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RESEARCH ARTICLE

EFFECT OF BIO-FERTILIZER IN CONJUNCTION WITH AGRO-CHEMICALS ON YIELD OF INDIAN MUSTARD UNDER NUTRIENTS STRESS CONDITION

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ABSTRACT

The present study was under taken during 2004-05 and 2005-06 at Regional Research Station, Mainpuri. The experimental soil was sandy loam, having pH 8.5, organic carbon 0.45%, total nitrogen 0.04%, available phosphorus 10 kg/ha and available potassium 278 kg/ha, therefore, poor fertility level indicated nutrients stress condition. The main objective was to enhanced the productivity of Indian mustard with suitable doses of chemical fertilizer in the combination of bacterial fertilizer. Four levels of *Bacillus circulans* culture (bacterial fertilizer) i.e. 0, 10, 15 and 20 kg/ha in combination of 50% RDF and 100% RDF were tested. Variety *Urvashi* was planted in the first fortnight of October and harvested in second fortnight of February after 130 days of seeding during both experimental years. Application of *Bacillus circulans* culture @ 15 kg/ha or 1.50 lakh caror bacteria of *Bacillus circulans*/ha with 100% RDF/ha registered significantly higher seed yield of Indian mustard by 20.97 q/ha over 100% RDF + 0 kg *Bacillus circulans* culture/control (18.99 q/ha). Thus application of bacterial fertilizer @ 15 kg/ha increased the seed yield by 10.45% over non use of bacterial fertilizer. Application of *Bacillus circulans* culture beyond 15 kg/ha confined the seed yield of Indian mustard. Application of 50% RDF reduced the seed yield of Indian mustard at each level of *Bacillus circulans* culture in comparison to 100% RDF + *Bacillus circulans* culture doses. The growth and yield contributing parameters were concordance to the seed yield of Indian mustard.

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INTRODUCTION

Farmers are the kingpin in the present system of agriculture. Scientific use of fertilizers assume vital importance for sustainable agriculture. Efficient use of fertilizers pay back to the farmers more profit for unit investment. A FAO study indicated that between 1965-1976, fertilizers were responsible for over 50 per cent increase of crop production in the developing countries. This is true in our country also where the contribution of fertilizers to total grain production can be placed at 1 per cent in 1950, 32 per cent in 1980 and around 53 per cent in 2000. This clearly showing significance of fertilizers as key input for achieving targets of agricultural production and to feed the burgeon population pressure (Narang and Gill, 2006). In the recent past there is increase in the use of bio-fertilizer. The response of crops to bio-fertilizers application varies depending upon the environment and cultural practices in order: Rhizobium > blue green algae > Azospirillum > Azotobactor > P and S solubilizers. Their use in low fertility and low fertilizer use areas need to be promoted. There are more than 100 firms in the country manufacturing bio-fertilizers.

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The advantage with bio-fertilizers in saving fertilizers N range from 20-40 kg/ha. There is still a need to improve the quality and shelf life of bio-fertilizers to promote their wide scale field application (Singh, 2006). Prasad and Gill (2006) reported that use of symbiotic/non symbiotic micro-organisms, mainly as seed dressers and residue decomposers is very common in organic farming. They perform better under nutrient stress conditions. The most common species are, Azotobactor (*A. chrococcum*) in cereals, millets, vegetables, cotton, sugarcane etc. Beijerinckia (*B. indica*) in rice, sugarcane forage grasses, coconut, arecanut, cashew, cocoa, pepper etc. Azospirillum (*A. lipoferum/A. brasiliense*) in rice, sorghum, sunflower, maize etc. Rhizobium spp. (*R. japonicum/R. leguminoserum/R. phaseoli/R. trifolii* etc.) in legumes crop, blue green algae (Cynobacteria)-Nostoc, Anabaena, Aulosira, Calothrix etc. PSM (Phosphate solubilizing micro-organism-bacteria, fungi (Actinomycete)- *Bacillus* spp., *Pseudomonas straita*, *Aspergillus awamori*, *A. acra, Penicillium digitam, Trichoderma* spp., for solubilization of low soluble- P and VAM (Vesiculas Arbuscular, Mycorrhiza) in wheat, maize, millets, beans, potato, soybean etc. India is the largest producer of Indian mustard in the world. Next only to groundnut, Indian mustard ranks second in terms of area and production in the country, contributing about 23% of total oil seed production. Poor

