Original Research Article

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

ABSTRACT

A field experiment was conducted during*zaid*season 2022 at Crop Research Farm 2, Department of Agronomy,Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj,Uttar Pradesh, India.The soil of the experimental field was sandy loam in texture, slightly alkaline in soil reaction(pH 8), low level of organic carbon (0.28%), available N (219 kg/ha), P (11.6 kg/ha) and K (217.2 kg/ha). The experiment was conducted in randomized block design consisting of 10 treatments with 3 different levels of boron 5kg/ha, 6kg/ha, 7kg/ha (soil application) and different levels of iron 0.3%, 0.4% and 0.5% (foliar application) with three replications and the treatments were allocated randomly in each replication.On the topic "Effect of Boron andIron on Growth and Yield of Baby corn (*Zea mays*L.)".The results showed thattreatment 9 with the application of Boron (7kg/ha)+Iron(0.5%)recorded (significantly higher plant height(138.42cm), higher plant dry weight (86.17g),maximum crop growth rate (82.42g/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(81,700.00INR/ha), maximum net returns (55,297.00INR/ha) and benefit ratio (2.01) was recorded in treatment 9 with the application of Boron (7kg/ha)+ Iron (0.5%) as compared to other treatments. Minimum parameters were recorded in treatment 10 control plot with RDF 100:60:40 kg/ha NPK.

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Keywords: *Baby corn, Boron, Iron,Growth,Yieldand Economics.*

INTRODUCTION

Baby corn is an ear of maize (Zea mays L.) that has been harvested when it is still young, typically before the silks have fully emerged or have just begun. Maize cobs are used as a vegetable is known as baby corn. The crop requires well-drained and sandy loam to silty loam soils for optimum growth and development. The cobs from a baby corn crop takes about 50–55 days to mature, and the rest of the plant can be used as green fodder. Presently baby corn is gaining popularity among Indian farming communities mainly due to its short duration, high market rate, nutritive value and also its multiuse.These are consumed by human beings as a source of vegetable and after harvest the plant can be used as green fodder. 100 grams of baby corn contains 89.1% of Moisture, 1.9 g of Protein, 0.2 gof Fat, 0.06 g of Ash, 8.2 mg of Carbohydrate, 28 mg of Calcium, 86 mg of Phosphorus and 11 mg of Ascorbic Acid **(Thavaprakash*et al*., 2005)**.

Globally, countries like Thailand, China and Taiwan are leading producers of baby corn. The greatest production of baby corn is in Thailand **(Wang, 2009).**In India, which is the 5thlargest producer in the world and accounts for 3% of worldwide production, maize is grown over an area of roughly 9.18 million hectares, with a yield of 27.23 million tonnes and an average productivity of 2965 kg/ha. With a contribution of 14.87% (1.37 million tonnes) of the total Indian maize produced area, while Uttar Pradesh gives an area of approximately 0.73 million hectares with a 7.98% to the entire country of India, which has a production of approximately 1.53 million **(GOI, 2021)**.

Problems facing by deficiency of Boron is it affects photosynthesis indirectly byweakening vascular tissues responsible for ion transport **(Wang *et al*., 2015).** B deficiency activates enzymatic and non-enzymatic oxidation by using phenol as substrate, resulting in elevated polyphenol oxidase and quinine concentrations, which are hazardous for plant growth and development **(Hajiboland*et al*., 2013).** Iron, the lack of which causes chlorosis and is responsible for significant decreases in yield and quality of plants.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 impact the amount of iron and its availability in soil. For instance, we know that high pH, bicarbonates content, and low soil temperatures reduce iron availability. Water excess particularly in acidic soils and compacted or poorly aerated soils can also decrease iron availability.

The micronutrient boron is essential to the growth and health of all crops. Cell walls and reproductive structures of plants contain this compound. The requirements of boron to crop is affected by several environmental factors like temperature, light and soil water conditions **(Shorrocks, 1997).** The nutrient is mobile in the soil, which means it is prone to movement. As

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Boron is needed in small amounts, it is important that it is distributed evenly across the field. It plays a key role in numerous plant functions, including cell wall formation and stability, the maintenance of structural and functional integrity of biological membranes, the movement of sugar into growing parts, and pollination and seed germination. Adequate B is also required for effective nitrogen fixation and nodulation in legume crops. It is more common for crops to lack boron than for any other micronutrient **(Gupta *et al.*, 1985)**. B is involved in the structural and functional integrity of the cell wall and membranes, cell division and elongation, nitrogen andcarbohydrate metabolism, sugar transport, cytoskeletal proteins, and plasmalemma-bound enzymes, nucleic acid, indoleacetic acid, polyamines, ascorbic acid, and phenol metabolism and transport.

