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Effect of Boron and Iron on Growth and Yield of Baby Corn (*Zea mays* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A field trail was conducted during *zaid* 2022 at Crop Research Farm 2, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj, on the topic "Effect of Boron and Iron on Growth and Yield of Baby corn (*Zea mays* L.)" to study treatments consisting of 10 with 3 different levels of boron 5 kg/ha, 6 kg/ha, 7 kg/ha (soil application) and different levels of iron 0.3%, 0.4% and 0.5% (foliar application) The soil of the experimental field was sandy loam in texture, slightly alkaline in soil reaction (pH 8), low level of organic carbon (0.62%), available N (225 kg/ha), P (38.2 kg/ha) and K (240.7 kg/ha). There were 10 treatments each being replicated thrice and laid out in randomized block design. The results showed that treatment 9 with the application of Boron (7 kg/ha) + Iron (0.5%) recorded significantly higher plant height (138.42 cm), higher plant dry weight (86.17 g), maximum crop growth rate (82.42 g/m^2/day), maximum number of cobs/plant (2.13), higher cob yield with husk (8.31 t/ha), higher cob yield without husk (2.65 t/ha), higher green fodder yield (19.14 t/ha) compared to other treatments. The maximum gross returns (81,700.00 INR/ha), maximum net returns (55,297.00 INR/ha) and benefit ratio (2.01) was recorded in treatment 9 [Boron (7 kg/ha) + Iron (0.5%)] as compared to other treatments. Minimum observations were recorded in treatment 10 control plot with RDF 100:60:40 kg/ha NPK.

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1. INTRODUCTION

Baby corn is an ear of corn (*Zea mays* L.) that has been harvested while it is still young, usually before silking has fully emerged or has just begun. Corn cobs are used as a vegetable known as baby corn. For optimal growth and development, the crop requires well-drained and sandy loam to clay soil. Cobs from a baby corn crop take about 50-55 days to mature and the rest of the plant can be used as green fodder. “Currently, baby corn is gaining popularity among Indian farming communities mainly due to its short duration, high market price, nutritional value and also its versatile uses. These are consumed by humans as a source of vegetables and after harvesting the plant can be used as green fodder. 100 grams of baby corn contains 89.1% moisture, 1.9 g protein, 0.2 g fat, 0.06 g ash, 8.2 mg carbohydrates, 28 mg calcium, 86 mg phosphorus and 11 mg ascorbic acid” [1].

“Globally maize grown in America, Asia and Africa. It is cultivated globally over an area of about 169.81 million hectares with a production of 835.32 million tonnes with the productivity of 49.2 q/ha” [2]. “In India, which is the 5th largest producer in the world and accounts for 3% of global production, maize is grown on an area of about 9.18 million hectares, with a yield of 27.23 million tons and an average productivity of 2965 kg/ha. Contributing 14.87% (1.37 million tonnes) of the total area under Indian maize production, while Uttar Pradesh contributes an area of about 0.73 million hectares with 7.98% to the whole of India, which has a production of about 1.53 million” [3].

“The problem with boron deficiency is that it affects photosynthesis indirectly by weakening the vascular tissues responsible for ion transport” [4]. “B deficiency activates enzymatic and non-enzymatic oxidation using phenol as a substrate, resulting in increased concentrations of polyphenol oxidase and quinine, which are dangerous for plant growth and development” [5]. Iron, the deficiency of which causes chlorosis and is responsible for a significant reduction in yield and plant quality. One of the symptoms of iron deficiency or iron chlorosis in plants is the development of yellow leaves with dark green veins. Many different factors can affect the amount of iron and its availability in the soil. For example, we know that high pH, bicarbonate content and low soil temperatures reduce iron availability. Excess water, especially in acidic soils and compacted or poorly aerated soils, can also reduce iron availability.