germination, reduced plant stand establishment, lack of high yielding varieties and nutrient stress condition are some of important constraints responsible for poor yield of Indian mustard in mustard growing tract of U.P. especially in South-western-Semi-Arid zone IV. Of the total area under this crop in the country, more than 60% of it is in U.P., where 6.89 lakh hectare Indian mustard is grown with total production of 8.58 lakh mt and productivity of 12.45 q/ha (Anonymous, 2017). Since, the nutrient stress condition in the Indian mustard growing tract of central U.P., therefore, for increasing the productivity, the present investigation was planned and under taken on fertility management.Since, the nutrient stress condition in the Indian mustard growing tract of central U.P., therefore, for increasing the productivity, the present investigation was planned and under taken on fertility management.

MATERIALS AND METHODS

A field experiment was laidout during 2004-05 and 2005-06 at Regional Research Station of the C.S. Azad University of Agriculture and Technology, Kanpur at Mainpuri. The soil was sandy loam, having pH 8.5, organic carbon 0.45%, total nitrogen 0.04%, available phosphorus 10 kg/ha and available potassium 278 kg/ha, thus, the nutrients of experimental soil were analysed low in organic carbon, total nitrogen, available phosphorus and high in available potassium. The pH was determined by Electrometric glass electrode method (Piper, 1950), while organic carbon was determined by Colorimetric method (Datta, *et al.,* 1962). Total nitrogen was analysed by Kjeldahl's method as discussed by Piper (1950). The available phosphorus and potassium were determined by Olsen's method (Olsen *et al.,* 1954) and Flame photometric method (Singh, 1971), respectively. Four levels of *Bacillus circulans* culture (bacterial fertilizer) i.e. 0, 10, 15 and 20 kg/ha in combination of 50% RDF and 100% RDF were tested. Variety *Urvashi* was planted in the first fortnight of October and harvested in second fortnight of February after 130 days of seeding during

The recommended agronomical practices were followed in both experimental years as suggested by Singh and Rathi (1985). The irrigations were given to Indian mustard as and when required. The experimental data of both years were statistically analysed as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

The pooled data of growth, yield traits and seed yield were recorded and reported in Table 1 & 2 and discussed here under appropriate heads.

Effect on growth parameters: Indian mustard raised under two levels of NPK in combination of four levels of bacterial fertilizer in nutrients stress condition of soil. The results revealed that Indian mustard did not influence to the plant height by different treatments (Table 1). Among the tested treatments sowing of Indian mustard at 100% RDF + 20 kg *Bacillus circulans* culture registered higher primary branches/plant (11.00) closely followed by 100% RDF + 15 kg *Bacillus circulans* culture (10.00). Similar trend was also noted in the production of siliqua/plant.

Effect on yield contributing characters: The maximum weight of siliqua was weighed by 37.25 g/plant under 100% RDF + 20 kg *Bacillus circulans* culture/ha, but statistically at par with 100% RDF + 15 kg *Bacillus circulans* culture (37.20 g/plant). The 100% RDF + 20 kg *Bacillus circulans* culture and 100% RDF + 15 kg *Bacillus circulans* culture produced seed weight/plant by 20.15 g/plant and 20.10 g/plant, respectively, which were highest over other tested treatments. The 1000-seed weight was also weighed highest at 100% RDF + 20 kg *Bacillus circulans* culture/ha (4.90 gram) and 100% RDF + 15 kg *Bacillus circulans* culture/ha (4.90 gram), while lowest was noted at 50% RDF + 0 kg *Bacillus circulans* culture/ha (4.10 gram). The values of test weight under other treatments were found between these two limits.

