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Evaluation of Sweetcorn Hybrids under Varying Planting Density and Nutrient Levels

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ABSTRACT

Background: Productivity of sweet corn depends on genetic makeup and adoption of innovative technological interventions *viz.*, planting density, balanced application of organic manures and fertilizers, herbicides *etc*. Nevertheless, the response to the aforementioned interventions may vary with different locations owing to varied climatic and edaphic and other management factors. Enhancement in productivity can be achieved through adoption of proper planting density and nutrient management as they play a vital role. The present study aimed to evaluate different sweet corn hybrids under varied planting density and nutrient levels for improving the productivity of sweetcorn.

Methods: Field experiments were conducted during *Kharif*, 2019 and *Kharif*, 2020 to evaluate sweet corn hybrids under varying planting density and nutrient levels. The experiments were laid out in a split split plot design. In the main plot, two sweet corn hybrids and in the sub plot, two planting densities and in the sub sub plot, three nutrient levels were tried. Observations on growth, green cob yield and green fodder yield were recorded.

Result: Based on the results of two years of experimentation, it is concluded that MISTHI recorded higher green cob yield (16330 kg ha^{-1}), net return (Rs. 64931/ha) and B:C ratio (2.47) under 60 × 15 cm with 100% RDF (120:60:45 NPK kg/ha). CSCH-15001 recorded relatively lower green cob yield (15649 kg ha^{-1}), net return (Rs. 61291/ha) and B:C ratio (2.38) under 60 × 15 cm with 100% RDF.

Key words: Nutrient levels, Planting density, Sweet corn, Yield.

INTRODUCTION

Sweet corn is one of the most promising vegetables in the developed countries of the world. In India, it is becoming popular among the peri-urban farmers due to high market potential in urban areas. It has high sugar content of 16-18% (Znidarcic, 2012) and is a rich source of carbohydrate, vitamin C, niacin, thiamine and vitamin A and has significant amount of dietary fibre and potassium (Erdal *et al.*, 2011 and Santos *et al.*, 2014). It is highly delicious and the green cobs are eaten as raw, boiled or steamed or used in the preparation of soup, salad and other recipes and the stover after harvest of cobs is used as a green fodder for milch animals.

Yield potential of sweet corn is mainly based on its genetic makeup and the environment where it grows. Nevertheless, maximum genetic potential can be exploited through congenial environment as the yield is interactive product of genotype, management and environmental factors. Agro techniques or management factors *viz.*, tillage, planting density, irrigation, weed management, nutrient management and pest and disease management are recommended for adoption to improve the productivity of sweet corn. However, responses to these aforementioned practices vary across environments. Among them, planting density and nutrient management plays an important role in enhancing the productivity of sweet corn. The yield of a crop is decided based on planting density as it directly affects the yield attributes and yield (Oktem and Oktem, 2005). Optimum planting density ensures effective utilization of land, water, nutrients and other resources resulting in better growth and development of crops. Sweet corn removes large quantities of nutrients especially nitrogen, phosphorus and potassium from soil for the growth. Remarkable reduction in yield is observed when the supply of nitrogen is suboptimal from the soil as other nutrients are not absorbed and translocated properly by the plants (Haque *et al.*, 2001). Hence, balanced application of nitrogen, phosphorus and potassium plays a vital role in increasing the yield of sweet corn. Keeping in view the above facts, the present experimentation was conducted to evaluate sweet corn hybrids under varying planting density and nutrient levels.

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MATERIALS AND METHODS

Field experiments were carried out at Department of Millets, Tamil Nadu Agricultural University, Coimbatore during *Kharif*, 2019 and *Kharif*, 2020 to evaluate sweet corn hybrids under varying planting density and nutrient levels.

The experimental site is located at 11°N latitude, 77°E longitude and at an altitude of 426.7 m above the MSL. The soil was sandy clay loam and low in available N, medium in available P and high in available K. During the cropping period, a total rainfall of 135.5 mm was received in 12 rainy days. The mean maximum and minimum temperatures were 30.8°C and 21.3°C, respectively. Relative humidity ranged from 71 to 86 and 32 to 48 per cent during forenoon and afternoon, respectively. The experiments were laid out in a split split plot design. In the main plot, two sweet corn hybrids *viz.*, H_1- CSCH - 15001 and H_2 - MISTHI and in the sub plot, two planting densities *viz.*, D_1- 60 × 20 cm and D_2 - 60 × 15 cm and in the sub sub plot, three nutrient levels *viz.*, N_1-100% RDF (120:60:45 NPK kg/ha),N_2-90% RDF (108:54:41 NPK kg/ha) and N_3- 80% RDF (96:48:36 NPK kg/ha) were tried in three replications in both the years. Observations on plant height at harvest, green cob yield, green fodder yield, TSS, nutrient uptake, soil available NPK were recorded.

