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Influence of nitrogen and zinc on plant growth and yield attributes of pearl millet

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Abstract
The field experiment was conducted on Pearl millet during *kharif* season of 2023 at Crop Research Farm, Department of Agronomy. The treatment consisted of three levels of nitrogen (60,80 and 100 kg/ha) and zinc (Soil application 25 kg/ha, Foliar application 0.5% and Soil application 25 kg/ha + Foliar application 0.5%) along with recommended doses of phosphorus and potash and a control (20-40-20 N-P-K/ha). The experiment was laid out in a Randomized Block Design with 10 treatment and replicated thrice. Application of Nitrogen 100 kg/ha + 0.5% Zinc (treatment 8) recorded significantly highest plant height (192.73 cm), plant dry weight (86.67 g), ear head length (23.03 cm), number of grains/ear head (2272.33) grain yield (1.77 t/ha), stover yield (5.15 t/ha) in pearl millet crop.

Keywords: Nitrogen, pearl millet, yield, zinc

Introduction
Pearl millet (*Pennisetum glaucum* L.) is multipurpose cereal crop belongs to the Poaceae family. It is commonly called as Bajra, Bajri, Sajje, Kambu, Kamban, Sajjalu etc in various Indian local languages. Pearl millet is appropriately termed as "nutri cereal" because it is a good source of energy, carbohydrate, protein, fat, ash, dietary fiber, iron and zinc. The grain include 11- 19% protein 60-78% carbohydrates and 3.0-4.6% fat and also has good amount of phosphorous and iron (Rakesh *et al.*, 2021) [7]. Pearl millet is grown in 6.70 M ha in India with the production level of 9.62 M t and the average productivity is about 1436 kg/ha. Uttar Pradesh is the second largest growing state of rice after Rajasthan in the country. Pearl millet production in Uttar Pradesh was 1.95 M t from an area of 0.90 M ha and productivity of 2156 kg/ha (Agricultural at a Glance, 2022) [1].

Nitrogen has the quickest and the pronounced effect on plant growth. Insufficient nitrogen may reduce yield drastically and deteriorates the quality of produce. It plays a vital role in various physiological processes within the plant, such as energy transfer, photosynthesis, and the formation of DNA and RNA. Phosphorus is especially important for the development of strong root systems and promoting early seedling growth in pearl millet (Gowd *et al*., 2023) [4]. Optimum dose of nitrogen fertilization plays a vital role in growth and development and grain formation as a result of higher yield of plant.

Zn has a vital role in the various physiological processes, including disease resistance and it is fourth-most powerful yield-limiting nutrient, and has a definite role in enhancing the quality of produce (Verma *et al.*, 2023) [8]. Zinc is a necessary component for crop production and plant development. It increases growth hormone biosynthesis, starch creation, and grain production and maturation (Dwivedi *et al.*, 2021) [2]. Keeping in the view the immense importance of nitrogen and zinc fertilization, the present study "Influence of nitrogen and zinc on yield and economics of Pearl millet" was undertaken.

Materials and Methods
The experiment was conducted during the *Kharif* season, at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj Uttar Pradesh, which is located at 25°39' 42''N latitude, 81°67'56" E longitude and 98 m altitude above the mean sea level.

The soil had a sandy loam texture, having pH 7.3, electrical conductivity 0.714 mm /cm and organic carbon 1.227%. The data collected for different parameters were statistically analyzed using Gomez and Gomez (1976) [3] analysis of variance for randomized block design. The results are presented at 5% level of significance (p=0.05) for making comparison among treatments.

Results and Discussion

Plant height (cm): Significantly higher plant height (192.73 cm) was recorded in (treatment 8) with application of nitrogen 100 kg/ha along with foliar application of zinc 0.5% whereas treatment-6 (Nitrogen 80 kg/ha + 25 kg/ha $ZnSO_4$ + 0.5% Zinc), treatment-7 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$) and treatment 9 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$ + 0.5% Zinc) were found to be statistically at par with the higher. Significant effect in plant height was recorded with application of nitrogen along with zinc in pearl millet. This might be due to the fact that nitrogen application might have enhanced the internodal length of stem, accelerated meristematic activity, vegetative growth and photosynthetic activity increased plant height. Zinc is involved in biosynthesis of Indole 3-acetic acid, a growth hormone, involved in stem elongation, hence the increase in the plant height (Meena *et al.*, 2012) [6].

Plant dry weight (g/plant): Significantly higher plant dry weight (86.67 g) was recorded in (treatment 8) with application of nitrogen 100 kg/ha along with foliar application of zinc 0.5% whereas treatment-6 (Nitrogen 80 kg/ha + 25 kg/ha $ZnSO_4$ + 0.5% Zin), treatment-7 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$) and treatment 9 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$ + 0.5% Zinc) were found to be statistically at par with the higher. The significant increase in plant dry weight might be due to the role of nitrogen and zinc. Zinc plays vital role in synthesis of various enzymes like carbonic anhydrase, glutamic acid dehydrogenase and some peptidases. It is also considered to be a precursor for auxin synthesis, involved in nitrogen metabolism and several oxidation reduction reactions, stability of RNA and starch formation might have increased plant dry weight. More uptake of nutrients by application of nitrogen probably favored better growth and development of crops resulting more plant dry weight (Meena *et al.*, 2012) [6].

