Original Research Article

Response of Bio fertilizers and Phosphorus on Yield and Economics of Pearl millet (*Pennisetumglaucum* L.)

ABSTRACT

A field experiment was conducted during kharif*season* of 2022, at crop research farm Department of Agronomy at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.).India. Theobjectiveofaimtostudyywastoassess theeffectsof response of bio fertilizers and Phosphorus on yield and economics pearl millet. The treatments consistsed of 3 levels of bio fertilizers (20 g/kg Azotobacter, 20g/kg Azospirillum, 20 g/kg Azotobacter + Azospirillum) and 3 levels of phosphorus (35, 40 and 45 kg/ha). The experiment was laid out in randomizedcomplete block design with the 10 treatments combinations andreplicated thrice. The soil in experimental field was sandy loam texture, having alkaline reaction (pH 7.7) with very low organic carbon (0.44%), available higher N (171.48 kg/ha), P (27.0 kg/ha) and higher level of K (291.2 kg/ha).The results showrecorded significantly highererin yield and yield attributes viz. ear head length (25.25 cm), number of grains/ear head (2010.9), grain yield (3.25 t/ha) and Stover yield (6.27 t/ha). Maximum gross returns (113750.00 INR/ha), net returns (81010.00 INR/ha) and Benefit – cost ratio (2.47) was found in treatment (T_9) with the application of 20 g/ kg Azotobacter + Azospirillum + 45 kg/ha Phosphorous.Conclusionismissing here. Please add.

INTRODUCTION

The primary crop grown in the country's dry, arid, and semi-arid regions is pearl millet (PennisetumglaucumL.). India contributes 42% of the global production of pearl millet, making it the greatest producer in the world. In India, pearl millet is primarily grown as a rainfed crop in a variety of soils, climates, and essential desert zones. In India, 8.06 million tonnes of pearl millet were produced in 2015–16 on 7.12 million hectares at a yield of 1132 kg/ha. Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, and Haryana are the main states in India that produce pearl millet. In order to increase plant density of present hybrids and ensure sustainable output, fertility management needs to be improved. **(Venkata*et al*., 2001).**

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Next to nitrogen, phosphorus is the element that most restricts the growth and development of crops. It is crucial for ~~the~~ metabolism of plant energy, photosynthesis, nitrogen fixation, synthesis of nucleic acids, and regulation of enzymes. Phosphorus influences root growth, flowering, and yield qualities, which promotes the growth of plants. Additionally, its uptake is constrained by the poor solubility of P in soil. **(Singh *et al*., 2017).**

Phosphorous, in addition to nitrogen, is essential for boosting production. It plays a crucial role in the energy transmission for living cells via ATP's high-energy phosphate bonds. Lack of phosphorus is the primary factor limiting plant growth because it encourages root formation, which improves uptake of other crucial nutrients.**(Dharmendra and Umesha 2022).**

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In the past ten years, bio fertilizers have become~~moreand~~ more popular in the fields of agricultural ~~and~~ food production due to their renewable, affordable, and environmentally friendly character. Chemical pesticides and fertilizers have had a significant negative impact on the environment. Bio fertilizers will aid in the resolution of issues such rising soil salinity and chemical runoff from agricultural fields. The usage of chemical fertilizers is reduced, soil fertility is increased, and crop output is increased thanks to their biological activity in the rhizosphere. Azotobacter is a helpful nitrogen-fixing free-living (no symbiosis) bacteria that is said to fix 20–60 kg/ha of nitrogen per year in soil. Auxin, cytokinin, and gibberellin are plant growth-promoting metabolites, enzymes, and hormones produced by Azotobacter, which was the first and is the most popular bio fertilizer for several plants like maize, wheat, sorghum, and rice in addition to fixing atmospheric nitrogen. **(Forlain*et al.*, 1998).**

By affecting the intake of minerals and increasing the generation of dry matter, Azospirillum promotes plant growth. Additionally, it aids in enhancing water absorption and raising crop yields. **(Goud*et al*.,2021).**

MATERIALSANDMETHODS

A field experiment was carried out during *kharif* season of 2022.The experiment was conducted in randomizedcomplete block design and it consist of 10 treatment combinations with three replications and was laid out with different treatments assigned randomly in each replication. The soil in experimental field was sandy loam texture, having alkaline reaction (pH 7.7) with very low organic carbon (0.44%), available higher N (171.48 kg/ha), P (27.0 kg/ha) and higher level of K (291.2 kg/ha). treatment combination were T_1 - 20 g/kg Azotobacter + 35 kg/ha Phosphorus; T_2 - 20 g/kg Azotobacter

