Original Research Article

Effect of Phosphorus and Boron on Growth, Yield and Economics of Sweet Corn(*Zea mays* L.)

ABSTRACT

The experiment was conducted in CRF in Department of Agronomy during summer *season* of 2022 on Sweet corn crop. The treatments consisted of 3 ~~Level~~ levels of Phosphorus (50kg/ha ,100kg/ha, 150kg/ha) and ~~Level of~~ Boron (200g/ha, 300g/ha, 400g/ha) each. The experiment was laid out in Randomized Block Design with ten treatments each replicated thrice. Application of Phosphorus 150kg/ha and Boron 400g/h produced higher Plant height (196.33cm),dry weight/plant(70.97g), maximum number of cobs per plant (1.93), cob length (20.27cm), Number of grain rows per cobs (26.65), Cob yield (6.5t/ha), Stover yield (12.23t/ha), Seed index (21.51), Harvest index (34.75) Treatment combination with Phosphorus 150kg/ha + Boron 400g/ha had highest gross return (256150INR/ha), net return (198768.98INR/ha), and benefit cost ratio (3.46) when compared to the control (RDF).

Keywords- Sweet corn, Phosphorus, Boron, Yield and Economics

INTRODUCTION

Maize (Zea mays L.) is a cereal crop and it is called as "queen of cereals" and "non-tillering plant". Maize is one of the three major world food crops, is recognized as the "golden food" because of its high grain yield and nutrition value, and plays a very important role in the daily calorie intake of humans. Maize is the third most important crop in India after rice and wheat. In the world, India's ranks 5th in acreage and 8th in production of maize (USDA2018). Globally, total area of maize was 186.86 m ha, production 1078.56 M mt and in India area under maize cultivation is about 9.63 m ha, production 25.90 M mt in 2016-17 (1). Maize is important crop in the world grown in more than 170 countries having 193.7 million ha area with 1162.35 million tons of production (FAOSTAT, 2021). The major maize producing countries are USA, China, Brazil, Mexico, France, and India. USA has the largest area and production in the world. Italy having highest productivity in the world 9600 kg/ha followed by France with 8800 kg/ha. It is a widely grown cereal and is categorized as primary staple food in many developing countries. It is third most important cereal crop after rice and wheat and is being

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grown throughout the year but mainly in Kharif crop. The maize is cultivated throughout the year in all state of the country for various purpose including grain, fodder, green cobs, sweet corn, baby corn, popcorn, in peri urban area. Contributing nearly 8.0% in the nation food basket. (Directorate of Economics and Statistics, Department of Agriculture and cooperation, Govt. of India) in Uttar Pradesh The area, production, and productivity of Maize are 0.78 million hectare, 1.19 million tons and 1504 kg/ha respectively.

Sweet corn scientifically known as *Zea mays* L. var Saccharata is a variety of maize with a high sugar content. Sweet corn is the result of a naturally occurring recessive mutation in the genes which control conversion of sugar to starch inside the endosperm of the corn kernel. Unlike field corn varieties, which are harvested when the kernels are dry and mature (dent stage), sweet corn must be picked when immature (milk stage) and prepared and eaten as a vegetable, rather than a grain. Since the process of maturation involves converting sugarto starch, sweet corn stores poorly and must be eaten fresh, canned or frozen, before the kernels become tough and starchy (Ronley C. Canatoy, 2018). Sweet corn is a medium plant type and provides green Cobs in 65 to 75 days after sowing. These are harvested earlier by 35 to 45 days compared to normal grain maize. The demand for sweet corn as a crunchy bite in the amusement parks, theatres, circus and exhibitions is increasing with increasing urban population. Due to its increasing demand, there is an increasing tendency for commercial production of sweet corn (Ashwani Kumar Thakur *et al.*2015). Of late, sweet corn is emerging as one of the important enterprises projecting diversified and value-added uses of maize.

