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# Study of productivity and economics of pearl millet (*Pennisetum glaucum* L.) Variety Jaigro 2828 in relation to phosphorus and plant growth regulators

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**Abstract**

**Background:** Pearl millet can thrive in a wide range of local conditions. In areas where sorghum cannot thrive, pearl millet is a viable alternative. Sorghum and maize can't compete with pearl millet when it comes to soil moisture utilisation and heat tolerance.

**Objectives:** Effects of phosphorus and plant growth regulators on yield and economics of pearl millet.

**Methods:** With the goal of studying the effect of phosphorus and plant growth regulators on yield and economics of Pearl millet (*Pennisetum glaucum* L.) Var. Jaigro-2828 under a Randomized block design with 10 treatments ($T_1$-$T_{10}$ The experimental results revealed that Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm, produced ear head length (22.57 cm), Number of grains/ear head (1989), grain yield (2.77 t/ha), Stover yield (3.80 t/ha) harvest index (43.00%). $T_9$ Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm produced greater gross returns (1,44,040 INR/ha), net returns (97,650.00 INR/ha), and benefit-to-cost ratios (2.10).

**Keywords:** Pearl millet, Phosphorus, Plant growth regulators, NAA, Triacontanol, yield, economics, attributes, net return, B:C ratio

## 1. Introduction

Pearl millet [*Pennisetum glaucum* (L.)] is a cereal crop, after rice, wheat, maize, and sorghum, that is essential. On 30 million acres of land in the tropical dry and semi-arid region of Asia and Africa, it is a staple meal for 90 million poor people and accounts for half of the world's millet output. After rice, wheat, and maize, teh fourth most grown crop in India. Several rural communities utilise the bajra crop as a feed grain for their cows and for thatching rooftops. Most bajra is grown in dry, arid regions [1]. A cereal crop, after rice, wheat, maize, and sorghum, that is essential. On 30 million acres of land in the tropical dry and semi-arid region of Asia and Africa, it is a staple meal for 90 million poor people and accounts for half of the world's millet output. After rice, wheat, and maize, teh fourth most grown crop in India. Several rural communities utilise the bajra crop as a feed grain for their cows and for thatching rooftops. Most bajra is grown in dry, arid regions [2].

Protein (11.6%), iron in particular (8.8%), fat (5%) and carbs (67%) are all abundant in its grains. Most of the world's pearl millet is cultivated in North West India, which also produces 24% of the world's coarse grains and covers 42% of the total area under pearl millet cultivation [2]. Concerns regarding agriculture's capacity to meet the demands of a population that is expanding at an exponential rate have increased due to a lack of new land available for food cultivation and deteriorating soil fertility. When compared to solitary cropping, intercropping increases overall production per unit area per unit time by making efficient use of resources. Planting short-lived crops like pearl millet alongside cluster beans and green gramme crops may increase economic returns per unit of land since there will be less rivalry due to their temporally varying peak resource demand.

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. 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) [8].

The plant growth regulators (PGRs) have potential for increasing crop productivity under environmental stress. Growth regulators are chemical substances which can alter the growth and developmental processes leading to increased yield, improved grain quality or facilitated harvesting (Espindula *et al*., 2009) [6]. Nutrient levels and plant growth regulators application had significant influence on growth parameters of Pearl millet. The exogenous applications of NAA to improve growth and yield under various stress conditions including drought, salinity, extreme temperatures, and heavy metal toxicity. They are also involved in developmental processes such as seed germination, leaf angle, flowering time, and seed yield, which are of great agronomic importance.

## 2. Materials and Methods

During the Zaid season of 2023, a field experiment was conducted out at the C.R.F of the wing of Agronomy in Shuats Prayagraj, which is located at 25o 24' 42" N latitude, 81o 50' 56" E longitude, and 98 m altitude over the mean sea degree (MSL). To see how Phosphorus and plant growth regulators effect the growth and yield of Pearl millet (*Pennisetum glaucum* L.). The trial was set up in a Randomized Block design with Ten treatments that were reproduced three times. The length of each plot is 3m x 3m. When given in combination, the treatment is classified as having a recommended dose of Potash via Muriate of Potash. As well as Nitrogen via Urea and Phosphorus via DAP. $T_1$-Phosphorus 30 kg/ha + NAA 50 ppm, $T_2$-Phosphorus 30 kg/ha + Triacontanol 250 ppm, $T_3$-Phosphorus 30 kg/ha + NAA 50 ppm + Triacontanol 250 ppm, $T_4$-Phosphorus 40 kg/ha + NAA 50 ppm, $T_5$-Phosphorus 40 kg/ha + Triacontanol 250 ppm,$T_6$-Phosphorus 40 kg/ha + NAA 50 ppm + Triacontanol 250 ppm, $T_7$-Phosphorus 50 kg/ha + NAA 50 ppm, $T_8$-Phosphorus 50 kg/ha + Triacontanol 250 ppm, $T_9$-Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm $T_{10}$-Control. At harvesting maturity, the pearl millet crop was harvested smartly. Plant height (cm) and dry rely accumulation g plant were manually recorded on five randomly selected consultant plants from each plot of each replication one at a time, and seeds were isolated from each plot and dried under solar for three days after harvesting. Later, the seeds were winnowed, washed, and the seed yield per hectare was calculated and expressed in tonnes per hectare. After 15 days of thorough drying in the sun, the Stover production from each plot was measured and expressed in tonnes per hectare. The statistics were calculated and analysed using. The benefit: cost ratio was reworked after the fee value of Grain was replaced with straw and the general value of crop cultivation was protected.

