GROWTH AND YIELD OF SWEET CORN AS INFLUENCED BY NITROGEN ~~FERTILIZATION~~ LEVELS AND CROP GEOMETRY~~.~~

ABSTRACT

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An experiment entitled, "Growth and yield of sweet corn as influenced by nitrogen ~~fertilization~~ levels and crop geometry" was conducted during *kharif*, 2023 at new experimental cum demonstration field, Shri Vaishnav Institute of Agriculture,Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore. The soil ~~at the~~type experimental site was clayey in texture~~, low in available nitrogen (210.11 kg ha^{-1}), medium in available phosphorus (14.53 kg ha^{-1}), and very high in available potassium (455.24 kg ha^{-1}). The pH, EC and OC content of soil was 0.49, 0.74 dSm^{-1} and 0.49 per cent, respectively.~~The field experiment was laid out in a split plot design with three replication. The main plot treatment comprised of three crop geometry *viz*., 60 cm x 20 cm (S_1), 60 cm x 30 cm (S_2), 60 cm x 40 cm (S_3) whereas, sub plot treatments comprised of four nitrogen levels *viz*., 125: 60: 40 kg ha^{-1} (N_1), 100: 60: 40 kg ha^{-1} (N_2), 75: 60: 40 kg ha^{-1} (N_3) and control (N_4). The crop geometry of 60 cm x 20 cm has shown noticeably greater growth and yield parameters such as~~.~~, plant height at harvest, days to 50% ~~tasselling and 50% silking~~flowering, green cob yield, green fodder yield, biological yield and harvest index while, the crop geometry of 60 cm x 40 cm has shown noticeably greater growth qualities such as~~.~~, number of leaves at harvest, leaf area at harvest, dry matter at flowering and at harvest, yield attributing cob length with husk and without husk, cob diameter with husk and without husk, cob weight with husk and without husk, number of grains and grain weight cob^{-1}.

Application of 125 per cent RDN has recorded significantly higher growth parameters of sweet corn such as, plant height at harvest, number of leaves at harvest, leaf area plant^{-1} at harvest, dry matter plant^{-1} at flowering and at harvest, yield attributing characters such as cob length plant^{-1}with husk and without husk, cob diameter plant^{-1}with husk and without husk, cob weight plant^{-1}with husk and without husk, number of grains cob^{-1}, number of grains row^{-1}, grain weight cob^{-1}, green cob yield, green fodder yield, biological yield and harvest index. Control treatment took maximum days to days to 50 per cent tasselling and 50 per cent silking.

Keywords: Sweet corn, plant spacing, crop geometry, nitrogen fertilizers.

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INTRODUCTION

Sweet corn, scientifically known as *Zea mays* L. var. rugosa, belongs to the Poaceae family, also known as the grass family, encompassing a diverse range of cereal crops such as maize (corn), rice, wheat, barley, and oats. This cultivated variety of maize typically possesses a diploid chromosome number of 2n = 20, though there can be genetic variation among different cultivars. There is no any other cereal on the earth, that has so immense yield potential as that of maize and hence, occupied a place of "Queen of Cereals".

Sweet corn (*Zea mays* L. var. *saccharata)* is the same botanical species as common corn, the main difference being that the endosperm in the grains of fresh sweet corn have a greater polysaccharide content at commercial maturity. Sweet corn is prized for its sweet, tender kernels and is primarily grown for human consumption. Sweet corn kernels come in various ~~colors~~colours, including yellow, white, and ~~bicolor~~bicolour varieties, with yellow being the most common. However, the sugar in the kernels rapidly converts to starch after its prime harvest stage; sweet corn can be harvested when it reaches the milk stage, while kernel moisture is at approximately 72 to 76 per cent (Add Reference).

