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Bhagyasree B
M.Sc. Scholar, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj, Uttar Pradesh, India

Akankhya Pradhan
Phd Scholar, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj, Uttar Pradesh, India

Rajesh Singh
Associate Professor, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Bhagyasree B
M.Sc. Scholar, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj, Uttar Pradesh, India

Effect of Bio-fertilizer and Sulphur on growth and yield attributes of pearlmillet

Bhagyasree B, Akankhya Pradhan and Rajesh Singh

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Abstract
The field experiment was conducted during *Kharif* 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The experiment was laid out in Randomized Block Design with ten treatments which are replicated thrice on the basis of one year experimentation. The treatment combinations are T_1 - Azospirillum + Sulphur 20 kg/ha, T_2 - Azospirillum + Sulphur 25 kg/ha, T_3 - Azospirillum + Sulphur 30 kg/ha, T_4 - PSB + Sulphur 20 kg/ha, T_5 - PSB + Sulphur 25 kg/ha, T_6 - PSB + Sulphur 30 kg/ha, T_7 - Azotobacter + Sulphur 20 kg/ha, T_8 - Azotobacter + Sulphur 25 kg/ha, T_9 - Azotobacter + Sulphur 20 kg/ha, T_{10} - Control (80:40:40) are used. The experiment was laid out in Randomized block design with ten treatments replicated thrice. The important findings of the experiment have been summarized and concluded here under the objectives taken. The application of Azotobacter + Sulphur 25 kg/ha recorded significantly higher Plant height (107.1 cm), Plant dry weight (42.5 g/plant), Significantly maximum Ear head length (27.20), grains/ear head (1677.53), Test weight (5.91 g) were obtained in the treatment of Azotobacter + Sulphur 25 kg/ha.

Keywords: Azospirillum, Azotobacter, PSB, Pearlmillet

Introduction
Pearl millet is a staple cereal crop in the dry arid and semi-arid regions. Being a staple food, it also has value for its dry fodder in livestock-based farming systems. Sorghum, pear millet, finger-millet and maize are some of the nutritious cereals in this group. These cereals are cultivated in harsh environments with poor soil and water conditions, which make them nutritious. Due to their extreme resistance to drought, their cultivation in dought-prone regions is effectively supplying nourishment and fodder security through risk-taking on an ongoing basis. This group of cereals is comparable to fine cereals like rice when it comes to providing nourishment, and in some ways it's even better. The starch content of pearl millet is comparable to that of wheat (Abdalla *et al.*, 1998) [1]. The pearl millet is also high in fat. The amino acid lysine is found in sorghum and pearl millet, ranging from 159 to 380 mg/100 grams of protein. Pearl millet is rich in threonine, methionine, and cysteine.
Millet is an important crop in the semi-arid regions of Asia and Africa. In Asia, it is grown mainly in countries such as India, and on the African continent, it is grown in countries such as Nigeria and Niger. The most widespread crop, millet occupies a leading position in global Agriculture. With an annual production of 10.1 million tonnes and an average productivity of 1069 kg/ha, India is the largest pearl millet producer in the world. India is the largest producer of pearl millet covering about 8.75 million ha of marginal and sub-marginal land mainly in the states of Rajasthan, Gujarat, Haryana, Uttar Pradesh and Maharashtra and ranks third after rice and wheat in acreage.
An insufficient supply of sulfur can affect the yield and quality of crops because sulfur is needed for the synthesis of the three amino acids cysteine, Cystine and methionine and the formation of various enzymes and proteins. (Kertesz *et al.* [8] Continued application of sulfur-free fertilizers increases sulfur deficiency in crops across states in India.

Reduced application of organic fertilizers, reduced application of sulfur-containing pesticides, and intensive cultivation result in higher removal of sulfur from soil About one million tons of sulfur is removed from the soil annually, while its addition through fertilizers is approximately 0.34 million tons, unless proper measures are taken, this gap is expected to widen in the coming years.

Materials and Methods

The effect of biofertilizer and sulfur on growth and yield characteristics of pearl millet was done in Kharif 2023-2024 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj. This area lies approximately 5 kilometers from the city of Prayagraj, on the right bank of the Yamuna River, adjacent to the Prayagraj Rewa Road. Between 0 to 30 cm down, a composite soil sample was taken between 0 and 30 cm down. Chemical and physical qualities were examined after it was crushed and let to air dry. The soil reaction of the sandy clay loam soil was 7.6, the organic matter content was 0.69 (0.72%), the available nitrogen was 152.7 kg/ha, the phosphorus was 10.4 kg/ha, the potassium was 174.0 kg/ha, and the sulfur content was 7.2 mg/kg. For sowing, pearlmillet variety KH - 302 was selected. The seeds were sown sequentially by hand in 2023. The soil immediately covered the seeds after they were sown. According to the treatment details, the spacing was 10 cm and row to row 30 cm, and the seeds were drilled at 4 - 5 cm depth. Crop response to supplied nutrients was accounted for by balancing initial soil test values and crop requirements in both years.