### 2.1 Details of treatment combinations

1. Phosphorus 30 kg/ha + NAA 50 ppm
2. Phosphorus 30 kg/ha + Triacontanol 250 ppm
3. Phosphorus 30 kg/ha + NAA 50 ppm + Triacontanol 250 ppm
4. Phosphorus 40 kg/ha + NAA 50 ppm
5. Phosphorus 40 kg/ha + Triacontanol 250 ppm
6. Phosphorus 40 kg/ha + NAA 50 ppm + Triacontanol 250 ppm
7. Phosphorus 50 kg/ha + NAA 50 ppm
8. Phosphorus 50 kg/ha + Triacontanol 250 ppm
9. Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm
10. Control 80:40:40 N:P:K

## 3. Results and Discussion

### 3.1 Yield and Yield Attributes

#### 3.1.1 Ear Head Length (CM)

The statistical analysis of ear head length revealed the enormous impact of ear head period. The treatment of Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm. resulted in a significant and maximal ear head length (22.57 cm). However, with Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm. No other treatment achieved statistical parity. The presence of 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. The results were similar to (Reddy *et al.* (2022) [10]. The application of triacontanol and NAA was attribute to an increased rate of photo synthetic activity accelerated transport and efficiency of utilization photosynthetic products thus result resulting cell elongation and rapid cell growing portion the plant.

### 3.2 Number of grains in the ear

Different combinations of Potassium & PGR can have a significant effect on grain production. A grain yield of 2.77 ta/ha was obtained with a treatment Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm however, Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm yielded results statistically equivalent to those of Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm). Increasing the amount of nitrogen and phosphorus applied greatly boosted pearl millet grain yields. This suggests that rising the potassium supply may have enhanced all growth indices, yield-related features biological yield affects grain yield. A significant improvement in biological yield can therefore be attributed to the better grain production characteristics. These findings are also consistent with those Sushila and Giri *et al.*, (2000) [14, 15], Sivakumar *et al.*, (2002) [12].

### 3.3 Grain yield

Different combinations of Potassium & PGR can have a significant effect on grain production. A grain yield of 2.77 ta/ha was obtained with a treatment Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm however, Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm yielded results statistically equivalent to those of Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm). Increasing the amount of nitrogen and phosphorus applied greatly boosted pearl millet grain yields. This suggests that rising the potassium supply may have enhanced all growth indices, yield-related features biological yield affects grain yield. A significant improvement in biological yield can therefore be attributed to the better grain production characteristics. These findings are also consistent with those Sushila and Giri *et al*., (2000) [14, 15], Sivakumar *et al*., (2002) [12].

### 3.4 Stover yield
The stover yield output of the pearl millet crop had also been greatly altered by the treatment of Nitrogen & Phosphorus. In terms of stover yield (3.78 ta/ha), the highest was observed, Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm however, (Phosphorus 50 kg/ha + Triacontanol 250 ppm) was shown to be statistically equivalent to, Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm) With the addition of Phosphorus and PGR, pearl millet yielded substantially more stover yield than it did without them. Growth of plant & dry matter production may have increased as a result of greater photosynthesis. In this way, rise of Phosphorus supply may have boosted all growth metrics and yield features, which finally contributed to rise of stover production. Straw production affects biological yield. As a result, enhanced straw yield qualities might be blamed for a large rise in biological yields following the addition of phosphorus. A higher Phosphorus supply could have resulted in a higher stover yield as a result of increased growth parameters and yield related features. Stover yield was increased by adjusting nutrient levels in Singh *et al*., (2019) [13], (Adey *et al*., (2022) [1].

### 3.5 Economics
#### 3.5.1 Gross Return (INR/ha)
Data pertaining to the gross returns as influenced by various treatments are presented Table 1. Gross returns (1,44,040 INR/ha) was found to be highest in treatment with application of Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm and the minimum gross (1,10,760 INR/ha) was found to be in treatment with application of Phosphorus 30 kg/ha + NAA 50 ppm as compared to other treatments.

#### 3.5.2 Net returns (INR/ha)
Data pertaining to the net returns as influenced by various treatments are presented in Table 2 Net returns (97,650 INR/ha) was found to be highest in treatment with application of Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm and the minimum gross (64,870 INR/ha**)** was found to be in treatment with application of Phosphorus 30 kg/ha + NAA 50 ppm as compared to other treatments.

