

Original Research Article

Effect of Potassium and Zinc on growth and yield of Pearl millet

(*Pennisetum glaucum* L.)

ABSTRACT

The field experiment was conducted in Crop Research Farm (CRF) in Department of Agronomy during Zaid season 2023-24 on Pearl millet crop. The treatment consisted of Potassium (30, 40 and 50 Kg/ha) and Zinc (15, 20 and 25 kg/ha) and a control. The experiment was laid out with a Randomize Block Design (RBD) with ten treatments which are replicated thrice as T₁ Potassium 30kg/ha+Zinc 15 kg/ha, T₂ Potassium 30kg/ha+Zinc 20 kg/ha, T₃ Potassium 30kg/ha+Zinc 25 kg/ha, T₄ Potassium 40kg/ha+Zinc 15 kg/ha, T₅ Potassium 40kg/ha+Zinc 20 kg/ha, T₆ Potassium 40kg/ha+Zinc 25 kg/ha, T₇ Potassium 50kg/ha+Zinc 15 kg/ha, T₈ Potassium 50kg/ha+Zinc 20 kg/ha, T₉ Potassium 50kg/ha+Zinc 25 kg/ha and a T₁₀ Control. The soil of experiment plot was sandy loamy in texture, nearly neutral in soil reaction (pH 6.8), low inorganic carbon (0.46 %), available N (225.42 kg/ha), available P (38.2 kg/ha) and available K (240.7 kg/ha). Application of Potassium 50kg/ha+Zinc 25 kg/ha was recorded with the results which revealed that significantly highest growth attributes of Pearl millet at 80 DAS viz., Plant height (203.24 cm), dry weight (144.17 g), Ear head length (30.23 cm), grains/head (1848.78) and yield attributes such as Grain yield (4530.43 kg/ha), Stover yield (7246.59 kg/ha).

Keywords: Nitrogen, Pearl millet, Phosphorus, Potassium, Zinc.

1. INTRODUCTION

Pearl millet is commonly known in India as Bajra or Bajri also known as 'cattail' and 'bullrush millet'. It is originated from tropical western Africa. It belongs to the family Gramineae (Poaceae). The cultivated species are *Pennisetum glaucum* L. (2n=14) used for grain and *Pennisetum purpureum* (2n=28) used for green and dry fodder. Pearl millet is the fifth most important cereal crop globally after rice, wheat, maize, and sorghum. It is used as a staple food for human consumption and fodder for livestock sector. It is a good source of energy (360 calories) and carbohydrates (67 g) and consist of 12 g protein, 5 g fat and 2 g

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minerals in 100 gm of bajra seeds (Directorate of Millets Development, 2021-22; Project Coordinator Review, 2022). It is considered as poor man's food. It is critically important for food and nutritional security as it possess several advantages such as early maturing, drought tolerance, require minimal purchase of inputs and is mostly free from biotic and abiotic stresses. Pearl millet (*Pennisetum glaucum* L.) is most widely grown as staple food by small and marginal farmers in Asia and Africa. It is a C4 plant having high photosynthetic efficiency, more dry matter productivity and survives under adverse agro-climatic conditions with lesser inputs and more economic returns. The crop is critically important for food and nutritional security of humans and animals in arid and semi-arid regions as Pearl millet is early maturing, drought tolerant, and has inherent ability to endure high temperatures up to 42°C during reproductive phase enabling it for cultivation in adverse conditions, thus making it a climate resilient crop. Due to its excellent nutritional properties, pearl millet is designated as nutri-cereal (Gazette of India, No.133 dtd 13th April, 2018) for production, consumption, trade and was included in Public Distribution System (PDS).

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Potassium is one of the primary nutrients required for the growth and development of plants. It improves both yield and quality of agricultural produce and enhances the plant resistance to various biotic and abiotic stresses. It majorly functions in the photosynthesis, metabolism of carbohydrate and physiological processes such as root development, water use efficiency, synthesis of protein and amino acids, enzyme activation (Choudhary *et al.* 2014).