Sweet corn contains c~~C~~arbohydrates 19 g, s~~S~~ugar 3.2 g,~~.~~ d~~D~~ietary fiber 2.7 g, f~~F~~at 1.2 g, p~~P~~rotein 3.2 g, v~~V~~itamin A 10 mg, f~~F~~oliate (Vit B9) 46 µg, v~~V~~itamin C 7 mg, i~~I~~ron 0.5 mg, m~~M~~agnesium 37 mg and p~~P~~otassium 270 mg nutritional value per 100 g sweet corn seed (Add reference). Rich in vitamins, minerals~~,~~ and dietary fiber, sweet corn provides a healthy addition to the Indian diet. It is particularly valued for its high content of vitamin A, vitamin C~~,~~ and folate, are essential for vision, immune function and skin, contributing to overall health and well-being.

Major sweet corn-producing nations include the United States, China, Brazil, Mexico, Argentina, Thailand~~,~~ and India (Add reference). It is cultivated on nearly 197 m ha with a production of 1148 m tonnes and productivity of 5823.8 kg ha^{-1} all over the world having wider diversity of soil, climate, biodiversity~~,~~ and management practices, contributing 37 per cent to global grain production (Add reference). In the scenario of India, production of sweet corn has been steadily increasing in response to growing domestic demand and expanding export opportunities due to diverse agro-climatic conditions and extensive agricultural infrastructure. The cultivation of sweet corn comes under more than 4 per cent of the net area sown in the country (Add reference). India produced 30 million tonnes in an area of 9.9 million hectares in 2020-21 (Anonymous 2021 add recent data). Major sweet corn-producing states include Karnataka, Andhra Pradesh, Maharashtra, Tamil Nadu, and Uttar Pradesh (Add reference). Madhya Pradesh, located in central India, is renowned for its significant contribution to the country's agricultural sector.

Sweet corn is a heavy feeder, which requires adequate quantity of nitrogen, phosphorus and potassium (Ortas and Sari, 2003) for growth and development. Nutrient requirement of sweet corn varies depending on inherent soil fertility status, cropping season, variety used and management practices. Besides other factors, the productivity of sweet corn is very much influenced by soil fertility status and quantity of applied nutrient specially nitrogen fertilizers. This nutrient is considered as major yield determining factor required for maize production. But, excessive nitrogen usage can lead to environmental pollution while deficiency results in low plant growth which reduces the grain yield, leaf area duration and rate of photosynthesis. Thus, balanced and optimum use of nitrogen plays a pivotal role in increasing the yield of maize.

Plant spacing is another important factor which plays a significant role on growth, development and yield of maize. Optimal crop geometry can affect the interception of solar radiation, air circulation~~,~~ and nutrient uptake efficiency, thus influencing crop growth and yield. ~~"~~Maximum yield can be expected only when plant population allows individual plant to achieve their maximum inherent potential~~"~~.

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MATERIAL AND METHODS

The experiment was carried out at new experimental cum demonstration field, Shri Vaishnav Institute of Agriculture, Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore during *rabi* 2023-24.

Soil of the experimental plot was medium and black in colour with good drainage. The topography of experimental field was uniform and fairly levelled. It was low in available nitrogen (210.11 kg ha^{-1}), medium in available phosphorous (14.53 kg ha^{-1}) and very high in available potassium (455.24 kg ha^{-1}). The soil organic carbon content, pH and EC was 0.49 per cent, 7.32 and 0.74 dSm^{-1} respectively.

The experiment was laid in split plot design with three main plot treatment of three crop geometry *viz*., 60 cm x 20 cm (S_1), 60 cm x 30 cm (S_2), 60 cm x 40 cm (S_3) whereas, sub plot treatments of four nitrogen levels *viz*., 125: 60: 40 kg ha^{-1} (N_1), 100: 60: 40 kg ha^{-1} (N_2), 75: 60: 40 kg ha^{-1} (N_3) and control (N_4). The soil was brought to fine tilth and then the ridges and furrows were opened at 60 cm apart. The field was divided into 36 plots with gross plot size of 3.60 m x 4.80 m each. (Net plot size?)

