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Influence of nitrogen and biofertilizers on growth and yield of Pearlmillet (*Pennisetum glaucum* L.) Var. JBV-3

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Abstract
The field experiment was laid out during Zaid, 2021 at CRF, SAM Higginbottom University of agriculture, technology and sciences, Prayagraj, Uttar Pradesh state to study the influence of Nitrogen and Biofertilizers on growth and yield of Pearl millet (*Pennisetum glaucum)*. The experiment was consisted of nine treatments which included three levels of Nitrogen (60, 80, 100 kg N per hectare) and Biofertilizers (Azotobacter, Azospirillum, Phosphate Solubilising Bacteria applied @ 200 g per 10 kg seeds trough seed inoculation). The treatment that received 80:40:40 kg of Nitrogen, Phosporous, Pottasium supplied trough Urea, SSP, MOP respectively along with Azotobacter, Azospirillum produced significantly higher plant height (193.14 cm), Plant dry weight (27.48 gm /plant), Crop growth rate (1.13 g/m2/day), Number of tillers (11.44 Tillers /m^2), Ears (10.55 / m^2), grain yield (4684.57 kg/ha), Stover yield (6604.02 kg/ha), Ear weight (13.60 g) gross returns (106454.00 INR/ha), B:C Ratio (2.13). This experiment shows that treatments that received N:P:K @80:40:40 Along with Azotobacter, Azospirillum was more productive and economic.

Keywords: Influence, nitrogen, biofertilizers, Pearlmillet, *Pennisetum glaucum* L.

Introduction
Pearl millet [*Pennisetum glaucum* (L.)] or Bajra is one of the most important cereal crops of India. Among the major food grain crops of India, pearl millet ranks fourth in acreage next to rice, wheat and sorghum. In India, pearl millet popularly known as 'bajra' or 'bajri' is an important staple food. It is grown in Africa and Asia since prehistoric time. Pearl millet is an important coarse grain cereal generally grown as rainfed crop on marginal lands under low input management conditions. It is generally cultivated in areas with rainfall ranging from 150 to 600 mm. It is a dual-purpose crop; its grain is used for human consumption and its fodder as cattle feed. The nutrient content of pearl millet compares very well with other cereals and millets.

Pearl millet is endowed with greater ability to withstand harsh climatic conditions. It is tolerant to adverse conditions such as drought, low soil fertility and high temperature. The higher production potential of pearl millet in rainfed areas might be owing to deeper root system, better extraction of soil moisture and its efficient utilization. Efficient photosynthetic mechanism and rapid translocation of photosynthates from leaves to grain. Pearl millet is grown mostly on marginal and sub-marginal lands, poor inorganic matter, low in available nitrogen and phosphorus. At present level of productivity, it removes about 72 kg NPK ha^{-1} but only about 10-12 kg of these nutrients are being supplied through fertilizers. However, general recommendation for these nutrients is 40, 30, and 30 kg of N, P_2O_5 and K_2O ha^{-1}, respectively under medium rainfall conditions (Meena and Gautam, 2005) [1].

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Biofertilizers are the preperations containing living cells or latent cells of efficient strains of microorganisms that help the crop plants in uptake of nutrients by their interaction in the rhizosphere when applied through seed or soil. There are various types of biofertilizers like Rhizobium, Azotobacter, Azospirillum, Phosphate solubilising bacteria (PSB) and Azolla. Biofertilizers add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth-promoting substances.

Bio-fertilizers can be expected to reduce the use of chemical fertilizers and pesticides. The microorganisms in biofertilizer restore the soil's natural nutrient cycle and buildup soil organic matter. Through the use of biofertilizers, healthy plants can begrown, besides enhancing the sustainability and the health of the soil. Inoculation of biofertilizers alone or in combination increase plant height, number of tillers and ultimately the yield and reduce the usage of chemical fertilizers to supply nutrient requirement usage of Biofertilizers has helped in reducing the recommended dose of chemical fertilizers needed for corn and millets by 50% without any loss in the yield (Pareek, 2016) [2].