+ 40 kg/ha Phosphorus : T_3 - 20 g/kg Azotobacter + 45 kg/ha Phosphorus; T_4 - 20 g/kg*Azospirillum* + 35 kg/ha Phosphorus ; T_5 -20 g/kgAzospirillum + 40 kg/ha Phosphorus; T_6 - 20 g/kgAzospirillum + 45 kg/ha Phosphorus ; T_7 - 20 g/kg Azotobacter +Azospirillum + 35 kg/ha Phosphorus ; T_8 - 20 g/kg Azotobacter +Azospirillum + 40 kg/ha Phosphorus ; T_9 - 20 g/kg Azotobacter +Azospirillum + 45 kg/ha Phosphorus ; T_{10} - Control (RDF – 80 – 40 - 40 NPK kg/ha) . The observations were recorded on yield and yield parameters *i.e.* Ear head length (cm), Number of Grains/ear head, Test weight (g), Grain yield (t/ha), Stoveryield (t/ha), Harvest index (%), Gross Return (INR/ha), Net Return (INR/ha), Benefit: Cost Ratio (B: C).

3. RESULTSANDDISSCUSIONS

3.1 Yield Parameters

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Treatmentwithapplication of 20 g/kg *Azotobacter* + *Azospirillum*+ 45 kg/ha Phosphorous was significantlyrecorded maximumEarheadlength(25.25cm). However, the treatments 20 g/kg *Azotobacter* + *Azospirillum*+ 40 kg/ha Phosphorous (23.87 cm) and 20 g/kg *Azotobacter* + *Azospirillum*+ 35 kg/ha Phosphorous (22.55 cm) which wasfoundtobestatisticallyatparwith20 g/kg *Azotobacter* + *Azospirillum*+ 45 kg/ha Phosphorous.The yield attributes were remarkable improved and gained significantly high ear head length response of biofertilizer and phosphorus application. The application of Phosphorus can be related to an overall improvement in plant growth as indicated by greater dry matter accumulation, which may result from a higher supply of phosphorus. Theresultsweresimilarto **Reddy *et al.* (2022).**Treatment ofapplication of 20 g/kg *Azotobacter* + *Azospirillum*+ 45 kg/ha Phosphorous was significantly reported maximum grains/ear head (2010.9). However, the treatment 20 g/kg *Azotobacter* + *Azospirillum*+ 40 kg/ha Phosphorous (1981.0)whichwerefoundto be statistically at par with 20 g/kg *Azotobacter* + *Azospirillum*+ 45 kg/ha Phosphorous. Therewasnosignificantdifferenceamongthetreatments.However, highest test weight (6.63 g) was recorded with the treatments 20 g/ kg *Azotobacter* + *Azospirillum* + 35 kg/ha Phosphorous whereas,minimumTest weight(5.47g)wasrecordedwith20 g/ kg *Azotobacter*+ 35 kg/ ha Phosphorus**.** Treatment withapplicationof20 g/ kg *Azotobacter* + *Azospirillum* + 45 kg/ha PhosphorousSignificantly recorded higherGrainyield(3.25t/ha).However, the treatments with (3.15 t/ha) in 20 g/ kg *Azotobacter* + *Azospirillum* + 40 kg/ha Phosphorous which were found tobe statistically at par with 20 g/ kg *Azotobacter* + *Azospirillum* + 45 kg/ha Phosphorous.The yield attributes were remarkable improved and gained significantly high grain yield response of bio fertilizer and phosphorus application. Increase in grain yield per hectare in response to increasing levels of P is due to increased number of grains per cob**(Mahmud*et al*.2003)**Treatment with application of 20 g/ kg *Azotobacter* + *Azospirillum* + 45 kg/ha Phosphorous Significantlyrecorded highestStoveryield(6.27 t/ha).However, the treatments with (5.64 t/ha) in 20 g/ kg *Azotobacter* + *Azospirillum* + 40 kg/ha Phosphorous (5.43 t/ha) which were found to be statistically at par with 20 g/ kg *Azotobacter* + *Azospirillum* + 45 kg/ha Phosphorous.

Phosphorus plays an important role in the production of pearl millet. The significant increase in pearl millet grain and stover yield was mainly a result of higher growth and the subsequent rise in the various yield attributes mentioned above. This major benefit could be due to P, which is well known for its function as "Energy currency" and plays a crucial part in the development and energy transformation in many crucial metabolic processes in the plant. Similar outcomes were reported by **Singh *et al*.(2019)**. Therewasnosignificantdifferenceamongthetreatments. However,highest Harvest index (36.94 %) was recorded with the treatments 20 g/ kg Azotobacter+ 35 kg/ha Phosphorous whereas,minimumHarvest index(32.55 %)wasrecordedwithControl (RDF 80-40-40 N-P-K kg/ha).

