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Influence of Sulphur and Zinc on Yield, Yield Attributes and Economics of Baby Corn (*Zea mays* L.)

Chilka Vandhana Varsha [a++*], Rajesh Singh [a#] and Alisha Peter [a++]

[a] *Department of Agronomy, Faculty of Agriculture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj-211007, Uttar Pradesh, India.*

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 *Zaid* season of 2023 at Crop Research Farm Department of Agronomy. The objective of this study is to asses the influence of sulphur and zinc on yield attritibutes of baby corn and to evaluate the economics of different treatment combinations taken. The treatments consisted of 3 levels of Sulphur *viz.,* (15, 30 and 45 kg/ha) and 3 levels of Zinc *viz.,* (10, 20 and 30 kg/ha) along with recommended doses of nitrogen, phosphorus and potash as control (60- 60-40 kg N-P-K/ha). The experiment was laid out in a Randomized Block Design with 10 treatments and replication thrice. Application of Sulphur 45 kg/ha along with Zinc 30 kg/ha (Treatment 9) recorded maximum cob yield with husk (10.6 t/ha), cob yield without husk (3.91 t/ha), green fodder yield (28.43 t/ha). The aforesaid treatment also recorded maximum gross returns (1,43,144.00 INR/ha), net returns (955,19.00 INR/ha) and Benefit cost ratio (2.01).

[++] *P.G. Scholar;*
[#] *Associate Professor;*
**Corresponding author: E-mail: varshavandhana452@gmail.com;*

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Keywords: Baby corn; economics; sulphur; yield; yield attributes; zinc; zaid.

1. INTRODUCTION

“Baby corn (*Zea mays* L.) being one of the most important dual purpose crop is grown widely round the year for its cob as well as green fodder in India. It has an edge over the other cultivated fodder crops due to its higher production potential, wider adaptability, fast growing nature and excellent fodder quality free from toxicants. It is highly valued for its nutritional benefits, including being a good source of fiber, vitamins A and C, and various minerals” [1-4]. “Baby corn production has been directly integrated with dairying farms in different countries because only 13-20% of fresh ear weight is used as human food and the rest (silk, husk and green stalk) can be used as excellent feed materials for milch ruminants to improve their productivity.It is dehusked young ear of the female inflorescence of maize plant, harvested at silk emergence before fertilization” [5], (Kapoor, 2002). Young cobs are handpicked when the silk length was about 2-4 cm.

It has significant economic potential due to its high market demand and versatility in culinary uses. It provides farmers with an additional revenue stream, especially in regions where traditional corn cultivation is prevalent. Baby corn cultivation is labor-intensive but requires shorter growing periods and can be harvested multiple times a year, optimizing land use [6-8]. Its production supports agro-industrial growth by creating value-added products and export opportunities. Furthermore, baby corn's role in crop rotation can enhance soil health and sustainability in agricultural practices, contributing to overall economic stability in farming communities.

One of the nutrients that is necessary for plant growth is Sulphur. equal to phosphorus, Sulphur is needed by plants in equal amounts. Sulphur plays specialized roles in the metabolism, enzymatic processes, and development of plants. Additionally, the synthesis of Sulphur-containing amino acids like cystine, cysteine, and methionine depends on Sulphur. Sulphur is also a component of coenzyme-A, S- glycosides (mustard oils), and vitamins (thiamine and biotin) (Text book of plant nutrient management by ISA (ISBN: 2000000075327) f-Indian Society of Agronomy) sulphur in baby corn cultivation significantly enhances growth and yield by improving nutrient uptake and chlorophyll formation. Sulphur is essential for the synthesis of amino acids and proteins, which are critical for plant development. Studies by Sharma et al. [9] have demonstrated that sulphur application increases the biomass and cob size of baby corn, leading to higher overall productivity and better-quality produce Additionally, sulphur helps in the efficient utilization of other nutrients like nitrogen and phosphorus, thereby enhancing the overall nutrient-use efficiency in baby corn crops.