The recommended dose of phosphorous P and potassiumK (60:40 P_2O_5 and K_2O kg ha^{-1}) was applied to all plots except control treatment before sowing. The dose of nitrogen was given as per treatments to individual plots. The nutrients were applied through Urea, single super phosphate (SSP) and muriate of potash (MOP).

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The seeds of sweet corn variety sweet-80 procured from the local market of Indore were used during experimentation. The seeds of sweet-80 provide long uniform cylindrical cobs, good plant vigorous, golden yellow kernels. The seeds were shown at 3-4 cm depth and different spacings according to treatment details. Sowing was done through hand dibbling method. One or two seeds were sown at each hill.

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The various biometric observations were recorded on five randomly selected sweet corn plants. Bamboo pegs along with tags were fixed at the north side of each plant for easy identification. The growth observations were recorded on these plants starting from 30 DAS at an interval of 15 days up to sweet corn harvesting. These plants were further used for recording yield contributing characters.

The cobs were harvested at milky stage. Harvesting was usually done in the morning when moisture per cent was high and the temperature was low. After the last picking, green fodder from net plot was harvested and weighed for individual plot and final green fodder yield was expressed in kg ha^{-1}.

The statistical analysis of the data was carried out by the standard statistical method 'Analysis of Variance' (Panse and Sukhatme, 1967). The null hypothesis was tested by F at significance to ascertain whether treatment effects were real or not. From the data, in which the treatment effects were significant, the appropriate standard error (SE) and critical difference (CD) at 5 per cent level of significance were worked out.

RESULT AND DISCUSSION

Effect of crop geometry

Growth attributes

The plant height of sweet corn increased progressively from initial growth phase up to crop maturity. The number of leaves and leaf area increased up to 60 days and decreased thereafter towards maturity due to leaf senescence. Total dry matter increased from flowering to harvest. The silking in crop took plant immediately after 4-5 days of tasselling.

The data presented in table 1 reveals that, the highest plant height (185.08 cm) at harvest was recorded with crop geometry of 60 cm x 20 cm and also took for days to 50 % tasselling and silking *i.e.* 58.11 and 63.08, respectively. The lowest plant height (168.09 cm) was recorded in treatment with crop geometry of 60 cm x 40 cm. However, the other growth parameters such as no. of leaves plant^{-1} (13.74), leaf area plant^{-1} (30.58), dry matter plant^{-1} (206.81 g) at harvest was recorded in treatment with application having 60 cm x 40 cm crop geometry. The lower value of the above-mentioned parameters was recorded in plots with crop geometry of 60 x 20 cm.

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The increased plant height in higher plant density might be due to thick plant stand. As the intensity of shading increases due to more population, the plant tends to grow taller; such increase in height of the plant at higher population was reported by Agasibagil *et al*., (2006), Kole (2010), Babu *et al.*, (2019).

Wider crop geometry produced more leaves and leaf area plant^{-1} than narrow spacing, which may be due to the efficient utilization of growth resources like sunlight, moisture, space, and nutrients.The higher dry matter production under wider spacing may be due to more availability of nutrients resulted into increase in cell division, assimilation rate and metabolic activities in plant (Reference). These findings are substantiated by the findings of Agasibagil*et al*., (2006), Kole (2010), Babu *et al.*, (2019), Saha *et al*., (2023) and Ibeawuchi*et al*., (2008).

Table 1: Growth attributing characters of sweet corn as influenced by different treatments nitrogen levels and crop geometry

Treatments	Growth attributes					
	Plant height (cm)	Number of leaves plant^{-1}	Leaf area plant^{-1} (dm^2)	Dry matter plant^{-1} (g)	Days to 50 % Tasselling	Days to 50 % Silking
A) Crop geometry						

