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Influence of Varying Plant Densities and Nitrogen Levels on Yield Attributes and Yield of Sweet Corn

P. Spandana Bhatt[1*], M. Yakadri[1] and Y. Sivalakshmi[2]

[1]Department of Agronomy, College of Agriculture, Acharya N.G. Ranga Agricultural University, Hyderabad, Andhra Pradesh (500 030), India
[2]Agricultural Research Institute, Acharya N.G. Ranga Agricultural University, Hyderabad, Andhra Pradesh (500 030), India

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Correspondence to

*E-mail: spandana9119@gmail.com

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Abstract

A field experiment was conducted to study the effect of varying plant densities and nitrogen levels on yield attributes and yield of sweet corn during *kharif* 2009 at Agricultural Research Institute, ANGRAU, Rajendranagar, Hyderabad, India. In this investigation, three plant densities viz., P_1-66,666, P_2-80,000 and P_3-1,00,000 plants ha^{-1} and four nitrogen doses i.e. N_1-120, N_2-160, N_3-200 and N_4-240 kg ha^{-1} were tested on sweet corn hybrid sugar -75. Out of all 12 combination of treatments, P_2N_4 (80,000 plants ha^{-1} with 240 kg N ha^{-1}) was found to have performed significantly better in terms of yield attributes and yield.

1. Introduction

Maize is a miracle crop emerging as third most important cereal next to rice and wheat with wide diversity of uses and large hidden potential for exploitation. This forced the renowned Nobel laureate, Norman E Borlaug to say that 'last two decades saw the revolution in rice and wheat, the next few decades will become the maize era". India is the seventh largest producer of maize with an area of 7.89m ha, production of 15.09 million tonnes and productivity of 1904 kg ha^{-1} (CMIE, 2010). Sweet corn is one type of specialty corns containing 13 to 15 % sugar in immature grain, where the conversion of sugars into starch in the endosperm of the kernel does not proceed to completion as it does in starchy types of maize viz., dent, flint and pop. Thus the storage material in the endosperm is composed of sugars-glucose and intermediate polysaccharide products. In Mexico sweet corn was the basis pinole, a confection prepared by grinding the mature seeds Kar et al. (2006). In Peru, kernels of sweet corn were parched to produce a favorite food, kamela. Sweet corn also found a special niche in the preparation of native beer by virtue of its greater sugar content. In India It is consumed at soft dough stage in various forms by urbanites viz., vegetables, roasted ears, soups, corn syrup, sweeteners etc. Presently greater emphasis is given to the cultivation of sweet corn near urban areas due to its increasing demand for its immature cobs. It helps to augment the income of farming community dwelling in the outskirts of big cities.

The demand of sweet corn is not getting fulfilled due to poor yield as the production technology for sweet corn is not yet standardized. Keeping in view very meager research on sweet corn production technology, an experiment was initiated to study optimum plant density and nitrogen level required to achieve higher productivity.

2. Materials and Methods

A field experiment was conducted during *kharif* 2009 season at Agricultural Research Institute, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad (518 m altitude) Total rainfall received during experimental period was 457.1mm distributed over 25 rainy days.. The experiment was laid out in a Randomized block design with factorial concept on clay loam soil with twelve treatments comprising of three plant densities viz., P_1-66,666, P_2-80,000, P_3-1,00,000 plants ha^{-1} and four nitrogen levels i.e., N_1-120, N_2-160, N_3-200 and N_4-240 kg ha^{-1} and replicated thrice. The field was once ploughed with disc plough followed by twice with cultivator and finally levelled. The sweet corn hybrid was sugar - 75 was used as test hybrid in the experiment. The soil was clay loam in texture containing low available nitrogen (255.7 kg N ha^{-1}),

