

**Effect of Bio fertilizers and Phosphorus on Growth and Yield of Pearl millet**  
**(*Pennisetum glaucum* L.)**

**ABSTRACT**

A field experiment was conducted at Crop Research Farm in Department of Agronomy during kharif season of 2022 on pearl millet. SHUATS, Prayagraj (U.P). the treatments consisted of 3 levels of biofertilizers (20 g/kg *Azotobacter*, 20 g/kg *Azospirillum*, 20 g/kg *Azotobacter*+ *Azospirillum*) and phosphorus (35,40,45 kg/ha) and a control. The experiment was laid out Randomized Block Design with ten treatments each replicated thrice. The results showed that application of 20 g/kg *Azotobacter*+ *Azospirillum*+ 45 kg/ha Phosphorus was recorded significantly higher plant height (200.13 cm), Plant dry weight (40.33 g/plant), Ear head length (25.25 cm), grains/ear head (2010.9), Grain yield (3.25 t/ha), Straw yield (6.27 t/ha) as compared to other treatments.

**Key words:** *Azospirillum*, *Azotobacter*, phosphorus, Growth attributes and Yield attributes.

**INTRODUCTION**

Pearl millet (*Pennisetum glaucum* L.) is the staple cereal of arid and semi-arid drier regions of the country. India is the largest Pearl millet growing country contributing 42 per cent of production in the world. In India, pearl millet is pre-dominantly cultivated as a rainfed crop in diverse soils, climatic condition and indispensable arid zone. In India pearl millet was cultivated in 7.12 million hectares with 8.06 million tones production and productivity of 1132 kg/ha during 2015-16. The major pearl millet producing states in India are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana. Therefore, there is need to improve fertility management along with optimum plant density of current hybrids for sustainable production and productivity (**Venkata *et al.*, 2001**).

Bio fertilizers are commonly called microbial inoculants which are capable of mobilizing important nutritional elements in the soil from non-usable to usable form by the crop plants through their biological processes. Bio fertilizers due to its renewable, cheap and eco-friendly nature has gained increasing popularity in the past one decade in the field of agriculture and food production. The use of chemical fertilizers and pesticides has caused tremendous effect to the environment. Bio fertilizers will help to solve such problems a

increased salinity of soil and chemical run off from the Agricultural field. It has been found to minimize the use of chemical fertilizers, improved soil fertility status and enhancing the crop production by their

biological activity in the Rhizosphere. Azotobacter and Azospirillum are the two examples of these microorganisms. Mycorrhizal symbiosis increases absorption of some elements such as phosphorus, nitrogen and micronutrients, improves water uptake, produces hormones, reduces damages caused by environmental stress. Improves quality of soil aggregate.

Azotobacter is a beneficial free living (no symbiosis) nitrogen fixing bacteria which is reported to fix 20-60 kg/ha nitrogen in soil annually. Azotobacter was the first and is the most common biofertilizer for some plants such as maize, wheat, sorghum and rice which produces some plant growth promoting metabolites, enzymes and hormones (auxin, cytokinin and gibberellin) in addition to fixing air nitrogen (**Forlain et al., 1998**).

Azospirillum enhance the growth of the plant by influencing the mineral uptake, enhances the dry matter production. Further it also helps in improving the uptake of water and increase the yield of crops. Azotobacter is a N fixing bacteria which improves the crop growth through absorption of N which is fixed near the soil root zone (**Goud et al., 2021**). *Azospirillum* is a rhizosphere bacterium colonizing the root of the crop plants making use of root exudates and fixes substantial amount of nitrogen and is benefit to plants by mechanisms related to enhancement of plant growth, increase the mineral uptake, increase the dry matter, improve the water absorption and improve the yield. Azotobacter is a free-living nitrogen fixation bacteria which has been reported to fix about 20 kg N/ha in non-legumes (**Goud et al., 2021**). Phosphorus is the most limiting factor next to nitrogen in crop's growth and development. It plays an important role in plant's energy metabolism, photosynthesis process, nitrogen fixation, synthesis of nucleic acids and enzyme regulations. Phosphorus enhances the crops growth by influencing the root growth, flowering and yield attributes. And its uptake is limited because of the low solubility of P in soil (**Singh et al., 2017**).

Phosphorus is widely called as "Bottleneck of world hunger" and an essential element with plays vital role in plant's growth and development. Adequate phosphorus nutrition enhances many aspects of plant growth development including flowering, fruiting, roots growth and yield components of different crops. P uptake in plants is often constrained by the very low solubility of P in the soil. In agricultural systems, Phosphorus in the harvested crops is removed from the system, resulting in P deprived soils if no P is supplemented as fertilizer (**Jain 2005**).

Phosphorus is essential for all living organisms. Plants must have phosphorus for normal growth and maturity. Phosphorus plays a role in photosynthesis, respiration, energy, storage and transfer, cell division enlargement and several other processes in plants. A Plant must have phosphorus to complete its normal production cycle. Phosphorus is a vital component of DNA, the genetic memory unit of all living things. It is also component of RNA, the compound that reads the DNA genetic transfer **Anonymous, (2016)**.