#### 3.5.3 Benefit cost ratio (B:C)
Data pertaining to the B:C ratio as influenced by various treatments are presented in Table 2. Benefit cost ratio (2.10) was found to be highest in treatment with application of Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm and the minimum Benefit cost ratio (1.41) was found to be in treatment with application Phosphorus 30 kg/ha + NAA 50 ppm as compared to other treatments.

**Table 1:** Effect of potassium and plant growth regulators on Ear head length (cm), No of Grains/ear head (g) and Stover Yield (t/ha) and harvest index (%) of pearl millet.

| S. 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 | Phosphorus 30 kg/ha + NAA 50 ppm | 15.40 | 1652.00 | 5.2 | 2.13 | 3.10 | 40.76 |
| 2 | Phosphorus 30 kg/ha + Triacontanol 250 ppm | 15.83 | 1685.00 | 5.3 | 2.23 | 3.17 | 41.37 |
| 3 | Phosphorus 30 kg/ha + NAA 50 ppm + Triacontanol 250 ppm | 16.53 | 1764.00 | 5.7 | 2.33 | 3.20 | 42.17 |
| 4 | Phosphorus 40 kg/ha + NAA 50 ppm | 17.50 | 1797.00 | 5.9 | 2.37 | 3.27 | 41.99 |
| 5 | Phosphorus 40 kg/ha + Triacontanol 250 ppm | 18.53 | 1826.00 | 6.1 | 2.47 | 3.47 | 41.58 |
| 6 | Phosphorus 40 kg/ha + NAA 50 ppm + Triacontanol 250 ppm | 19.40 | 1847.00 | 6.2 | 2.57 | 3.53 | 42.07 |
| 7 | Phosphorus 50 kg/ha + NAA 50 ppm | 20.47 | 1906.00 | 6.3 | 2.60 | 3.57 | 42.16 |
| 8 | Phosphorus 50 kg/ha + Triacontanol 250 ppm | 21.43 | 1944.00 | 6.5 | 2.70 | 3.73 | 42.19 |
| 9 | Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm | 22.57 | 1989.00 | 6.7 | 2.77 | 3.80 | 43.00 |
| 10 | Control 80:40:40 N:P: K | 12.80 | 1523.00 | 5.1 | 1.97 | 3.07 | 39.05 |
| | F test | S | S | NS | S | S | S |
| | SEm± | 0.29 | 2.76 | 0.30 | 0.04 | 0.04 | 0.58 |
| | CD (P = 0.05) | 0.86 | 8.21 | 0.90 | 0.11 | 0.13 | 1.72 |

**Table 2:** Effect of Phosphorus and plant growth regulators on economics of pearl millet.

| S. No | Treatments | Cost of Cultivation (INR/ha) | Gross return (INR) | et return NR/ha) | B:C ratio |
|---|---|---|---|---|---|
| 1 | Phosphorus 30 kg/ha + NAA 50 ppm | 45,890 | 1,10,760 | 64,870 | 1.41 |
| 2 | Phosphorus 30 kg/ha + Triacontanol 250 ppm | 45,940 | 1,15,960 | 70,020 | 1.52 |
| 3 | Phosphorus 30 kg/ha + NAA 50 ppm + Triacontanol 250 ppm | 46,040 | 1,21,160 | 75,120 | 1.63 |
| 4 | Phosphorus 40 kg/ha + NAA 50 ppm | 46,050 | 1,23,240 | 77,190 | 1.67 |
| 5 | Phosphorus 40 kg/ha + Triacontanol 250 ppm | 46,100 | 1,28,440 | 82,340 | 1.78 |
| 6 | Phosphorus 40 kg/ha + NAA 50 ppm + Triacontanol 250 ppm | 46,200 | 1,33,640 | 87,440 | 1.89 |
| 7 | Phosphorus 50 kg/ha + NAA 50 ppm | 46,210 | 1,35,200 | 88,990 | 1,92 |
| 8 | Phosphorus 50 kg/ha + Triacontanol 250 ppm | 46,260 | 1,40,400 | 94,140 | 2.03 |
| 9 | Phosphorus 50 kg/ha + NAA 50 ppm + Triacontanol 250 ppm | 46,360 | 1,44,040 | 97,650 | 2.10 |
| 10 | Control 80:40:40 N:P: K | 45,150 | 1,02,440 | 57,290 | 1.26 |

## 4. Conclusion

Treatment Potassium 60 kg/ha + NAA 100 ppm + Triacontanol 500 ppm. produced the highest grain yield (2.72 ta/ha), gross return (1,36,000.00 INR/ha), net return (92,840.00 INR/ha), and benefit: cost ratio (2.14), which may be more preferable for farmers because it is more economically profitable and thus can be recommended to farmers.

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## 6. Competing Interests

Authors have declared that no competing interests exist.

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