“Zinc has a key role as a structural constituent or regulatory co-factor of a wide range of enzymes and proteins in many important biochemical pathways and these are mainly concerned with carbohydrate metabolism, both in photosynthesis and in the conversion of sugars to starch, protein metabolism, auxin metabolism, maintenance of integrity of biological membranes and resistance to some diseases infection” [10]. zinc in baby corn cultivation enhances growth and yield by playing a crucial role in various physiological processes, including enzyme activation and protein synthesis. Zinc is essential for the production of auxin, a hormone that promotes cell elongation and division. Research by Cakmak [11] and Singh et al. [12] has shown that zinc supplementation improves plant vigor, increases cob size, and boosts overall yield in baby corn . Additionally, zinc enhances the plant's ability to withstand stress conditions, further contributing to improved crop performance.

2. MATERIALS AND METHODS

The experiment was conducted during *Zaid* season of 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the field constituting a part of central gangetic alluvium is neutral and deep. The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH - 7.6), organic carbon (0.870%), available N (219 kg/ha), available P (41.8 kg/ha) and available K (261.2 kg/ha). The treatment consists of T_1: Sulphur 15 kg/ha + Zinc 10 kg/ha, T_2: Sulphur 15 kg/ha + Zinc 20 kg/ha, T_3: Sulphur 15 kg/ha+ Zinc 30 kg/ha, T_4: Sulphur 30 kg/ha + Zinc 10 kg/ha, T_5: Sulphur 30 kg/ha + Zinc 20 kg/ha, T_6: Sulphur 30 kg/ha + Zinc 30 kg/ha, T_7: Sulphur 45 kg/ha + Zinc10 kg/ha, T_8: Sulphur 45 kg/ha + Zinc 20 kg/ha, T_9: Sulphur 45 kg/ha + Zinc 30 kg/ha, T_{10}: Control (RDF-N-P-K-60-60-40 kg/ha). In the experiment, zinc and sulphur were not applied to the control treatments, which only received the standard NPK (nitrogen, phosphorus, and potassium) fertilization [13-15]. The NPK fertilization was applied uniformly to all treatments, ensuring that the basic nutrient requirements for the crops were met. This allows the experiment to specifically assess the impact of zinc and sulphur supplementation on plant growth and yield, isolating the effects of these two micronutrients from the baseline provided by the NPK fertilizers. The uniform application of NPK across all treatments ensures that any observed differences in crop performance can be attributed to the presence or absence of zinc and sulphur, rather than variations in the primary macronutrients.

The experiment was laid out in Randomized Block Design, with 10 treatments replicated thrice. The observations were recorded for No. of corns per plant, Cob yield (t/ha). a) With husk b) Without husk, Green fodder yield (t/ha). Intercultural operations like thinning and weeding practices were done. Thinning practice was done at 10 DAS to promote better plant growth and spacing which it leads to higher yielding. Effective weed management strategies were done frequently for not only reduce competition for resources but also minimize pest and disease incidence, further enhancing crop productivity. Additionally, precision application of fertilizer was done to meet the specific nutritional needs of crop. The collected data was subjected to statistical analysis by analysis of variance method [16]. Baby corn, variety (G-5414 Syngenta) were selected for sowing. Seeds are sowed of spacing (45 cm X 10 cm)

3. RESULTS AND DISSCUSSION

3.1 Yield Parameter

The number of cobs/plant (2.06) was recorded significantly high in (T9) which is 45 kg/ ha Sulphur along with 30 kg/ha Zinc. However T8 45 kg/ha Sulphur along with 20 kg/ha Zinc is statistically at par with T9. In Baby corn crop Sulphur is crucial for protein synthesis, while zinc plays a vital role in the formation of auxins, essential for plant growth and development. By optimizing these micronutrients, we can potentially enhance cob formation, leading to higher yields per plant [17].

