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Effect of Zinc and Panchagavya on Growth and Yield of Pearl Millet (*Pennisetum glaucum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *Kharif* 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) on the topic "Effect of Zinc and Panchagavya on Growth and Yield of Pearl millet (*Pennisetum glaucum* L.)", to study treatments consisting of three levels of Zinc *viz*. 10, 15 and 20 kg/ha and three levels of Panchagavya *viz*. 3, 4 and 5%. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.6), low in organic carbon (0.25 %), available N (183.8 kg/ha), available P (11.50 kg/ha) and available K (87 kg/ha). There were 10 treatments each being replicated thrice and laid out in Randomized Block Design. The results

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revealed that treatment 9 ($ZnSO_4$ 20 kg/ha + Panchagavya- 5%) recorded significantly higher plant height (158.97 cm), plant dry weight (65.16 g) and length of ear (32.18 cm), No. of grains/ear (1824.66), test weight (8.02 g), grain yield (2.12 t/ha), stover yield (7.33 t/ha), gross return (INR 66509.00), net return (INR 46709.90) and B:C ratio (2.36) compared to other treatments.

Keywords: Zinc; economics; growth; panchagavya, yield; pearl millet.

1. INTRODUCTION

"Pearl millet (*Pennisetum glaucum* L.) popularly known as Bajra is an important cereal crop of India after rice, wheat and sorghum. It is the most drought tolerant crop among cereals and millets and generally grown as rainfed on marginal lands under low input management conditions. But respond well to good management and higher fertility levels. It is generally cultivated in area with rainfall ranging from 150 to 600 mm. Pearl millet is a dual-purpose crop. Its grain is used for human consumption and its fodder as cattle feed. Pearl millet is a small seeded caryopsis. The nutrient content of pearl millet compares very well with other food grain crops. It has 11.6% protein (with slightly superior amino acid profile), about 12.4% moisture, 5% fat, 67% carbohydrates and 2.7% minerals. It also contains higher amount of carotene, riboflavin (Vit- B2) and niacin (Vit- B4). The Crop is also valued as an important source of green and dry fodder (karbi) for cattle and small proportion of grains is used for poultry feed. Now a days, pearl millet grain is also gaining importance as a cheap source of starch for making fine quality breweries [1].

"The Panchagavya is an efficient plant growth stimulant that enhances the biological efficiency of crops. It is used to activate soil and to protect the plants from diseases and also increase the nutritional quality of fruits and vegetables. It is used as a foliar spray, as soil application along with irrigation water, seed or seedling treatment etc. Three per cent Panchagavya is an ideal concentration for the foliar spray. Bio-chemical properties of Panchagavya revealed that it possesses almost all the major nutrients like NPK and micro nutrients essential for plant and growth hormones like IAA and GA required for crop growth" [2].

"Zinc is an essential micronutrient and a cofactor for about more than 300 enzymes and involved in cell division, nucleic acid metabolism and protein synthesis. Zinc is an important nutrient for plant growth, as plants require a proper balance of all the essential nutrients for normal growth and optimum yield. It is required as a structural component of a large number of proteins and enzymes. It also helps in the formation of chlorophyll and auxins. Zinc is the most common deficient micronutrient element in the soil the world and more than 50% soils of India are deficient in Zn. By utilizing of fertilizers contain zinc and other micronutrients, performance and quality of crops is gets enhanced and shortage of this elements due to decline in plant photosynthesis and destroys RNA, amount of soluble carbohydrates and synthesis of protein, resulting in decrease in performance and quality of crop" [3]. Its deficiency in soils may reduce crop yield and quality because zinc plays a vital role in protein metabolism. Deficiency symptoms of zinc will shows initially occurs in middle leaves and zinc deficient plant shows stunted appearance due to shortened internodes and chlorotic small leaves.

2. MATERIALS AND METHODS

This experiment was laid out during the *kharif* season of 2023 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 250 39" 42" N latitude, 810 67" 56" E longitude and at an altitude of 98 m above mean sea level. The experiment was laid out in Randomized Block Design and comprised of Zinc and Panchagavya with ten treatments and each was replicated thrice. "The recommended dose of Nitrogen (80 kg/ha), Phosphorus (40 kg/ha) and Potassium (40 kg/ha) and Panchagavya were applied as per the treatments. Data recorded on different aspects of crop, *viz*., growth, yield attributes were subjected to statistically analysis by analysis of variance method and economic data analysis mathematical method" [4].

2.1 Treatment Combination

1. $ZnSO_4$ 10 kg/ha + Panchagavya-3%
2. $ZnSO_4$ 10 kg/ha + Panchagavya-4%
3. $ZnSO_4$ 10 kg/ha + Panchagavya-5%

4. $ZnSO_4$ 15 kg/ha + Panchagavya-3%
5. $ZnSO_4$ 15 kg/ha + Panchagavya-4%
6. $ZnSO_4$ 15 kg/ha + Panchagavya-5%
7. $ZnSO_4$ 20 kg/ha + Panchagavya-3%
8. $ZnSO_4$ 20 kg/ha + Panchagavya-4%
9. $ZnSO_4$ 20 kg/ha + Panchagavya-5%
10. Control (N:P: K, 80:40:40 kg/ha)

3. RESULT AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height (cm)

At 80 DAS, significant and higher plant height (158.97 cm) was recorded in treatment 9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. However, treatment 8 [$ZnSO_4$ 20 kg/ha + Panchagavya- 4%] and treatment 7 [$ZnSO_4$ 20 kg/ha + Panchagavya- 3%] were found to be statistically at par with treatment 9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. Significant and higher plant height was observed with application of Zinc (20 kg/ha) which might be due to zinc involves in different physiological process like enzyme activation, stomatal regulation and chlorophyll formation which results in plant growth. Similar result was also reported by Muhammad et al. [5].