Phosphorus plays a vital role besides nitrogen in plant nutrient that influences vigour of plant, root growth and improves the quality of crop yield. Phosphorus is an essential factor for cell division because it is a constituent element of nucleoproteins which are involved in the cell reproduction processes. It is also a component of a chemical essential to the reactions of carbohydrate synthesis and degradation. It is important for seed and fruit formation and crop maturation. Phosphorus hastens the ripening of fruits thus counteracting the effect of excess nitrogen application to the soil. It helps to strengthen the skeletal structure of the plant thereby preventing lodging. It also affects the quality of the grains and it may increase the plant resistance to diseases. (Umeri *et. al* 2016)

Boron is an important nutrient for the growth and development of plants and participates in several physiological processes in plants. Boron contributes to cell wall strength and development, as well as being critical to cell division, seed development, sugar synthesis and transport, respiration, and hormone development. This element also regulates the production of auxin in the plants, which is a plant hormone that among other functions is responsible for elongation, cell division, and growth of the plant Boron is essential to pollen

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kernel germination and pollen tube elongation which helps provide successful fertilization or pollination, preventing the abortion of flowers, and improves the grain setting by improving the grain filling process and reducing the male sterility often observed in boron deficient condition. (Ziaeyan *et.al* 2009)

MATERIALS AND METHODS:

The field experiment was conducted during *kharif* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P.). The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 8), low level organic carbon (0.62%), medium available N (225 Kg/ha), high in available P (38.2 kg/ha) and low available K (240.7 kg/ha). The treatment consists of 3 levels of Phosphorus (50 kg/ha), Phosphorus (100kg/ha) and Phosphorus (150 kg/ha) with combination of different levels of Boron (200 g/ha), (300 g/ha) and (400 g/ha). The experiment was laid out in RBD with 10 treatments each replicated thrice. The treatment combinations are T_1 Phosphorus (50 kg/ha) + Boron (200 g/ha). T_2 Phosphorus (50 kg/ha) + Boron (300 g/ha), T_3 Phosphorus (50 kg/ha) + Boron (400 g/ha), T_4 Phosphorus (100 kg/ha) + Boron (200 g/ha), T_5 Phosphorus (100 kg/ha) +Boron (300 g/ha), T_6 Phosphorus (100 kg/ha) + Boron (400 g/ha), T_7 Phosphorus (150 kg/ha) + Boron (200 g/ha), T_8 Phosphorus (150 kg/ha)+ Boron (300 g/ha), T_9 Phosphorus (150 kg/ha) + Boron (400 g/ha), T_{10} (Control) N:P:K 100:60:40 kg/ha.

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Kindly mention. And If the nitrogen is scheduled into 2-3 doses, kindly also mention why or just provide reference such as:

1.Verma, K., Prasad, S. K., Singh , M. K., & Sharma , P. . (2023a). Assessment of Agronomic Zinc Biofortification of Alley Cropped Pearl Millet. *Bangladesh Journal of Botany*, *52*(1), 203–209. https://doi.org/10.3329/bjb.v52i1.65252

2. Verma, K., Prasad, S.K., Singh, M.K., & Sharma, P. (2023b). Response of alley-cropped pearl millet (Pennisetum glaucum) to nitrogen and zinc schedules under semi-arid regions. Indian Journal of Agronomy, 68(1), 105-109.

The growth parameters and yield, production was recorded at harvest from randomly selected plants in each plot. The data was computed and analyzed by following statistical method .

Comment [PS12]: The statistically procedure need to mentioned in detail.

RESULT AND DISSCUSSION

GROWTH PARAMETERS

Plant height (cm)

There was a significant increase in plant height (196.33cm) was observed with application of 150kg P/ha along with 400g/ha B. However, treatment Phosphorus 150kg/ha +Boron 200g/ha (189.11cm) and treatment Phosphorus 150kg/ha +Boron 300g/ha (193.27cm) were statistically at par with application of 150kg/ha Phosphorus along with 400g/ha Boron. It might be due to the optimum rate of P trigger an increase in production per unit area. Phosphorus improves the root growth which has a great effect on the overall plant growth performance. Boron will also play a major role in plant height which might be attribute to greater photosynthesis activity and chlorophyll synthesis resulting into better vegetative growth. The improvement in plant height was due to interaction of both Phosphorus and Boron application in sweet corn crops. Similar results were reported by (**Umeri *et al*. 2016) and** (**Tahir *et al*. 2012)**

Comment [PS13]: Relevant citation should be provided. Such as:
Sharma, I., Singh, R. K., Tiwari, P., & Sharma, P. (2017). Effect of different Spacing and Phosphorus levels on growth and yield parameters of Mungbean under guava based Agri-horti System. *Journal of Pharmacognosy and Phytochemistry*, *6*(6S), 993-996.