Maximum Corn yield with husk (10.06 t/ha) was recorded significantly high in Treatment 9 (Sulphur 45 kg/ha along with Zinc 30kg/ha). However, treatment T8 (45 kg/ha Sulphur along with 20 kg/ha Zinc) was found to be statistically at par with highest. the cob yield with husk retention in baby corn with Sulphur and zinc levels unveils an intriguing nexus. Sulphur fosters husk development, aiding in moisture retention and protecting cobs, while zinc enhances enzymatic processes crucial for husk strength and cob development [18] Treatment-9 (45 Kg/ha Sulphur + 30 kg/ha Zinc) was recorded significantly maximum Corn yield without husk (3.91 t/ha) which was superior over all other treatments. However, treatment T8 was found to be statistically at par with highest. "Increase in corn yield with fertilization might be due to the role of Sulphur and zinc play a vital role in increasing corn yield because Sulphur and zinc takes place in many physiological process of plant such as chlorophyll formation, stomatal regulation, starch utilization which enhance corn yield. The continuous filling of grains due to sufficient photosynthesis might have resulted in increased length and sizeof the corn" [19].

Significantly maximum Green Fodder (28.43 t/ha) was recorded in Treatment-9 (45 Kg/ha Sulphur along with 30 kg/ha Zinc) which was superior over all other treatments. However, treatments T8 was found to be statistically at par with Treatment- 9 (45 Kg/ha Sulphur + 30 kg/ha Zinc). Increase in a green fodder yield might be due to the enhanced translocation of Sulphur with applied Zinc, which resulted in a higher production of green fodder in a respective level of nutrient. Similar results of significantly higher fodder yield with Zn application was also reported by Mahdi et al. [20].

In the experiment, Treatment 9, which included the application of 45 kg/ha of sulphur and 30 kg/ha of zinc, produced the highest results in terms of baby corn growth and yield. This superior performance can be attributed to the synergistic effects of sulphur and zinc on plant physiology and nutrient uptake. Sulphur is vital for the synthesis of essential amino acids and proteins, enhancing chlorophyll formation and improving overall plant health. Zinc, on the other hand, is crucial for enzyme activation, protein synthesis, and the production of auxin, a hormone that promotes cell division and elongation.

Studies by Sharma et al. [9] have shown that sulphur application increases biomass and cob size, while Cakmak [11] and Singh et al. [12] have demonstrated that zinc supplementation improves plant vigor and stress resistance.

Table 1. Effect of Sulphur and Zinc on yield attributes on Baby corn

S.no	Treatments	Numberof cobs /plant	Cob yieldwith husk (t/ha)	Cob yield without husk (t/ha)	Green fodder yield (t/ha)
1	Sulphur 15kg/ha + Zinc 10kg/ha	1.20	7.42	2.16	21.10
2	Sulphur 15kg/ha + Zinc 20kg/ha	1.33	7.66	2.42	21.85
3	Sulphur 15kg/ha + Zinc 30kg/ha	1.40	8.05	2.55	22.83
4	Sulphur 30kg/ha + Zinc 10kg/ha	1.50	8.23	2.73	24.15
5	Sulphur 30kg/ha + Zinc 20kg/ha	1.50	8.24	2.74	24.22
6	Sulphur 30kg/ha + Zinc 30kg/ha	1.56	8.24	2.78	25.12
7	Sulphur 45kg/ha + Zinc 10kg/ha	1.83	9.55	3.34	26.64
8	Sulphur 45kg/ha + Zinc 20kg/ha	2.03	9.79	3.52	27.90
9	Sulphur 45kg/ha + Zinc 30kg/ha	2.06	10.06	3.91	28.43
10	Control: (60-60-40 N-P-K kg/ha)	1.46	8.12	2.62	23.54
	SEm(±)	0.11	0.370	0.420	1.40
	CD (p=0.05)	0.32	1.10	0.360	3.19

