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Effect of NPK and Zinc Levels on Growth and Yield of Pearl millet (*Pennisetum glaucum* L.)

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ABSTRACT

The experiment was conducted in crop research farm in department of Agronomy during *Zaid* season of 2022 on Pearl millet crop. The treatment consisted of three levels of NPK (50,75 and 100%) and Zinc (10,15 and 20 kg/ha) and a control. The experiment was laid out with a Randomize Block Design (RBD) with ten treatments which are replicated thrice as T_1 : 50% NPK kg/ha + Zinc 10 kg/ha, T_2 : 50% NPK kg/ha + Zinc 15 kg/ha, T_3: 50% NPK kg/ha + Zinc 20 kg/ha, T_4 : 75% NPK kg/ha + Zinc 10 kg/ha, T_5 : 75% NPK kg/ha + Zinc 15 kg/ha, T_6 : 75% NPK kg/ha + Zinc 20 kg/ha , T_7 : 100% NPK kg/ha + Zinc 10 kg/ha, T_8 : 100% NPK kg/ha + Zinc 15 kg/ha, T_9 : 100% NPK kg/ha + Zinc 20 kg/ha and a T_{10} : Control. Application of 100% NPK kg/ha combination with Zinc 20 kg/ha was recorded significantly higher plant height (192.43 cm), plant dry weight (42.54 g/plant), ear head length (18.10 cm) number of grains per ear head (1658), grain yield (2.62 t/ha), stover yield (3.33 t/ha), harvest index (43.99%). Maximum gross returns (1,30,750.00INR/ha), net returns (89,939.00INR/ha) and higher Benefit Cost ratio (2.22).

Keywords Growth parameters, Pearl millet, Nitrogen, Phosphorus, Potassium, Zinc, Yield and yield attributes.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* L.) is the fifth most important cereal crop in the world after rice, wheat, maize and sorghum. It is widely grown rainfed cereal crop in the arid and semi- arid regions of Africa and southern Asia, and can be grown in areas where rainfall is not sufficient (200 to 600 mm/yr) for the cultivation of maize and sorghum. However, Pearl millet accounts for almost half of global millet production, with 60% of the cultivation areas in Africa, followed by 35% in Asian countries. Areas planted with Pearl millet are estimated at 15 million hectares in Asia. In India, During 2019-20, Pearl millet was grown in 7.41 million ha with an average production of 10.3 million tonnes and 1391 kg/ha productivity 3rd advanced estimate from Directorate of Millets Development 2020-21. Pearl millet covers an estimated 31 m ha worldwide and is grown in higher than 30 countries in arid and semi-arid tropical and subtropical areas of Africa, Asia. (ICRISAT; http://

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The food grain demand of India will increase to about 291 million tonnes by 2025 and to 377 million tonnes by 2050 (Amarasingh *et al.* 2010). The trends in area, production and productivity of pearl millet suggest that area has increased marginally (2%) during last two years and productivity has gone up by 19% (Yadav 2011). It is a good source of carbohydrate, energy, RS, 92.5% dry matter, fat (5–7%), ash (2.1%), dietary fiber (1.2/100 g), 13.6% crude protein, quality protein (8–19%), 63.2% starch, α-amylase activity, minerals (2.3 mg/100 g), vitamins A and B, and antioxidants such as coumaric acids and ferulic acid (Goswami *et al.* 2020).

The major production factor to boost up the yield of pearl millet is fertilizer management, which has contributed to the extent of 27%. Nitrogen, phosphorus and potassium are major elements required to increase the crop production. Among these elements, nitrogen is one of the decisive as well as expensive inputs which for increasing the efficiency of applied Nitrogen in pearl millet it is therefore govern the cereal crop production. Generally, pearl millet has been known for growing under low Nitrogen management. But several studies showed that Nitrogen application can increases millet production efficiency (Singh *et al.* 2012). The improvement of yield attributes with progressive increase of nitrogen levels.

Phosphorus is second important major plant nutrient for crop production. It has been called as the "Bottleneck of world hunger". Phosphorus plays key roles in many plant processes such as energy metabolism, the synthesis of nucleic acids and membranes, photosynthesis, respiration, nitrogen fixation and enzyme regulation (Raghothama 1999).