“The micronutrient boron is essential for the growth and health of all crops. The cell walls and reproductive structures of plants contain this compound. Crop boron requirements are influenced by several environmental factors such as temperature, light and soil water conditions” [6]. “A nutrient is mobile in soil, meaning it is prone to movement. Because boron is needed in small amounts, it is important that it is evenly distributed throughout the field. It plays a key role in many plant functions, including cell wall formation and stability, maintaining the structural and functional. integrity of biological membranes, sugar movement to growing parts, and pollination and seed germination. Adequate B is also required for efficient nitrogen fixation and nodulation in legumes. It is more common for crops to be deficient in boron than any other micronutrient” [7]. “B is involved in the structural and functional integrity of the cell wall and membranes, cell division and elongation, nitrogen and carbohydrate metabolism, transport of sugars, cytoskeletal proteins and plasmalemma-bound enzymes, nucleic acids, indoleacetic acid, polyamines, ascorbic acid, and phenol metabolism and transport” [7].

“Essential nutrient is Iron (Fe), plays a significant role in various physiological and biochemical pathways of plants. It serves as a component of many vital enzymes, such as the cytochromes of the electron transport chain, and is therefore required for a wide range of biological functions. In plants, iron is involved in the synthesis of chlorophyll and is essential for maintaining the structure and function of chloroplasts. Foliar feeding is a new and controversial technique of feeding plants by applying liquid fertilizer directly to their leaves” [8]. Keeping all the points in view the above fact, the experiment was conducted to find out the “Effect of Boron and Iron on Growth and Yield of Baby corn” (*Zea mays* L.)’’.

2. MATERIALS AND METHODS

The experiment was conducted during *Zaid* 2023 season at Crop Research Farm 2, Department of Agronomy, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, (UP). The topic titled “Effect of boron and iron on growth and yield of Baby corn (Zea mays L.)”, to study the response of Boron (5 kg/ha, 6 kg/ha, 7 kg/ha) with combination of Iron (0.3 %, 0.4% and 0.5%). The soil in the experimental plot was sandy loam texture, almost neutral in soil reaction (pH 8.0), low in organic carbon (0.62%), available nitrogen (225 kg/ha), available P (38.2 kg/ha) and available K (240.7 kg/ha). There were 10 treatments, and replicated thrice and laid out in Randomized Block Design (RBD). The treatment combinations are treatment 1 [Boron (5 kg/ha) + Iron (0.3%)], treatment 2 [Boron (5 kg/ha) + Iron (0.4%)], treatment 3 [Boron (5 kg/ha) + Iron (0.5%)], treatment 4 [Boron (6 kg/ha) + Iron (0.3%)], treatment 5 [Boron (6 kg/ha) + Iron (0.4%)], treatment 6 [Boron (6 kg/ha) + Iron (0.5%)], treatment 7 [Boron (7 kg/ha) + Iron (0.5%)], treatment 8 [Boron (7 kg/ha) + Iron (0.3%)], treatment 8 [Boron (7 kg/ha) + Iron (0.4%)], treatment 9 [Boron (7 kg/ha) + Iron (0.5%)], treatment 10.

(Control). The data recorded on various aspects of crops such as growth parameters and yield attributes were subjected to statistical analysis by variance method of Gomez and Gomez [9].

3. RESULT AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height (cm)

The data revealed that, significant and higher plant height (138.42 cm) was recorded in treatment 9 [Boron (7 kg/ha) + Iron (0.5%)]. However, treatment 8 [Boron (7 kg/ha) + Iron (0.4%)] and treatment 7 [Boron (7 kg/ha) + Iron (0.3%)] were found to be statistically at par with treatment 9 [Boron (7 kg/ha) + Iron (0.5%)]. (Table 1). Significant and higher plant height was observed with application of Boron (7 kg/ha) attribute in greater photosynthetic activity and chlorophyll synthesis resulting in better vegetative growth. Priyanka et al. [10] in maize. Further, significantly higher plant height with foliar application of iron was probably due to improve in photosynthesis activity, it activates many enzymes and helpfull in transportation of assimilates towards stem. Similar results were reported by Babu and Mehera [11].

