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Effects of Biofertilizers and Phosphorus on Growth and Yield of Mustard

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The field experiment titled "Effect of Biofertilizers and Phosphorous on Growth and Yield of Mustard" was conducted during *Rabi* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The experiment was laid out in randomized block design with nine treatments and control which are replicated thrice. The treatments *viz* T_1: PSB + Phosphorus 40 kg/ha, T_2: PSB + Phosphorus 50 kg/ha, T_3: PSB + Phosphorus 60 kg/ha, T_4: VAM + Phosphorus 40 kg/ha, T_5: VAM + Phosphorus 50 kg/ha, T_6: VAM + Phosphorus 60 kg/ha, T_7: PSB + VAM + Phosphorus 40 kg/ha, T_8: PSB + VAM + Phosphorus 50 kg/ha, T_9: PSB + VAM + Phosphorus 60 kg/ha. The results obtained that growth parameters *viz.* plant height (180.40 cm), Number of branches (18.10), dry weight (42.01 g/plant), Significantly higher yield parameters *viz*. number of silique/plant (314.47), test weight (6.80 g) and number of seeds/silique (16.50). were recorded higher with the application of PSB + VAM + Phosphorus 60 kg/ha.

Keywords: Phosphate solubilizing bacteria; vesicular arbuscular mycorrhizae; phosphorus; yield.

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1. INTRODUCTION

Indian Mustard (*Brassica juncea* L.) is popular by different names according to different regions such as Chinese mustard, Rai or Loha, Raya, Brown mustard, leaf mustard and locally known as khardal [1]. In Latin word, mustard means 'must or museum. It belongs to the Cruciferae family and originated from middle-east, India and China. In the World mustard is the most important oilseed crop after palm and soybean. It is a cool season crop and follows the C3 pathway and requires a temperature range between 06-26°C. It has an efficient photosynthetic response at 15-20°C. It is generally grown under rainfed conditions, well-drained soil and moderately tolerant to acidic soil [2,3]. Its low water requirement (240-400 mm) is sufficient for a rainfed cropping system. It has a tapering root system and the height of the plant is about 90-200 cm. It is self-pollinated, the flower has 4 sepals and 4 petals having dark yellow-pale yellow colour.

In the world, the crop is grown both in tropical and subtropical countries. It is cultivated in India, China, Pakistan, Canada, Poland, Sweden, France and Bangladesh. In India, mustard is the second most important edible oilseed crop after groundnut. It accounts for about 30% of total oilseeds production. The estimated area, production and yield of rapeseed mustard in the world is 36.59 million hectares (MHA), 72.37 million tonnes (mt) and 1980 kg/ha, respectively (2018-19). India accounts for 19.8% and 9.8% of the total acreage and production (USDA). The area and production of Maharashtra are 9500 hectares and 3300 tonnes respectively [4]. There has been a considerable increase in productivity from 1840 kg/ha to 1980 kg/ha (2010-11 - 2018-19) and production has also increased from 61.64 mt to 72.42 mt (2010-11 to 2018-11). In the world, the area and production of Rapeseed-Mustard is highest in Canada (24.27%) and the European Union (30.87%) respectively. In India, Mustard is cultivated on a large scale in Rajasthan, MP, Haryana, Panjab, Assam, Bihar, Gujrat, WB etc. Rajasthan ranks first in both area (40.74%) and production (44.97%) during 2013-14 to 2017-18. Rapeseed Mustard crops in India are grown in diverse agroclimatic conditions ranging from north-eastern - northwestern hills to down south under irrigated-rainfed, timely-late sown, saline soils and mixed cropping. Indian mustard accounts for about 75-80 % of the 6.23 m/ha area in the country during the 2018- 19 crop season [5].

The mustard crop is highly sensitive to fertilizers. Phosphorus and sulphur are essential nutrients for the well development of mustard. Generally, equal quantities of phosphorus and sulphur are absorbed by the plants. Phosphorus occurs in plants at 0.1- 0.4% and it is absorbed by plants mostly in other phosphate ions from soil and available as monovalent and divalent ion forms from soil. It is one of the important nutrients among the first three macronutrients. Phosphorus is important for the establishment of a healthy root system. Deficiency of phosphorus results in stunted growth of the plant. Plants will have purple discolouration on the stem and leaves with severe deficiency. Oil content in mustard is increased by applying the low analysis fertilizers [6].

2. MATERIALS AND METHODS

The experiment conducted to know the “Effects of Biofertilizers and Phosphorus on growth and yield of Mustard” was carried out at Crop Research Farm of Sam Higginbottom University, Prayagraj, Uttar Pradesh in 2022. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.2), low in organic carbon (0.22 %), available N (171.48 kg/ha), available P (12.3 kg/ha) and available K (235.7 kg/ha). Prayagraj has a sub-tropical and semi-arid climatic condition, with both extremes of temperature, *i.e*., winter and summer. It receives southwest monsoon rains which commence in the month of July and withdraws by the end of September. To facilitate sowing the experiment field was thoroughly ploughed followed by harrowing and brought to fine tilth. Stubbles and weeds were picked from the field and the land was levelled with the help of a rake and the plots were demarcated according to layout. To facilitate sowing, the experimental field was thoroughly ploughed and followed by harrowing and brought to fine tilth 18 October 2022. Stubbles and weeds were picked up from the field and the land was levelled with the help of a rake and the plots were demarcated according to layout. Fertilizers were applied at 4-5cm deep furrows were made along the seed rows with a hand hoe. The nutrient sources were Urea, SSP and MOP to fulfil the requirement of nitrogen, phosphorous and potassium. The recommended dose of 80 kg/ha nitrogen, 40 kg/ha phosphorous and 40 kg/ha potassium were applied according to the treatment details.

