Original Research Article

Response of Nitrogen and Zinc on Growth, Yield and Economics of Sorghum (*Sorghum bicolor* L.)

Abstract

The field experiment was conducted at Crop Research Farm, Naini Agricultural Institute, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during *kharif*, 2022. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.9), low in organic carbon (0.57 %), available N (278.93 kg/ha), available P (10.8 kg/ha kg/ha) and available K (206.4 kg/ha). The treatment consists of 3 levels of Nitrogen and 3 levels of Zinc There were 9 treatments each replicated thrice. The experiment was laid out in Randomized Block Design. The results showed that growth parameters *viz.*, The field experiment results revealed that application of Nitrogen 100 kg/ha along with Zinc 25 kg/ha has significantly increased the growth parameters *viz.*, Plant height (238.83 cm), Dry matter accumulation (122.37 g), Head Length (27.51 cm). This treatment also showed its positive effect in enhancing all yield attributing parameters *viz.*, No. of grains per head (981.34), Grain yield (4430.43 kg/ha), Stover yield (7246.58 kg/ha) and Economics *viz.*, Gross return (INR 1,46,993.65), Net return(INR 99,186.03) and Benefit cost ratio (2.08) were found higher in this treatment.

Key words **:** Sorghum, nitrogen, zinc, growth, yield, economics

Introduction

Sorghum is the fifth most important cereal crop and is the dietary staple food of more than 500 million people in 30 countries (Kumar 2011). 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 It is grown in the countries of Africa, Asia, Oceania and America. Among them, the USA, India, Mexico, Nigeria, Sudan and Ethiopia are the major producers. The grain is mostly used as food (55%), in the form of flatbreads and porridges (thick or thin) in

Asia and Africa, and as feed (33%) in America (ICRISAT, 2011).Sorghum (*Sorghum bicolor* L.) is used for food, feed and forage. It is a staple food for millions in Africa and Asia. It can tolerate hot and dry condition but cannot be grown in area with high precipitation in world in water lodging may occur. Sorghum is generally grown under less favorable condition with meager amount of fertilizer applied

Nitrogen is an essential nutrient for plant growth and development. Nitrogen is a very important constituent of cellular components. Alkaloids, amides, amino acids, proteins, DNA, RNA, enzymes, vitamins, hormones and many other cellular compounds contain Nitrogen as one of the elements. An adequate supply of Nitrogen is associated with vigorous vegetative growth and deep green color. Crop yields are often limited by low soil levels of mineral micronutrients such as Zinc (Zn). Zinc is essential for tryptophan synthesis, which is a prerequisite for auxin formation. Zinc exerts a great influence on basic plant life processes, such as nitrogen metabolism and uptake of nitrogen and protein quality; photosynthesis and chlorophyll synthesis, carbon anhydrase activity; resistance to abiotic and biotic stresses and protection against oxidative damage. Zinc is the main component of the ribosome and is essential for their development. Crop yields are often limited by low soil levels of mineral micronutrients such as Zinc (Zn). Zinc deficiency symptoms include small leaves, shortened internodes giving the plant a stunted appearance. These all lead to poor fodder qualities.

Materials and Methods

The Present investigation was carried out during *kharif,* 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institue, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The farm is situated at 25. 57'N latitudes, 87. 50'E longitude and latitude of 98 meters above mean seal level in North Eastern Plain Zone. The soil of experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 6.9). the total rainfall received during crop season 2021-22 was (66535). Sorghum was sown @ 12 kg/ha on 24th July 2022 with plant geometry of 45 x 15 cm apart and evaluated in Randomized Block Design with 10 treatments and Replicated thrice. The treatment combination with Nitrogen and Zinc with each three levels *viz.*, Nitrogen 60, 80 and 100 kg/ha and Zinc 15, 20 and 25 kg/ha. Treatment combinations are., T_1 Nitrogen 60 kg/ha + Zinc at 15kg/ha, T_2 Nitrogen 60 kg/ha + Zinc at 20 kg/ha, T_3 Nitrogen 60 kg/ha + Zinc at 25kg/ha, T_4 Nitrogen 80 kg/ha + Zinc at 15kg/ha, T_5 Nitrogen 80 kg/ha + Zinc at 20 kg/ha, T_6

Nitrogen 80 kg/ha + Zinc at 25kg/ha, T_7 Nitrogen 100 kg/ha + Zinc at 15 kg/ha, T_8 Nitrogen 100 kg/ha + Zinc at 20 kg/ha, T_9 Nitrogen 100 kg/ha + Zinc at 25 kg/ha, T_{10} Control (80:40:40 NPK kg/ha), Optimum plant population was maintained by thinning and gap filling. Thinning operation was done after 10 days after sowing. Spray of Emamectin Benzoate 2ml/L to reduce the Infesetation of stem borer. The Biometric observations were recorded at various stages of crop growth on different parameters *viz.*, Plant height, Dry weight, Crop Growth Rate, Realtive Growth Rate on five plants randomly selected from each net plot. Post harvest Observations include Length of Head, Number of grains per Head, Test weight, Garin yield, stover yield and Harvest Index. The experimental crop was harvested in month of 21st November 2022. 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 plots were weighed and the weight was recorded grain yield in kg/plot.