RESULTS AND DISCUSSION

Plant height, green cob yield, green fodder yield and TSS

The data on plant height, yield and TSS are given in Table 1. Experimental results revealed that the sweet corn hybrids exerted significant influence on plant height at harvest during *Kharif*, 2019. Among the hybrids, MISTHI (H_2) recorded higher plant height of 192.1cm at harvest which was significantly superior to H_1 (CSCH-15001). The hybrids did not evince significant effect on plant height at harvest during *Kharif*, 2020. Planting densities and nutrient levels failed to exert significant influence on plant height at harvest in both the years. Nevertheless, D_2 (60 × 15 cm) recorded higher plant height of 186.9 cm and 216.8 cm during *Kharif*, 2019 and *Kharif*, 2020,respectively. This was ascribed to more competition for space, light, nutrients and other resources which favoured higher plant height under high density. The results are in accordance with the findings of Mathukia *et al.*, 2014 and Nandeha *et al.*,2016.In respect of nutrient levels, N_1 (100%RDF) recorded higher recorded higher plant height of 189.5 cm and 219.2 cm during *Kharif*, 2019 and *Kharif*, 2020,respectively.This might be due to higher availability of nutrients leading to prolonged vegetative growth thus favoured plant height .These results confirm with those findings of Singh *et al.*, 2019, Kumar *et al.*, 2007 who reported that plant height increased with enhanced level of NPK application. The interaction effect was not significant.

Though MISTHI (H_2) recorded higher green cob yield of 13905 kg $ha^{-1}$and 14663 kg ha^{-1} during *Kharif*, 2019 and *Kharif*, 2020, respectively there was no significant influence on green cob yield among the hybrids in both the years. With respect to planting density, D_2 (60 × 15 cm) recorded higher green cob yield of 14745 kg $ha^{-1}$and 15651 kg ha^{-1} during *Kharif*, 2019 and *Kharif*, 2020, respectively. This was significantly superior to D_1 (60 × 20 cm). This might be due to higher dry matter production through effective utilization of space, light, nutrients *etc*. under high density compared to low density as the yield directly depends on plant population. The results confirm the findings of Massey and Gaur, 2013, Dangariya *et al.*, 2017 and Kumar and Chawla, 2018. In respect of nutrient levels, N_1(100%RDF) recorded higher yield of 14295 kg ha^{-1} during *Kharif*, 2019 which was comparable with 90% RDF but was superior to 80% RDF. In *Kharif* 2020, also N_1(100%RDF) recorded higher yield of 15130 kg ha^{-1} which was comparable with 90% RDF but was superior to 80% RDF. The increased yield with 100%RDF might be due to improved absorption and translocation of nutrients through better root establishment thus favouring more production of chlorophyll in plants. This facilitated the utilization of more solar energy for production of carbohydrates. Better availability of photosynthates improved length, girth of cob and test weight of grain resulting in higher yield. The results are in accordance with the findings of Akhtar and Silva,1999; Grazia *et al.*, 2003; Singh *et al.*, 2003; Sonbai *et al.*, 2013; Dangariya *et al.*, 2017 and Rao *et al.*, 2020. The interaction was found to be non-significant.

Green fodder yield was not significantly influenced by the hybrids. Nevertheless, H_1(CSCH-15001) recorded higher green fodder yield of 9855 kg ha^{-1} and 10210 kg ha^{-1} during *Kharif*, 2019 and *Kharif*, 2020, respectively. Among the planting densities, D_2 (60 × 15 cm) recorded higher green fodder yield of 10393 kg $ha^{-1}$and 10768 kg ha^{-1} during *Kharif*, 2019 and *Kharif*, 2020, respectively. This was significantly superior to D_1 (60 × 20 cm).This was ascribed to higher biomass accumulation by utilizing the natural resources effectively under high density. The results confirm the findings of Sunitha and Reddy (2012), Mathukia *et al.* (2014) and Kumar and Narayan (2018). With respect to nutrient levels, N_1 (100%RDF) recorded higher yield of 10644 kg ha^{-1} during *Kharif*, 2019 which was comparable with 90% RDF but was superior to 80% RDF. During *Kharif*, 2020, also N_1 (100%RDF) recorded higher yield of 10916 kg ha^{-1} which was comparable with 90% RDF but was superior to 80% RDF. The increased green fodder yield with the application of 100%RDF might be due to the development of extensive root system, which favoured more absorption and translocation of nutrients thus enhanced photosynthetic activity, high rate of assimilation, better growth and development. The results are in accordance with the findings of Massey and Gaur (2013); Kumar and Chawla, (2018) and Singh, (2019). The interaction effect was not significant. None of the treatments evinced significant influence on TSS.