S_1: 60 cm x 20 cm	185.08	12.47	26.33	190.34	58.11	63.08
S_2: 60 cm x 30 cm	182.88	13.24	28.70	202.09	57.88	62.83
S_3: 60 cm x 40 cm	176.09	13.74	30.58	206.81	56.29	61.31
S. Em. $\pm$	1.13	0.19	0.66	2.24	0.15	0.16
CD at 5%	3.31	0.56	1.92	6.52	0.43	0.47
B) Nitrogen levels						
N_1: 125 % RDN	187.73	14.01	30.21	212.47	53.93	58.87
N_2: 100 % RDN	184.59	13.24	28.89	206.91	56.60	61.62
N_3: 75 % RDN	180.76	12.88	27.60	195.38	59.38	64.36
N_4: Control	172.32	12.47	27.46	184.23	59.79	64.79
S. Em. $\pm$	1.27	0.28	0.48	1.91	0.28	0.28
CD at 5%	3.70	0.82	1.40	5.58	0.83	0.81
C) Interaction effect						
A x B	NS	NS	NS	NS	NS	NS
General mean	**181.35**	**13.15**	**28.54**	**199.75**	**57.43**	**62.41**

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Yield attributes

As per the data presented in table 2.a and 2.b indicates that, the yield attributing characters *viz.*, length of cob with (21.25 cm) and without husk (17.33 cm), diameter of cob with (7.04) and without husk (6.33 cm), fresh weight of cob with (213.50 g) and without husk (193.50 g), no. of grains cob^{-1} (432.42), no. of grain rows cob^{-1} (17.80) and grain weight cob^{-1} (164.92) were found highest in crop geometry of 60 cm x 40 cm spacing. Whereas the minimum values were recorded from the treatment crop geometry of 60 cm x 20 cm spacing. The values of number of cobs plant^{-1} as influenced by different treatments showed non-significant results.

Table 2.a: Yield attributing characters of sweet corn as influenced by nitrogen levels and crop geometry ~~different treatments~~

Treatments	**Yield attributing characters**				
	Cobs plant^{-1}	**Cob length**		**Cob Diameter**	
		(with husk)	**(without husk)**	**(with husk)**	**(without husk)**
A) Crop geometry					
S_1: 60 cm x 20 cm	1.29	18.75	14.69	5.04	4.29
S_2: 60 cm x 30 cm	1.30	19.96	16.09	6.58	5.85
S_3: 60 cm x 40 cm	1.27	21.25	17.33	7.04	6.33

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S. Em. +	0.02	0.35	0.48	0.17	0.17
CD at 5%	NS	1.02	1.41	0.48	0.50
B) Nitrogen levels					
N_1: 125 % RDN	1.32	21.68	17.66	7.10	6.33
N_2: 100 % RDN	1.29	21.04	17.04	6.61	5.90
N_3: 75 % RDN	1.27	19.77	15.72	5.80	5.10
N_1: Control	1.25	17.46	13.73	5.37	4.63
S. Em. +	0.03	0.23	0.30	0.20	0.19
CD at 5%	NS	0.68	0.88	0.57	0.54
C) Interaction effect					
A x B	NS	NS	NS	NS	NS
General mean	**1.28**	**19.99**	**16.04**	**6.22**	**5.49**

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The yield attribute values decreased as the plant population increased. These results indicate that there is a positive relationship between crop spacing and yield attributing characters probably due to variable plant competition.The enhanced yield under wider planting geometry might be due to significant improvement in overall crop growth of sweet corn by increased photosynthetic efficiency. Earlier researchers, *viz.*,Kar *et al.*, (2006), Mahapatra *et al*., (2006) and Kanakdurga*et al.*, (2012) reported the same trend regarding plant geometry and yield attributed of different crops.