3.1.2 Plant dry weight (g)

The data revealed that, significant and maximum plant dry weight (106.76 g) was recorded in treatment 9 [Boron (7 kg/ha) + Iron (0.5 %)]. However, treatment 8 [Boron (7 kg/ha) + Iron (0.4 %)] was found to be statistically at par with treatment 9 [Boron (7 kg/ha) + Iron (0.5 %)]. (Table 1). Significant and maximum plant dry weight (g) was with application of Boron (7 kg/ha) might be due to rapid photosynthetic rate by more leaf area exposer to sunlight that helped the accumulation of dry matter in plant. Similar results were reported by Ojha et al. [12] in sweet corn. Further, significantly higher plant dry weight was with application of iron which may have increases shoot dry weight by Fe application under aerobic plots in respect of green and dry matter yield. Similar results were reported by Kumar et al. [1].

3.1.3 Crop growth rate (g/m^2/day)

The data revealed that, significant and maximum crop growth rate (82.42 g/m^2/day) was recorded in treatment 9 [Boron (7 kg/ha) + Iron (0.5 %)]. However, treatment 8 [Boron (7 kg/ha) + Iron (0.4 %)] was found to be statistically at par with treatment 9 [Boron (7 kg/ha) + Iron (0.5%)]. (Table 1). Significant and higher crop growth rate was recorded with application of boron (7 kg/ha) might be due to chlorophyll formation, enzyme activation, stomatal balance and utilization of starch at early stages which enhances the accumulation of assimilate, this application accelerates plant growth, cell division and contributed to increase in higher CGR. Similar results were reported by Priyanka et al. [10] in maize.

3.1.4 Relative growth rate (g/g/day)

The data found that non- significant and highest relative growth rate (0.058 g/g/day) was recorded with 9 [Boron (7 kg/ha) + Iron (0.5 %)] as compared to rest of the treatments (Table 1).

3.2 Yield Attributes and Yield

3.2.1 Number of cobs/plant

The data showed that, Significant and higher number of cobs/plant (2.13) was observed in treatment 9 [Boron (7 kg/ha) + Iron (0.5 %)]. However, treatment 8 [Boron (7 kg/ha) + Iron (0.4 %)] was found to be statistically at par with treatment 9 [Boron (7 kg/ha) + Iron (0.5 %)] (Table 2). Significant and higher number of cobs/plant was observed with application of boron might be due to it’s positive effect that play’s a key role in metabolism of plant and in the synthesis of the nucleic acid. Similar results were reported by Ojha et al. [12] in sweet corn. Further, significantly higher number of cobs/plant was with the application of iron may be due to it's foliar spray that helps the inoculant for increasing the transportation of iron in baby corn. Similar results were reported by Reddy et al. [13].

3.2.2 Length of cob (cm)

The data found that non- significant and highest length of cob (18.57cm) was recorded with 9 [Boron (7 kg/ha) + Iron (0.5 %)] as compared to rest of the treatments (Table 2).

3.2.3 Girth of cob (cm)

The data found that non- significant and highest girth of cob (5.27cm) was recorded with 9 [Boron (7 kg/ha) + Iron (0.5 %)] as compared to rest of the treatments (Table 2).