Nutrient uptake

The data on nutrient uptake in grain and stover are given in Table 2. The results revealed that planting density and nutrient levels exerted significant influence on nitrogen, phosphorus and potassium uptake in grain and stover. Among the hybrids, MISTHI (H_2) recorded higher nitrogen uptake of 62.6 kg ha^{-1} and 66.1 kg ha^{-1} in grain during *Kharif*, 2019 and *Kharif*, 2020, respectively which were significantly superior to H_1. With respect to planting density, D_2 (60 × 15 cm)

Table 1: Effect of planting density and nutrient levels on plant height, green cob yield, green fodder yield and TSS.

Treatments	Plant height at harvest (cm)		Green cob yield (kg/ha)		Green fodder yield (kg/ha)		TSS (%)	
	Kharif, 2019	*Kharif*, 2020	*Kharif*, 2019	*Kharif*, 2020	*Kharif*, 2019	*Kharif*, 2020	*Kharif*, 2019	*Kharif*, 2020
Main plot								
H_1	178.8	211.6	13324	14009	9855	10210	17.6	15.9
H_2	192.1	219.2	13905	14663	9432	9872	18.6	16.3
SEd	2.3	4.1	276	294	171	218	1.14	1.19
CD (p=0.05)	7.1	NS	NS	NS	NS	NS	NS	NS
Sub plot								
D_1	184.1	213.9	12484	13021	8893	9315	18.7	16.1
D_2	186.9	216.8	14745	15651	10393	10768	17.4	16.0
SEd	2.6	2.3	233	257	249	168	1.31	1.42
CD (p=0.05)	NS	NS	647	714	692	467	NS	NS
Sub sub plot								
N_1	189.5	219.2	14295	15130	10644	10916	17.7	16.1
N_2	185.6	215.7	13678	14471	9752	10184	18.0	16.0
N_3	181.3	211.3	12872	13407	8534	9023	18.6	16.1
SEd	7.4	4.6	289	331	427	374	1.46	1.59
CD (p=0.05)	NS	NS	635	702	906	792	NS	NS

Table 2: Effect of planting density and nutrient levels on NPK uptake in grain and stover.

Treatments	N uptake (kg/ha)				P uptake (kg/ha)				K uptake (kg/ha)			
	Grain		Stover		Grain		Stover		Grain		Stover	
	Kharif, 2019	*Kharif*, 2020	*Kharif*, 2019	*Kharif*, 2020	*Kharif*, 2019	*Kharif*, 2020	*Kharif*, 2019	*Kharif*, 2020	*Kharif*, 2019	*Kharif*, 2020	*Kharif*, 2019	*Kharif*, 2020
Main plot												
H_1	58.0	61.6	61.2	63.8	20.1	20.3	26.2	28.1	32.1	33.1	104.9	102.3
H_2	62.6	66.1	60.3	61.5	23.0	23.6	25.9	27.5	33.9	34.7	100.6	99.4
SEd	0.66	0.73	0.54	0.62	0.64	0.91	1.07	1.18	0.43	0.54	1.14	1.38
CD(p=0.05)	2.82	3.14	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sub plot												
D_1: 60 × 20 cm	55.8	58.4	56.7	59.7	19.4	19.7	24.7	26.7	30.8	31.4	94.9	94.0
D_2: 60 × 15 cm	64.7	69.2	64.8	67.5	22.6	23.3	27.5	28.9	35.2	36.3	109.6	106.8
SEd	1.07	1.28	1.05	1.15	1.17	1.39	0.71	0.80	0.60	0.64	1.78	2.25
CD(p=0.05)	2.98	3.55	2.92	3.21	NS	NS	1.97	2.13	1.68	1.77	4.96	6.24
Sub sub plot												
N_1: 100% RDF	65.2	69.1	68.6	70.6	22.7	23.4	29.9	32.1	35.4	36.9	114.8	111.0
N_2: 90% RDF	60.9	64.9	61.5	64.7	21.1	21.6	26.4	27.9	33.1	33.8	103.3	102.2
N_3: 80% RDF	54.8	57.4	52.2	55.6	19.4	19.2	21.9	23.2	30.6	30.7	88.9	87.9
SEd	2.16	2.40	1.99	2.98	0.86	0.95	1.76	1.95	1.22	1.48	5.57	4.29
CD(p=0.05)	4.57	5.09	4.21	6.32	1.83	2.01	3.72	4.24	2.59	3.23	11.8	9.10