Table 2.b: **Yield attributing characters of sweet corn as influenced by nitrogen levels and crop geometry ~~different treatments~~**

Treatments	Yield attributing characters				
	Cob weight (plant^{-1})		No. of grains cob^{-1}	No. of grain rows cob^{-1}	Grain weight cob^{-1}
	(with husk)	(without husk)			
A) Crop geometry					
S_1: 60 cm x 20 cm	208.50	186.00	414.96	15.17	155.00
S_2: 60 cm x 30 cm	211.00	190.58	426.43	16.57	161.83
S_3: 60 cm x 40 cm	213.50	193.50	432.42	17.80	164.92
S. Em. +	0.88	1.31	2.15	0.46	1.63
CD at 5%	2.57	3.83	6.27	1.35	4.77
B) Nitrogen levels					
N_1: 125 % RDN	215.56	195.33	441.46	18.09	167.00
N_2: 100 % RDN	213.00	192.44	425.93	17.52	165.22

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N_3: 75 % RDN	210.22	189.11	418.50	16.22	159.22
N_1: Control	205.22	183.22	412.51	14.21	150.89
S. Em. ±	1.15	1.62	5.47	0.30	1.18
CD at 5%	3.35	4.72	15.97	0.88	3.43
C) Interaction effect					
A x B	NS	NS	NS	NS	NS
General mean	**211.00**	**190.03**	**424.60**	**16.51**	**160.58**

Yield

The green cob yield, green fodder yield and~~,~~ biological yield of sweet corn was significantly influenced by different crop geometry. Treatment with crop geometry of 60 cm x 20 cm recorded maximum green cob yield (19157.93 kg ha^{-1}), green fodder yield (35474.94 kg ha^{-1}) and biological yield (54632.87 kg ha^{-1}) which was found to be at par with crop geometry of 60 cm x 30 cm.

Even though the growth and yield parameters were maximum in 60 cm x 40 cm spacing, higher yields under plant spacing of 60 cm x 20 cm was increased yield owing to the maximum number of marketable cobs compared with those of 60 cm x 30 cm and 60 cm x 20 cm spacing. Decrease in crop geometry significantly increased crop cob and green fodder yield resulting in maximum biological yield. These findings are substantiated by the findings Verma and Tomar (2014), Pagar *et al*., (2022) and saha*et al*., (2023).

The harvest index of sweet corn as influenced by different treatment was found to be non-significant.

Table 3: Green cob yield, green fodder yield, biological yield and harvest index of sweet corn as influenced by nitrogen levels and crop geometry ~~different treatments~~

Treatments	**Yield of sweet corn**			
	Green cob yield (kg ha^{-1})	**Green fodder yield (kg ha^{-1})**	**Biological yield (kg ha^{-1})**	**Harvest index**
A) Crop geometry				
S_1: 60 cm x 20 cm	19157.93	35474.94	54632.87	34.61
S_2: 60 cm x 30 cm	18673.69	34355.92	53029.61	34.98
S_3: 60 cm x 40 cm	14903.85	31049.68	45953.53	32.14
S. Em. ±	830.46	861.35	1593.59	0.74

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CD at 5%	2424.06	2514.23	4651.59	NS
B) Nitrogen levels				
N_1: 125 % RDN	21913.27	39297.51	61210.78	35.80
N_2: 100 % RDN	18885.74	35088.99	53974.73	34.81
N_3: 75 % RDN	16023.33	31919.24	47942.57	32.94
N_4: Control	10118.70	28201.66	31269.95	32.08
S. Em. ±	1212.17	1686.14	2834.04	0.80
CD at 5%	3538.23	4921.74	8272.39	2.33
C) Interaction effect				
A x B	NS	NS	NS	NS
General mean	**17096.64**	**33626.85**	**49716.29**	**33.91**

Effect of nitrogen levels

Growth attributes

The plant height of sweet corn increased progressively from initial growth phase up to crop maturity. The number of leaves and leaf area increased up to 60 days and decreased thereafter towards maturity due to leaf senescence. Total dry matter increased from flowering to harvest. The silking in crop took plant immediately after 4-5 days of tasselling.

The highest values for growth parameters such as plant height (187.73 cm), no. of leaves plant^{-1} (14.01) at harvest, leaf area plant^{-1} (30.21) at harvest, dry matter plant^{-1} (212.47 g) at harvest was recorded in treatment with application of 125 per cent RDN. The lower value of the above-mentioned parameters was recorded in control treatment. While days required for 50 per cent tasselling (59.79) and silking (64.79) were more in control treatment.