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medium in available phosphorus (23.4 kg P_2O_5 ha^{-1}) and available in potassium (156 .7 kg K_2O ha^{-1}) with pH 7.8. 1/3rd dose of nitrogen and full dose of phosphorus and potassium were applied as basal in band placement in small grooves of 5cm from the seed. The remaining 2/3rd N in two equal splits at 30 and 60 days after sowing. Seed of sweet corn sugar-75 was dibbled by hand as per the treatment to get desired population on ridges and was irrigated foe uniform irrigation. Gap filling was done one week after sowing and thinning was carried out to get single plant $hill^{-1}$. Timely recommended cultural operations and plant protection measures were adopted to raise a good crop. The observations on the cob length (cm), cob girth(cm), number of kernels cob^{-1}, 100 kernel weight (g) from five plants randomly selected $treatment^{-1}$ in each replication from the net plot area. The data collected was analyzed statistically by the method of analysis of variance outlined by Gomez and Gomez (1984) for factorial randomized block design.

3. Result and Discussion

3.2. *Yield attributes*

Number of green cobs $plant^{-1}$ has not shown any significant variation due to different plant densities. But cob length, cob girth, cob weight with husk, number of kernels row^{-1} and number of kernels cob^{-1} were highly influenced by varying plant densities. Significantly higher values for the above mentioned characters were observed at low plant density (66,666 ha^{-1}) and it was found to be on par with 80,000 ha^{-1}. This clearly indicated that plants at lower density fully exploited the natural resources efficiently, besides responding to externally applied inputs. The findings of Sahoo and Mahapatra (2004) and Ashok kumar (2009) confirmed these results. Yield attributes *viz*., cob weight without husk, number of kernel rows cob^{-1} and 100 kernel weight were significantly greater when plant density was maintained @ 66,666 ha^{-1} as compared to that of 80,000 ha^{-1}, indicating a stress free environment at low plant density (Table 1). Though, more number of cobs ha^{-1} were observed at higher plant density (1,00,000 ha^{-1}), but it recorded significantly lower values for all the above discussed yield attributes. Surprisingly the cob yield obtained with plant density of 80,000 ha^{-1} produced more cob yield compared to 1,00,000 and 66,666 ha^{-1}.

Each increment of nitrogen from 120 to 240 kg ha^{-1} influenced the yield attributes markedly. Nitrogen at 240 kg ha^{-1} significantly improved all the yield attributes. Application of 240 kg N ha^{-1} recorded significantly more cob length and girth, number of cobs ha^{-1}, weight of green cobs and number of kernels cob^{-1} over its immediate lower dose which recorded similar values for yield attributes (cob length and girth, cob weight with and without husk) compared to 200 kg N ha^{-1} and both of these differed significantly from 120 & 160 kg N ha^{-1}, but higher dose (240 kg N ha^{-1}) differed significantly even from 200 kg N ha^{-1} as for yield attributes (Number of

Table 1: Yield attributes of sweet corn as influenced by varying plant densities and nitrogen levels

Treatment	Cob length (cm)	Cob girth (cm)	Number of kernel rows cob^{-1}	Cob weight With husk (g cob^{-1})	Cob weight Without husk (g cob^{-1})	100 kernel weight	Sucrose content (%)	Crude protein content (%)	Green cob yield (kg ha^{-1})	Green fodder yield (kg ha^{-1})
Plant densities ('000 ha^{-1})										
66.6	18.6	14.6	16.4	275.3	208.3	28.9	14.8	10.1	10225	15040
80.0	18.0	14.3	14.1	268.8	187.4	27.8	14.4	9.2	14159	16585
100.0	16.3	13.6	12.3	223.9	164.0	25.5	14.1	8.7	9248	18533
SEm±	0.26	0.12	0.41	2.44	2.52	0.40	0.16	0.12	178.29	153.68
CD (p=0.05))	0.75	0.34	1.19	7.16	7.38	1.17	0.48	0.36	523.04	450.83
Nitrogen levels (kg ha^{-1})										
120	16.2	13.3	13.1	225.0	169.9	23.1	13.5	8.0	8494	14315
160	17.1	14.1	14.0	258.2	181.4	26.0	14.2	9.0	10555	16526
200	18	14.5	14.7	267.1	194.1	28.9	14.8	9.7	12089	17316
240	18.9	14.8	15.2	275.2	200.8	31.7	15.4	10.5	13706	18720
SEm±	0.29	0.13	0.47	2.82	2.90	0.46	0.19	0.14	205.87	177.45
CD (p=0.05)	0.86	0.4	1.38	8.27	8.52	1.35	0.55	0.41	603.96	520.58
P x N Interaction										
SEm±	0.51	0.08	0.81	4.88	5.03	0.79	0.33	0.24	356.58	307.35
CD (p=0.05)	NS	0.24	NS	NS	NS	NS	NS	NS	1046.09	901.67