Potassium is one of the chief plant nutrients for the growth and development of plants. In pearl millet potassium plays vital role in enzyme activities, water and energy metabolism, translocation of assimilates photosynthesis, protein and starch synthesis (Mengel and Kirkby1996).

Zinc plays a very important role in plant growth, in metabolic functions and it increases protein content in plant. In order to function properly, many proteins, such as transcription factors and metallic enzymes, need zinc as a structural component (Singh and Kumar 2009).

In addition, to include millets into the mainstream and exploit its nutritionally superior qualities and promote its cultivation, Government of India has declared Year 2018 as the "Year of Millets" and FAO Committee on Agriculture (COAG) forum has declared Year 2023 as "International Year of Millets." (Satyavathi *et al.* 2021).

MATERIALS AND METHODS

The experiment was conducted during *Zaid* 2022-23. The experiment was conducted in Randomized Block Design (RBD) consisting of ten treatments which are replicated thrice and was laid out with the different treatments allocated randomly in each replication. The soil of the experimental field was sandy loam in texture, slightly alkaline reaction (pH 7.1) with low level of organic carbon (0.48%), available N (225 kg/ha), P (13.6 kg/ha) and higher level of K (215.4 kg/ha). The treatment combinations are 50% NPK kg/ha + Zinc 10 kg/ha, 50% NPK kg/ha + Zinc 15kg/ha, 50% NPK kg/ha + Zinc 20kg/ha, 75% NPK kg/ha + Zinc 10 kg/ha, 75% NPK kg/ha + Zinc 15kg/ha , 75% NPK kg/ha + Zinc 20kg/ha , 100% NPK kg/ha + Zinc 10kg/ha, 100% NPK kg/ha + Zinc 15 kg/ha, 100% NPK kg/ha + Zinc 20 kg/ha and control. The observations were recorded on different growth parameters at harvest viz. plant height(cm), plant dry weight (g/plant), ear head length(cm), no. of grains/ear head, test weight (g), grain yield (t/ha) and stover yield (t/ha).

RESULTS AND DISCUSSION

Growth parameters

Plant height

The plant height measurements improved as per crop growth progressed. Treatment nine with the application of 100% NPK kg/ha + Zinc 20 kg/ha was recorded higher plant height (192.43 cm) and treatments eight and six were found to be statistically at par

Table 1. Effect of NPK and zinc levels on growth parameters of pearl millet.

Sl. No.	Treatments	Plant height (cm) at 60 DAS	Plant dry weight (g/plant) at 60 DAS
1	50% NPK kg/ha + Zinc 10 kg/ha	161.20	32.07
2	50% NPK kg/ha + Zinc 15 kg/ha	167.33	34.31
3	50% NPK kg/ha + Zinc 20 kg/ha	166.47	34.69
4	75% NPK kg/ha + Zinc 10 kg/ha	172.10	34.03
5	75% NPK kg/ha + Zinc 15 kg/ha	181.00	36.45
6	75% NPK kg/ha + Zinc 20 kg/ha	184.40	38.81
7	100% NPK kg/ha + Zinc 10 kg/ha	177.73	35.99
8	100% NPK kg/ha + Zinc 15 kg/ha	186.70	40.07
9	100% NPK kg/ha + Zinc 20 kg/ha	192.43	42.54
10	Control (RDF 80:40:40 NPK kg/ha)	170.36	32.87
	SEm (±)	3.54	1.18
	CD (p=0.05)	10.52	3.51

with treatment nine in Table 1. The maximum plant height was attained by the regular supply of plant nutrients during all growth stages, through a supply of NPK and zinc. Increasing NPK level up to 50 kg/ha significantly developed plant height throughout the crop growth period. Nitrogen enables the plant to capture sunlight energy by photosynthesis, driving plant growth. Phosphorus is an important element in all biological systems, participating in most metabolic pathways and as a structural component of nucleic acids, coenzymes, phosphor proteins, and phospholipids. Potassium is associated with the movement of water, nutrients and carbohydrates in plant tissue. Plant height has been shown to increase due to the role of zinc as a "catalyst" in most physiological, metabolic, and tryptophane synthesis processes. Certain protein elements are required to produce growth hormones (auxins) including IAA. There were similar findings described in Mehta *et al.* (2008).