Essential nutrient is Iron (Fe), plays a significant role in various physiological and biochemical pathways in plants. It serves as a component of many vital enzymes such as cytochromes of the electron transport chain, and it is thus required for a wide range of biological functions. In plants, iron is involved in the synthesis of chlorophyll, and it is essential for the maintenance of chloroplast structure and function. Foliar feeding is a new and controversial technique of feeding plants by applying liquid fertilizer directly to their leaves **(Rout and Sahoo,2015)**. 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.)’’.

Materials and Methods

The experiment was conducted during *Zaid*season 2022 at Crop Research Farm 2, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, (U.P). The topic titled “Effect of boron and iron on growth and yield of Baby corn (Zea mays L.)”, to study the response of Boron (5kg/ha, 6kg/ha, 7kg/ha) with combination of Iron (0.3%, 0.4% and 0.5%). Thesoil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 8.0), low in organiccarbon (0.64 %), available Nitrogen (220 kg/ha), available P (37 kg/ha) and available K(240.7 kg/ha). There were 10 treatments, and replicated thrice and laid out in Randomized BlockDesign(RBD). The treatment combinations are treatment 1 [Boron (5 kg/ha) + Iron (0.3%)], treatment2 [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 (0.3%)], 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 different aspects of crop such as, growth parameters and yield attributes were subjected to statistical analysis byvariance method Gomez and Gomez (1976).

RESULT AND DISCUSSION

Growth parameters

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*. (2022)** in maize. Further, significantly higher plant height with foliar application of iron was probably due to improve in photosynthesis activity, activates many enzymes and helps in transportation of assimilates towards stem. Similar results were reported by **Babu and Mehera (2022).**

Plant dry weight (g)

The data revealed that, significant and maximum plant dry weight (106.76g) 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 accumulation of dry matter in plant. Similar results were reported by **Ojha*et al*. (2023)** 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.* (2022).**

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

The data revealed that, significant and maximum crop growth rate (82.42g/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 starch utilization at early stages which enhances the accumulation of assimilate, this application accelerates plant growth, cell division and contributed to increase in higher crop growth rate. Similar results were reported by

Priyanka *et al*. (2022) in maize.

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).

Yield attributes and Yield

Number of cobs/plant

The data revealed 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 key role in plant metabolism and in the synthesis of nucleic acid. Similar results were reported by **Ojha*et al*. (2023)** 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.* (2020).**

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).

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).

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 carbohydrate from the source to sink by the effect of applied nutrients on the cell metabolism which promoted the meristematic activity of the crop and its better uptake by plants for favorable metabolic processes such as nucleic acid,carbohydrate, protein, auxins etc. Similar results were reported by **Prashanth*etal.* (2018)** 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.* (2019)** in rice.

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.* (2020)** 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.* (2017)** in sorghum.

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 in better vegetative growth. Similar results were reported by**Ojha*et al.*(2023)** in sweet corn. Further, significantly higher green fodder yield was with the foliar application of iron may be due to carbohydrate metabolism, maintenance of the integrity of cellular membranes, protein synthesis and regulation of auxin synthesis which increased shoot growth and development. Similar results were reported by **Jolli*et al.* (2020)** in sweet corn.

Economics

Cost of cultivation (INR/ha)

The maximum cost of cultivation (27,403.00INR/ha) was found to be highest in treatment-9[Boron (7 kg/ha) + Iron (0.5%)] and minimum cost of cultivation (23,743.00 INR/ha) was found to be in treatment-10 (control) as compared to other treatments (Table 3).

Gross return (INR/ha) The maximum gross returns (81700.00 INR/ha) were found to be highest in treatment-9[Boron (7 kg/ha) + Iron (0.5%)]and minimum gross returns (61,800.00 INR/ha) was found to be in treatment-10 (control) as compared to other treatments (Table 3).

Net returns (INR/ha)

The maximum net returns (55,297.00 INR/ha) were found to be highest in treatment-9 [Boron (7 kg/ha) + Iron (0.5%)]and minimum gross returns (38,059.00INR/ha) was found to be in treatment-10 (control) as compared to other treatments (Table 3).

Benefit cost ratio (B:C)

The maximum Benefit Cost ratio (2.01) was found to be highest in treatment-9 [Boron (7 kg/ha) + Iron (0.5%)] and minimum gross returns (1.61) was found to be in treatment-10 (control) as compared to other treatment (Table 3). Higher B:C ratio was obtained with application of boron due to maximum output of yields such as cob yield, green fodder yield and low inputs used in the cultivation resulted in highest benefit cost ratio. Further, highest benefit cost ratio was recorded with the application of iron (0.5%) which might have played major 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 attributesof 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

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 observed highest cob yield and benefit cost ratio.

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