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Effect of nitrogen, sulphur and zinc on Wheat (*Triticum aestivum* L.)

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Abstract

A field experiment entitled Effect of Nitrogen, Sulphur and Zinc on Wheat (*Triticum aestivum* L.) conducted during *Rabi* 2025-26 at Agriculture farm, Suresh Gyan Vihar University, Jaipur on sandy loam soil. Application of 120 kg N ha⁻¹ significantly improved number of effective tillers, grains per spike, grain, straw and biological yield over 90 kg N ha⁻¹, while remaining statistically at par with 150 kg N ha⁻¹. Sulphur application at 20 kg ha⁻¹ significantly enhanced number of effective tillers per plant, number grains per spike, seed, straw & biological yield and net returns over control and was remained statistically at par with 40 kg ha⁻¹. Zinc application at 2.5 kg ha⁻¹ significantly improved number of effective tillers per plant, number grains per spike, seed, straw & biological yield, nitrogen and sulphur content, uptake, and net returns over control and remained statistically at par with 5.0 kg ha⁻¹. Economic analysis indicated that higher levels of nutrients increased gross and net returns, with maximum benefit-cost ratios observed at higher nitrogen and zinc levels. Overall, the study concluded that the combined application of 120 kg N ha⁻¹, 20 kg S ha⁻¹, and 2.5 kg Zn ha⁻¹ is the most efficient and economically viable nutrient management strategy for wheat under the given agro-climatic conditions, ensuring optimum productivity, improved nutrient uptake, and higher profitability.

Keywords: Nitrogen, grain, spike, zinc and yield

Introduction

Wheat (*Triticum aestivum* L.) is one of the most widely grown staple food crops globally, after rice. It is a primary food source for a significant portion of the global population, providing essential nutrients and energy (Kumar *et al.* 2024) [8]. Wheat is grown on 32.80 million hectares (m ha) lands with total production of 117.94 million tons (m t) contributes 34 per cent of the total food grain production in the country with the productivity of 3595 kg ha⁻¹ (Ministry of Agriculture, GOI 2025-26). Wheat Productivity has to be raised to meet ever increasing food demand in the country. In Rajasthan area under wheat crop is 3.17 m ha with production of 11.27 m t and productivity of 3559 kg ha⁻¹ (Ministry of Agriculture, GOR, 2025-26). Adequate nitrogen promotes vigorous vegetative growth and impart deep green color of foliage. Nitrogen had been recognized as one of the most limiting nutrients in higher crop productivity. Even under the best management practices, 30-50% of the applied N is lost and hence the farmer is compelled to apply more than the actual need of the crop to meet the losses (Mahmud *et al.*, 2021) [9]. Increase in sulphur uptake by high yielding crops, leaching losses, wide spread soil erosion etc. are some of the important causes for occurrence of Sulphur deficiency in soil (Chaudhary *et al.*, 2023) [10]. Zinc is essential for the formation of chlorophyll and growth hormones such as Indole Acetic Acid (IAA). It is involved in many enzymatic activities and is essential for the normal healthy growth and reproduction of plants, animals, and humans. When the supply of plant-available zinc is inadequate, crop yields are decreased and the quality of crop products is frequently (Prajapati *et al.* 2022) [11].

Methods and Materials

A field experiment entitled Effect of Nitrogen, Sulphur and Zinc on Wheat (*Triticum aestivum* L.) conducted during *Rabi* 2025-26 at Agriculture farm, Suresh Gyan Vihar University, Jaipur

on sandy loam soil. Geographically, the study area is located at 75°48'84" E longitude and 26°82'47" N latitude and this region falls under agro-climatic zone III A (Semi-arid Eastern Plain Zone) of Rajasthan. The experiment consisting three nitrogen levels in main plot (90, 120 and 150 kg/ha) and Sulphur levels in sub plot (control, 20 and 40 kg/ha) and zinc levels sub sub plot (control, 2.5 and 5.0 kg/ha). The total twenty seven treatment combinations were tested in spilt plot design with three replications.

Results and Discussion

Effect of nitrogen levels

Application of 120 kg nitrogen per hectare significantly increased the number of effective tillers of wheat and grains per spike over 90 Nitrogen per but remained at par with 150 kg nitrogen per hectare. The positive effect of nitrogen application on yield attributing characters of wheat seems to be owing to cumulative effect on growth and vigour of plants. The improvements in production attributing characters with increasing nitrogen fertilizer application are in close conformity with Singh *et al.* (2017) ^[14] and Kaur *et al.*, (2015) ^[13]. Application of nitrogen @ 120 kg per hectare significantly increased the grain, straw and biological yield of wheat over 90 kg per hectare but remained at par with 120 kg nitrogen per hectare. Application of nitrogen of 150 kg/ha significantly increased straw yield by 16.52 and 6.93 percent over 90 and 120 kg N ha⁻¹, respectively. These upshots are in close conformity with the findings of Iqbal *et al.* (2012) ^[16] and Mitra *et al.* (2014). The economic analysis revealed that increasing levels of nitrogen markedly improved the gross return, net return and benefit: cost ratio of wheat. The highest economic returns obtained under 150 kg N ha⁻¹ may be attributed to higher grain and straw yields resulting from better growth, enhanced nutrient availability and efficient utilization of applied nitrogen. These findings are in close conformity with the results of Havlin J.L (2014) ^[4] and Fageria *et al.* (2011) ^[6], who reported that optimum nitrogen application significantly enhances crop yield and economic returns.

