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Effect of nitrogen and zinc levels on growth and economics of sorghum (*Sorghum bicolor* L. Moench)

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Abstract
A field experiment was conducted during *kharif* 2019 at Central Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.3). The treatments consists of 3 levels of Nitrogen *viz.* 60, 80 and 100 N/ha and 3 levels of Zinc *viz.* 10, 20 and 30 kg $ZnSo_4$ as both basal and side dressing, whose effect was observed on Sorghum. There were nine treatments each replicated thrice. The experiment was laid out in Randomized Block Design. The result showed that growth parameters *viz.* Plant height (130.02 cm), Number of leaves (19.22) were recorded superior with the application of Nitrogen 100kg/ha and Zinc 20kg/ha. The Gross returns (₹ 46024.8/ha), Net returns (₹ 150712/ha), B:C ratio (2.27) were recorded superior with the application of Nitrogen 100 kg/ha and Zinc 20kg/ha.

Keywords: Sorghum, nitrogen, zinc, growth, economics

Introduction
Sorghum is the most important food and fodder crop of dry land agriculture. It is one of the few resilient crops that can adapt well to future climate change conditions, particularly drought, soil salinity and high temperatures. In India, it is the third most widely grown crop after rice and wheat. The crop accounts for nearly 52% of the area and 63% of production under millets with an area of 4.71 m ha and production of 4.73 m t (USDA 2019/20). Nitrogen is an essential nutrient for plant growth and development. Nitrogen is a very important constituent of cellular components. An adequate supply of Nitrogen is associated with vigorous vegetative growth and deep green color. Also, Nitrogen is an integral part of chlorophyll (C35H72O5N4Mg) and to improve the yield and quality of forage pearl millet. Several studies showed that N application can increase millet production efficiency (Singh *et al.*, 2010) [13]. Zinc plays a significant role in various enzymatic and physiological activities in the plant system. Zinc is the main nutrient in building part of some enzymes like alcohol dehydrogenase, Carbonic anhydrase and superoxide dismutase and is needed for the plant enzymes formation, besides, many enzymatic reactions become active by Zinc (Pedler *et al.*, 2000) [11].

Materials and Methods
The present investigation was carried out during *Kharif*, 2019 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The farm is situated at 250 57'N latitudes, 87050'E longitude and an altitude of 98 meters above mean sea level in North Eastern Plain Zone. The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 7.6). The total rainfall received during crop season 2019-20 was 165.7 mm. Sorghum was sown @ 12 kg/ha on 20th July 2019 with plant geometry of 45 x 15 cm apart and evaluated in Randomized black design with twelve treatments and three replications. The treatment combinations with Nitrogen and Zinc with each 3 levels *viz*. Nitrogen 60, 80 & 100 kg/ha and Zinc 10, 20 & 30 kg/ha. Optimum plant population maintained by thinning and gap filling. The thinning operation was done after 10 days of sowing. Spray of Emamectin benzoate 1ml/litre to reduce the infestation of stem borer.

The observations were recorded on the different growth parameters *viz*. plant height, number of leaves per plant. Yield parameters *viz*. Number of grains per panicle, Grain yield, and Stover yield. The experimental crop was harvested in the month of November 10, 2020. The produce from net plots were harvested in one lot and tied in bundles and allowed to complete dried material was passes through threshing operation. After threshing and winnowing the clean seeds from each plot were weighed and the weight was recorded as grain yield in kg/plot and then converted in q/ha.

Results and Discussion

Growth parameters

Plant height

Plant height maximum at harvest (130.02 cm), was observed in treatment T_8 [Nitrogen 100 kg/ha + Zinc 20 kg / ha]. However, at par plant height value was observed in treatment T_7 [Nitrogen 100 kg/ha + Zinc 10 kg/ha]. Application of Nitrogen was accelerated the meristematic activity, vegetative growth and photosynthetic activity, consequently resulting in to increase plant height. Similar results were also observed by Azam *et al.*, 2010 [2]. Since Zinc is involved in the biosynthesis of Indole 3-acetic acid, a growth hormone, involved in stem elongation, hence the increase in the plant height. Earlier Patel *et al.*, (2007) [10] also reported a significant increase in the plant height with soil application of Zinc over its foliar application and control.