Micronutrients are important for maintaining soil health and also increasing productivity of crops. These are needed in very small amounts. Zinc is especially for regular healthy growth and reproduction of plants (Marschner, 1995). In plants, zinc plays a key role as a structural constitute or regulatory co-factor of a wide range of different enzymes in many important biochemical pathways.

2. MATERIALS AND METHOD

This experiment was laid out during the *Zaid* season of 2023-24 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The crop research farm is situated at 25° 39' 42" N latitude, 81° 67' 56" E longitude and at an altitude of 98 m above mean sea level. The experiment was layout in Randomized Block Design (RBD) with ten treatment and three replicated. The treatment details are as follows T₁Potassium 30kg/ha+Zinc 15 kg/ha, T₂Potassium 30kg/ha+Zinc 20 kg/ha, T₃Potassium 30kg/ha+Zinc 25 kg/ha

T₄Potassium40kg/ha+Zinc 15 kg/ha, T₅Potassium 40kg/ha+Zinc 20 kg/ha, T₆Potassium 40kg/ha+Zinc 25 kg/ha,T₇Potassium 50kg/ha+Zinc 15 kg/ha, T₈Potassium 50kg/ha+Zinc 20 kg/ha, T₉Potassium 50kg/ha+Zinc 25 kg/ha and a T₁₀ Control. The observations were recorded for plant height (cm), plant dry weight (g),Crop growth rate (g/m²/day), Relativegrowthrate(g/g/day), Ear head length (cm), Number of grains/heads, Test weight (g), grain yield (kg/ha), Stover yield (kg/ha).

3. RESULT AND DISCUSSION

3.1 Growth Parameter

3.1.1 Plant height (cm)

At 80 DAS maximum plant height of (203.24 cm) was recorded with treatment 9 (Potassium 50kg/haalong withZinc25 kg/ha), whereas treatment 7 and 8 (Potassium 50kg/ha along withZinc 15kg/ha and Potassium 50kg/ha along withZinc 20kg/ha) were statisticallyatparwith treatment 9 (Potassium 50kg/haalong withZinc25 kg/ha).

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The plant height of Pearl millet increased significantly due to application of different levels of Potassium and Zinc. Potassiumis an essential element of all the amino acids in plant structures; theseare the building blocks of plant proteins and are important to the development of plant tissuesuch as the cells, membranes, and chlorophyll. Similar results were reported by Iqbal *etal.*,(2013) &Manwar and Mankar (2015). The increase in plant height may be attributed to role of Zinc as a catalyst or stimulant in most of physiological and metabolic process and it alsoimportant in synthesis of tryptophan, a component of some protein and a compound neededfor production of growth hormones (auxins) like Indole Acetic Acid (IAA). Similar results were alsoreportedbyReddy*etal.*, (2021).

3.1.2 Plant dry weight (g/plant)

At 80 DAS highest plant dry weight (144.17 g) was found in treatment 9 (Potassium 50kg/haalong withZinc25 kg/ha). However, treatment 5, 6, 7 and 8(Potassium 40kg/haalong with Zinc20kg/ha , Potassium 40kg/ha along withZinc 25kg/ha,Potassium 50kg/ha along withZinc 15kg/ha and Potassium 50kg/ha along withZinc 20kg/ha) were statistically at par with the treatment 9 (Potassium 50kg/haalong withZinc25 kg/ha).

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The dry weight of Pearl millet increased significantly due to application of Potassium. As Potassium might have provided congenial nutritional environment to the plants, which helps in attributing to its pivotal role in several physiological and biochemical processes which are of vital importance for growth and development of plant in terms of dry weight. The increase in dry weight may be attributed to role of Zinc as a catalyst or stimulant in most of the physiological and metabolic processes and metal activator or enzymes resulting in increased growth and development of plant. Similar results were also reported by Reddy *et al.*, (2021) and Vinod Kumar *et al.*, (2018)

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3.1.3 Crop growth rate (g/m²/day)

Although, the statistical analysis of CGR during 60 - 80 DAS significant highest CGR value (43.07/m²/day) was observed in treatment 3 (Potassium 30kg/ha along with Zinc 25kg/ha) and accept treatment 9 and 10 (Potassium 50kg/ha along with Zinc 25kg/ha and Control) which was not found statistically at par with treatment 3 (Potassium 30kg/ha along with Zinc 25kg/ha).