Economics

Economic viability of crop cultivation are mostly of crop production with less production cost higher cost of cultivation (32740.00 INR /ha) was observed in T_9 20 g/kg *Azotobacter* + *Azospirillum*+ 45 kg/ha Phosphorous. Higher gross returns (Rs. 113750.00 INR /ha), net returns (Rs. 81010.00 INR /ha), Benefit cost ratio (2.47) was reported in 20 g/kg *Azotobacter* + *Azospirillum*+ 45 kg/ha Phosphorous

CONCLUSION

From the results, it is concluded that with the application of 20 g/kg *Azotobacter*+ *Azospirillum*and 45 kg/ha Phosphorus (Treatment 9) was found more productive (3.25 t/ha) in Pearl millet crop and it can be recommended to farmers after further trails.

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Table 1. Response of Bio fertilizers and Phosphorus on Yield attributes and Yield of Pearl millet

Sr.no	Treatments	Ear head Length (cm)	No.of Grains/Ear head	Test Weight (g)	Grain yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1	20 g/ kg Azotobacter + 35 kg/ ha Phosphorus	17.29	1597.2	5.47	2.38	4.15	36.94
2	20 g/ kg Azotobacter + 40 kg /ha Phosphorus	19.44	1682.9	6.03	2.31	4.30	35.49
3	20 g/ kgAzotobacter + 45 kg/ ha Phosphorus	20.81	1796.17	6.13	2.22	4.47	33.66
4	20 g /kg Azospirillum + 35 kg /ha Phosphorus	18.05	1613.4	6.00	2.70	4.98	36.22
5	20 g/ kg Azospirillum + 40 kg/ ha Phosphorus	19.85	1747.5	6.43	2.75	5.15	35.23
6	20 g/ kg Azospirillum + 45 kg/ ha Phosphorus	21.52	1891.8	6.40	2.61	5.20	33.80
7	20 g/ kg Azotobacter + Azospirillum + 35 kg/ha Phosphorous	22.55	1902.0	6.63	2.98	5.32	36.79
8	20 g/ kg Azotobacter + Azospirillum + 40 kg/ha Phosphorous	23.87	1981.0	6.53	3.15	5.64	36.05
9	20 g/ kg Azotobacter + Azospirillum + 45 kg/ha Phosphorous	25.25	2010.9	6.27	3.25	6.27	34.26
10	Control (RDF 80-40-40 N-P-K kg/ha)	15.84	1404.8	5.47	1.96	4.13	32.55
	F-test	S	S	NS	S	S	NS
	SEm(±)	0.27	32.00	0.61	0.04	0.27	1.17
	CD (p=0.05)	2.33	95.06	-	0.13	0.80	-

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Table2 Response ofBio-fertilizersandPhosphorusonEconomicsofPearlmillet.

Sr.no	Treatments	Cost ofcultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C Ratio
1.	20 g/kg *Azotobacter* + 35 kg/ha Phosphorus	31848.00	83300.00	51452.00	1.61
2.	20 g/kg *Azotobacter* + 40 kg/ha Phosphorus	32173.00	80850.00	48677.00	1.51
3.	20 g/kg *Azotobacter* + 45 kg/ha Phosphorus	32500.00	77700.00	45200.00	1.39
4.	20 g/kg*Azospirillum* + 35 kg/ha Phosphorus	31828.00	94500.00	66672.00	1.96
5.	20 g/kg*Azospirillum* + 40 kg/ha Phosphorus	32153.00	97125.00	64972.00	2.02
6.	20 g/kg*Azospirillum* + 45 kg/ha Phosphorus	32480.00	91350.00	58870.00	1.81
7.	20 g/kg *Azotobacter*+*Azospirillum* + 35 kg/ha Phosphorus	32088.00	104300.00	72212.00	2.25
8.	20 g/kg *Azotobacter*+*Azospirillum* + 40 kg/ha Phosphorus	32413.00	110250.00	77837.00	2.44
9.	20 g/kg *Azotobacter* +*Azospirillum* + 45 kg/ha Phosphorus	32740.00	113750.00	81010.00	2.47
10	Control (RDF – 80-40-40 N-P-K kg/ha)	29306.00	68600.00	39294.00	1.34

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