Number of leaves per plant

Number of leaves per plant at harvest (19.22) were found to be significantly highest in treatment T8 [Nitrogen 100 kg/ha + Zinc 20 kg / ha] whereas treatment T7 [Nitrogen 100 kg/ha + Zinc 10 kg / ha] and T5 [Nitrogen 80 kg/ha + Zinc 20 kg / ha] were statistically at par with T8 [Nitrogen 100 kg/ha + Zinc 20 kg / ha]. The study also revealed that the number of leaves per plant increased significantly at all crop growth periods with increase in Nitrogen dose up to 100 kg/ha. Osman *et al.*, (2010) [9] also reported significant increase in leaf number per plant with increase in the Nitrogen levels.

Table 1: Effect of Nitrogen and Zinc levels on growth parameters of Sorghum

Treatments	Plant height (cm)	No. of leaves/plant
Nitrogen 60kg/ha + Zinc 10 kg / ha	78.66	14.02
Nitrogen 60 kg/ha + Zinc 20 kg / ha	81.86	14.01
Nitrogen 60 kg/ha + Zinc 30 kg / ha	65.48	12.02
Nitrogen 80 kg/ha + Zinc 10 kg / ha	99.53	15.01
Nitrogen 80 kg/ha + Zinc 20 kg / ha	125.27	18.97
Nitrogen 80 kg/ha + Zinc 30 kg / ha	99.28	15.00
Nitrogen 100 kg/ha + Zinc 10 kg / ha	126.82	18.98
Nitrogen 100 kg/ha + Zinc 20 kg / ha	130.02	19.22
Nitrogen 100 kg/ha + Zinc 30 kg / ha	102.74	15.01
S.Em (±)	1.14	0.20
C. D. (P =0.05)	3.42	0.60

Economics

Cost of cultivation (₹ 46024.8/ha), Gross returns (₹ 150712/ha), Net returns (₹ 104687/ha), Benefit cost ratio (2.27) were found higher with the application of Nitrogen 100 kg/ha + Zinc 20 kg/ha. It might be attributed to increased grain and stover yields with Nitrogen and Zinc application. The value of increased yield was much more than the cost of Nitrogen and Zinc application which increased the net returns and B: C ratio. On the basis of result, 100 kg N/ha and 20 kg Zn/ha earned maximum net returns which was found higher than other treatments. Due to per unit cost of Nitrogen is lower when supplied through urea as compared to other sources which directly reflect the net returns and B/C ratio. These results corroborate to the findings of Jakhar *et al.*, (2006), Sharma *et al.*, (2008), Kumar *et al.*, (2007) and Singh *et al.*, (2007) [6, 12, 7, 14]

Table 2: Effect of Nitrogen and Zinc levels on economics of Sorghum

Treatments	Treatment combination	COC*	Gross Return (₹/ha)*	Net Return (₹/ha)*	B:C*
1.	Nitrogen 60kg/ha + Zinc 10 kg / ha	42967.4	89272.5	46305.1	1.08
2.	Nitrogen 60 kg/ha + Zinc 20 kg / ha	45542.9	92571.7	47028.7	1.03
3.	Nitrogen 60 kg/ha + Zinc 30 kg / ha	48118.4	74842.3	26723.9	0.56
4.	Nitrogen 80 kg/ha + Zinc 10 kg / ha	43209.4	112951	69742.0	1.61
5.	Nitrogen 80 kg/ha + Zinc 20 kg / ha	45784.9	142165	96380.1	2.11
6.	Nitrogen 80 kg/ha + Zinc 30 kg / ha	48360.4	113485	65124.8	1.35
7.	Nitrogen 100 kg/ha + Zinc 10 kg / ha	43449.3	140056	96606.8	2.21
8.	Nitrogen 100 kg/ha + Zinc 20 kg / ha	46024.8	150712	104687	2.27
9.	Nitrogen 100 kg/ha + Zinc 30 kg / ha	48600.3	117433	68832.8	1.42

*Data was not subjected to statistical analysis

Conclusion

On the basis of one season experimentation application of Nitrogen 100 kg/ha + Zinc 20 kg/ha was found more productive in plant height (130.02 cm), number of leaves per plant (19.22 leaves/plant), and economic (2.27).

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