Original Research Article

Effect of phosphorus and zinc on yield and economics of Pearl millet (*Pennisetum glaucum* L.)

ABSTRACT

Phosphorus and zinc effects on pearl millet variety 'ABV-04' during the rainy season (*Kharif*) of 2021 were studied in field experiments with nine treatments, *i.e.*, P at 30, 40, 50 kg/ha and Zn at 5, 15 and 25 kg/ha respectively, at Crop Research Farm, Department of Agronomy, Faculty of Agriculture, SHUATS, Prayagraj, India (U.P). The treatments comprised T_1 – 30 kg P/ha + 5 kg Zn/ha, T_2 – 30 kg P/ha + 15 kg Zn/ha, T_3 – 30 kg P/ha + 25 kg Zn/ha, T_4 – 40 kg P/ha + 5 kg Zn/ha, T_5 – 40 kg P/ha + 15 kg Zn/ha, T_6 – 40 kg P/ha + 25 kg Zn/ha, T_7 – 50 kg P/ha + 5 kg Zn/ha, T_8- 50 kg P/ha + 15 kg Zn/ha, T_9 – 50 kg P/ha + 25 kg Zn/ha. Results revealed that the application of 50 kg P + 25 kg Zn recorded highest ear head length (18.90 cm), maximum grain production (2.66 t/ha), maximum stover yield (3.90 t/ha), highest gross and net returns of (1,33,667.00₹) and (92,861.00₹), respectively. b.c ratio (2.26) was also found.

Key words: Yield, Phosphorus, Zinc, Pearl millet, Economics.

INTRODUCTION

The millets are a diverse group of small-grained grasses that are commonly cultivated as cereal crops across the world. It's a crop that may be used both as a food source and as a feed for livestock. Millets are an important crop in Asia and Africa's semi-arid tropical regions. Indian and African nations like Nigeria and Niger are the primary producers of the plant. For their great production and short growing season, millets are a popular choice. In many places of the world, the wild and cultivated forms of millets may be found, and their evolutionary origins can be traced to tropical western Africa. Human civilization has relied heavily on millets, notably in Asia and Africa, for the last 10,000 years of its existence. Millet is a staple food in India, and the country is the world's largest producer (Directorate of Millet Development, 2018).

In terms of global cereal production, pea millet (*Pennisetum glaucum* L.) is the fourth and fifth most important crop. There are several additional popular names for pearl millet, such as bajra, cattail,spiked, and bulrush. Pearl millet is a superior crop to other grains like sorghum and maize because of its high photosynthetic efficiency, high dry matter production capacity, and ability to grow in the most severe agro-climatic conditions. Many arid and semiarid parts of Africa and Asia are home to rainfed cereal crops like sorghum and maize, which may thrive in places with rainfall of 200 to 600 mm per year. It's grown in response to the environment in which it was grown. Globally, it's difficult to pinpoint exact locations because of conflicting information about finger and other millet crops. Nearly half of the world's pearl millet output is grown in Africa, with 60% of the total area under cultivation, followed by Asia with 35%. Only 1% of millet is grown in North America, with the rest being grown in Europe mostly for fodder. Over half a billion people rely on millet as their primary source of nutrition today. A total of 15 million hectares of pearl millet have been cultivated across Asia. Nearly 7.5 million tonnes of grain are produced each year in India's yearly planting area of roughly 10 million hectares. The annual global output surpasses ten million metric tonnes (National Research Council, 1996).