Table 2. Effect of Sulphur and Zinc on economics on Baby corn

S.no	Treatments	Cost of cultivation(INR/ha)	Gross returns (INR/ha)	Net returns(INR/ha)	B:C Ratio
1	Sulphur 15kg/ha + Zinc 10kg/ha	43,143.00	1,04,048.00	70,862.00	1.64
2	Sulphur 15kg/ha + Zinc 20kg/ha	47,436.00	1,25,903.00	78,467.00	1.65
3	Sulphur 15kg/ha + Zinc 30kg/ha	47,502.00	1,27,423.00	79,921.00	1.68
4	Sulphur 30kg/ha + Zinc 10kg/ha	43,238.00	1,17,430.00	74,192.00	1.72
5	Sulphur 30kg/ha + Zinc 20kg/ha	47,495.00	1,30,081.00	82,586.00	1.74
6	Sulphur 30kg/ha + Zinc 30kg/ha	43,057.00	1,20,501.00	77,444.00	1.80
7	Sulphur 45kg/ha + Zinc 10kg/ha	47,530.00	1,37,946.00	90,415.00	1.90
8	Sulphur 45kg/ha + Zinc 20kg/ha	47,596.00	1,40,926.00	93,330.00	1.96
9	Sulphur 45kg/ha + Zinc 30kg/ha	47,625.00	1,43,144.00	95,519.00	2.01
10	Control: (60-60-40 N-P-K kg/ha)	47,400.00	1,21,957.00	74,556.00	1.57

The combination of these two micronutrients in Treatment 9(45 kg/ha of sulphur and 30 kg/ha of zinc) likely optimized metabolic processes and nutrient use efficiency, leading to the observed superior growth and yield compared to other treatments. This highlights the importance of balanced micronutrient management in maximizing crop productivity.

Studies collectively demonstrate that sulphur and zinc play vital roles in enhancing the growth, yield, and quality of various crops, making their supplementation a key component of effective agricultural practices.

Research has shown that sulphur application in wheat improves grain yield and quality. Sulphur enhances the synthesis of essential amino acids and proteins, which are crucial for grain development. Studies by Jamal et al. [21] indicated that sulphur-deficient soils result in lower yields and poor quality grains and Zinc supplementation in wheat increases grain yield, protein content, and improves disease resistance. Studies by Cakmak [11] highlighted that zinc-deficient soils lead to stunted growth and lower yields. Zinc also plays a crucial role in enzyme activation and hormone regulation, essential for wheat development [22,23].

3.2 Economics

Embarking on the economics of baby corn it was observed that Sulphur 45 kg/ha along with Zinc 30 kg/ha in Treatment 9 has gained maximum Gross returns (143144.00 INR/ha), Net returns (95519.00 INR/ha) and highest Benefit cost ratio (2.01). “In Baby corn production sulphur and zinc plays pivotal role. Sulphur enhances photosynthetic efficiency and nitrogen metabolism, while zinc promotes enzyme activity crucial for nutrient uptake and crop yield, collectively optimizing economic outcomes for growers”. The interplay of sulphur and zinc reveals nuanced impacts on gross returns, net returns, and benefit-cost ratio, illuminating strategies for optimizing profitability while maintaining sustainability [24].

The application of 45 kg/ha of sulphur and 30 kg/ha of zinc, achieved higher economic results compared to all other treatments. This outcome can be justified by the synergistic effects of these two micronutrients on the growth and yield of baby corn.

The combination of sulphur and zinc in Treatment 9(45 kg/ha of sulphur and 30 kg/ha of zinc) likely optimized these physiological processes, resulting in enhanced plant growth and yield. Higher yields translate directly into greater economic returns for farmers, as they can produce more baby corn per hectare. Additionally, improved nutrient uptake and plant health reduce the likelihood of crop losses and increase the overall marketability of the produce [25].

Thus, the superior economic results of Treatment 9 (45 kg/ha of sulphur and 30 kg/ha of zinc) can be attributed to the combined benefits of sulphur and zinc, which together enhance plant growth, increase yield, and ultimately boost the profitability of baby corn cultivation.

4. CONCLUSION

From the results of the experiment, it can be concluded that the application of 45 kg/ha of sulphur along with 30 kg/ha of zinc (Treatment 9) resulted in the highest production and economic returns in baby corn. This combination likely optimized the physiological and biochemical processes essential for plant growth, such as chlorophyll synthesis, enzyme activation, and protein formation. These micronutrients enhanced nutrient uptake and utilization, leading to improved plant vigor, larger cob size, and increased yield. Therefore, incorporating both sulphur and zinc at these levels proved to be the most effective strategy for maximizing both the productivity and profitability of baby corn cultivation.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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