recorded higher nitrogen uptake of 64.7 kg ha^{-1} and 69.2 kg ha^{-1} in grain during *Kharif*,2019 and *Kharif*, 2020, respectively which were significantly superior to D_1. This was ascribed to more plant population under high density which favoured more nutrient uptake. The results confirm the findings of Bharud *et al.*, 2014. In respect of nutrient levels, N_1 (100%RDF) recorded higher nitrogen uptake of 65.2 kg ha^{-1} and 69.1 kg ha^{-1} in grain during *Kharif*, 2019 and *Kharif*, 2020, respectively. This was comparable with 90% RDF but was superior to 80% RDF. Higher uptake of nutrients with application of 100%RDF might be due to establishment of extensive root system, which helped in extraction of nutrients from soil and hastened the process of translocation of nutrients to sink thereby improved the nutrient concentration in grain. The results are in conformity with the findings of Akpan and Udoh, (2017) and Kumar and Narayan, (2018). With respect to nitrogen uptake in stover, there was no significant influence among the hybrids. Nevertheless, H_1 (CSCH-15001) recorded higher nitrogen uptake of 61.2 kg ha^{-1} and 63.8 kg ha^{-1} during *Kharif*, 2019 and *Kharif*, 2020, respectively. Among the planting density, D_2 (60 × 15 cm) recorded higher nitrogen uptake of 64.8 kg $ha^{-1}$and 67.5 kg ha^{-1}

Table 3: Effect of planting density and nutrient levels on economics of sweetcorn hybrids.

Treatments	Green cob yield (kg/ha)		Net return (Rs./ha)		B:C ratio	
	Kharif, 2019	*Kharif*, 2020	*Kharif*, 2019	*Kharif*, 2020	*Kharif*, 2019	*Kharif*, 2020
$H_1D_1N_1$	12871	13416	45006	48545	2.06	2.15
$H_1D_1N_2$	12257	12832	40988	44855	1.98	2.07
$H_1D_1N_3$	11462	11943	35592	38945	1.86	1.94
$H_1D_2N_1$	15134	16141	58180	64402	2.31	2.45
$H_1D_2N_2$	14513	15439	53970	59890	2.23	2.37
$H_1D_2N_3$	13706	14284	48305	52214	2.12	2.21
$H_2D_1N_1$	13446	14054	48027	52026	2.13	2.23
$H_2D_1N_2$	12837	13443	44069	48200	2.06	2.15
$H_2D_1N_3$	12034	12439	38672	41638	1.94	2.01
$H_2D_2N_1$	15728	16909	61243	68618	2.38	2.55
$H_2D_2N_2$	15103	16171	57052	63916	2.30	2.46
$H_2D_2N_3$	14285	14961	51379	48545	2.18	2.15

in stover during *Kharif*, 2019 and *Kharif*, 2020, respectively. This was significantly superior to D_1. In respect of nutrient levels, N_1 (100%RDF) recorded higher nitrogen uptake of 68.6 kg ha^{-1} in stover during *Kharif*, 2019 which was significantly superior to 90% RDF and 80% RDF. Crop raised in *Kharif* 2020, N_1 (100%RDF) recorded higher nitrogen uptake of 70.6 kg ha^{-1} in stover which was comparable with 90% RDF but was superior to 80% RDF.

