



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 6, June 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512



9940 572 462



6381 907 438



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Effect of Biofertilizers on Growth and Yield of Field Mustard (*Brassica campestris*) Varieties

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ABSTRACT: Economic growth of India is mostly dependent on agriculture. About 114 million hectares, out of the 329 million hectares of India's geographical area, are under cultivation [1]. Three types of fertilizers are basically used in India—they are either chemical or organic or biofertilizers. Among them Indian farmers mostly used chemical fertilizers which cause not only soil degradation, pollution but also posed severe health and environmental hazards. Organic farming methods (or use of biofertilizers) would solve these issues and make the ecosystem healthier. Biofertilizers mainly plant growth promoting rhizobacteria (PGPR) play an important role in improving soil fertility by fixing atmospheric nitrogen, solubilize insoluble phosphorus and produce plant growth promoting substances. In India, mustard is the second most important edible oilseed after groundnut. *Brassica campestris* have higher number of siliquae per plant and higher number of seeds per siliquae, that's why higher yield, were found to be important for the breeders. Industrialization and green revolution have brought about an increase in productivity but they have also resulted in massive abuse of environment. Hence, there is a need to search for alternative strategies to improve soil health without causing damage to environment. 'Sustainable agriculture' is a method of farming system that are productive and profitable, conserve the natural resources as well as protect the environment for a long period [2] To achieve the highest priority of agricultural sustainability, use of biofertilizer is dominated over chemical fertilizer. Biofertilizers are the preparations containing live and efficient strains of rhizobacteria with plant growth promoting activities. These are used mainly in seed, soil or other organic manure for increasing their number; as a result accelerate their metabolic processes and the metabolites ultimately assimilated by plants [3]. Biofertilizers not only provides nitrogen but also provides plant growth promoting substances such as indole acetic acid, gibberellins, vitamin B etc. [4]. Biofertilizers can enhanced the yield by 20–30% and activate the soil biologically [5]. Moreover, biofertilizer applications not only increase root development of plants but also increase the level of mineral and water uptake [6]. However, absolute use of biofertilizer may not enhance the productivity of the food grain. They cannot replace the chemical fertilizers for getting maximum crop yields. The improved level of productivity was achieved by combined application of biofertilizer and chemical fertilizer [7].

I. INTRODUCTION

Mustard [*Brassica campestris* cv. B₉] belongs to the family Cruciferae (Brassicaceae) where, out of the three genera, Brassica is the most important one. It is mostly cultivated for oilseed and fodder and mustard crops are basically cultivated in temperate region. Mustard is the second important edible oilseed crop after soybean. Oilseeds play a vital role in Indian economy. The oil and protein content of rapeseed-mustard crop is found to vary from 34.9 to 44.9% and 17.8 to 22.0% respectively. The leaves of young plants are used as green vegetables, as they supply sulphur and minerals in the diet. Agronomical achievements for increasing yield, use of chemical fertilizers has badly affected the soil microflora and soil health. Excessive use of nitrogenous fertilizers has reduced the natural availability of many micronutrients which are difficult to provide chemically. Biofertilizers have potential to solubilize / mobilize major nutrients such as nitrogen and phosphorus in addition to micronutrients and thus act as nutrient flow regulator in nature. *Azotobacter* is non-symbiotic nitrogen fixing agro-microbe having potential to fix considerable quantities of atmospheric nitrogen in the rhizosphere of non-legumes. Besides nitrogen fixation, *Azotobacter* inoculation may improve the crop productivity up to 25% over the control in the absence of any amendment and by 8.75% in the presence of NPK. Phosphate solubilizing bacteria (PSB) provides alternative biotechnology solution in sustainable agriculture to meet the P demand of the plant. These organisms in addition to providing P to the plants also facilitate



plant growth by different mechanism . Sulphur, now recognized as the 4th major nutrient after nitrogen, phosphorus and potassium, is a constituent of three sulphur containing amino acids (cysteine, cystine and methionine), which are the building blocks of protein and about 90% of plant sulphur is present in these amino acids. Sulphur improves protein and oil content in seeds and is also associated with special metabolism in plant and the structural characteristics of protoplasm. Adequate supply of sulphur has been reported to enhance photosynthetic efficiency and productivity of Brassica genotypes.[8]

II. MATERIALS AND METHODS

Field experiments were conducted with mustard (*Brassica campestris* cv. B₉). In the first year, varietal screening of mustard under recommended dose of chemical fertilizer (100:50:50) were performed with seven mustard varieties. In the second year, two experiments were conducted to study the effects of six different combined doses of chemical fertilizer and biofertilizer and six different levels of growth retardant cycocel. In the third year, six different levels of compost along with the best screened dose of growth retardant (CCC-300 ppm) and the best combined dose of biofertilizer and chemical fertilizer (3/4th chemical fertilizer:1/4th biofertilizer) from the previous year were applied to study the effects on agronomic traits and growth attributes of mustard, and the field data were analyzed statistically. The variety B₉ recorded a significant higher seed yield along with other yield contributing factors, which was found to be superior to other varieties under old alluvial soil . Seed yield was found to be the best for CCC-300 ppm treatment and the best combined dose of biofertilizer and chemical fertilizer was found to be 3/4th chemical fertilizer:1/4th biofertilizer. The best yield was given by the treatment of 7.5 t-hm⁻² compost along with the best dose of growth retardant cycocel and the best combined dose of biofertilizer and chemical fertilizer.[9]