Beside N, phosphorous also plays a vital role in increasing the yield. It is an important nutrient in energy transfer for the living cells by means of high-energy phosphate bonds of ATP. Phosphorous deficit is the most important restrictive factor in plant growth because it promotes root development that in turn enhances uptake of other essential elements **(Dharmendra and Umesha 2022)**.

## **MATERIALS AND METHODS**

A field experiment was conducted during kharif season of 2022. The experiment was conducted in randomized block design and it consist of 10 treatment combinations with three replications and was laid out variously 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<sub>1</sub> - 20 g/kg Azotobacter + 35 kg/ha Phosphorus; T<sub>2</sub> - 20 g/kg Azotobacter + 40 kg/ha Phosphorus ; T<sub>3</sub> - 20 g/kg Azotobacter + 45 kg/ha Phosphorus; T<sub>4</sub> - 20 g/kg *Azospirillum* + 35 kg/ha Phosphorus ; T<sub>5</sub> - 20 g/kg *Azospirillum* + 40 kg/ha Phosphorus; T<sub>6</sub> - 20 g/kg *Azospirillum* + 45 kg/ha Phosphorus ; T<sub>7</sub> - 20 g/kg Azotobacter + *Azospirillum* + 35 kg/ha Phosphorus ; T<sub>8</sub> - 20 g/kg Azotobacter + *Azospirillum* + 40 kg/ha Phosphorus ; T<sub>9</sub> - 20 g/kg Azotobacter + *Azospirillum* + 45 kg/ha Phosphorus ; T<sub>10</sub> - Control (RDF – 80 – 40 – 40 NPK kg/ha) . The observations were recorded on growth parameters at harvest yield i.e. plant height(cm), dry weight (g/plant), Ear head length (cm), Number of Grains/ear head, Test weight (g), Grain yield (t/ha), Stover yield (t/ha), Harvest index (%).

### 3. RESULTS AND DISCUSSIONS

#### Growth attributes

##### 3.1 Plant height (cm)

At 80 DAS, significantly highest plant height (200.13 cm) was observed in the treatment with 20 g/kg *Azotobacter* + *Azospirillum* + 45 kg/ha Phosphorus over all the other treatments. However, the treatments with application of 20 g/kg *Azotobacter* + *Azospirillum* + 40 kg/ha Phosphorus (196.40 cm) which were found to be at par with treatment 20 g/kg *Azotobacter* + *Azospirillum* + 45 kg/ha Phosphorus.

The probable reason for increase in plant height due to application of biofertilizer and phosphorus were biofertilizer play crucial role in a free-living nitrogen-fixing bacterium termed *Azotobacter* has been reported to fix about 20 kg/ha of nitrogen in non-legumes. The results were found in accordance with **Ramdev et al (2017)**. The significant increase in the height may be due to inoculation of bacterial preparation accelerate plant growth provide biologically fixed nitrogen to the inoculated plant and also stimulate plant growth by excreting plant growth promoting substances like auxins, kinetins, vitamins and gibberellins as similarly observed by **Patidar and Mali (2004)**. Phosphorus plays a pivotal role in extensive root systems efficient utilization of nutrients under conditions of sufficient P application similar results was observed by **Lakhan et al (2017)**

##### 3.1.2 Dry weight (g/plant)

At 80 DAS, treatment with 20 g/kg *Azotobacter* + *Azospirillum* + 45 kg/ha Phosphorus was recorded with significantly maximum dry weight (40.33 g/plant) over all the treatments. However, the treatments with 20 g/kg *Azotobacter* + *Azospirillum* + 40 kg/ha Phosphorus ( 37.67 g/plant) which were found to be statistically at par 20 g/kg *Azotobacter* + *Azospirillum* + 45 kg/ha Phosphorus.

The significant increase in a plant dry weight at different stages of growth due to application of biofertilizers and phosphorus was might be due to crucial role of *Azotobacter* can transform elemental nitrogen into ammoniacal form ( $\text{NH}_4^+$ ), which plant life uses. In addition, *Azotobacter* has a distinct benefit due to its capacity to synthesize auxins, vitamins, growth factors, and antifungal antibiotics. The roots absorbed the nitrogen that was being fixed by *Azotobacter* in the soil near the root zone (rhizosphere), which may have increased the crop's growth parameters. These findings closely match those of **Kumar et al., (2012)**

Inoculation of biofertilizers stimulates activation of hormones which helps in shoot and root elongation and high dry matter production, similar results were observed by **Rathore *et al.* (2006)**

## **3.2 Yield**

### **3.2.1 Ear head length (cm)**

The application of 20 g/kg Azotobacter + Azospirillum + 45 kg/ha Phosphorous significantly increased the maximum ear head length (25.25 cm) over all other treatments. However, the treatments of 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) were statistically comparable to 20 g/kg Azotobacter + Azospirillum + 45 kg/ha Phosphorous.