Effect of sulphur levels

Application of sulphur of 40 kg/ha significantly increased number of effective tillers by 5.24 and 1.52 percent over control and 20 kg S ha⁻¹, respectively. Application of sulphur of 40 kg/ha significantly increased number of grains per spike by 10.32 and 4.27 percent over control and 20 kg S ha⁻¹, respectively. Application of sulphur @ 40 kg per hectare significantly increased the grain, straw and biological yield of wheat over control but remained at par with 20 kg sulphur per hectare. Kumar *et al.* (2021) ^[2] reported that sulphur application up to 40 kg ha⁻¹ significantly improved tiller number and grain yield in wheat. Singh *et al.* (2022) ^[3] also observed enhanced yield attributes and productivity with sulphur fertilization due to improved nutrient uptake and metabolic activities. The highest gross return (Rs. 106972 ha⁻¹) and net return (Rs. 60772 ha⁻¹) were obtained under 40 kg S ha⁻¹, which was significantly superior to control and 20 kg S ha⁻¹. Kumar *et al.* (2021) ^[2] reported higher net returns in wheat with sulphur application up to 40 kg ha⁻¹ due to increased yield. Similarly, Singh *et al.* (2022) ^[3] observed that sulphur fertilization enhanced economic returns, although the B:C ratio showed only marginal differences among sulphur levels.

Effect of zinc levels

Application of zinc @ 2.5 kg per hectare significantly increased

the number of effective tillers and number of grains per spike of wheat over control but remained at par with 5.0 kg zinc per hectare. Application of zinc 5.0 kg/ha significantly increased the seed, straw and biological yield as compared to control and remained statistically at par with 2.5 kg/ha. These findings are in agreement with earlier studies. Kumar *et al.* (2021) ^[2] reported significant improvement in tiller number and grains per spike with zinc application, but non-significant effects on test weight. Meena *et al.* (2023) similarly reported increased straw and biological yield with zinc fertilization, while grain yield response remained marginal beyond optimum levels. Zinc @ 5.0 kg/ha application significantly enhanced the economic returns and profitability of wheat, with the highest gross return, net return and B:C ratio recorded under 5.0 kg Zn ha⁻¹. The increased profitability under higher zinc levels may be due to improved nutrient uptake, better physiological efficiency and increased yield. These results are in agreement with the findings of Alloway B.J. (2008) ^[11] and Cakmak I. (2008) ^[12].

Table 4.4: Effect of nitrogen, sulphur and zinc on yield attributes

Treatments	Number of effective tillers per meter row length	Number of seeds per spike	Test weight (g)
Nitrogen levels (kg/ha)			
90	75.7	31.0	39.7
120	80.5	35.1	39.7
150	81.6	36.0	40.0
SEm±	0.7	0.3	0.5
CD (P=0.05)	2.3	1.0	NS
Sulphur levels (kg/ha)			
0	75.3	29.0	38.7
20	79.1	32.8	39.0
40	80.3	33.2	39.3
SEm±	0.6	0.4	0.6
CD (P=0.05)	1.9	1.2	NS
Zinc levels (kg/ha)			
0	73.6	30.1	38.9
2.5	77.3	33.7	39.3
5.0	78.9	34.4	40.1
SEm±	0.6	0.5	0.5
CD (P=0.05)	2.0	1.5	NS

Table 2: Effect of nitrogen, sulphur and zinc on yields (kg/ha)

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest Index (%)
Nitrogen levels (kg/ha)				
90	2803	4001	6804	41.19
120	3095	4578	7673	41.33
150	3212	4667	7879	40.26
SEm±	39	47	74	0.4
CD (P=0.05)	119	143	210	NS
Sulphur levels (kg/ha)				
0	2843	4038	6881	41.32
20	2998	4278	7276	41.14
40	3106	4447	7553	41.12
SEm±	35	59	75	0.37
CD (P=0.05)	111	179	215	NS
Zinc levels (kg/ha)				
0	3048	4401	7449	40.92
2.5	3238	4636	7874	41.12
5.0	3326	4770	8096	41.08
SEm±	48	65	82	0.45
CD (P=0.05)	138	186	232	NS

Table 3: Effect of nitrogen, sulphur and zinc on economics (Rs/ha)

Treatments	Economics (Rs/ha)		
	Gross return	Net return	B: C ratio
Nitrogen levels (kg/ha)			
90	98296	54724	2.26
120	106754	62791	2.43
150	111632	67279	2.52
SEm±	950	950	-
CD (P=0.05)	2765	2765	-
Sulphur levels (kg/ha)			
0	97720	55320	2.30
20	102960	58660	2.32
40	106972	60772	2.32
SEm±	810	810	-
CD (P=0.05)	2411	2411	-
Zinc levels (kg/ha)			
0	105197	62797	2.48
2.5	111518	68581	2.60
5.0	114597	71122	2.64
SEm±	990	990	-
CD (P=0.05)	2860	2860	-

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