Results and Discussion

Plant height

There was significant difference among the treatments. However, highest plant height (107.1 cm) was recorded with the application of Azotobacter + Sulphur 25 kg/ha, whereas with the application of Azotobacter + Sulphur 30 kg/ha (103.2 cm) and PSB + Sulphur 25 kg/ha (103.0 cm) were found to be statistically at par with T_8, and minimum was reported in control (98.0 cm). Sulfur may be responsible for increasing plant height due to its beneficial effect on various metabolic activities and its important role in cell division, the process of photosynthesis and the formation of chlorophyll in leaves. The findings agreed with those of Dahich and Gupta (2005) [4], Degra *et al.* (2008) [3].

Plant dry weight

There was a significant difference between treatments for Harvest. However, the highest plant dry weight (42.5 g) was recorded with Azotobacter + Sulfur 25 kg/ha, while the Azotobacter + Sulfur 30 kg/ha (41.5 g) treatment was statistically at par with T_8 and the lowest was reported in controls (36.50 g). The increased yield can be attributed to efficient metabolic processes associated with an increased rate of photosynthesis, leading to a more efficient transfer of photosynthates to the sink. Singh *et al.* (2017) [10] reported the same results. Pearl millet grain yield was significantly increased with S application over control. The highest grain yields were recorded with 40 kg S kg/ha yielding 27.42 q ha kg/ha.

Ear head length

There was a significant difference between treatments. The highest ear head length (27.20 cm) was recorded with Azotobacter + Sulfur 25 kg/ha application, while Azotobacter + Sulfur 25 kg/ha (26.13 cm) treatment was statistically at par with T_8 and the least was reported for control (21.40 cm). Chauhan *et al.* (2017) [2] reported the same results. A sample of the grain was examined for sulfur and phosphorus, which were found to affect the quality of pearl production. Different doses of phosphorus affected the protein content of the grain. The maximum (11.71% protein content) was recorded with 50 kg P2O5 kg/ha, followed by treatments of 40 and 30 kg P2O5 kg/ha. The control chart showed a minimum protein content of 10.88% The maximum protein content of pearl millet grain was 11.97% due to the presence of sulfur (40 kg kg/ha) Sulfur plays a vital role in protein synthesis and also plays an important role in protein structure. The degree of gluten strength and bread volume varies depending on the rate of fertilizer applied, according to Rao and Bharti (1996) [9], higher fertilizer dosage results in higher protein content. Interaction data show that both sulfur and phosphorus had a positive effect on the protein content of pearl millet. Kumar *et al.* (2014) [7], Singh *et al.* (2009) [10] and Jat *et al.* (2002) [5] reported similar results.

Grains per ear head

Significant difference among the treatments. However, highest grains per ear head (1677.53) was recorded with the application of Azotobacter + Sulphur 25 kg/ha, whereas treatment Azotobacter + Sulphur 25 kg/ha (1623.60) was found to be statistically at par with T_8, and minimum was reported in control (1400.40).

Test weight (g)

There was significant difference among the treatments. However, highest test weight (5.91 gm) was recorded with the application of Azotobacter + Sulphur 25 kg/ha, whereas treatment Azotobacter + Sulphur 25 kg/ha (5.68 gm) was found to be statistically at par with T_8, and minimum was reported in control (4.22 gm).

Table 1: Effect of bio-fertilizers and sulphur on growth and yield attributes of Pearlmillet

S. No.	Treatments	Plant height	Plant dry weight	ear head length (cm)	Grains/Ear head (no)	Test weight (gm)
1.	Azospirillum + Sulphur 20 kg/ha	99.0	38.5	22.07	1407.20	4.27
2.	Azospirillum + Sulphur 25 kg/ha	101.1	40.5	24.07	1501.13	4.93
3.	Azospirillum + Sulphur 30 kg/ha	100.9	39.6	24.00	1486.33	4.80
4.	PSB + Sulphur 20 kg/ha	100.0	39.0	22.93	1421.20	4.36
5.	PSB + Sulphur 25 kg/ha	103.0	41.2	25.87	1575.67	5.32
6.	PSB + Sulphur 30 kg/ha	101.5	40.9	24.47	1532.40	5.04
7.	Azotobacter + Sulphur 20 kg/ha	100.5	39.5	23.47	1450.27	4.65
8.	Azotobacter + Sulphur 25 kg/ha	107.1	42.5	27.20	1677.53	5.91
9.	Azotobacter + Sulphur 30 kg/ha	103.2	41.5	26.13	1623.60	5.70
10.	control(RDF): 80:40:40 NPK kg/ha	98.0	36.5	21.40	1400.40	4.22
	SE m (±)	1.61	0.52	0.38	19.59	0.07
	CD (p=0.05)	4.79	1.54	1.12	58.21	0.21

Conclusion

Pearl millet stands as a resilient and vital staple cereal crop, particularly in arid and semi-arid regions, providing both nourishment for humans and fodder for livestock. Its cultivation in harsh environments with poor soil and water conditions underscores its nutritional value and adaptability. Pearl millet, along with other cereals like sorghum, finger millet, and maize, serves as a crucial source of sustenance in regions prone to drought. India emerges as a key player in pearl millet production, contributing significantly to global agricultural output. However, the sustainability of pearl millet cultivation faces challenges, such as the depletion of sulfur in soil due to reduced application of fertilizers and intensive farming practices. Research into optimizing nutrient application, such as sulfur and phosphorus, has shown promising results in enhancing pearl millet growth, yield, and nutritional content. Therefore, ensuring proper nutrient management practices is essential for sustaining and maximizing the productivity of pearl millet cultivation in the face of evolving agricultural landscapes and climate change.

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