Original Research Article

Response of Spacing and Nitrogen on Yield and Economics of *Kharif* Sweetcorn (*Zea mays* L. *saccharata*)

ABSTRACT

A field experiment was conducted during *Kharif* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P)~~.T~~to study treatments consisting of three levels of ~~Nitrogen~~ nitrogen ~~such as,~~(80, 100 and 120 kg/ha)with spacing such as 75×~~x~~10 cm^2, 60×~~x~~20 cm^2 and 45×~~x~~30 cm^2. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.28 %), available N (225 kg/ha), available P (19.50 kg/ha) and available K (92 kg/ha). There were 9 treatments each being replicated thrice and laid out in ~~Randomized~~ randomized ~~Block~~ block ~~Design~~design. The results revealed that treatment 8 (Nitrogen 120 kg/ha + 65x20 cm) was recorded maximum number of cobs/plant (2.33), higher seeds/row (41.33), maximum row/cob (14.40), weight of green cob (351.20 g), higher green cob yield (4.15 t/ha), higher stover yield (4.59 t/ha), harvest index (45.90 %), gross returns (1,48,950.00 INR/ha), net returns (1,04,914.00 INR/ha) and benefit cost ratio (2.38).

Comment [H1]: No need of writing soil initial properties in abstract;
Mention objective clearly along with treatment variables;
Result should be written in the form of increase in grain yield or any other important parameter over control/ check or inferior treatment.
Avoid giving the values for all parameter measured for best treatment (This make abstract difficult to read and get some conclusion).

Keywords: *Nitrogen, Spacing, Growth, Yield, Economics.*

INTRODUCTION

Comment [H2]: Avoid general information on sweet maize/corn, nitrogen nutrition and plan spacing in introduction section;
Include the review of literature on effect of crop nutrition and plant geometry on sweet maize or any other type of maize;
Author has to define research gap clearly followed by writing the objective of study.

Sweet corn (*Zea mays* L.*saccharata*), belongs to a family ~~Poaceae~~poaceae, is an important cereal food grain crop of the world, which is being grown in more than 166 countries across the globe including tropical, subtropical and temperate regions. It is a warm weather crop and grows from sea level to 3000m altitude and optimum temperature for better growth is 28-32^{o}C. It grows well in areas with annual rainfall 250-400 cm. It can be grown successfully in soils with pH ranging from 6.5-7.5. The alluvial soils of Uttar Pradesh are well suitable for raising sweet corn. The soils with sandy loam to silty loam texture are best for the crop **(Tomar *et al.* 2011)**. Globally, sweet corn is cultivated in nearly 201 m ha with a production of 1162 m tonnes and productivity of 5754.7 kg/ha all over the world, having wider diversity of soil, climate, biodiversity and management practices **(FAO 2020).** India produced 31.51 million tonnes in an area of 9.9 million hectares in 2020-21, whereas in *kharif* 2021-

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22, maize production was 21.24 million tonnes (~~1st advance~~1st advance estimates) in an area of 8.15 million hectares**.** In Uttar Pradesh, the area, production and productivity of maize are 0.78 million hectare, 1.19 million tonnes and 1504 kg/ha, respectively **(GOI, 2021)**.

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In central India, peoples consume a sizeable quantity of green cob, which generates potential for sweet corn cultivation in the area. As it is harvested at green cob stage, much before the maturity of the grain. It provides green cob in 75-80 days after sowing and harvested earlier by 35 to 45 days compared to normal grain maize. It has great market potential and high market value in India **(Sahoo and Mahapatra, 2007).** The higher content of water-soluble polysaccharides in the kernel adds texture and improves quality in addition to sweetness **(Venkatesh*et al.* 2003)**.It is a species of maize however, it differs from all other species of corn because it contains and retains a high amount of sugar in kernels. Since, the kernels of sweet corn accumulate two to three times more sugar in the endosperm than normal starchy maize **(Doehlert and kuo, 1993)**. It has single genes (sugary gene) that promote the sweetness in kernels, and convert the sugar in starch slowly, hence preserving the sweetness for longer period after harvest **(Garwood *et al.* 1976)**. So, it is grown for consuming immature kernels and harvest (at milky stage). Sweet corn is commonly used in many food dishes, cooking ingredient in salads and soups because it has unique taste and high nutritional value.