Ear head length: Significantly higher ear head length (23.03 cm) was recorded in (treatment-8) with application of nitrogen 100 kg/ha along with foliar application of zinc 0.5%, whereas treatment-6 (Nitrogen 80 kg/ha + 25 kg/ha $ZnSO_4$ + 0.5% Zinc), treatment-7 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$) and treatment 9 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$ + 0.5% Zinc) were found to be statistically at par with the highest.

Number of grains/ear head: Significantly higher number of grains/ear head (2272.33) was recorded in (treatment-8) with application of nitrogen 100 kg/ha along with foliar application of zinc 0.5%, whereas treatment-7 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$) and treatment 9 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$ + 0.5% Zinc) were found to be statistically at par with the highest.

Test weight: Higher test weight (6.83 g) was recorded in (treatment-7) with application of nitrogen 100 kg/ha along with 25 kg/ha $ZnSO_4$, which was found to be statistically at par with all the treatments.

Grain yield: Significantly higher grain yield (1.77 t/ha) was recorded in (treatment-8) with application of nitrogen 100 kg/ha along with foliar application of zinc 0.5%, whereas treatment-7 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$) and treatment 9 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$ + 0.5% Zinc) were found to be statistically at par with the highest.

Stover yield: Significantly higher stover yield (5.15 t/ha) was recorded in (treatment-8) with application of nitrogen 100 kg/ha along with foliar application of zinc 0.5%, whereas treatment-6 (Nitrogen 80 kg/ha + 25 kg/ha $ZnSO_4$ + 0.5% Zinc), treatment-7 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$) and treatment 9 (Nitrogen 100 kg/ha + 25 kg/ha $ZnSO_4$ + 0.5% Zinc) were found to be statistically at par with the highest.

Significant increase in yield might due to zinc in biosynthesis indole acetic acid especially due to its role initiation of primordial reproductive parts promoting photosynthesis towards them. Application of nitrogen increases the fertility of flowers and increase in leaf area and duration and resulted into increase in supplying assimilates for the sink. Nitrogen along with Zinc, improves physiological and molecular mechanism within the plant that increases grain yield**.** Zinc role in various enzymatic reactions and it acts as a catalyst in various growth processes and in hormone production and protein synthesis which results in increasing the, growth and yield attributes and ultimately the stover and grain yield (Jakhar *et al*., 2006) [5].

Table 1: Influence of nitrogen and zinc on plant growth and yield attributes of Pearl millet.

	Treatment Combinations	Plant height (cm)	Plant dry weight (cm)	Ear head length (cm)	No of grains/ear head	Test weight (g)	Grain yield (t/ha)	Stover yield (t/ha)
1.	Nitrogen 60 kg/ha + SA-25 kg/ha $ZnSO_4$	174.20	74.10	17.09	1505.33	5.76	1.39	4.61
2.	Nitrogen 60 kg/ha +FA- 0.5% Zinc	175.37	73.03	16.70	1523.67	6.66	1.49	4.56
3.	Nitrogen 60 kg/ha +SA- 25 kg/ha $ZnSO_4$ +FA- 0.5% Zinc	177.97	76.37	18.00	1715.33	5.50	1.56	4.62
4.	Nitrogen 80 kg/ha + SA-25 kg/ha $ZnSO_4$	177.17	77.80	21.33	1685.00	5.80	1.62	4.73
5.	Nitrogen 80 kg/ha +FA- 0.5% Zinc	180.93	79.37	18.26	1757.67	5.53	1.58	4.76
6.	Nitrogen 80 kg/ha +SA- 25 kg/ha $ZnSO_4$ + FA-0.5% Zinc	181.07	78.90	21.00	1706.33	6.26	1.60	4.82
7.	Nitrogen 100 kg/ha +SA- 25 kg/ha $ZnSO_4$	185.53	80.92	23.00	2107.33	6.83	1.65	5.06
8.	Nitrogen 100 kg/ha +FA- 0.5% Zinc	192.73	86.67	23.03	2272.33	6.43	1.77	5.15
9.	Nitrogen 100 kg/ha + SA-25 kg/ha $ZnSO_4$ +FA- 0.5% Zinc	188.80	84.20	22.13	2162.67	6.53	1.63	5.12
10.	80-40-40 NPK kg/ha (Control)	165.43	71.81	16.43	1624.00	6.30	1.36	4.23
	S.Em(±)	4.04	2.29	1.12	104.81	0.54	0.05	0.15
	CD (p=0.05)	12.05	6.82	3.34	311.43	-	0.15	0.46

Conclusion

Application of Nitrogen 100 kg/ha and foliar application of zinc (0.5%) recorded in higher plant growth and yield attributes pearl millet crop.

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