III. DISCUSSION

Researchers suggested that biofertilizers, especially plant growth promoting rhizobacteria (PGPR), are the most reliable replacements for the chemical ones in sustainable agroecosystems nutrient management. However, enhancement of plant growth promoting traits do not occur independently, the multiple mechanisms, such as phosphate solubilization, dinitrogen fixation, ACC deaminase and antifungal activity, IAA and siderophore biosynthesis *etc.* are responsible for the plant growth promotion and increased yield. [10] Therefore, our result highlighted that dual application of biofertilizer and reduced dose of chemical fertilizer has some additive effect over chemical fertilizer. This is perhaps due to the perfect balancing of nutrient uptake in the root environment which equally support for beneficial bacterial growth and plant growth [11]. Previous research [12] also support that proper supply of mineral, especially, phosphorus can increase flowering rate. Moreover, both phosphorus and nitrogen can improve the reproductive growth and fruit production in the plant.

IV. RESULTS

Judicious use of chemical fertilizers can lead toward increase in yield under this agro-climatic condition of the old alluvial soil . This type of practice can, therefore, be applied in the field for commercial scale of crop production with less environmental pollution with good economic returns. Effective management of natural resources, integrated approach to plant-water, nutrient and pest management and extension of rapeseed-mustard cultivation to newer areas under different cropping systems will play a key role in further increasing and stabilizing the productivity and production of rapeseed-mustard. Rapeseed-mustard crop is sensitive to water shortage. A substantial rapeseed-mustard area in Rajasthan (82.3%), Gujarat (98%), Haryana (75.6%), and Punjab (92.4%) is covered under irrigation. A positive effect of irrigating rapeseed-mustard at critical stages is observed. Water use efficiency was highest when irrigation was applied at 0.8 IW : CPE ratio and increased with increasing N rate [13]. Number of irrigations is important for working out the most efficient water use by mustard. For mustard, two irrigations, one at flowering stage and at siliqua formation stage increased seed yield by 28% over the rainfed plots [13]. Increase in the amount of water increased leaf water potential, stomatal conductance, light absorption, leaf area index, seed yield, and evapotranspiration and decreased canopy temperature [14]. In similar study an average increase in seed yield with irrigation at the flowering and pod development stages and irrigation at the flowering stage over the control was 62.9% and 41.7%, respectively. However, for number of seeds per siliqua and oil content, single irrigation at 45 DAS remained parallel with two irrigations .The water use efficiency was highest with one irrigation at 45 DAS. Crop receiving two irrigations at preflowering and pod-filling stages produce about 33 percent more seed than unirrigated crops .Single irrigation given at vegetative stage is found to be most critical, as irrigation at this stage produces the highest yield. When two



irrigations are given, the irrigation at vegetative and pod formation stages is of maximum benefit. The irrigation at vegetative, flowering, and pod formation stages resulted in the highest yield, where three irrigations were given. Oil and protein yield were also significantly affected by number and stages of irrigation.

V. CONCLUSION

Mustard will continue to contribute considerably to the oilseed bowl of the country. A streamlined research programme for rapeseed-mustard should be focused on the below-mentioned points. (i) Horizontal and vertical intensification in rapeseed-mustard production needs to be done for self-sufficiency in oilseed production. It is possible through varietal improvement and introduction of mustard in nontraditional areas. (ii) An optimum agronomic package of practices for high yielding and insect, pest, and disease resistant varieties, along with the upcoming hybrids needs to be worked out. (iii) Adoption of site-specific nutrient management (SSNM), precision agriculture, and conservation agriculture can bring more profits to the mustard growers. (iv) An integrated weed management approach needs to be developed for problematic and parasitic weeds in mustard. Proper land preparation, proper time of sowing, selection of better quality seeds, and so forth are always neglected. Fertilizer application is little or nonexistent leading to poor productivity. Whether little is spent on fertilizer input goes entirely on nitrogenous fertilizers. This results in a big gap between requirement and production of mustard in India. Therefore site-specific nutrient management through soil-test recommendation based should be adopted to improve upon the existing yield levels obtained at farmers field. [14] Optimum crop geometry, balanced NPK fertilizers, intercultural operations, and inclusion of farmyard manure are the building blocks for achieving the utmost yield targets of rapeseed-mustard. Effective management of natural resources, integrated approach to plant-water, nutrient and pest management and extension of rapeseed-mustard cultivation to newer areas under different cropping systems will play a key role in further increasing and stabilizing the productivity and production of rapeseed-mustard to realize 24 million tonnes of oilseed by 2021 AD. [15]

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