3.2.4 Cob yield with husk (t/ha)

Significant and higher cob yield with husk (8.33 t/ha) was observed in treatment 9 [Boron (7 kg/ha) + Iron (0.5 %)]. However, treatment 8 [Boron (7 kg/ha) + Iron (0.4 %)] and treatment 7 [Boron (7 kg/ha) + Iron (0.3 %)] were found to be statistically at par with treatment 9 [Boron (7 kg/ha) + Iron (0.5 %)] (Table 2). Significant and higher cob yield with husk was observed with the application of boron might be due to efficient metabolism and translocation of the carbohydrate from the source to the sink by the effect of applied nutrients on the cell metabolism which promoted meristematic crop's activity and its better uptake by plants for favorable metabolic processes such as nucleic acid, carbohydrate, protein, auxins etc. Similar results were reported by Prashanth et al. [14] in rice. Further, significantly higher cob yield with husk was with the application of iron may be due to active involvement of electron transport enzymes like cytochrome and ferridoxin in photosynthesis and mitochondrial respiration. It is also a constituent of the enzyme catalase and peroxidase, which catalyse the breakdown of H_2O_2 (hydrogen peroxide) released during respiration into H_2O (water) and O_2 (oxygen) and oxygen preventing hydrogen peroxide toxicity. These two physiological process proved instrumental in increasing yield. Similar results were reported by Sudhagar et al. [15] in rice.

3.2.5 Cob yield without husk (t/ha)

Significant and higher cob yield without husk (5.45 t/ha) was observed in treatment 9 [Boron (7 kg/ha) + Iron (0.5 %)]. However, treatment 8 [Boron (7 kg/ha) + Iron (0.4%)] and treatment 7 [Boron (7 kg/ha) + Iron (0.3 %)] were found to be statistically at par with treatment 9 [Boron (7 kg/ha) + Iron (0.5%)] (Table 2). Significant and higher cob yield without husk was observed with the application of boron might be due to higher production of assimilates and better partitioning of photosynthates towards economic sinks. Similar results were reported by Jolli et al. [16] in sweet corn. Further, significantly higher cob yield without husk was with the application of iron may be due to because of favourable nutritional environment in rhizosphere of plant leading to the increased photosynthetic efficiency and production of assimilates by higher absorption of nutrients. Similar results were reported by Choudhary et al. [17] in sorghum.

3.2.6 Green fodder yield (t/ha)

Significant and higher green fodder yield (t/ha) was observed in treatment 9 [Boron (7 kg/ha) + Iron (0.5%)]. However, treatment 8 [Boron (7 kg/ha) + Iron (0.4%)] and treatment 7 [Boron (7 kg/ha) + Iron (0.3%)] were found to be statistically at par with treatment 9 [Boron (7 kg/ha) + Iron (0.5%)] (Table 2). Significant and higher green fodder yield was observed with the application of boron might be due to increase in plant height due to greater photosynthesis activity and chlorophyll synthesis results better in vegetative growth. Similar results were reported by Ojha et al. [12] in sweet corn. Further, significantly higher green fodder yield was with the foliar application of iron may be due to metabolism of carbohydrate, maintenance of the integrity of the cellular membranes, synthesis of protein and regulation of the auxin synthesis which increased shoot growth, development. Similar results were reported by Jolli et al. [16] in sweet corn.

3.3 Economic Analysis

3.3.1 Economics

The result showed maximum gross returns (81700.00 INR/ha), maximum net returns (55,297.00 INR/ha), highest benefit cost ratio (2.01) were observed in treatment-9 [Boron (7 kg/ha) + Iron (0.5%)] as compared to other treatment (Table 3). Highest benefit cost ratio was recorded with the application of iron (0.5%) which might have played key role in both assimilation rate and metabolic activities in plant and improved yield, resulted highest benefit cost ratio. Similar results were reported by Rakesh and Bohra (2014).