Plant height (cm) :

Five plants were selected randomly from each plot and tagged for observations.The height (cm) of these plants was measured from base of the plant up to tip of the main axis. Plant height was recorded at 25,50,75 and100 DAS.

Panicle length (cm)

Panicle length (cm) was measured at the time of harvest, randomly from five panicles collected from the tagged plants and their average was recorded.

Number of seeds/head

Number of seeds per head was counted from five plants harvested from 1m^2 area from each plot and an average was taken.

Test weight (g)

Random sample of 1000 seeds were taken from the harvested yield and weighed.

Grain yield (kg/ha)

Grain yield from the harvested area (1m^2) were dried in sun, cleaned and weighed separately from each plot for calculating the seed yield in kg/ha

Stover Yield kg/ha

Stalks from harvest area ($1m^2$) was dried in the sun, bundled, tagged and weighed separately from each plot for calculating the stover yield in kg/ha.

Statistical analysis

The data recorded during the course of investigation was subjected to ststistical analysis by "Analysis of variance technique". The significant and non significant treatments effects were judged with the help of 'F' (variance ratio) table. The significant differences between the means were tested against the critical difference at 5% probability level. Statistical analysis was performed for randomized block design (Gomez *et al.,* 1983.,) the data generated for one season and analysed statistically.

Results and Discussion

The growth parameters like Plant height, Dry Weight were significantly affected by application of Nitrogen and Zinc. Sorghum crop fertilized with Nitrogen100 kg/ha along with Zinc 25 kg/ha resulted in significant increase in plant height (228.93 cm) At 100 DAS. The reason of increasing in growth with increasing of nitrogen fertilizer is the effect of nitrogen element on the biological processes which take place in the plant, its an necessary element in building of amino acid tryptophan which uses in the formation of auxin and the later play an important role in the elongation of plant and increase the activation of meristem cell, so the leaf area will be increase due to increasing cell division (**Afzal *et al.*, 2012)** 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. **Patel *et al.*, (2007)** The results revealed that, there was a significant increase in plant dry weight (122.37 g) at 100 DAS with application of Nitrogen at 100 kg/ha along with zinc 25 kg/ha Through the application of Nitrogen, the production of taller plants with increased photosynthetic area (LAI) that paved the way for more production of photosynthetic dry matter **(Patel *et al.* (2006)**. The significant increase in dry matter yield may be attributed to the higher photosynthetic rate. Zinc is a constituent of carbonic anhydrase and there is direct relationship between carbonic anhydrase activity and photosynthetic carbon dioxide assimilation or growth of a plants.

Yield attributes and Yield

Yield attributes and Yield were significantly affected by Nitrogen and Zinc application. Sorghum crop fertilised with Nitrogen 100 kg/ha along with Zinc 25 kg/ha resulted in significant increase in Head Length (27.51 cm), Grains per Head (969.35), Grain yield (4430.43 kg/ha) and Stover yield (7246.58 kg/ha) Higher number of grains per panicle might be due to 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 **(Mousavi *et al.*, 2012 and Chaitanya *et al.*, 2017)** The increase in growth and yield attributes might be due to role of Zinc in biosynthesis of indole acetic acid (IAA) and especially due to its role in initiation of primordial for reproductive parts and partitioning of photosynthates towards them. Research shows us that Zinc is required for the synthesis of tryptophan, which in turn is the precursor for the synthesis of IAA (Indole Acetic Acid). In the absence of IAA plant growth is stunted particularly internode growth and leaf size. The favourable influence of applied $ZnSO_4$ on these characters may be explained to its catalytic or stimulatory effect on most on most of the physiological and metabolic process of plant. The favourable effect of basal dose of $ZnSO_4$ may be due to better absorption and efficient utilization of Zinc by plant and its direct influence on the quantity of auxin produced which in turn enable the plant to grow taller and produce more dry matter. Remarkable effect of Zinc may also be appeared on account of balanced nutritional environment inside the plant. **Dixit *et al.*, (2005)**.

Economics

Cost of cultivation(INR 47,807.62), Gross return (INR 1,46,993.65), Net return(INR 99,186.03) and Benefit cost ratio (2.08) were found higher with application of Nitrogen 100 kg/ha along with Zinc 25 kg/ha it might be attributed to increase grain and stover yield with nitrogen and zinc application. The value of increased yield was much more than the cost of Nitrogen and zinc application which increased Net returns and B:C ratio. On the basis of results, 100 kg N/ha and 25 kg Zn/ha earned maximum net return which was found higher than other treatment. 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. Theses results collaborate to the findings with Jakhar *et al.,* (2006), Sharma *et al.,* Kumar *et al.,* ((2007) and Singh *et al.,*(2007).