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Nitrogen is a vital plant nutrient and a major yield determining factor required for maize production. It is essential for carbohydrates metabolism within plants and stimulates vegetative and along with development uptake of other nutrients **(Khan *et al.* 2014)**. When more nitrogen is applied, excess vegetative growth occurs, and the plant lodges with a high wind velocity. Crop maturity is delayed, and the plants are more susceptible to pest and disease. Deficiency of nitrogen results in low plant growth which reduces the grain yield, leaf area duration and rate of photosynthesis. It imparts dark green color to plants. **(Pooja *et al.* 2018).** Nitrogen fertilizer is universally accepted as a key component to high yield and optimum economic return as it plays very important part in crop productivity and its deficiency is one of the major yield limiting factors for cereals production. Balanced and optimum use of nitrogen plays a pivotal role in increasing the yield of maize **(Sanjeev and Bangarwa, 1997)**. Nitrogen increases biomass production of a crop which largely depends on the function of leaf area development and consequential photosynthetic activity. Nitrogen in sweet corn growing is an important component influencing both yield and amino acids, which decide on the taste and nutrient value of kernels. **(Natr*et al.* 1992).**

Plant spacing is another important factor which plays a significant role on growth, development and yield of maize. Optimum plant population provides scope to the plants for efficient utilization of solar radiation and nutrients. Closer spacing hampers intercultural operations and as such more competition arises among the plant for nutrients, air and light. As results, plant becomes shorter, weaker, thinner and consequently reduces yield of maize. Adjustment of proper plant spacing in the maize field is important to ensure maximum utilization of solar energy by the crop and reduce evaporation of soil moisture **(FAO, 2012)**. So, optimum population should be maintained to exploit maximum natural resources, such as nutrients, sunlight, and soil moisture, to ensure satisfactory growth and yield. Narrow row spacing and higher plant density results to delay initiation of intraspecific competition **(Duncan, 1984)**. Maximum yield can be expected only when plant population allows individual plant to achieve their maximum inherent potential **(Rathod *et al.* 2018).**

Materials and Methods

The experiment was conducted during*Kharif*2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) ~~on the topic "Influence of Spacing and Nitrogen on growth and yield of *Kharif* Sweet corn (*Zea mays* L. *saccharatam*)",~~ to study treatments consisting of three levels of Nitrogen *viz.* 80, 100 and 120 kg/ha with spacing such as 75×~~x~~10 cm, 60×~~x~~20 cm and 45×~~x~~30 cm. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.28 %), available N (225 kg/ha), available P (19.50 kg/ha) and available K (92 kg/ha). There were 9 treatments each being replicated thrice and laid out in ~~R~~randomized b~~B~~lock d~~D~~esign. The treatment combinations are treatment 1 (Nitrogen 80 kg/ha + 75x10 cm), treatment 2 (Nitrogen 80 kg/ha + 60x20 cm), treatment 3 (Nitrogen 80 kg/ha + 45x30 cm), treatment 4 (Nitrogen 100 kg/ha + 75x10 cm), treatment 5 (Nitrogen 100 kg/ha + 60x20 cm), treatment 6 (Nitrogen 100 kg/ha + 45x30 cm), treatment 7 (Nitrogen 120 kg/ha + 75x10 cm), treatment 8 (Nitrogen 120 kg/ha + 60x20 cm), treatment 9 (Nitrogen 120 kg/ha + 45x30 cm). The data recorded on different aspects of crop such as, growth parameters, yield attributes and economics were subjected to statistical analysis by variance method **Gomez and Gomez, (1984)**.

RESULT AND DISCUSSION

Yield and Economics

Green cob yield (t/ha)

The data revealed that,~~Treatment~~treatment-8 (Nitrogen 120 kg/ha + 60 x 20 cm) was recorded significantly maximum green cob yield (4.59 t/ha) which was superior over all other treatments.