3.1.2 Plant dry weight

At 80 DAS, significant and maximum dry weight/plant (65.16 g) was recorded in treatment 9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. However, treatment 8 [Sulphur 40 kg/ha + Zinc 0.5 % (Foliar Application)] were found to be statistically at par with treatment 9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. Zinc (20 kg/ha) application resulted in a significantly higher plant dry weight. This could be because micronutrients are components of ferrodoxin and electron transport, which are also associated with chloroplasts, which accelerate photosynthesis and promote better vegetative growth. Micronutrients also help to activate the synthesis of tryptophan and precursor of IAA, which is responsible for stimulating plant growth and biomass accumulation. . Similarly, findings were also reported by Singh et al. [6]. Further, significantly higher plant dry weight was with application of Panchagavya foliar spray made improvements in dry matter accumulation, chlorophyll content, and nitrogen content discussed above may be attributed to higher yield and yield attributes with Panchagavya. Similar findings also reported Kumawat et al. [7].

3.1.3 Length of ear

The highest significantly ear head length (32.18 cm) of pearl millet was significantly was recorded the treatment 9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. However, treatment-8 [$ZnSO_4$ 20 kg/ha + Panchagavya- 4%] and treatment-7 [$ZnSO_4$ 20 kg/ha + Panchagavya- 3%] were statistically at par with treatment-9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. Significant and higher length of cob was observed with the application of Zinc (20 kg/ha) might be due to higher chlorophyll contents and photosynthetic activity, synthesis of metabolites and regulate growth substances oxidation and metabolic activities. These similar findings were reported by Meena et al. [8].

3.1.4 Number of grains per ear

The highest significantly Number of grains/ear (1824.66) of pearl millet was significantly was recorded the treatment-9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. However, treatment-8 [$ZnSO_4$ 20 kg/ha + Panchagavya- 4%] were statistically at par with treatment-9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. Significant and higher number of grains/ear head was obtained with the application of zinc (20 kg/ha) might be due to the increased fertilizers application could be attributed to the increased physiological processes in crop plant leading to higher growth and increased photosynthates to silk. The similar findings were reported by Kumar et al. [9]. Further, significant higher grains/ear head was with application of panchagavya on reproductive growth *viz*., grains/ear head which is one of the important yield attributes having significant positive correlation with seed and straw yield. Similar findings also reported by Choudhary *et al*. [10].

3.1.5 Test weight (g)

The significantly highest test weight (8.02 g) was recorded in the treatment 9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. However, treatment 10 [Control] and treatment 8 [$ZnSO_4$ 20 kg/ha + Panchagavya- 4%] were statistically at par with treatment-9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. Significantly higher test weight was with application of Zinc (20 kg/ha) might be due to zinc plays a vital role in enzyme activation and makes hydrocarbon and proteins quick transfer towards grain which led to increase in grain weight. Similar result was also reported by Muhammad *et al.* [5].

Table 1. **Influence of zinc and panchagavya on growth of pearl millet**

S. No.	Treatment combination	At 80 DAS	
		Plant height (cm)	Dry weight (g)
1.	$ZnSO_4$ 10 kg/ha + Panchagavya- 3%	144.89	50.49
2.	$ZnSO_4$ 10 kg/ha + Panchagavya- 4%	145.97	51.76
3.	$ZnSO_4$ 10 kg/ha + Panchagavya- 5%	146.81	53.83
4.	$ZnSO_4$ 15 kg/ha + Panchagavya- 3%	148.71	54.29
5.	$ZnSO_4$ 15 kg/ha + Panchagavya- 4%	152.65	55.42
6.	$ZnSO_4$ 15 kg/ha + Panchagavya- 5%	152.84	58.25
7.	$ZnSO_4$ 20 kg/ha + Panchagavya- 3%	153.40	58.72
8.	$ZnSO_4$ 20 kg/ha + Panchagavya- 4%	156.71	61.88
9.	$ZnSO_4$ 20 kg/ha + Panchagavya- 5%	158.97	65.16
10.	Control: N:P: K, 80:40:40 kg/ha	133.70	49.54
	F-test	S	S
	SEm±	4.52	1.81
	CD (p=0.05)	13.42	5.39

Table 2. **Influence of zinc and panchagavya on yield attributes and yield of pearl millet**