Because pearl millet is high in calories, carbohydrate, protein, fat, ash and dietary fibre as well as iron, magnesium and zinc, it is a "nutricereal," as the name suggests. Its grain is more nutrient-dense, with higher levels of high-quality protein. Additionally, the grain has 11-19 percent protein, 60-78 percent carbohydrate, and 3.5-4.6 percent fat. When compared to other cereals, it has a higher fat content. Because it has the most potential of any of the millets, it tends to be cultivated in drought-prone and marginal soil locations. Indian farmers cultivate as much as 10 crops of coarse grains in a variety of soils, weather conditions and severe environments. The most extensively farmed millet in India, after jowar, is pearl millet, which comes in fourth in terms of cereals and second in terms of coarse cereals When it comes to pearl millet, India dominates the field and the market. More than 9.73 million tonnes of grain were produced over an area of 7.5 million hectares in India in 2016-17, with a productivity of 1305 kg/ha (Directorate of Millet Development, 2018). There has been just a 2% growth in pearl millet area over the previous two years, yet output has improved by 19%. (**Yadav, 2011**). This includes Rajasthan, Maharashtra and Gujarat as well as Uttar Pradesh and Haryana as well as Karnataka and Madhya Pradesh and Tamil Nadu as significant pearl millet producing states in India.

There has been a 27% increase in pearl millet yield due to better fertiliser management in the production process. Crop production requires large amounts of nitrogen, phosphate, and potassium. Crop production's second most critical nutrient is phosphorus. As a result, it's been dubbed the "Bottleneck to world hunger." Carbon dioxide and nitrogen fixation, photosynthesis and respiration, and enzyme control are all critical processes in which phosphorus plays a role. The R**aghothama**

(1999). 40 percent of the world's arable land lacks phosphorus, a limiting factor for plant development and production. **Vance (2001)**. Many elements of plant growth development, including blooming, fruiting, root growth, and yield components of different crops, can be boosted by adequate phosphorus nutrition. The poor solubility of P in the soil might limit the amount of P that plants can absorb. If no more phosphorus is added as fertiliser to agricultural systems, harvested crops are depleted of phosphorus, resulting in P-deficient soils.

Plant growth and development need a good nutritional balance of all the key minerals, including the micronutrient zinc. While increasing large quantity of phosphorus may affect to the plant deficient of micronutrients like zinc, calcium etc. Many proteins, including transcription factors and metalloenzymes, require it as a structural component (**Singh and Kumar, 2009**). Micronutrients have been shown to be effective in the treatment of plant nutritional problems as well as in increasing production and improving quality **(Jakhar *et al*., 2006)**. In many parts of India, zinc is currently the third most important nutrient for plants, behind nitrogen and phosphorus.

MATERIALS AND METHODS

Researchers from Sam Higginbottom University in the city of Prayagraj, located at 25^{o} 24' 42" N latitude and 81.5^{o} 50' 56" E longitude and 98 m above sea level with the pH of black soil is 7.2 – 8.5 did research in the *Kharif* of 2021. (MSL). Phosphorus and zinc can affect Pearl millet development and output (*Pennisetum glaucum* L.). Randomized Block Design was used to set up the study, which included nine treatments that were duplicated three times. The treatment net plots are 3m×3m in size. The following combinations of phosphorus and zinc, as well as the required nitrogen and potash doses delivered by urea and muriate of potash, constitute the treatment: (T1) 30 kg/ha Phosphorus + 5 kg/ha Zinc, (T2) 30 kg/ha Phosphorus + 15 kg/ha Zinc, (T3) 30 kg/ha Phosphorus + 25 kg/ha Zinc, (T4) 40 kg/ha Phosphorus + 5 kg/ha Zinc, (T5) 40 kg/ha Phosphorus + 15 kg/ha Zinc , (T6) 40 kg/ha Phosphorus + 25 kg/ha Zinc, (T7) 50 kg/ha Phosphorus + 5 kg/ha Zinc, (T8) 50 kg/ha Phosphorus + 15 kg/ha Zinc, (T9) 50 kg/ha Phosphorus + 25 kg/ha Zinc. Sources of Phosphorus was SSP and $Znso_4$ for Zinc. The pearl millet crop was collected according to maturity and treatment. Plant height (cm) and dry matter accumulation were assessed on five randomly chosen plants from each plot for each replication (g plant-1). Seeds were taken from each net plot and sun dried for three days following harvest. Afterwards, the seed yield per hectare was calculated and represented in tonnes of seed per hectare. For ten days, the stover output of each net plot was measured and reported in tonnes per hectare. According to the Gomez & Gomez statistical method, the data were calculated and analysed (1984). Cost-to-benefit analysis was carried out after considering both the cost of seed with straw and the total cost of cultivating a crop.