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Dry weight (g)

There was significant increase in dry weight (70.97g) observed with the application of Phosphorus 150kg/ha +Boron 400g/ha. However treatment Phosphorus 150kg/ha + 200g/ha (69.23g) and treatment Phosphorus 150kg/ha + 300g/ha (67.84g) were statistically at par with application of 150kg/ha Phosphorus along with 400g/ha Boron.

Dry weight was increased significantly with increasing level of boron as boron generally influences cell division and nitrogen absorption from the soil might enhanced plant growth which reflects intern of plant dry weight. The probable reason for recording higher dry weight due to application of 150kg phosphorus might be due to enhanced availability and use of N, water and other associated soil properties due to organic source which make plant more efficient is photosynthetic activity. Phosphorus improves the root growth and better biomass production which has a great effect on the overall plant growth performance. The result was found in accordance with (**Ram *et.al* 2019)**

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YIELD PARAMETERS

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Cob / Plant

At the time of harvest, significantly maximum number of cobs per plant (1.93) recorded in treatment Phosphorus 150kg/ha +Boron 400g/ha. However, treatment 50kg/ha +Boron 300g/ha (1.66) were statistically at par with application of 150kg/ha Phosphorus along with 400g/ha Boron. The increase in number of cob/plant due to the application of Boron and positive effect of boron may due to key role in plant metabolism and in the synthesis of nucleic acid., similar result found by (**Tahir *et.al* 2012**). However maximum number of cobs/plant was observed in sweet heart variety with application of Phosphorus 150kg/ha. it might be due to the fact that optimum availability of Phosphorus has associated with increase rapid growth and development thus those plots which received optimum Phosphorus produced more cobs/plant as compared to 50kg/ha Phosphorus. similar result found by (**Sabu *et.al* 2021)**

Cob Length

At the time of harvest, significantly maximum cob length was recorded (20.27cm) recorded in treatment Phosphorus 150kg/ha +Boron 400g/h. However, treatment Phosphorus 150kg/ha +Boron 300g/ha (18.95cm) were statistically at par with application of 150kg/ha Phosphorus along with 400g/ha Boron. However, maximum cob length was observed in sweet heart variety with application of Phosphorus 150kg/ha + Boron 400g/ha. It might be due to the fact that optimum availability of P has been associated with increased rapid growth and development, thus those plots which received optimum P produced maximum cob length. They argued that minimum cob length with application of Phosphorus 50kg/ha. similar result found by (**Wasim *et. al* 2017)**

Grain row

At the time of harvest, significantly maximum Grain row was recorded (26.65) recorded in treatment Phosphorus 150kg/ha +Boron 400g/h. However, treatment Phosphorus 150kg/ha +Boron 300g/ha (25.16), Phosphorus 150kg/ha +Boron 300g/ha (24.13), and 24 respectively. were statistically at par with application of 150kg/ha Phosphorus along with 400g/ha Boron. The probable reason for recording maximum grain row in sweat heart variety of with application of Phosphorus + Boron might be due to the increased availability of photosynthates with increased fertility level might have enhanced number of flowers and their fertilization resulting in higher number of filled cobs or grain per cob. Further , in most of cereals greater assimilating surface at reproductive developments results in better grains formation because of adequate production of metabolites and their translocation towards grains. Similar result found with (**Sankadiya *et.al* 2021)**