Comment [H4]: The material and method section need to rewrite considering following points:
1. Information on climate of selected location and weather condition prevailing during experimentation duration.
2. Information on crop cultivation practices were not given and need to mention;
3. Information on procedure of measurement of growth and yield parameters were not mentioned.

Comment [H5]: Trend in green cob yield and straw yield was same; hence results need to be combined;
It is difficult to understand-, If harvest index is higher T-8, than how both grain as well as straw yield is higher in same treatment? Moreover in table 1 Harvest index was reported as non-significant; while in text, it is written as significantly superior for T8 treatment.
Replace "x" with sign "×" from symbol in MS word.
The economics need to be discussed rather than just giving higher and lower value for cost of cultivation and gross and net return.
Author have to give yield attributes data as well as growth parameter data [As the data presented is not sufficient to be published as research paper and that too for single season.].
Express the values of cost of cultivation, gross return and net returns in multiple of 1000 for ease in reading of table (This is most commonly followed).
Cross returns, net returns and B:C ration can be given with statistical significance; See for the needful.

However, the treatment-9 (Nitrogen 120 kg/ha + 45 x 30 cm) was found to be statistically at par with treatment-8 (Nitrogen 120 kg/ha + 60 x 20 cm) [Table 1].Significant and higher green cob yield was with application of nitrogen 120kg/ha might be due to increasing rate of nitrogen could be attributed to enhanced availability of the nutrient for uptake by the plants and increased photo assimilates production that would eventually lead to improved partitioning of carbohydrates to the grains. Similar result was also reported by **Dankhar*et al.* (2019)**. Further, significant and higher green cob yield was with 60x30cm^2 spacing might be due to the competition between the plants might have reduced and equal distribution of all resources and increased nutrient uptake results in increase the yield of sweetcorn. Similar result was also reported by **Reddy *et al.* (2021).**

Stover yield (t/ha)

The data revealed that,Treatment-8 (Nitrogen 120 kg/ha + 60 x 20 cm) was recorded significantly maximum stover yield (4.59 t/ha) which was superior over all other treatments. However, the treatment-9 (Nitrogen 120 kg/ha + 45 x 30 cm) was found to be statistically at par with treatment-8 (Nitrogen 120 kg/ha + 60 x 20 cm) [Table 1].Significant and higher stover yield was with 60x30cm^2 spacing might be due to increased number of leaves, leads to increase photosynthetic rate and accumulation of more assimilates, increase the sink size of plant which leads to increase the stover yield of the crop. Similar result was also reported by **Naik *et al.* (2019)**. Further, higher stover yield was with application of nitrogen 120kg/ha might be due to higher availability of nitrogen to plants have stimulates various physiological process in plants and leads to increased growth parameters and stover yield of crop. Similar result was also reported by **Maurya *et al.* (2021)**.

Harvestindex (%)

The data revealed that,Treatment-8 (Nitrogen 120 kg/ha + 60 x 20 cm) was recorded significantly maximum harvest index (45.90%) which was superior over all other treatments and there was no significantly difference between the treatments [Table 1].

Economics

Cost of cultivation (INR/ha)

Cost of cultivation (50,286.00 INR/ha) was found to be highest in treatment-7 (Nitrogen 120 kg/ha + 75 x 10 cm) and minimum cost of cultivation (42,482.00 INR/ha) was found to be in treatment-3 (Nitrogen 80 kg/ha + 45 x 30 cm) as compared to other treatments [Table 2].

Gross return (INR/ha)

Gross returns (1,48,950.00 INR/ha) were found to be highest in treatment-8 (Nitrogen 120 kg/ha + 60 x 20 cm) and minimum gross returns (12,4350.00 INR/ha) was found to be in treatment-1 (Nitrogen 80 kg/ha + 75 x 10) cm as compared to other treatments [Table 2].

Net returns (INR/ha)

Net returns (1,04,914.00 INR/ha) were found to be highest in treatment-8 (Nitrogen 120 kg/ha + 60 x 20 cm) and minimum net returns (74,368.00 INR/ha) was found to be in treatment-1 (Nitrogen 80 kg/ha + 75 x 10) cm as compared to other treatments [Table 2].

