic carbon (0.28%), available N (225 Kg/ha), P (19.50 kg/ha) and higher level of K (92.00 kg/ha). The treatment combinations are $T_1$-Azotobacter 20g/kg + Sulphur 0kg/ha, $T_2$-Azotobacter 20g/kg + Sulphur 20kg/ha, $T_3$-Azotobacter 20g/kg + Sulphur 40kg/ha, $T_4$-PSB 20g/kg + Sulphur 0kg/ha, $T_5$-PSB 20g/kg + Sulphur 20kg/ha, $T_6$-PSB 20g/kg + Sulphur 40kg/ha, $T_7$-Azotobacter+PSB 20g/kg + Sulphur 0kg/ha, $T_8$-Azotobacter+PSB 20g/kg + Sulphur 20kg/ha, $T_9$-Azotobacter+PSB 20g/kg + Sulphur 40kg/ha. The observations were recorded on different growth parameters at harvest *viz*. plant height (cm), number of branches per plant, plant dry weight, Number of siliqua per plant, number of seeds per siliqua, test weight, grain yield and stover yield.

## Results and Discussion

### Growth Attributes

At 80 DAS, the treatment Azotobacter + PSB 20g/kg + Sulphur 40kg/ha resulted in significantly higher plant height (104.04 cm). However, the treatments PSB 20g/kg + Sulphur 40kg/ha (97.17 cm) and Azotobacter 20g/kg + Sulphur 40kg/ha (93.63m) were found to be statistically at par with Azotobacter + PSB 20g/kg + Sulphur 40kg/ha. At 80 DAS, the treatment Azotobacter + PSB 20g/kg + Sulphur 40kg/ha resulted in significantly higher plant height (16.90 g/plant). However, the treatments PSB 20g/kg + Sulphur 40kg/ha (16.37 g/plant) and Azotobacter 20g/kg + Sulphur 40kg/ha (15.40 g/plant) were found to be statistically at par with Azotobacter + PSB 20g/kg + Sulphur 40kg/ha. At 80 DAS, the treatment Azotobacter + PSB 20g/kg + Sulphur 40kg/ha resulted in significantly higher number of primary branches per plant (6.80). However, the treatments PSB 20g/kg + Sulphur 40kg/ha (6.60) and Azotobacter 20g/kg + Sulphur 40kg/ha (6.47) were found to be statistically at par with Azotobacter + PSB 20g/kg + Sulphur 40kg/ha. At 80 DAS, the treatment Azotobacter + PSB 20g/kg + Sulphur 40kg/ha resulted in significantly higher number of secondary branches per plant (5.18). However, the treatments PSB 20g/kg + Sulphur 40kg/ha (4.96) and Azotobacter 20g/kg + Sulphur 40kg/ha (4.75) were found to be statistically at par with Azotobacter + PSB 20g/kg + Sulphur 40kg/ha.

### Yield Attributes

Significantly, the treatment that applied Azotobacter +PSB 20g/kg +Sulphur 40kg/ha resulted in the highest number of siliquae per plant (251). However, the treatments Azotobacter +PSB 20g/kg + Sulphur 20kg/ha (225) and Azotobacter +PSB 20g/kg + Sulphur 0kg/ha (209) which were found to be statistically at par with Azotobacter +PSB 20g/kg +Sulphur 40kg/ha. Significantly, the treatment that applied Azotobacter+ PSB 20g/kg+ Sulphur 40kg/ha resulted in the highest number of seeds per siliquae (17.9). However, the treatments Azotobacter+ PSB 20g/kg + Sulphur 20kg/ha (16.5) and PSB 20g/kg+ Sulphur 20kg/ha (16.1) which were found to be statistically at par with Azotobacter+ PSB 20g/kg+ Sulphur 40kg/ha. Non-significantly, the treatment that applied Azotobacter +PSB 20g/kg +Sulphur 40kg/ha resulted in the highest test weigh (4.12). However, the treatments Azotobacter +PSB 20g/kg + Sulphur 20kg/ha (3.99) and Azotobacter +PSB 20g/kg + Sulphur0kg/ha (3.90) which were found to be statistically at par with Azotobacter +PSB 20g/kg +Sulphur 40kg/ha. Significantly, the treatment that applied Azotobacter +PSB 20g/kg +Sulphur 40kg/ha resulted in the highest stover yield (1782). However, the treatments Azotobacter +PSB 20g/kg + Sulphur 20kg/ha (1716) and Azotobacter +PSB 20g/kg + Sulphur 0kg/ha (1693) which were found to be statistically at par with Azotobacter +PSB 20g/kg +Sulphur 40kg/ha. Significantly, the treatment that applied PSB 20g/kg + Sulphur 0kg/ha resulted in the highest harvesting index (37.49). However, the treatments PSB 20g/kg + Sulphur 40kg/ha (34.11) and Azotobacter 20g/kg + Sulphur 20kg/ha (33.98) which were found to be statistically at par with PSB 20g/kg + Sulphur 0kg/ha. Significantly, the treatment that applied Azotobacter +PSB 20g/kg +Sulphur 40kg/ha resulted in the highest seeds yield (1119). However, the treatments Azotobacter +PSB 20g/kg + Sulphur 20kg/ha (1116) and PSB 20 g/kg + Sulphur 0kg/ha (1035) which were found to be statistically at par with Azotobacter +PSB 20g/kg +Sulphur 40kg/ha.