With respect to phosphorus uptake in grains, there was no significant influence among the hybrids and planting density. However, MISTHI (H_2) recorded higher phosphorus uptake of 23.0 kg ha^{-1} and 23.6 kg ha^{-1} in grain during *Kharif*, 2019 and *Kharif*, 2020, respectively. Among the planting density, D_2 (60 × 15 cm) recorded higher phosphorus uptake of 22.6 kg ha^{-1} and 23.3 kg ha^{-1} in grain during *Kharif*, 2019 and *Kharif*, 2020, respectively. This might be due to increase in plant density which influenced the nutrient uptake. Similar view has been expressed by Massey and Gaur, 2013. With regard to nutrient levels, N_1 (100%RDF) recorded higher phosphorus uptake of 22.7 kg ha^{-1} and 23.4 kg ha^{-1} in grains during *Kharif*, 2019 and *Kharif*, 2020, respectively. This was comparable with 90% RDF but was superior to 80% RDF. Higher nutrient uptake with the application of 100% RDF was due to increase in nutrient content of grain and yield. The results are in accordance with the findings of Singh *et al.*, (2009). With respect to phosphorus uptake in stover, there was no significant influence among the hybrids. Nevertheless, H_1 (CSCH-15001) recorded higher phosphorus uptake of 26.2 kg ha^{-1} and 28.1 kg ha^{-1} during *Kharif*, 2019 and *Kharif*, 2020, respectively. Among the planting density, D_2 (60 × 15 cm) recorded higher phosphorus uptake of 27.5 kg ha^{-1} and 28.9 kg ha^{-1} in stover during *Kharif*, 2019 and *Kharif*, 2020, respectively. This was significantly superior to D_1. Among the nutrient levels, N_1 (100%RDF) recorded higher phosphorus uptake of 29.9 kg ha^{-1} in stover during *Kharif*, 2019 which was comparable with 90% RDF but was superior to 80% RDF. During *Kharif* 2020, N_1 (100%RDF) recorded higher phosphorus uptake of 32.1 kg ha^{-1} in stover which was comparable with 90% RDF but was superior to 80% RDF.

There was no significant influence among the hybrids in respect of potassium uptake in grain. Nevertheless, MISTHI (H_2) recorded higher potassium uptake of 33.9 kg ha^{-1} and 34.7 kg ha^{-1} in grain during *Kharif*, 2019 and *Kharif*, 2020, respectively. Among the planting density, D_2 (60 ×15 cm) recorded higher potassium uptake of 35.2 kg ha^{-1} and 36.3 kg ha^{-1} in grain during *Kharif*, 2019 and *Kharif*, 2020, respectively which were significantly superior to D_1. Higher nutrient uptake under high density was due to increased number of plants ha^{-1}. The results confirm the findings of Nandeha *et al.*(2016). Among the nutrient levels, N_1 (100%RDF) recorded higher potassium uptake of 35.4 kg ha^{-1} and 36.9 kg ha^{-1} in grain during *Kharif*, 2019 and *Kharif*, 2020, respectively. This was comparable with 90% RDF but was superior to 80% RDF. This might be due to improvement in nutrient concentration of grain favoured by inorganic fertilizer application. The results are in accordance with the findings of Rasool *et al.* (2016). With respect to potassium uptake in stover, there was no significant influence among the hybrids. However, H_1 (CSCH-15001) recorded higher potassium uptake of 104.9 kg ha^{-1} and 102.3 kg ha^{-1} during *Kharif*, 2019 and *Kharif*, 2020, respectively. Among the planting density, D_2 (60 × 15 cm) recorded higher potassium uptake of 109.6 kg ha^{-1} and 106.8 kg ha^{-1} in stover during *Kharif*, 2019 and *Kharif*, 2020, respectively. This was significantly superior to D_1. In respect of nutrient levels, N_1 (100%RDF) recorded higher potassium uptake of 114.8 kg ha^{-1} and 111 kg ha^{-1} during *Kharif*, 2019 and *Kharif*, 2020, respectively. This was comparable with 90% RDF but was superior to 80% RDF.

Economics

The data on net return and B:C ratio are given in Table 3. During *Kharif*, 2019, H_2 (MISTHI) under 60 × 15 cm spacing with 100% RDF (120:60:45 NPK kg/ha) registered higher net return (Rs. 61243/ha) and B:C ratio (2.38). This was followed by H_1 (CSCH-15001) which recorded a net return of Rs. 58180/ha and B:C ratio of 2.31 under 60 × 15 cm spacing with 100% RDF. During *Kharif* 2020, H_2 (MISTHI) under 60 × 15 cm spacing with 100% RDF (120:60:45 NPK kg/ha) registered higher net return (Rs. 68618/ha) and BC ratio (2.55). This was followed by H_1 (CSCH-15001) which recorded a net return of Rs. 64402/ha and B:C ratio of 2.45 under 60 × 15 cm spacing with 100% RDF. Lower net return and B:C ratio were registered by H_1 (CSCH-15001) under 60 × 20 cm spacing with 80% RDF (96:48:36 NPK kg/ha) in both the years.

CONCLUSION

Based on the results of two years of experimentation, it is concluded that MISTHI recorded higher green cob yield (16330 kg ha^{-1}), net return (Rs. 64931/ha) and BC ratio (2.47) under 60 × 15 cm with 100% RDF (120:60:45 NPK kg/ha). CSCH-15001 recorded relatively lower green cob yield (15649 kg ha^{-1}), net return (Rs. 61291/ha) and B:C ratio (2.38) under 60 × 15 cm with 100% RDF.

Conflict of interest: None.

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