3.1.4 Relative growth rate (g/g/day)

During the growth interval of 60 - 80 DAS interval highest RGR value (0.028 g/g/day) was recorded with treatment 1, 2 and 3 (Potassium 30kg/ha along with Zinc 15kg/ha, Potassium 30kg/ha along with Zinc 20kg/ha, and Potassium 30kg/ha along with Zinc 25kg/ha).

Comment [RC12]: Add references of similar research finding

3.2 Yield attributes and Yield Parameter

3.2.1 Earhead length (cm)

A significant impact was experienced by the statistical analysis of earhead length. Treatment with Potassium 50kg/ha along with Zinc 25 kg/ha was recorded highest ear head length (30.23). However, treatment 7 and 8 (Potassium 50kg/ha along with Zinc 15kg/ha and Potassium 50kg/ha along with Zinc 20kg/ha) were found statistically at par with treatment 9 (Potassium 50kg/ha along with Zinc 25 kg/ha). 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 availability of nutrients to plants at the flowering stage, which

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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.* (2012) and Sharma *et al.* (2008) came to the same result.

3.2.2 Number of grains/earhead

Significant effect was observed by the statistical analysis of number of grains/ear head. Treatment 9 (Potassium 50kg/ha along with Zinc 25 kg/ha) recorded significant and highest number of grains/ear head (1848.75). However, treatment 5, 6, 7 and 8 (Potassium 40kg/ha along with Zinc 20kg/ha, Potassium 40kg/ha along with Zinc 25kg/ha, Potassium 50kg/ha along with Zinc 15kg/ha and Potassium 50kg/ha along with Zinc 20kg/ha) were statistically at par with the treatment 9 (Potassium 50kg/ha along with Zinc 25 kg/ha). Potassium could be attributed to overall improvement in plant growth and increased availability of nutrients to plants at the flower primordium initiation stage which might have helped in greater effective tillers formation and ultimately increased number of grains/ear head and ear head length may be attributed to the role of Zinc as a catalyst or stimulant in most of physiological and metabolic process a component of some protein and a compound needed for production of growth hormones (auxins) like Indole Acetic Acid. Similar results were also reported by Reddy *et al.*, (2021), Vinod Kumar *et al.*, (2018) and Chouhan *et al.*, (2015).

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3.2.3 Test weight (g)

The statistical analysis on test weight was found to be non-significant. However, highest test weight (8.22 g) was recorded with treatment 9 (Potassium 50kg/ha+Zinc 25 kg/ha) and lowest test weight (5.71 g) was recorded in control.

Comment [RC16]: Add some supporting research studies

3.2.4 Grain yield (kg/ha)

Increased grain yield was obtained due to Potassium and Zinc and RDF treatment combinations. The highest grain yield (4530.43 kg/ha) was obtained in treatment 9 (Potassium 50 kg/ha along with Zinc 25 kg/ha) whereas, treatment 8 (Potassium 50kg/ha along with Zinc 20kg/ha) were statistically at par with treatment 9

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(Potassium 50kg/ha along with Zinc 25 kg/ha). Applying potassium might be applied to improve vegetative development, probably uptake and utilization of other elements fascinated by its wide root system developed by NPK imitation. 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 Sharma *et al.*, (2012) and Singh *et al.*, (2016).