Conclusion

Based on the findings of this experiment it can be concluded that application of Nitrogen 100 kg/ha + Zinc 25 kg/ha is profitable for farmers and was found to be more productive in Growth and Yield Parameters. The maximum net return and B:C ratio in Sorghum crop. The findings were recorded are based on the research done in one season it may be repeated for further recommendation.

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S.No.	**Treatments**	**Plant height (cm)**	**Dry weight (g/plant)**
1	Nitrogen 60kg/ha + Zinc 15 kg/ha	209.03	103.07
2	Nitrogen 60 kg/ha + Zinc 20 kg/ha	208.83	106.58
3	Nitrogen 60 kg/ha + Zinc 25 kg/ha	213.53	108.84
4	Nitrogen 80 kg/ha + Zinc 15 kg/ha	217.93	109.52
5	Nitrogen 80 kg/ha + Zinc 20 kg/ha	219.50	108.92
6	Nitrogen 80 kg/ha + Zinc 25 kg/ha	218.53	109.15
7	Nitrogen 100 kg/ha + Zinc 15 kg/ha	227.13	113.65
8	Nitrogen 100 kg/ha + Zinc 20 kg/ha	228.93	115.87
9	Nitrogen 100 kg/ha + Zinc 25 kg/ha	238.83	122.37
10	Control (80-40-40 NPK kg/ha)	199.51	101.69
	SEm(±)	6.46	3.44
	CD (p =0.05)	19.19	10.24

Table 1 Effect of Nitrogen and Zinc on Growth attributes of Sorghum

S.No.	Treatments	Head Length (cm)	Grains/Head (No.)	Grain yield (kg/ha)	Stover yield (kg/ha)
1	Nitrogen 60kg/ha + Zinc 15 kg/ha	22.66	770.05	3426.04	6391.84
2	Nitrogen 60 kg/ha + Zinc 20 kg/ha	23.63	777.24	3490.14	6367.02
3	Nitrogen 60 kg/ha + Zinc 25 kg/ha	24.36	786.93	3540.04	6418.94
4	Nitrogen 80 kg/ha + Zinc 15 kg/ha	24.20	794.21	3518.26	6393.59
5	Nitrogen 80 kg/ha + Zinc 20 kg/ha	24.59	891.75	3754.11	6412.65
6	Nitrogen 80 kg/ha + Zinc 25 kg/ha	24.26	860.73	3844.08	6625.26
7	Nitrogen 100 kg/ha + Zinc 15kg/ha	23.90	925.71	4071.64	6652.48
8	Nitrogen 100 kg/ha + Zinc 20kg/ha	26.11	981.34	4340.04	7176.39
9	Nitrogen 100 kg/ha + Zinc 25kg/ha	27.51	969.35	4430.43	7246.58
10	Control (80-40-40 NPK kg/ha)	20.86	780.27	3309.39	6033.03
	SEm(±)	0.97	25.27	109.99	193.60
	CD (p =0.05)	2.88	75.09	326.81	575.22

Table 2 Effect of Nitrogen and Zinc on Yield attributes and Yield of Sorghum

Table 3 Effect of Nitrogen and Zinc on Economics of Sorghum

S.No.	Treatments	Cost of cultivation INR	Gross Returns INR	Net Returns INR	B:C Ratio
1.	Nitrogen 60 kg/ha + Zinc at 15kg/ha	45511.18	117610.2	72099.02	1.58
2.	Nitrogen 60 kg/ha + Zinc at 20kg/ha	46420.27	119118.6	72698.33	1.57
3.	Nitrogen 60 kg/ha + Zinc at 25kg/ha	47329.36	120595.7	73269.34	1.55
4.	Nitrogen 80 kg/ha + Zinc at 15kg/ha	45750.31	119924.45	74173.69	1.62
5.	Nitrogen 80 kg/ha + Zinc at 20 kg/ha	46659.40	125916	79256.6	1.69
6.	Nitrogen 80 kg/ha + Zinc at 25 kg/ha	46568.49	129228.3	82659.9	1.77
7.	Nitrogen 100 kg/ha + Zinc at15 kg/ha	45984.44	135053.4	89068.96	1.93
8.	Nitrogen 100 kg/ha + Zinc at 20 kg/ha	46898.53	144382.95	97484.42	2.07
9.	Nitrogen 100 kg/ha + Zinc at 25 kg/ha	47807.62	146993.65	99186.03	2.08
10.	Control (RDF 80-40-40 Kg/ha)	42066.52	112899.9	70833.38	1.68