Table 1. Effect of treatment combination on growth and yield contributing characters (pooled data of two years)

Treatment	Plant height (cm)	Primary branches / plant	Siliqua/ plant	Weight of siliquae/ plant (g)	Weight of seed/ plant (g)	1000-seed weight (g)
50% RDF + 0 kg *Bacillus circulans* culture/ha	218.00	8.00	231.00	31.00	16.90	4.10
50% RDF + 10 kg *Bacillus circulans* culture/ha	219.00	8.00	233.00	32.00	17.33	4.25
50% RDF + 15 kg *Bacillus circulans* culture/ha	219.00	9.00	237.00	35.00	18.00	4.60
50% RDF + 20 kg *Bacillus circulans* culture/ha	221.00	9.00	238.00	35.10	18.05	4.65
100% RDF + 0 kg *Bacillus circulans* culture/ha	222.00	9.00	240.00	36.00	19.00	4.70
100% RDF + 10 kg *Bacillus circulans* culture/ha	224.00	9.00	248.00	37.00	19.05	4.80
100% RDF + 15 kg *Bacillus circulans* culture/ha	224.00	10.00	251.00	37.20	20.10	4.90
100% RDF + 20 kg *Bacillus circulans* culture/ha	226.00	11.00	252.00	37.25	20.15	4.90

Table 2 Effect of *Bacillus circulans* on seed yield of Indian mustard with different doses of NPK

1st year

Doses of NPK	Doses of *Bacillus circulans* culture (kg/ha)				Mean
	0	10	15	20	
50% RDF	15.44	16.68	17.30	18.53	16.98
100% RDF	18.53	19.77	20.39	20.08	19.69
Mean	16.98	18.22	18.84	19.30	18.33

Factors	RDF	*B. circulans* culture	RDF x B.C.C.
S.E. (m±)	0.36	0.50	0.72
C.D. 5%	1.09	1.51	N.S.

2nd year

Doses of NPK	Doses of *Bacillus circulans* culture (kg/ha)				Mean
	0	10	15	20	
50% RDF	16.06	17.64	18.97	19.21	17.57
100% RDF	19.46	20.72	21.55	21.56	20.82
Mean	17.76	19.18	20.26	20.38	19.39

Factors	RDF	*B. circulans* culture	RDF x B.C.C.
S.E. (m±)	0.37	0.52	0.73
C.D. 5%	1.12	1.57	N.S.

Effect on seed yield: Application of bacterial fertilize in terms of *Bacillus circulans* culture @ 15 kg/ha or 1.50 lakh caror bacteria of *Bacillus circulans*/ha registered significantly higher seed yield of Indian mustard over control during both years but further installment of *Bacillus circulans* culture confined to the seed yield of Indian mustard. The similar results have also been reported by Singh *et al.* (2006), Singh (2007), Singh *et al.* (2010), Singh *et al.* (2012) and Singh *et al.* (2013). The recommended dose of 150 kg N + 75 kg P_2O_5 + 75 kg K_2O/ha (100% RDF) significantly enhanced the seed yield of Indian mustard over the 50% RDF during two season of experiment. The pooled yield of two years displayed that 100% RDF increased the seed yield by a margin of 2.98 q/ha or 14.71% over 50% RDF. These findings are in agreement with those reported by Rathi and Singh (1983), Singh and Rathi (1985) and Singh *et al.* (2016). Although the independent effect between bacterial fertilizer and NPK dose was computed but under nutrients stress condition of soil, bacterial fertilizer supported to chemical fertilizers in improving the growth and yield contributing parameters.

There had been considerable increase in primary branches/plant, siliqua/plant, weight of siliqua/plant, seed yield/plant and weight of 1000-seed under Indian mustard sown with 100% RDF in combination of 15 kg/ha culture of *Bacillus circulans* that contributed to increase the seed yield (q/ha). The better combination of 100% RDF and 15 kg culture of *Bacillus circulans* maintained better source-sink relationship. Under this situation, the dry matter or photosynthates produced by source organs translocated towards sink organ (economic part) and produced higher seed of Indian mustard. The sowing of Indian mustard under 100% RDF in association of 15 kg/ha *Bacillus circulans* culture had higher weight of siliqua/plant, it possessed higher sink capacity to utilized the photo assimilates translocated from source, resulted in, higher seed weight/plant, weight of 1000-seed and more seed yield (q/ha). These results confirm the findings of Panwar *et al.* (1986), Shrivastava and Bharadwaj (1986), Pachpor and Shete (2010), Singh *et al.* (2015), Singh *et al.* (2015) and Singh *et al.* (2016).

Conclusion

The result clearly displayed that under moisture stress condition of soil, the Indian mustard produced higher seed yield with the application of 150 kg N + 75 kg P_2O_5 + 75 kg K_2O + 15 kg *Bacillus circulans* culture/ha. therefore, the farm families may be advocated for obtaining higher seed yield with application of this dose.

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