The yield characteristics were significantly enhanced, and the biofertilizer and phosphorus application significantly increased the ear head length response. Azotobacter that helped roots grow better. Accordingly, better root advancement and energetic plant development, which thus came about to more dry matter lastly better blossoming and ear head improvement, may have been helped by the expanded accessibility of

nitrogen. findings are in line with the obtained results (**Patel et al 2014**). A greater accumulation of dry matter as a result of a higher supply of phosphorus may indicate a connection between the application of phosphorus and an overall improvement in plant growth. Similar findings were found (**Patel et al 2022**).

### **3.2.2 Grains /ear head**

The application of 20 g/kg Azotobacter + Azospirillum + 45 kg/ha Phosphorous produced the highest grains/ear head (2010.9) of any of the treatments. Notwithstanding, the treatment 20 g/kg Azotobacter + Azospirillum+ 40 kg/ha Phosphorous (1981.0) which were found to be statistically at par with 20 g/kg Azotobacter + Azospirillum+ 45 kg/ha Phosphorous. A significant increase in the number of grains per ear head is the result of an increase in the availability of nitrogen through bio fertilizer inoculation, which also results in an increase in the number of ear heads produced as a result of increased rates of spikelet primordial production; Marngar and Dawson (2017) found results that were comparable.

### 3.2.3 Test weight (g)

There was no significant difference among the treatments. However, highest test weight (6.63 g) was recorded with the treatments 20 g/ kg *Azotobacter* + *Azospirillum* + 35 kg/ha Phosphorous whereas, minimum Test weight (5.47 g) was recorded with 20 g/ kg *Azotobacter* + 35 kg/ ha Phosphorus.

### 3.2.4 Grain yield (t/ha)

Significantly highest Grain yield (3.25 t/ha) was recorded with the treatment application of 20 g/ kg *Azotobacter* + *Azospirillum* + 45 kg/ha Phosphorous over all the treatments. However, the treatments with (3.15 t/ha) in 20 g/ kg *Azotobacter* + *Azospirillum* + 40 kg/ha Phosphorous which were found to be statistically at par with 20 g/ kg *Azotobacter* + *Azospirillum* + 45 kg/ha Phosphorous.

The application of biofertilizer and phosphorus recorded significantly higher grain yield, This could mainly be ascribed to the increased availability of the nitrogen to the plants through biological nitrogen fixation in rhizosphere by *Azotobacter* that caused better root development. Thus, the greater availability of nitrogen might have helped in better root proliferation and vigorous plant growth, resulting in more dry matter and ultimately better flowering and ear head development. The increase in yield might be due to the cumulative effect of increased growth and yield attributes noted under this treatment. The results obtained are in close agreement with the findings of **Sushila and Giri (2000)**

### 3.2.5 Straw yield (t/ha)

Significantly highest Straw yield (6.27 t/ha) was recorded with the treatment application of 20 g/ kg *Azotobacter* + *Azospirillum* + 45 kg/ha Phosphorous over all the treatments. 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.

Straw yield is dependent on vegetative growth as use of balanced and optimum use of fertilizer increased plant height, green leaves per hill, and dry matter production, which finally resulted in higher straw yield, similar results were obtained by **Zothanmawii et al (2018)**

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)**

### **3.2.6 Harvest index (%)**

There was no significant difference among the treatments. However, highest Harvest index (36.94 %) was recorded with the treatments 20 g/ kg Azotobacter + 35 kg/ha Phosphorous whereas, minimum Harvest index (32.55 % ) was recorded with Control (RDF 80-40-40 N-P-K kg/ha ) .

### **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. Effect of Bio fertilizers and Phosphorus on Yield attributes and Yield of Pearl millet**

<b>Sr.no</b>	<b>Treatments</b>	<b>Plant height (cm) 80 DAS</b>	<b>Dry weight (g/plant) 80 DAS</b>
1	20 g/ kg Azotobacter + 35 kg/ ha Phosphorus	171.23	30.70
2	20 g/ kg Azotobacter + 40 kg /ha Phosphorus	179.80	31.19
3	20 g/ kg Azotobacter + 45 kg/ ha Phosphorus	185.43	33.59
4	20 g /kg Azospirillum + 35 kg /ha Phosphorus	175.03	34.22
5	20 g/ kg Azospirillum + 40 kg/ ha Phosphorus	183.17	34.30
6	20 g/ kg Azospirillum + 45 kg/ ha Phosphorus	188.70	33.88
7	20 g/ kg Azotobacter + Azospirillum + 35 kg/ha Phosphorous	192.10	34.87
8	20 g/ kg Azotobacter + Azospirillum + 40 kg/ha Phosphorous	196.40	37.67
9	20 g/ kg Azotobacter + Azospirillum + 45 kg/ha Phosphorous	200.13	40.33
10	Control (RDF 80-40-40 N-P-K kg/ha )	168.13	31.87
	F-test	S	S
	SEm(±)	1.40	0.93
	CD (p=0.05 )	4.15	2.75

**Table 2. Effect 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/ kg Azotobacter + 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	-