Seed index

The maximum seed index was observed with application of Phosphorus 150kg/ha +Boron 400g/h (21.51g). which was significantly superior over all the treatment .However, the treatment with application of Phosphorus 150kg/ha + Boron 300g/ha (20.92g) was found to be statistically at par with application of 150kg/ha Phosphorus along with 400g/ha Boron. The probable reasons for recording maximum seed index with application of Phosphorus and Boron might be due to greater contribution of P&B by producing healthy grain i-e well filled grains and bigger grains while minimum grain weight was obtained at lower level of P&B kg/ha The interaction of varieties and fertilizer from the data is also significant. Similar result found by (**Mehta *et. al* 2005).**

Harvest index

The highest harvest index was recorded with the application of Phosphorus 150kg/ha +Boron 400g/h (41.07). which was significantly superior over all the treatment .However, the treatment with application of Phosphorus 150kg/ha + Boron 300g/ha (38.55) , and Phosphorus 150kg/ha + Boron 200g/ha (38.04) was found to be statistically at par with application of 150kg/ha Phosphorus along with 400g/ha Boron. (**Kumar *et.al* 2019)**

Grain Yield

The data showed that the grain yield (6.5 t/ha) of sweet corn was found with application of Phosphorus 150kg/ha + Boron 400g/ha which was superior over all other treatments. respectively, treatment with application of Phosphorus 150kg/ha + Boron 300g/ha(6.26t/ha) and treatment with application of Phosphorus 150kg/ha + Boron 200g/ha (6.16t/ha) was found to be statistically at par with application of 150kg/ha Phosphorus along with 400g/ha Boron. Phosphorus and Boron play a vital role in increasing grain yield because Boron takes place in many physiological process of plant such as chlorophyll formation , stomatal regulation, starch utilization which enhances grain yield .Boron required for many physiological processes and plant growth, also adequate nutrition is a critical for increase yields and quality of crops. These results are in confirmatory with the work of (**Humtsoe *et al.* 2018)** and (**Tahir *et .al* 2012)**

Stover Yield

The maximum stover yield was recorded (12.23t/ha) with the application of Phosphorus 150kg/ha + Boron 400g/ha which was superior over all other treatments. respectively, treatment with application of Phosphorus 150kg/ha + Boron 300g/ha (11.83t/ha) and treatment with application of Phosphorus 150kg/ha + Boron 200g/ha (11.63t/ha) was found to be statistically at par with application of 150kg/ha Phosphorus along with 400g/ha Boron. Phosphorus and Boron play a vital role in increasing stover yield because application of Phosphorus might be the optimum rate of trigger an increase in production of stover per unit area. It improves the root growth which has a great effect on the overall plant growth performance. With the increase in levels of boron the plant height gradually increased which might be attributable to greater photosynthesis activity and chlorophyll synthesis due to boron fertilizer resulting into better vegetative growth. Similar result found by (**Soomro *et al*. 2011)**

ECONOMICS

The result showed (Table 3) that maximum grass return (INR_256150/ha), net return (198768.98/ha)and B:C ratio (3.46) was recorded in treatment 9 [Phosphorus (150kg/ha)+Boron (400g/ha)] as compared to other treatment. Higher Gross return, Net return and Benefit cost ratio was recorded with application of Phosphorus 150kg/ha along with application of Boron 400g/ha . From the one year experiment it can be concluded that treatment 9 Phosphorus 150kg/ha+ Boron 400g/ha gave maximum Plant height, dry weight, No. of cobs/plant, cob length, grain rows, seed index, cob yield, stover yield and Harvest index.

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CONCLUSION

It can be concluded that in Sweet corn with the application of Phosphorus 150 kg/ha along with the application of Boron 400 g/ha (Treatment 9) was observed highest Cob yield and benefit cost ratio.

Comment [PS17]: Conclusion need to be extended.

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Table 1. Influence of Phosphorus and Boron on growth attributes of Sweet corn.