RESULTS AND DISCUSSION

Yield and Yield Attributes:

Ear head length

Ear head length was shown to have a substantial impact on the outcomes of a statistical study. There was a considerable increase in the length of the ear head when treated with 50 kg P/ha + 25 kg Zn/ha (18.90). There was statistical parity at 50 kg P/ha + 15 kg Zn/ha, 40 kg P/ha and 50 kg P/ha + 25 kg Zn/ha. The overall improvement in plant development might be linked to the use of phosphorus. There may have been a correlation between increased food availability to plants during the flower primordial intiation stage and an increase in the length of the ear head. Zinc's role as a catalyst or stimulant in the majority of physiological and metabolic processes may explain the rise in Ear head length (cm). Growth hormones (auxins), such as indole acetic acid, require trytophane, a protein component and chemical that zinc aids in the synthesis of. A similar pattern was discovered by **Jakhar *et al*.** (2006) in their investigation as well.

Number of grains/ear head

Grain count per ear head was shown to have a significant impact on statistical analysis. With treatment 50 kg P/ha + 25 kg Zn/ha, there was a significant and highest amount of grains/ear head (1958). All three plots recorded statistical parity: 50 kg P/ha + 15 kg Zn/ha, 40 kg P/ha + 25 kg Zn/ha, and 50 kg P/ha + 25 kg Zn/ha. The overall improvement in plant development might be attributed to the use of phosphorus. It's possible that enhanced nutrition availability to plants during the floral primordial intiation stage aided in the creation of more efficient tillers and hence, a higher number of grains/ear head. Zinc is a catalyst or stimulant for the synthesis of trytophane, which is essential for the formation of growth hormone (auxins) such as indole acetic acid. According to **Simgh *et al***., the same findings were found (2017).

Grain yield

Different combinations of phosphorus, zinc, nitrogen, and potassium have a substantial impact on grain production. Although 50 kg P/ha + 25 kg Zn/ha yielded the maximum grain production (2657 Kg) statistically, 50 kg P/ha + 15 kg Zn/ha yielded the same amount of grain. Phosphorus fertilisation may have resulted in greater vegetative development, which may have been a result of the plant's vast root system effectively collecting and using other nutrients. Grain yield affects biological yield. Because of this, adding phosphorus to a crop has the potential to boost biological yields by a large amount. Similarly, **Jakhar *et al*. (2018), Bhuva and Sharma (2017)**, and others have found similar results. Because zinc acts as a catalyst or stimulant in nearly all physiological and metabolic processes, as well as a metal activator of enzymes, it may be responsible for the rise in grain production. **Kumawat and Sharhawat(2017)** both reported similar results.

Stover yield

The stover yield of the pearl millet crop has also been greatly altered by the application of Phosphorus and Zinc to the soil. The stover yields of 50 kg P/ha + 25 kg Zn/ha and 50 kg P/ha + 15 kg Zn/ha were statistically equal (3.90 t/ha), although the stover yield of 50 kg P/ha + 25 kg Zn/ha was the highest. Phosphorus fertilisation may have resulted in increased vegetative development, which may have been a result of the plant's extensive root system effectively absorbing and using other nutrients. Straw yield determines the biological yield. As a result, higher straw production might be attributed with a large rise in biological yield when phosphorus is used. In many physiological and metabolic processes, zinc serves as a catalyst or stimulant, which promotes plant growth and development. Metal enhancers or enzymes may also play a factor in strengthening stover yields. **Singh *et al*. (2017)**, and **Kumawat and Sharhawat (2016)** all observed similar findings.