4.15 Benefit Cost ratio (B:C)

Benefit Cost ratio (2.38) was found to be highest in treatment-8 (Nitrogen 120 kg/ha + 75 x 20 cm) and minimum benefit cost ratio (1.49) was found to be in treatment-1 (Nitrogen 80 kg/ha + 75 x 10) cm as compared to other treatments[Table 2].

Table 1 Influence of Spacing and Nitrogen on yield attributes of *Kharif* sweet corn

S.No.	Treatments combinations	Green Cob yield (t/ha)	Green fodder yield (t/ha)	Harvest Index (%)
1	Nitrogen 80 kg/ha + 75 x 10 cm	3.45	4.17	45.26
2	Nitrogen 80 kg/ha + 60 x 20 cm	3.73	4.46	45.58
3	Nitrogen 80 kg/ha + 45 x 30 cm	3.50	4.36	44.52
4	Nitrogen 100 kg/ha + 75 x 10 cm	3.60	4.29	45.62
5	Nitrogen 100 kg/ha + 60 x 20 cm	3.87	4.62	45.54
6	Nitrogen 100 kg/ha + 45 x 30 cm	3.64	4.52	49.48
7	Nitrogen 120 kg/ha + 75 x 10 cm	3.61	4.34	45.15
8	Nitrogen 120 kg/ha + 60 x 20 cm	4.15	4.89	45.90
9	Nitrogen 120 kg/ha + 45 x 30 cm	3.85	4.80	45.78
	F- test	S	S	NS
	S Em (±)	0.03	0.02	0.58
	CD (p =0.05)	0.11	0.08	-

Table 2Influence of Spacing and Nitrogen on Economics of *Kharif* Sweet corn~~.~~

S. No.	Treatment combinations		Cost of Cultivation (INR/ha)	Gross returns (INR/ha)	Net Return (INR/ha)	B:C ratio
~~1.~~	Nitrogen 80 kg/ha	+ 75 x 10 cm	49982~~.00~~	124350.00	74368.00	1.49
~~2.~~	Nitrogen 80 kg/ha	+ 60 x 20 cm	43732~~.00~~	134200.00	90468.00	2.06
~~3.~~	Nitrogen 80 kg/ha	+ 45 x 30 cm	42482~~.00~~	126800.00	84318.00	1.98
~~4.~~	Nitrogen 100 kg/ha	+ 75 x 10 cm	50132~~.00~~	129450.00	79318.00	1.58
~~5.~~	Nitrogen 100 kg/ha	+ 60 x 20 cm	43882.00	139200.00	95318.00	2.17
~~6.~~	Nitrogen 100 kg/ha	+ 45 x 30 cm	42632.00	131800.00	89168.00	2.09
~~7.~~	Nitrogen 120 kg/ha	+ 75 x 10 cm	50286.00	130000.00	79714.00	1.58
~~8.~~	Nitrogen 120 kg/ha	+ 60 x 20 cm	44036.00	148950.00	104914.00	2.38
~~9.~~	Nitrogen 120 kg/ha	+45 x 30 cm	42786.00	139500.00	96714.00	2.26

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CONCLUSION

Based on the above findings it was concluded that the Influence of spacing and Nitrogen perform effective improvement to yield and economics of *Kharif* sweet corn. The application of nitrogen 120 kg/ha along with spacing 60 x 20 cm for obtaining better production, net return and benefit cost ratio of sweet corn.

Comment [H6]: Write percent increase in grain and straw yield best treatment over control or inferior treatment.
Also write increase in return in best treatment over control or inferior treatment.

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References

Comment [H7]: Number of references enlisted in the reference section are not cited in the entire MS. See for correction;
Cross check the reference for their presence both in text and reference list.
Strictly follow the reference writing style of the Journal both for citing references in text and enlisting them in reference list.

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Comment [H8]: Not cited in the text

Comment [H9]: Not cited in the text.

Comment [H10]: Not cited in text.

10. Tomar, G.S., Tomar, S.P.S. and Khajanji, S.N., 2014. Science of Crop Production, Part-1 *Kharif* Crops, pp: 98-99.

Comment [H11]: Tomar et al., 2011 was cited in text; while here it is 2014; cross check