Materials and Methods

The experiment was carried out during *Zaid* season of 2020-2021 CRF, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) which is located at 25^0 24' 33" N latitude, 81^0 51' 12" E longitude and 96 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Prayagraj, Rewa Road about 5 km away from Prayagraj city. The soil is Sandy loam, Ph (7.1), organic carbon (0.48%) available Nitrogen (102.0 kg/ ha), phosphorous (20.5 kg/ha), Potassium (285.0 kg/h). Treatments comprised of T1- N:P:K (60:40:40) + Azospirillum, T2- N:P:K (80:40:40) + Azotobacter, T3- N:P:K (100:40:40) + PSB, T4- N:P:K (80:40:40) + Azotobacter + Azospirillum, T5 - N:P:K (100:40:40) + Azospirillum + PSB, T6 – N:P:K (60:40:40) + Azotobacter + PSB, T7 – N:P:K (100:40:40), T8- N:P:K (60:40:40), T9 – N:P:K (80:40:40). These treatments wre replicated thrice on randomized block design. Nitrogen is supplied as 50% as basal application and remaining 50% at 30 DAS.

Results and Discussion

Plant height

At harvest observed that significantly maximum plant height (193.14 cm) was recorded with application of N:P:K (80:40:40)+ Azotobacter + Azospirillum. However, treatments with application of N:P:K (60:40:40)+ Azotobacter + PSB was statistically on par with application of N:P:K (80:40:40) + Azotobacter + Azospirillum compared to other treatments.

Higher plant height was observed in Azotobacter + Azospirillum treated plots with combination of nutrients than the other treatments. This might be due to the higher nutrient content (NPK and other micronutrients) and higher organic matter content of which are essential for plant growth. Similar results also reported by Zeid *et al.,* 2015, who also found highest plant height of other cereals when Azotobacter + Azospirillum is used either alone or in combination with seed inoculants.

Leaf area

At harvest recorded that the maximum Leaf area (8.71 cm^2) was observed with application of N:P:K(80:40:40)+ Azotobacter + Azospirillum as compared to other treatments. There was no significant difference among different treatment combinations.

The reason for better growth and development under these treatments might be the increased availability of nutrients to plant initially through nitrogen. Which leads to increase in number of leaves as well as size of the leaves Similar results also reported by Zeid *et al.,* 2015.

Plant dry weight

At harvest recorded that the significantly maximum plant dry weight per plant (27.47 g) was observed with application of N;P:K(80:40:40)+ Azotobacter + Azospirillum and However, treatments with application of N:P:K(100:40:40)and N:P:K(80:40:40) were statistically on par with application of N;P:K (80:40:40)+ Azotobacter + Azospirillum compared to other treatments.

The increase in dry matter was found due to increase in plant height, number of leaves per plant. This might be due to application of recommended amount of nitrogen and bio fertilizer thereby increase in soil microorganism and due to better moisture and nutrient availability. Similar findings were reported by Singh *et al.,* 2001 and Sharma *et al.,* (2017).

Crop growth rate

At 60-at harvest recorded that the significantly maximum Crop Growth Rate (1.33g/m^2/day) was observed with application of N:P:K (80:40:40) + Azotobacter + Azospirillum. However, treatments with application of N:P:K(80:40:40) was statistically on par with application of Azotobacter + Azospirillum compared to other treatments.

Crop growth rate was found maximum between 60-80 DAS thereafter decreasing trend was observed. Similar results were found by Rathore (2006) [5]. The increased availability of nutrients in soil due to application of the manure expectedly led to increased uptake of N, P, K, Ca, and Mg. The finding that Azotobacter, Azospirillum significantly increased growth and grain yield of pearl millet.

Grain yield (q/ha)

The Grain yield of Pearl millet (4684.57kg/ha) was significantly higher with the application of N:P:K(80:40:40)+ Azotobacter+ Azospirillum. However, treatments with application of N:P:K(100:40:40)+ Azospirillum+ PSB *and* N:P:K(80:40:40)were statistically on par with application of N:P:K(80:40:40)+ Azotobacter+ Azospirillum *as* compared to other treatments.

Straw yield (q/ha)

The Straw yield of Pearl millet (6604.02kg/ha) was significantly higher with the application of N:P:K(80:40:40)+ Azotobacter+ Azospirillum. However, treatments with application of N:P:K(100:40:40)+ Azospirillum+ PSB *and* N:P:K(80:40:40)were statistically on par with application of N:P:K(80:40:40)+ Azotobacter+ Azospirillum *as* compared to other treatments.