**Table 1:** Effect of Biofertilizers and Sulphur on growth attributes of Rapeseed

| Treatments | Plant height (cm) At 80 DAS | Dry weight (g) At 80 DAS | Number of primary branches per plant At 80 DAS | Number of secondary branches per plant At 80 DAS |
|---|---|---|---|---|
| Azotobacter 20g/kg + Sulphur 0kg/ha | 83.36 | 12.00 | 5.13 | 3.77 |
| Azotobacter 20g/kg + Sulphur 20kg/ha | 86.73 | 13.80 | 6.00 | 4.33 |
| Azotobacter 20g/kg + Sulphur 40kg/ha | 93.68 | 15.40 | 6.47 | 4.75 |
| PSB 20g/kg + Sulphur 0kg/ha | 88.22 | 12.53 | 5.93 | 3.92 |
| PSB 20g/kg + Sulphur 20kg/ha | 90.67 | 14.30 | 6.20 | 4.4 |
| PSB 20g/kg + Sulphur 40kg/ha | 97.17 | 16.37 | 6.60 | 4.96 |
| Azotobacter+PSB 20g/kg + Sulphur 0kg/ha | 88.49 | 13.40 | 6.13 | 4.20 |
| Azotobacter+PSB 20g/kg + Sulphur 20kg/ha | 92.62 | 14.83 | 6.33 | 4.63 |
| Azotobacter+PSB 20g/kg + Sulphur 40kg/ha | 104.04 | 16.90 | 6.80 | 5.18 |
| SEm(±) | 2.37 | 0.21 | 0.28 | 0.25 |
| CD (p=0.05) | 7.11 | 0.62 | 0.85 | 0.75 |

**Table 2:** Effect of Biofertilizers and Sulphur on yield attributes and yield of Rapeseed.

| Treatments | No. of Siliquae per plant | No. of seeds per Siliquae | Test weight (g) | Seed yield (kg/ha) | Stover yield (kg/ha) | Harvest index (%) |
|---|---|---|---|---|---|---|
| Azotobacter 20g/kg + Sulphur 0kg/ha | 104 | 10.5 | 3.9 | 785 | 1509 | 33.73 |
| Azotobacter 20g/kg + Sulphur 20kg/ha | 122.3 | 11.2 | 3.51 | 825 | 1527 | 33.98 |
| Azotobacter 20g/kg + Sulphur 40kg/ha | 149.7 | 12.4 | 3.7 | 916 | 1607 | 33.66 |
| PSB 20g/kg + Sulphur 0kg/ha | 187.7 | 14.5 | 3.77 | 1035 | 1754 | 37.49 |
| PSB 20g/kg + Sulphur 20kg/ha | 122 | 16.1 | 3.88 | 810 | 1528 | 33.79 |
| PSB 20g/kg + Sulphur 40kg/ha | 175.7 | 11.8 | 3.60 | 968 | 1668 | 34.11 |
| Azotobacter+PSB 20g/kg + Sulphur 0kg/ha | 209 | 13.1 | 3.90 | 1033 | 1693 | 33.89 |
| Azotobacter+PSB 20g/kg + Sulphur 20kg/ha | 225 | 16.5 | 3.99 | 1116 | 1716 | 33.82 |
| Azotobacter+PSB 20g/kg + Sulphur 40kg/ha | 251 | 17.9 | 4.12 | 1119 | 1782 | 33.79 |
| SEm (±) | 9.3 | 0.33 | 0.3 | 0.75 | 58.1 | 0.75 |
| CD (5%) | 28.05 | 1.0 | 0.05 | 1.78 | 174 | 1.78 |

## Conclusion

It is concluded that application of Azotobacter + PSB 20g/kg + Sulphur 40kg/ha recorded significantly higher gross return (1,34,280 ₹/ha) while application of Azotobacter + PSB 20g/kg + Sulphur 20kg/ha recorded higher net return (98,445.5 ₹ /ha) and benefit cost ratio (2.77). These findings are based on one season; therefore, further trail may be required for fiurther confirmation.

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