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kernel rows cob^{-1}, 100 kernel weight, number of kernels row^{-1}, number of kernels cob^{-1} and number of cobs ha^{-1}) are concerned. This evidently proved that increased availability of nitrogen to crop at higher levels resulted in production of longer cobs accompanied by increased grain filling, that gave more kernels cob^{-1}. Not only grain filling but also size of grain was also better as supported from increase in 100 grain weight. Better corn and grain development was owing to increased availability of nitrogen and greater production of photosynthates and their efficient translocation for development of reproductive parts. Similar results were reported by Sahoo and Mahapatra (2004), Kar et al. (2006), Muniswamy et al. (2007) and Suryavanshi et al. (2008) and Ashok kumar (2009).

3.3. Cob and fodder Yield

The varying plant densities and nitrogen levels significantly affected the green cob and fodder yields. There was significant improvement to an extent of 35.8% in cob yield due to increasing plant density from 66,666 to 80,000 ha^{-1} (Table 1). Lower yields at 66,666 plants ha^{-1} were due to production of less number of cobs. When plant density was further increased from 80,000 to 1,00,000 ha^{-1}, the cob yield declined to the tune of 53.1% as compared to 80,000 ha^{-1}, which might be due to more competition for resources and mutual shading at higher plant density. These findings are in conformity with that of Sahoo and Maha Patra (2004) and Ashok Kumar (2009).

Plant population unit area significantly influenced the green fodder yield. Increase in plant density significantly increased green fodder yield maximum being at 1,00,000 ha^{-1}. Linear increase in green fodder yield with increasing plant density was also noticed by Ashok kumar (2009).

The cob and fodder yields were significantly affected by nitrogen levels. (Table 1). With each successive increase in nitrogen level from 160 to 240 kg N ha^{-1}, enhancement in green cob yield was observed to the tune of 36%, 13.2% and 12.3%, respectively over 120 kg N ha^{-1}. Ameta and Dhakar (2000), Kar et al. (2006), Muniswamy et al. (2007) and Suryavanshi et al. (2008) and Ashok Kumar (2009) also reported similar findings.

Study of interaction effects of plant densities and nitrogen levels revealed (Table 2) that green cob yield increased due to increase in nitrogen level at same level of plant density. Highest green cob yield was obtained at 80,000 plants ha^{-1} and 240 kg N ha^{-1}. This plant density of 80,000 ha^{-1} might be an optimum density at which interplant competition was sufficiently severe at the time of floral initiation to reduce the growth of primordia to a level at which the load on individual plant was not excessive, resulting in maximum green cob production. As the experimental soil was deficit in available nitrogen, it responded well to increased levels of nitrogen up to 240 kg ha^{-1}. Similar response of normal corn yield and sweet corn cob yield to nitrogen levels and population interaction was reported by Misra et al. (1994), Tyagi et al. (1998), Kar et al. (2006) and Muniswamy et al. (2007) and Ashok kumar (2009) respectively.