Table 1. Effect of boron and iron on growth attributes of baby corn

S. No.	Treatments	Plant height (cm) 60 DAS	Dry weight (g) 60 DAS	Crop growth rate (g/m^2/day) 45-60 DAS	Relative growth rate (g/g/day) 45-60 DAS
1.	Boron 5 kg/ha + Iron 0.3%	134.69	80.44	75.28	0.055
2.	Boron 5 kg/ha + Iron 0.4%	135.01	81.27	75.90	0.055
3.	Boron 5 kg/ha + Iron 0.5%	135.75	81.11	76.27	0.055
4.	Boron 6 kg/ha + Iron 0.3%	135.79	81.81	75.86	0.054
5.	Boron 6 kg/ha + Iron 0.4%	136.37	81.98	77.05	0.055
6.	Boron 6 kg/ha + Iron 0.5%	137.04	82.11	76.90	0.055
7.	Boron 7 kg/ha + Iron 0.3%	137.42	85.53	81.80	0.055
8.	Boron 7 kg/ha + Iron 0.4%	138.41	86.15	82.21	0.057
9.	Boron 7 kg/ha + Iron 0.5%	138.42	86.17	82.42	0.058
10.	Control	135.86	81.39	77.43	0.056
	F-test	S	S	S	NS
	SEm (±)	0.346	0.055	0.12	0.0001
	CD (p=0.05)	1.03	0.16	0.38	-

Table 2. Effect of boron and iron on yield attributes of baby corn

S. No.	Treatments	Number of cobs/plant	Length of cob (cm)	Girth of cob (cm)	Cob yield with husk (t/ha)	Cob yield without husk (t/ha)	Green fodder yield (t/ha)
1.	Boron 5 kg/ha + Iron 0.3%	1.20	18.03	4.80	8.18	5.30	18.56
2.	Boron 5 kg/ha + Iron 0.4%	1.40	18.13	4.83	8.22	5.31	18.67
3.	Boron 5 kg/ha + Iron 0.5%	1.67	18.17	4.97	8.22	5.32	18.75
4.	Boron 6 kg/ha + Iron 0.3%	1.60	18.07	5.00	8.26	5.34	18.78
5.	Boron 6 kg/ha + Iron 0.4%	1.80	18.17	5.10	8.27	5.38	18.83
6.	Boron 6 kg/ha + Iron 0.5%	2.00	18.23	5.13	8.27	5.40	18.87
7.	Boron 7 kg/ha + Iron 0.3%	1.80	18.33	5.17	8.28	5.41	19.09
8.	Boron 7 kg/ha + Iron 0.4%	2.08	18.43	5.20	8.30	5.44	19.10
9.	Boron 7 kg/ha + Iron 0.5%	2.13	18.57	5.27	8.33	5.45	19.14
10.	Control	1.07	18.43	4.76	7.65	4.82	18.26
	F-test	S	NS	NS	S	S	S
	SEm(±)	0.037	0.047	0.018	0.018	0.047	0.009
	CD (p=0.05)	0.11	-	-	0.05	0.06	0.14

Table 3. Effect of boron and iron on economics of baby corn

S. No.	Treatments	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C ratio
1.	Boron 5 kg/ha + Iron 0.3%	26,803.00	79,500.00	52,698.00	1.97
2.	Boron 5 kg/ha + Iron 0.4%	26,803.00	79,650.00	52,846.00	1.97
3.	Boron 5 kg/ha + Iron 0.5%	26,803.00	79,850.00	53,047.00	1.98
4.	Boron 6 kg/ha + Iron 0.3%	27,103.00	80,100.00	52,999.00	1.96
5.	Boron 6 kg/ha + Iron 0.4%	27,103.00	80,700.00	53,595.00	1.98
6.	Boron 6 kg/ha + Iron 0.5%	27,103.00	81,000.00	53,896.00	1.99
7.	Boron 7 kg/ha + Iron 0.3%	27,403.00	81,150.00	53,748.00	1.96
8.	Boron 7 kg/ha + Iron 0.4%	27,403.00	81,550.00	54,146.00	1.98
9.	Boron 7 kg/ha + Iron 0.5%	27,403.00	81,700.00	55,297.00	2.01
10.	Control	23,743.00	61,800.00	38,059.00	1.61

4. CONCLUSION

It is concluded that in baby corn with the combination of Boron (7 kg/ha) along with the Iron (0.5%) in (treatment 9) was recorded highest cob yield and benefit cost ratio.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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