S.No.	Treatment combination	Length of ear (cm)	No. of grains/ear	Test weight (g)	Grain Yield (t/ha)	Stover Yield (t/ha)
1.	$ZnSO_4$ 10 kg/ha + Panchagavya- 3%	25.50	1224.81	5.89	1.41	3.42
2.	$ZnSO_4$ 10 kg/ha + Panchagavya- 4%	26.28	1241.95	5.92	1.45	3.57
3.	$ZnSO_4$ 10 kg/ha + Panchagavya- 5%	26.47	1264.08	6.01	1.48	3.79
4.	$ZnSO_4$ 15 kg/ha + Panchagavya- 3%	27.44	1275.72	6.09	1.52	4.12
5.	$ZnSO_4$ 15 kg/ha + Panchagavya- 4%	29.23	1301.65	6.46	1.56	4.47
6.	$ZnSO_4$ 15 kg/ha + Panchagavya- 5%	30.27	1399.51	6.29	1.65	4.60
7.	$ZnSO_4$ 20 kg/ha + Panchagavya- 3%	31.34	1618.60	6.89	1.85	5.70
8.	$ZnSO_4$ 20 kg/ha + Panchagavya- 4%	31.20	1710.65	7.31	2.03	5.83
9.	$ZnSO_4$ 20 kg/ha + Panchagavya- 5%	32.18	1824.66	8.02	2.12	7.33
10.	Control: N:P: K, 80:40:40 kg/ha	25.43	1104.05	8.00	1.33	2.68
	F-test	S	S	S	S	S
	SEm(±)	1.07	42.48	0.53	0.11	0.44
	CD (p=0.05)	3.17	126.19	1.56	0.34	1.32

Table 3. Influence of zinc and panchagavya of economics on pearl millet

S.No.	Treatment combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
1.	$ZnSO_4$ 10 kg/ha + Panchagavya- 3%	18600	41307	22707	1.22
2.	$ZnSO_4$ 10 kg/ha + Panchagavya- 4%	18700	42595	23895	1.28
3.	$ZnSO_4$ 10 kg/ha + Panchagavya- 5%	18800	43799	24999	1.33
4.	$ZnSO_4$ 15 kg/ha + Panchagavya- 3%	19100	45373	26273	1.38
5.	$ZnSO_4$ 15 kg/ha + Panchagavya- 4%	19200	47170	27970	1.46
6.	$ZnSO_4$ 15 kg/ha + Panchagavya- 5%	19300	49526	30226	1.57
7.	$ZnSO_4$ 20 kg/ha + Panchagavya- 3%	19600	56727	37127	1.89
8.	$ZnSO_4$ 20 kg/ha + Panchagavya- 4%	19700	61477	41777	2.12
9.	$ZnSO_4$ 20 kg/ha + Panchagavya- 5%	19800	66509	46709	2.36
10.	Control: N:P: K, 80:40:40 kg/ha	17300	38034	20734	1.20

3.1.6 Grain yield (t/ha)

The significantly highest grain yield (2.12 t/ha) was recorded in the treatment 9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. However, treatment 8 [$ZnSO_4$ 20 kg/ha + Panchagavya- 4%] were statistically at par with treatment-9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. Significant higher grain yield was with application of Zinc (20 kg/ha) might be due to zinc plays a major role in reproductive physiology, especially in initiation of reproductive primordial and favourable partitioning of photosynthates towards sink that led to significant improvement in yield characters resulting higher grain yield. Similar result was also reported by Kumar et al. [11]. Further, significant might be due to the IAA and GA present in Panchagavya when applied as foliar spray could have created stimuli in the plant system and increased the production of growth regulators in cell system and the action of growth regulators in plant system ultimately stimulated the necessary growth and development This may be due to the positive impact on plant height and reproductive growth characteristics, which are both indicators of vegetative development. The similar findings were also reported by Chakraborty et al. [12].

3.1.7 Stover yield (t/ha)

The significantly highest grain yield (7.33 t/ha) was recorded in the treatment 9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. However, treatment 8 [$ZnSO_4$ 20 kg/ha + Panchagavya- 4%] were statistically at par with treatment-9 [$ZnSO_4$ 20 kg/ha + Panchagavya- 5%]. Significant and higher straw yield was with application of Zinc (20 kg/ha) might be due to increased availability of Zn in soil helps in absorption of other nutrients which led to improved functioning of physiological process and improves the straw content of barley. Similar result was also reported by Kumar et al. [11]. Additionally, it's possible that the IAA and GA in Panchagavya, when used as a foliar spray, stimulated the plant system and enhanced the production of growth regulators in the cell system. The action of growth regulators in the plant system ultimately stimulated the required growth and development. This may be due to the positive impact on plant height and reproductive growth characteristics, which are both indicators of vegetative development. The similar findings were also reported by Chakraborty *et al*. [13].

3.2 Economics

The result showed that [Table 3] the maximum gross return (66509.00 INR/ha), net return (46709.90 INR/ha) and B:C ratio (2.36) was recorded in $ZnSO_4$ 20 kg/ha + Panchagavya- 5% as compared to other treatments.

4. CONCLUSION

It is concluded that soil application of $ZnSO_4$ 20 kg/ha and foliar application of Panchagavya 5% recorded highest yield and benefit cost ratio in pearl millet.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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