S. No.	Treatment combination	At 60 DAS	
		Plant height (cm)	**dry weight (g)**
1.	Phosphorus 50kg/ha + Boron 200g/ha	164.67	57.43
2.	Phosphorus 50kg/ha + Boron 300g/ha	169.91	58.56
3.	Phosphorus 50kg/ha + Boron 400g/ha	164.92	59.92
4.	Phosphorus 100kg/ha + Boron 200g/ha	174.79	62.08
5.	Phosphorus 100kg/ha + Boron 300g/ha	170.07	63.44
6.	Phosphorus 100kg/ha + Boron 400g/ha	176.35	64.04
7.	Phosphorus 150kg/ha + Boron 200g/ha	189.11	67.84
8.	Phosphorus 150kg/ha + Boron 300g/ha	193.27	69.23
9.	Phosphorus 150kg/ha + Boron 400g/ha	196.33	70.97
10.	(Control) N:P: K 100:60:40 kg/ha	161.48	52.05
	F-test	S	S
	SEm (±)	5.94	2.09
	CD (p=0.05)	17.67	6.21

Table 2. Effect of Phosphorus and Boron on Yield attributes and Yield of Sweet corn

		Yield and Yield attributes						
S.No.	Treatments	Cob/Plant	Cob length	Grain Row	Seed index	Harvest Index (%)	Cob yield (t/ha)	Stover yield (t/ha)
1.	Phosphorus 50kg/ha +Boron 200g/ha	1.20	15.92	20.94	17.62	31.57	4.2	9.13
2.	Phosphorus 50kg/ha +Boron 300g/ha	1.33	15.76	22.03	17.91	33.08	4.5	9.13
3.	Phosphorus 50kg/ha +Boron 400g/ha	1.40	16.56	22.36	18.11	33.33	5.1	10.2
4.	Phosphorus 100kg/ha +Boron 200g/ha	1.40	16.69	23.02	18.58	32.91	5.2	10.6
5.	Phosphorus 100kg/ha +Boron 300g/ha	1.46	16.68	23.60	18.59	33.12	5.4	10.9
6.	Phosphorus 100kg/ha +Boron 400g/ha	1.53	16.36	24.00	19.12	33.74	5.5	10.8
7.	Phosphorus 150kg/ha +Boron 200g/ha	1.53	17.10	24.13	19.30	34.46	6.1	11.6
8.	Phosphorus 150kg/ha +Boron 300g/ha	1.66	18.95	25.16	20.92	34.44	6.2	11.8
9.	Phosphorus 150kg/ha +Boron 400g/ha	1.93	20.27	26.65	21.51	34.75	6.5	12.2
10.	Control Plot (N:P: K 100:60:40)	1.06	16.60	21.00	16.73	31.34	4.2	9.26
	F test	S	S	S	S	S	S	S
	SEm(±)	0.12	0.49	0.89	0.61	1.15	0.30	0.33
	CD(p=0.05)	0.37	1.47	2.66	1.82	0.98	0.89	1.00

Table 3. Effect of Phosphorus and Boron on economics of Sweet corn

S. No.	Treatment combination	Economics			
		Cost of cultivation (₹/ha)	**Gross return (₹/ha)**	**Net return (₹/ha)**	**B:C ratio**
1.	Phosphorus 50 kg/ha + Boron 200 g/ha	51731.52	171650	119918.48	2.31
2.	Phosphorus 50 kg/ha + Boron 300 g/ha	51931.52	180650	128718.46	2.47
3.	Phosphorus 50 kg/ha + Boron 400g/ha	52131.52	204000	151868.47	2.91
4.	Phosphorus 100 kg/ha + Boron 200g/ha	54356.52	209000	154643.43	2.84
5.	Phosphorus 100 kg/ha + Boron 300g/ha	54556.52	216500	161943.54	2.96
6.	Phosphorus 100 kg/ha + Boron 400g/ha	54756.52	219000	164243.62	2.99
7.	Phosphorus 150 kg/ha + Boron 200g/ha	56981.52	241150	184168.76	3.23
8.	Phosphorus 150 kg/ha + Boron 300g/ha	57181.52	245150	187968.88	3.28
9.	Phosphorus 150 kg/ha + Boron 400g/ha	57381.52	256150	198768.98	3.46
10.	Control + RDF (NPK-100:60:40 kg/ha)	48706.52	172000	123293.11	2.53