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Influence of Sulphur and Foliar Spray of Iron on Growth and Economics of Maize

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Authors' contributions

This work was carried out in collaboration among all authors. Author SG contributed to experimentation, manuscript writing, data analysis, idea conceptualizing manuscript editing. Authors TH and RSVR done the manuscript correction. Author JD managed supervision, validation, data correction. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Prayagraj, UP, during the Zaid season of 2022 on sandy loam soil. The experiment was laid out in Randomized Block Design, consisting of three levels of sulphur (10 kg/ha, 15 kg/ha, 25 kg/ha) and three levels of iron as a foliar spray (1500, 2000, 2500 mg/kg**)**. The maize variety Kanchan was sown in April 2022. The results of the experiment revealed that the application of 25 kg/ha of

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sulphur along with 2500 mg/kg of iron significantly increased the growth parameters viz., plant height (196.4 cm), and dry weight (83.03 g/plant), whereas, application of 25 kg/ha of sulphur and iron at 2500 mg/kg also showed a positive effect on economics viz., gross returns (121644.00 INR/ha), net returns (84843.00 INR/ha) and B: C (1:2.30).

Keywords: Economics; growth parameters; iron; maize, sulphur.

1. INTRODUCTION

"Cereal grains provide majority of its food calories and protein they are good sources of secondary nutrient like calcium, micronutrients such as iron and vitamins of group B. Maize (*Zea mays L.*) is the most versatile crop that can be successfully grown in varied agro-ecologies ranging from sea level to high altitudes up to 3000 m. It has highest genetic yield potential among the food grain crops. maize grain contain 10% protein, 4% oil and 70% carbohydrates. Protein is called 'zein' and is deficient in tryptophan and lysine. (A competitive book of agriculture, Nem raj sunda,"[1]. " In India, maize is the third most important crop after rice, wheat and is cultivated throughout the year in different parts of the country for various purposes including grain, fodder, green cobs, sweet corn, baby corn, popcorn". [2]. "Maize provides nutrients for humans and animals and serves as a basic raw material for the production of starch, oil, protein, alcohol beverages, food sweeteners and more recently, fuel. Maize is high yielding, easy to process, and cost is less than other cereals" [3].

As per the data provided by Agricultural statistics at a glance [4] , in India maize is cultivated in 9.86 million hectares, production 31.51 million tonnes and productivity 3.1 tonnes/ha (2020-2021). The maize growing states are Karnataka (16.45%), Madhya Pradesh (11.3%), Maharashtra (10.91%), Tamil Nadu (8.63%). "About 66% of total maize production used as feed, 25% as food and industrial products while the rest is used as seed"[5].

"Sulphur is an essential constituent of amino acids", viz. cysteine which involved in Kreb's cycle, cystine and methionine used in the formation of Anthocyanin, chlorophyll, lignin and pectin of cell membrane (Crop Nutrition-Principles and Practices, [6]. Sulphur is a precursor of the plant hormone ethylene [7]. "It plays an important role in electron transfer reactions and in metabolic activities of vitamins, biotin, thiamine, co-enzyme" [2]. "Sulphur, a molybdenum co-factor and lipolic acid and many secondary compounds which serves as important structural, regulatory and catalytic functions in context of proteins and cellular redox buffer in the form of glutathione" [8].

"However, iron is a constituent of Haem and non-Haem proteins, Haem protein contains Fe-porphyrin complex molecule, a prosthetic group of cytochromes, haematin, ferrochrome, oxidase, catalase, peroxidase, leghaemoglobin enzymes. The non-haem contains stable Fe-S protein, the ferrodoxin which is a compound of photosynthetic electron transport chain. It is necessary for synthesis and maintenance of chlorophyll and nucleic acid" [2]. "Fe has a vital role in formation ALA, the precursor of porphyrins. Fe is involved in protein, nucleic acid, lipid (lipoxinase) metabolism. Micronutrient iron gives electrical charge for many enzymatic transformations in maize plants. Iron also provides structural component of porphyrin helps in oxidation-reduction reactions in respiration and photosynthesis" [9].

2. MATERIALS AND METHODS

"The field trial was conducted during *the Zaid* season from April to July 2022 in Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, U.P. which is located at 25^0 24' 42" N latitude, 81^0 50' 56" E longitude and 98 m altitude above the mean sea level. This area is located on the right side of river Ganga which is 11 km away from Prayagraj city". The soil of the experimental field is neutral in nature with a (p^H of 7.1). It had a sandy loam texture, high in Nitrogen (210.25 kg/ha), Potassium (187.3 kg/ha) and medium in Phosphorous (21.6 kg/ha). The experiment was laid out in Randomized Block Design consisting of ten treatment combinations which were replicated thrice. The experimental field was ploughed thoroughly and brought to a fine tilth by removing stubbles. 30 plots of each 3.0 m x 3.0 m were made.