2.1 Observations Recorded

2.1.1 Plant height (cm)

The average height of plants was recorded at an interval of 20 DAS. The height of the plant was measured from the base of the plant up to the last node. Height of the five randomly selected plants was recorded.

2.1.2 Dry weight (g/plant)

Dry weight of plants was recorded without root at intervals of 20, 40, 60, 80, 100 and harvest days by uprooting three plants from second row in each plot. These plants were first dried then wrapped with paper and then kept in oven for oven drying at 70°C for 24-48 hours. The dry weight of samples was recorded, averaged and expressed as g/plant.

2.1.3 Siliqua/plant (No.)

Randomly siliqua/plant is recorded from tagged plants of different plots and their averages are recorded.

2.1.4 Seeds/siliqua (No.)

Randomly seeds/siliqua is recorded from tagged plants of different plots and their averages are recorded.

2.1.5 Test weight (g)

One thousand seeds were randomly taken from siliqua obtained from each plot then weighed and recorded as test weight (g).

3. RESULTS

3.1 Plant Height

At 120 DAS significantly higher number of branches was recorded with the application of PSB + VAM + Phosphorus 60 kg/ha (12.10) However, treatment with PSB + VAM+ Phosphorus 50 kg/ha (11.80) was statistically at par with PSB + VAM + Phosphorus 60 kg/ha.

3.2 Plant Dry Weight

Further 120 DAS significantly higher dry weight was recorded with the application of PSB + VAM + Phosphorus 60 kg/ha (42.01g). However, treatment with PSB +VAM+ Phosphorus 50 kg/ha (41.75 g) was statistically at par with PSB + VAM +Phosphorus 60 kg/ha.

3.3 No of Siliqua/Plant

The number of siliqua per plant was significantly influenced due to different treatment combinations. The number of siliquae per plant was recorded significantly higher (314.00) with the application of PSB + VAM + Phosphorus 60 kg/ha. PSB + VAM + Phosphorus 50 kg/ha (314.00) and PSB + VAM + Phosphorus 40 kg/ha (309.50) which were statistically at par with PSB + VAM + Phosphorus 60 kg/ha.

3.4 No of Seeds/Siliqua

The number of seeds per siliqua was significantly influenced due to different treatment combinations. The number of seeds per siliqua was recorded as significantly higher (16.50) with the application of PSB + VAM + Phosphorus 60 kg/ha and PSB + VAM + Phosphorus 50 kg/ha (16.00), which was statistically at par with PSB + VAM + Phosphorus 60 kg/ha.

Table 1. Effect of biofertilizers and phosphorus on the growth of mustard

Treatments	Plant Height (cm)	Dry weight Per plant (g)	No. of siliqua/plant	No. of seeds/siliqua	Test weight (g)
T1	169.10	8.90	297.00	11.00	5.10
T2	170.30	9.70	300.00	12.10	5.11
T3	171.40	10.00	301.00	13.20	5.28
T4	172.20	10.50	306.00	13.70	5.40
T5	175.00	10.90	309.00	14.50	5.57
T6	175.50	11.30	309.50	15.30	6.00
T7	178.10	11.50	311.00	15.70	6.62
T8	179.60	11.80	314.00	16.00	6.71
T9	180.40	12.10	314.47	16.50	6.80
T10 (Control)	168.60	8.50	295.00	10.50	5.04
Se M(±)	2.20	0.64	3.61	0.22	0.11
CD (p=0.05)	6.54	1.91	10.75	0.65	0.34

3.5 Test Weight (g)

The test weight was significantly influenced due to different treatment combinations. The number of seeds per siliqua was recorded significantly higher (6.80 g) with the application of PSB + VAM + Phosphorus 60 kg/ha and PSB + VAM + Phosphorus 50 kg/ha (6.71 g), which was statistically at par with PSB + VAM + Phosphorus 60 kg/ha.

4. DISCUSSION AND CONCLUSION

Kang et al. [7] observed that microorganisms enhance the phosphorus availability to plants by mineralizing organic P in soil and by solubilizing precipitates phosphates in soil. The increase in root and shoot weight in all the PSB treatments indicate that the PSB helped in keeping the native and applied phosphates available for a longer period. A similar observation was reported by Dhage and Kachave [8]. The soil properties and PSB seed inoculation greatly influenced the soil Bacillus and Pseudomonas sp. A higher population was observed in normal soil indicating that, the soil Bacillus sp. and Pseudomonas sp. populations of PSB increased in the normal soil as compared to saline soil. Similar results were found by Sandeep and Stephen (2008), and Narula et al. [9], and also, with Application of phosphorus favourably influenced the photosynthesis, biosynthesis of proteins and phospholipids and other metabolic processes of the plant. Comparable results were also noted by Singh and Thenua [10]. A significantly higher crop growth rate was observed with the application of Biofertilizers. Phosphate solubilizing bacteria inoculants when applied to many crop plants, promote seed germination and initial vigour of plants by producing growth promoting substances. Application of biofertilizers results in increased mineral and water uptake, root development, vegetative growth and nitrogen fixation [11].

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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