Dry weight

Treatment nine with the application of 100% NPK kg/ha + Zinc 20 kg/ha was recorded a higher dry matter (42.54 g) in Table 1. Treatment eight is statistically at par with treatment nine. It is more important because all other vegetative characters contain it. Dry weight of pearl millet increased due to the application of NPK. Nitrogen has been found to increase the content of plant dry weight, chlorophyll, and photosynthetic rate. Phosphorus may have provided a favorable nutritional environment for the plants, which contributes to their essential role in several physical and chemical processes that remain critical for plant development and advance in terms of dry weight. The improved in dry weight may be attributed to zinc's role in most physiological, metabolic processes, and the synthesis of tryptophane. Growth hormones (auxins) like IAA are created by the metabolism of protein. Similar results were stated by Sammauria and Yadav (2010), Singh *et al*. (2016).

Yield parameters

Ear head length

A significant impact was experiential by the statistical analysis of ear head length. Treatment with 100% NPK kg/ha + Zinc 20 kg/ha was recorded higher ear head length (18.10). However, statistical parity was obtained with 100% NPK kg/ha + Zinc 15 kg/ha in Table 2. NPK application can be attributed to a general development in plant growth as replicated by increased dry matter accumulation, which may be due to an increased supply of NPK and other nutrients to plants. Increased availability of nutrients to plants at the flowering stage, which might take greater effective tiller formation and ultimately increased ear head length. The increase in ear head length (cm) may be attributed to physiological and metabolic processes rely on zinc, as well as tryptophan synthesis. Zinc is a vital component of several proteins that produce growth hormones (Auxins) such as IAA. In two separate studies, Sharma *et al.* (2008) came to the same result.

Number of grains/ear head

A significant impact was experiential by the statistical analysis of number of grains/ear head. Treatment with 100% NPK kg/ha + Zinc 20 kg/ha was recorded higher number of grains/ear head (1688). However, statistical parity was obtained with 100% NPK kg/ha + Zinc 15 kg/ha and 100% NPK kg/ha + Zinc 15 kg/ha. NPK application can be ascribed to an overall enhancement in plant development as reflected by increased dry weight, which may be due

Table 2. Effect of NPK and zinc levels on yield parameters and yield of pearl millet.

Treatment 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	50% NPK kg/ha + Zinc 10 kg/ha	14.80	1549.33	7.17	2.27	3.11	42.20
2	50% NPK kg/ha + Zinc 15 kg/ha	15.63	1562.67	7.13	2.32	3.15	42.44
3	50% NPK kg/ha + Zinc 20 kg/ha	16.80	1582.67	7.27	2.45	3.22	43.22
4	75% NPK kg/ha + Zinc 10 kg/ha	16.30	1570.67	7.17	2.38	3.10	43.44
5	75% NPK kg/ha + Zinc 15 kg/ha	16.90	1610.33	7.50	2.48	3.21	43.54
6	75% NPK kg/ha + Zinc 20 kg/ha	17.20	1618.00	7.53	2.54	3.25	43.86
7	100% NPK kg/ha + Zinc 10 kg/ha	17.27	1659.67	7.40	2.51	3.23	43.75
8	100% NPK kg/ha + Zinc 15 kg/ha	18.03	1631.67	7.60	2.55	3.32	43.48
9	100% NPK kg/ha + Zinc 20 kg/ha	18.10	1658.00	7.63	2.62	3.33	43.99
10	Control (RDF 80:40:40 NPK kg/ha)	17.33	1624.33	7.23	2.51	3.21	43.81
	SEm (±)	0.23	19.88	0.16	0.01	0.03	0.32
	CD (5%)	0.68	59.07	-	0.05	0.10	0.95

to an increased supply of NPK and other nutrients to plants. Increased nutrient availability to plants during the flower primordial initiation stage, which may have resulted in more effective tiller formation and, ultimately, increased the no. of grains/ear head. The growth in the no. of grains/ear head may be attributed zinc plays a crucial role in a myriad of physiological and metabolic processes such as the synthesis of tryptophane. It is also used to produce growth hormones (auxins) such as IAA.