Table 1. Effect of Phosphorus and Zinc on yield and yield attributing characters of pearl millet var. 'ABV - 04'

S. No	Treatment combinations	Ear head length (cm)	No. of grains/ear head	Grain Yield (t/ha)	Stover Yield (t/ha)
1	30 kg P/ha + 05 kg Zn/ha	15.80	1849.33	2.29	3.72
2	30 kg P/ha + 15 kg Zn/ha	16.63	1862.67	2.33	3.75
3	30 kg P/ha + 25 kg Zn/ha	17.47	1882.67	2.42	3.82
4	40 kg P/ha + 05 kg Zn/ha	16.97	1870.67	2.37	3.74
5	40 kg P/ha + 15 kg Zn/ha	17.90	1910.33	2.50	3.75
6	40 kg P/ha + 25 kg Zn/ha	18.20	1918.00	2.54	3.79
7	50 kg P/ha + 05 kg Zn/ha	17.60	1893.00	2.45	3.77
8	50 kg P/ha + 15 kg Zn/ha	18.53	1931.67	2.60	3.85
9	50 kg P/ha + 25 kg Zn/ha	18.90	1958.00	2.66	3.90
	SEm (±)	0.31	14.40	0.03	0.03
	CD (P 0.05)	0.91	42.77	0.07	0.10

Economics

Gross returns (1,33,667.00 ₹ /ha) was found to be highest in treatment with application of 50 kg P/ha + 25 kg Zn/ha and the minimum gross (1,14,733.00 ₹/ha) was found to be in treatment with application of 30 kg P/ha + 5 kg Zn/ha as compared to other treatments.

Net returns (92,681.00 ₹/ha) was found to be highest in treatment with application of 50 kg P/ha + 25 kg Zn/ha and the minimum gross (79,497.00 ₹/ha) was found to be in treatment with application of 30 kg P/ha + 5 kg Zn/ha as compared to other treatments.

Benefit cost ratio (2.26) was found to be highest in treatment with application of 50 kg P/ha + 25 kg Zn/ha and the minimum Benefit cost ratio (1.97) was found to be in treatment with application of 30 kg P/ha + 5 kg Zn/ha as compared to other treatments.

Table 2. Effect of phosphorus and zinc on economics of production of pearl millet var. 'ABV - 04

S. No	Treatment combinations	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	Benefit:Cost ratio
1	30 kg P/ha + 05 kg Zn/ha	38,236.00	1,14,733.00	76,497.00	2.00
2	30 kg P/ha + 15 kg Zn/ha	39,233.00	1,16,550.00	77,317.00	1.97
3	30 kg P/ha + 25 kg Zn/ha	40,236.00	1,20,800.00	80,564.00	2.00
4	40 kg P/ha + 05 kg Zn/ha	38,611.00	1.18,483.00	79,872.00	2.07
5	40 kg P/ha + 15 kg Zn/ha	39,611.00	1,24,883.00	85,272.00	2.15
6	40 kg P/ha + 25 kg Zn/ha	40,611.00	1,27,100.00	86,489.00	2.13
7	50 kg P/ha + 05 kg Zn/ha	38,986.00	1,22,600.00	83,614.00	2.14
8	50 kg P/ha + 15 kg Zn/ha	39,986.00	1,29,467.00	89,481.00	2.24
9	50 kg P/ha + 25 kg Zn/ha	40,986.00	1,33,667.00	92,681.00	2.26

CONCLUSION

Treatment 50 kg P/ha + 25 kg Zn/ha had the maximum grain yield (2.66 t/ha), gross return (1,33,667.00 ₹/ha), net return (92,681.00 ₹/ha), and benefit:cost ratio (2.26). It may be preferred by farmers since it is more economically lucrative and hence may be suggested to farmers after further trails.

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