1. Sulphur at 10kg/ha + iron at 1500mg/kg
2. Sulphur at 15kg/ha + iron at 1500mg/kg
3. Sulphur at 25kg/ha + iron at 1500mg/kg

4. Sulphur at 10kg/ha + iron at 2000mg/kg
5. Sulphur at 15kg/ha + iron at 2000mg/kg
6. Sulphur at 25kg/ha + iron at 2000mg/kg
7. Sulphur at 10kg/ha + iron at 2500mg/kg
8. Sulphur at 15kg/ha + iron at 2500mg/kg
9. Sulphur at 25kg/ha + iron at 2500mg/kg
10. Blanket application of 120:60:40 kg/ha NPK

Major nutrients were applied in 120-60-40 kg/ha amount through urea, SSP, and MOP, to all treatments after opening the furrows and covered with soil while sulphur was applied as elemental sulphur (80%), Iron as chelated form. Kanchan variety was sown by line sowing method in furrows with the spacing of 45 cm between rows and 30 cm between plants. The growth parameters *viz.,* plant height (cm), dry weight (g/plant), were recorded at 15 days-time intervals till physiological maturity and data was statistically analysed by using ANOVA technique [10].

3. RESULTS AND DISCUSSION

Observations of growth attributes *viz.,* plant height and dry weight were presented in Table 1. The significantly highest plant height (196.4 cm) was recorded with the application of 25 kg/ha of sulphur and iron at 2500 mg/kg. However, the application of 25 kg/ha sulphur and iron at 2000 mg/kg in plant height (194.3 cm) was statistically at par with the highest. Similarly, the highest dry weight (83.03 g/plant) at 60 DAS was recorded with the application of 25 kg/ha of sulphur and iron at 2500 mg/kg. However, with the application of 25 kg/ha sulphur and iron at 1500 mg/kg, dry weight (80.47 g/plant) was statistically at par with the highest. The increase in plant height, and dry weight, might be because the application of higher dose of both sulphur and iron had a positive role in metabolic activities, ferrodoxin an iron containing protein leads to an increase in photosynthetic activities and nitrate, sulphate reduction thereby increased plant height.

Table 1. Influence of sulphur and iron on growth attributes of maize

	At 60 DAS		
S. No	**Treatments**	**Plant height (cm)**	**Dry weight (g/plant)**
1	Sulphur at 10 kg/ha and iron at 1500 mg/kg	176.2	72.70
2	Sulphur at 15 kg/ha and iron at 1500 mg/kg	184.7	76.17
3	Sulphur at 25 kg/ha and iron at 1500 mg/kg	191.3	80.47
4	Sulphur at 10 kg/ha and iron at 2000 mg/kg	177.7	74.70
5	Sulphur at 15 kg/ha and iron at 2000 mg/kg	184.9	74.40
6	Sulphur at 25 kg/ha and iron at 2000 mg/kg	194.3	79.50
7	Sulphur at 10 kg/ha and iron at 2500 mg/kg	178.0	75.83
8	Sulphur at 15 kg/ha and iron at 2500 mg/kg	184.7	76.37
9	Sulphur at 25kg/ha and iron at 2500 mg/kg	196.4	83.03
10	Control (120:60:40 kg/ha NPK)	178.1	72.00
	S.Em (±)	1.05	1.42
	CD (5%)	3.13	4.22

Table 2. Influence of Sulphur and foliar application of iron on economics of maize

S. No	**Treatments**	**Gross returns (INR/ha)**	**Net returns (INR/ha)**	**B:C**
1.	Sulphur at 10 kg/ha and iron at 1500 mg/kg	86328.00	51002.00	1.40
2.	Sulphur at 15 kg/ha and iron at 1500 mg/kg	94176.00	58400.00	1.60
3.	Sulphur at 25 kg/ha and iron at 1500 mg/kg	111834.00	75158.00	2.04
4.	Sulphur at 10 kg/ha and iron at 2000 mg/kg	90252.00	54676.00	1.50
5.	Sulphur at 15 kg/ha and iron at 2000 mg/kg	92214.00	56238.00	1.57
6.	Sulphur at 25 kg/ha and iron at 2000 mg/kg	115758.00	79032.00	2.15
7.	Sulphur at 10 kg/ha and iron at 2500 mg/kg	88290.00	52839.00	1.49
8.	Sulphur at 15 kg/ha and iron at 2500 mg/kg	103986.00	68025.00	1.89
9.	Sulphur at 25 kg/ha and iron at 2500 mg/kg	121644.00	84843.00	2.30
10.	Control (120:60:40 kg/ha NPK)	84366.00	50565.00	1.49

An increase in plant height with an increase in sulphur levels might be due to the increase in uptake of NPK during knee high stage and silking stage. [3].

The economics of maize were presented in Table 2 Gross returns (121644.00 INR/ha), net returns (84843.00 INR/ha) and B:C (2.30) ratio were highest with the application of sulphur at 25 kg/ha and 2500 mg/kg of iron.

4. SUMMARY AND CONCLUSION

Under irrigated conditions, cultivation of maize during *Zaid* season with the application of sulphur at 25 kg/ha and iron at 2500 mg/kg was more desirable in terms of growth when compared to other treatments at inceptisol. It also fetched good net returns and B:C.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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