3.4. Quality parameters

The protein content of kernel was influenced by plant densities(Table 1). There was reduction in protein content of grain with increased plant density which might be due to inadequate availability of nitrogen as a result of competition. Similar observations were made by Singh et al. (1997) and Suryavanshi et al. (2008). The increased supply of nitrogen increased the protein content of grain since nitrogen is the constituent of protein molecule. Similar increase in protein content with increase in nitrogen level was observed by Krishna et al. (1998), Raja (2001), Kar et al. (2006) and Suryavanshi et al. (2008). Varying plant densities showed significant effect on sugar content (sucrose%) in kernel of sweet corn. The more sugar content in kernel was observed with the plant

Table 2: Influence of interaction between varying plant densities and nitrogen levels on yield parameters

	Number of kernels row^{-1}					Number of kernels cob^{-1}					Number of cobs ha^{-1}				
	N (kg ha^{-1})					N (kg ha^{-1})					N (kg ha^{-1})				
PD	120	160	200	240	Mean	120	160	200	240	Mean	120	160	200	240	Mean
66.6	30.4	33.5	34.1	35.0	33.3	342.3	448.7	500.3	520.0	452.8	55603.7	60927.0	64137.0	67359	62006.7
80.0	26.4	33.4	34.7	37.7	33.1	332.7	436.0	483.0	513.0	441.2	70682.7	74462.7	76957.3	80566	75667.2
100.0	25.2	27.5	29.6	31.6	28.5	276.7	329.7	367.7	391.7	341.4	81867.3	84958.7	94561.3	98564	89987.8
Mean	27.3	31.5	32.8	34.8		317.2	404.8	450.3	474.9		69384.6	73449.4	78551.9	82163	
	SEm±	CD (p=0.05)				SEm±	CD (p=0.05)				SEm±	CD (p=0.05)			
PD	0.24	0.70				4.22	12.37				362.39	1063.14			
N	0.27	0.81				4.87	14.28				418.46	1227.61			
P x N	0.48	1.40				8.43	24.73				724.79	2126.28			

PD: Plant densities in '000 ha^{-1}; N: N levels

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Table 3: Cost of cultivation ,Gross return, Net return and B:C ratio of sweet corn as influenced by varying plant densities and nitrogen levels

Treatment combinations	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
P_1N_1	17986	47364	29378	1.63
P_1N_2	18420	64632	46212	2.51
P_1N_3	18855	73870	55015	2.92
P_1N_4	19290	85678	66388	3.44
P_2N_1	19486	66257	46771	2.40
P_2N_2	19920	87883	67963	3.41
P_2N_3	20355	97858	77503	3.81
P_2N_4	20790	109169	88379	4.25
P_3N_1	20986	48004	27018	1.29
P_3N_2	21420	62927	41507	1.94
P_3N_3	21855	70208	48353	2.21

density of 66,666 ha^{-1} but it was on par with 80,000 ha^{-1} and differed significantly from 1,00,000 ha^{-1}.Nitrogen levels also showed significant effect on sugar content (sucrose %) in kernel of sweet corn. Application of nitrogen @ 240 kg ha^{-1} recorded significantly higher sugar content in kernel compared to remaining doses. The increase in sugar content of sweet corn due to heavier dose (240 kg N ha^{-1}) compared to 120 kg N ha^{-1} was 14.0%.The interaction effect due to varying plant densities and nitrogen levels was not significant.

3.5. Economics

The treatment combination of 80,000 plants ha^{-1} and application of 240 kg N ha^{-1} (P_2N_4) gave maximum net returns (₹ 88379 ha^{-1}) and B:C ratio (4.25). Sahoo and Maha patra (2007) and Ashok kumar (2009) also reported higher net returns at 83,333 plants ha^{-1}.

4. Conclusion

The results suggested that Sweet corn hybrid can be grown profitably with a plant density of 80,000 ha^{-1} along with the application of 240 kg N ha^{-1} in clay loam soils with low available nitrogen in Southern Telangana Zone of Andhra Pradesh.

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