Increase in the fertilizer levels might have increased photosynthate formation and partitioning to stems that might have favourable impacts on plant height of maize. Similar findings in corn were also reported by Singh *et al*., (2012), Thakur *et al*., (2015) and Araujo *et al*., (2005). The readily available nitrogen in soil and for higher absorption of nutrients must have resulted in increase in number of leaves plant^{-1}. It may be due to increase in assimilation rate, cell division and metabolic activities in plant. Similar results were reported by Tiwari *et al*., (2021), Shravankumar *et al*., (2023). The increase in leaf area with higher nitrogen levels may be because of increased amount of cellular protoplasm. This resulted in the expansion of the cell wall, which was manifested in the increased linear and lateral dimensions of leaves of the plant. Similar results were reported by Thakur *et al*., (2015) and Sravankumar.*et al*., (2023).

Yield attributes

Yield attributing characters *viz*., length of cob with (21.68 cm) and without husk (17.66 cm), diameter of cob with (7.10 cm) and without husk (6.33 cm), fresh weight of cob with (215.56 g) and without husk (195.33 g), no. of grains cob^{-1} (441.46), no. of grain rows cob^{-1} (18.09) and grain weight cob^{-1} (167.00) were found highest in treatment with application of 125 per cent RDN. Whereas the minimum values were recorded from control treatment.

The values of number of cobs plant^{-1} as influenced by different treatments showed non-significant results.

This evidently proved that increased availability of nitrogen to crop at higher levels resulted in productionofphotosynthatesandtheirefficienttranslocationfor development of reproductive parts. Similar results were reported by Abhishekh and basavanneppa (2020) and Thakur*et al*., (2015).

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Thus, greater availability of photosynthates, metabolites and nutrients to develop reproductive structures seems to have resulted in increased productive plants like cob girth, cob length, cob weight and weight of grains of cob with wider spacing and higher nitrogen levels.

Yield

The green cob yield, green fodder yield, biological yield of sweet corn was significantly influenced by different nitrogen levels. Treatment with application of 125 per cent nitrogen recorded maximum green cob yield (21913.27 kg ha^{-1}), green fodder yield (39325.49 kg ha^{-1}) and biological yield (61238.76 kg ha^{-1}) which was found to be at par with application of 100 per cent RDN.

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The fresh cob yield in sweet corn was increased with application of 125 per cent RDN over other nitrogen fertilizer levels. The yield of the sweet corn crop is a function of several yield components, which are dependent on complementary interaction between vegetative and reproductive growth of the crop. Increase in growth and yield attributes along with increased nitrogen level must have resulted in maximum green yield of sweet corn. The

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present findings are in close agreement with the results obtained by Thakur *et al*., (2015), Singh *et al*., (2000), Bhadu*et al*., (2015).and Khan *et al.,* (2018).

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The increased fresh cob yield and green fodder yield which ultimately increase biological yield in sweet corn with application of 125 per cent RDN over other treatments. This might be due to the fact that higher levels of nitrogen leads to adequate supply of nutrients to the plant resulting in better growth which in turn lead to better physiological process and movement of photosynthetic to sink. The present findings are in close agreement with the results obtained by Singh *et al*., (2000)

Increase in nitrogen fertilizer level has resulted to increase in green cob yield and fodder yield. Thus, the harvest index was also found to be increased.

Interaction effect

The interaction effect of crop geometry and nitrogen fertilization in respect of growth attributes, yield attributes and yield was found to be non-significant.

CONCLUSION

It can be concluded that sowing of sweet corn with 60 cm x 20 cm resulted in higher plant height, green cob yield and biological yield which was at par with 60 cm x 30 cm spacing while all other growth and yield parameters were found to be highest in spacing of 60 cm x 40 cm. while treatment with application of 125 per cent RDN recorded highest growth and yield of sweet corn.

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