Grain yield

Increasing grain yields required nitrogen, potassium, phosphorus and zinc treatment combinations. The highest grain yield was obtained in treatment nine 100% NPK kg/ha + Zinc 20 kg/ha (2.62 t/ha). However, Treatment nine 100% NPK kg/ha + Zinc 15 kg/ha is statistically at par with 100% NPK kg/ha + Zinc 20 kg/ha. Applying NPK might be ascribed to improved vegetative development, probably uptake and utilization of other elements fascinated by its wide root system developed by NPK imitation. Phosphorus can be credited with a significant rise in natural yield because of the increase in grain production. Zinc's role as a "catalyst" in the synthesis of tryptophan, as well as the growth and development of the plant, may be ascribed to the increase in grain yield. Similar findings were previously published by Singh *et al.* (2016).

Stover yield

Application of NPK and zinc has significantly impact on stover production of the pearl millet. At 100% NPK kg/ha + Zinc 20 kg/ha, the higher stover yield (3.33t/ha) was obtained. 100% NPK kg/ha + Zinc 15 kg/ha was statistically at par with 100% NPK kg/ha + Zinc 20 kg/ha. Applying NPK might be ascribed to improved vegetative development, probably uptake and utilization of other elements fascinated by its wide root system developed under NPK. The biological yield is a function of the stover yield. Zinc is critical to the growth and development of tryptophane, a necessary amino acid for plant growth and development.

Economic analysis

Observations regarding economics of different treatments of pearl millet are given in Table 3.

Gross return (INR/ha)

Data pertaining to the gross returns as influenced by various treatments are presented in Table 3. Gross returns (1,30,750.00 INR/ha) was found to be higher in treatment with application of 100% NPK kg/ha + Zinc 20 kg/ha and the minimum gross (113,567.00 INR/ha) was found to be in treatment with application of 50% NPK kg/ha + Zinc 10 kg/ha as compared to other treatments.

Net returns (INR/ha)

Data pertaining to the net returns as influenced by various treatments are presented in Table 3. Net returns (89,939.00 INR/ha) was found to be higher

Table 3. Effect of NPK and zinc levels on economics of production of pearl millet.

Treatment No.	Treatment combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	Benefit: Cost ratio
1	50% NPK kg/ha + Zinc 10 kg/ha	37,810.00	113,567.00	75,757.00	2.00
2	50% NPK kg/ha + Zinc 15 kg/ha	38,310.00	1,16,217.00	77,907.00	2.03
3	50% NPK kg/ha + Zinc 20 kg/ha	38,810.00	1,22,467.00	83,657.00	2.16
4	75% NPK kg/ha + Zinc 10 kg/ha	38,415.00	1,19,150.00	80,735.00	2.10
5	75% NPK kg/ha + Zinc 15 kg/ha	38,915.00	1,23,883.00	84,968.00	2.18
6	75% NPK kg/ha + Zinc 20 kg/ha	39,680.00	1,27,100.00	87,685.00	2.20
7	100% NPK kg/ha + Zinc 10 kg/ha	39,811.00	1,25,733.00	85,922.00	2.16
8	100% NPK kg/ha + Zinc 15 kg/ha	40,311.00	1,27,633.00	87,322.00	2.17
9	100% NPK kg/ha + Zinc 20 kg/ha	40,510.00	1,30,750.00	89,939.00	2.22
10	Control (RDF 80:40:40 NPK kg/ha)	39,311.00	125,283.00	85,972.00	2.19

in treatment with application of 100% NPK kg/ha + Zinc 20 kg/ha and the minimum gross (75,757.00 INR/ha) was found to be in treatment with application of 50% NPK kg/ha + Zinc 10 kg/ha as compared to other treatments.

Benefit : Cost ratio (B:C)

Data pertaining to the B:C ratio as influenced by various treatments are presented in Table 3. Benefit cost ratio (2.22) was found to be highest in treatment with application of 100% NPK kg /ha + Zinc 20 kg/ha and the minimum Benefit : Cost ratio (2.00) was found to be in treatment with application of 50% NPK kg/ha + Zinc 20 kg/ha as compared to other treatments.

CONCLUSION

Based on experimental findings it is concluded that Treatment (9) application of 100% NPK kg/ha with Zinc 20 kg/ha performed better in growth, yield parameters and economics. As it was more productive it can be recommended to farmers after further trail.

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