3.2.5 Stover yield (kg/ha)

Application of Potassium and Zinc has significantly impacted on stover production of the Pearl millet. At Potassium 50kg/ha + Zinc 25kg/ha, the highest stover yield (7246.59 kg/ha) was obtained whereas, treatments 6, 7 and 8 (Potassium 40kg/ha + Zinc 25kg/ha, Potassium 50kg/ha + Zinc 15kg/ha and Potassium 50kg/ha + Zinc 20kg/ha) were obtained statistically at par with the treatment 9 (Potassium 50kg/ha + Zinc 25 kg/ha). Applying Potassium might be ascribed to improve vegetative development, probably uptake and utilization of other elements fascinated by its wider root system developed under Potassium. The biological yield is a function of the stover yield. Zinc is critical to the growth and development of tryptophan, a necessary amino acid for plant growth and development. Both Sharma *et al.*, (2012) and Singh *et al.*, (2016) found the same results in their research.

CONCLUSION

From the results, it is concluded that application of Potassium 50 kg/ha along with Zinc 25kg/ha (Treatment 9) in Pearl millet has recorded highest plant height, dry weight, grain yield and stover yield.

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Table 1 Influence of Potassium and Zinc on growth of Pearl millet.

S.No.	Treatments	Plant height (cm) 80DAS	Dry weight (g) 80DAS	CGR (g/m ² /day) 60-80DAS	RGR (g/g/day) 60-80DAS
1.	Potassium 30kg/ha+ Zinc15kg/ha	176.70	131.93	42.57	0.028
2.	Potassium 30kg/ha+ Zinc20kg/ha	177.83	133.17	42.29	0.028
3.	Potassium 30kg/ha+ Zinc25kg/ha	181.80	135.87	43.07	0.028
4.	Potassium 40kg/ha+ Zinc15kg/ha	185.11	136.74	42.26	0.027
5.	Potassium 40kg/ha+ Zinc20kg/ha	187.17	137.93	41.76	0.026
6.	Potassium 40kg/ha +Zinc 25kg/ha	191.67	139.82	42.32	0.026
7.	Potassium 50kg/ha +Zinc 15kg/ha	195.68	141.90	42.34	0.026
8.	Potassium 50kg/ha +Zinc 20kg/ha	198.92	143.10	41.41	0.025
9.	Potassium 50kg/ha+Zinc25 kg/ha	203.24	144.17	39.47	0.022
10.	Control(RDF:- 80:40:40NPK kg/ha)	168.85	118.62	33.42	0.024
	F	S	S	S	NS
	testS	3.70	2.17	1.74	0.0010
	Em±	11.01	6.45	5.18	-
	CD (P=0.05)				

		Earhead length (cm)	No.ofgrains/earhead	Testweight (g)	Seedyield(Kg/ha)	Stoveryield (Kg/ha)
1.	Potassium 30kg/ha+ Zinc15kg/ha	22.77	1279.65	5.80	3359.37	6391.84
2.	Potassium 30kg/ha+ Zinc20kg/ha	23.21	1308.55	5.93	3490.14	6473.69
3.	Potassium 30kg/ha+ Zinc25kg/ha	23.63	1339.06	6.31	3573.38	6585.61
4.	Potassium 40kg/ha+ Zinc15kg/ha	24.87	1409.91	6.76	3718.26	6660.26
5.	Potassium 40kg/ha+ Zinc20kg/ha	25.28	1516.07	6.94	3854.11	6751.13
6.	Potassium 40kg/ha +Zinc 25kg/ha	26.04	1610.44	7.55	3964.08	6958.59
7.	Potassium 50kg/ha +Zinc 15kg/ha	28.82	1629.51	7.66	4171.65	7085.82
8.	Potassium 50kg/ha +Zinc 20kg/ha	29.04	1715.03	7.92	4340.04	7176.40
9.	Potassium 50kg/ha+Zinc25 kg/ha	30.23	1848.75	8.22	4530.43	7246.59
10.	Control(RDF:- 80:40:40NPK kg/ha)	21.43	1215.07	5.71	3076.06	5689.70
	F	S	S	NS	S	S
	testS	1.17	80.20	0.40	113.02	165.13
	Em±	3.48	338.30	1.197	335.81	490.63
	CD (P=0.05)					

Table2Influence ofPotassium andZinon yield and yield attributes of Pearlmillet.

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