Ear weight (g)

The Ear weight (13.60 g) of Pearl millet was significantly higher with the application of N:P:K(80:40:40)+ Azotobacter+ Azospirillum. However, treatments with application of N:P:K(100:40:40)+ Azospirillum+ PSB, N:P:K(60:40:40)+ Azotobacter + PSB *and*

N:P:K(100:40:40)were statistically on par with application of N:P:K(80:40:40)+ Azotobacter+ Azospirillum *as* compared to other treatments.

Increase in grain yield may be ascribed to better root growth and development, resulting in more nutrient uptake and higher dry matter accumulation per plant and its subsequent translocation to the developing panicle. And relate to the release of essential nutrient elements by the poultry litter and increase of nutrient availability. Application of biofertilizer like Azotobacter and Azospirillum provides the nitrogen to the crops. The ability to fix atmospheric nitrogen is a vital physiological characteristic of Azotobacter. Azotobacter cells are usually not present on the root surface but are abundant in the rhizosphere and protect the roots from other pathogens present in soil. The result was in agree with the findings of Udom *et al.*, 2007 [8], Silva *et al.*, 2003 [6], Rathore *et al.* (2004) [4] and Parveen *et al.* (2007) [3].

Influence of nitrogen and bio fertilizers on growth and yield of pearl millet

Application of N:P:K @ 80:40:40 kg /ha recorded maximum Gross returns (106453.00 INR /ha), Net returns (72470.40 INR/ha), and Benifit cost ratio (2.13) which is superior over all the treatments.

Table 1: Effect of biofertilizers and nitrogen level on Yield of Pearl Millet

	Treatments	Grain yield (kg/ha)	Stover yield (kg/ha)	Ear Weight (g)
1	N:P:K(60:40:40)+Azospirillum	4417.89	6011.27	12.46
2	N:P:K(80:40:40)+ Azotobacter	4350.00	5847.34	12.66
3	N:P:K(100:40:40)+Phospate solubilising bacteria	4358.00	5894.02	12.69
4	N;P:K(80:40:40)+ Azotobacter+ Azospirillum	4684.57	6604.02	13.60
5	N:P:K(100:40:40)+ Azospirillum+ PSB	4596.45	6395.24	13.51
6	N:P:K(60:40:40)+ Azotobacter + PSB	4403.75	5947.76	13.11
7	N:P:K(100:40:40)	4366.00	5860.54	13.25
8	N:P:K(60:40:40)	4440.88	6062.83	12.61
9	N:P:K(80:40:40)	4594.54	6398.23	12.98
	S.Em(+)	54.7	118.92	020
	CD (0.05%)	162.78	353.33	0.61

Table 2: Effect of bio fertilizers and nitrogen level on Economics of Pearl Millet

	Treatments	Total Cost of Cultivation (INR /ha) *	Gross Returns (INR /ha)*	Net Returns (INR /ha)*	B:C Ratio*
1	N:P:K(60:40:40)+Azospirillum	33481.3	99851.7	66370.4	1.98
2	N:P:K(80:40:40)+ Azotobacter	33803.4	98138.4	64335	1.90
3	N:P:K(100:40:40)+Phospate solubilising bacteri	34185.5	98408.7	64223.2	1.88
4	N;P:K(80:40:40)+Azotobacter+Azospirillum	33983.4	106454	72470.4	2.13
5	N:P:K(100:40:40)+ Azospirillum+ PSB	34405.4	104240	69874.5	2.03
6	N:P:K(60:40:40)+ Azotobacter,+PSB	33761.3	99421.4	65620.1	1.94
7	N:P:K(100:40:40)	33865.5	98478.6	64613.1	1.91
8	N:P:K(60:40:40)	33583.4	100422	66838.6	1.99
9	N:P:K(80:40:40)	33301.3	104211	70909.5	2.10

Conclusion and future scope

Based on the findings it may be concluded that for maximum grain yield, stover yield and optimum economics. The performance of Pearl millet at N:P:K of 80:40:40 Along with Azotobacter + Azospirillum is the best. Increased dose of nitrogen over the recommended dose has improved the vegetative growth parameters significantly, this lead to higher rate of photosynthesis and bio matter accumulation which acted as resrves for supply of nutrients to growing ears which in turn has produced higher grain yield. Application of biofertilizers has improved the amount of available Nitrogen, The usage of biofertilizers along with conventional fertilizers could bring down the inhibitory effects of fertilizers on soil and environment. The conclusion is drawn based on one season data only it requires further conformation for recommendation.

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Conflict of interest

There is no conflict of interests among the Authors.

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