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Effect of plant population and fertility levels on yield attributes, yield and nutrient uptake of sweet corn (*Zea mays* L.) cultivars

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ABSTRACT : A field experiment was conducted during *Kharif* 2001 and 2002 to compare efficacy of three cultivars, three plant population and three fertility levels in sweet corn at the Instructional Farm (Agronomy), RCA, Udaipur (Rajasthan). The test cultivars did not differ significantly in respect of yield attributes, yield, N and P uptake. Population at 55 thousand plants/ha gave significantly higher fresh weight of cob per plant both with and without husk over population at 75 thousand plants/ha. While, varying plant population did not significantly influence the other yield attributes. Significantly higher green cob yield, green fodder yield, N and P uptake was recorded under population at 75 thousand plants/ha. Population at 75 thousand plants/ha gave higher green cob yield by 5.9 and 14.9 per cent over 65 thousand and 55 thousand plants/ha, respectively. Application of 90 kg N + 45 kg P_2O_5/ha level gave significantly higher yield attributes, yield and NP uptake over 60 kg N + 30 kg P_2O_5/ha. Application of 90 kg N + 45 kg P_2O_5/ha recorded green cob yield of 76.58 q/ha which was found significantly higher by 21.1 per cent over application of 60 kg N + 30 kg P_2O_5/ha. The maximum net returns and benefit-cost ratio were recorded with sweet corn cultivar Madhuri at 75 thousand plants/ha and application of 90 kg N + 45 kg P_2O_5/ha.

Key Words : Sweet corn, Plant population, Fertility levels, Cultivars, Yield attributes, Yield, Uptake

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Sweet corn is special type of corn used for table purpose. It is one of the most popular vegetables in USA, Europe and other advanced countries of the world. Approximately 40 per cent of such corn is frozen and the rest is canned while processing. Now-a-days sweet corn is becoming popular and is being cultivated in maize growing areas of India. Being a high value crop, there is growing demand for sweet corn in star hotels for soup making. In addition, the seed of this crop is used for canning purpose and for preparation of different sweet items. The farmers dwelling at the outskirts of the cities can take up this crop for better profits. Added advantage of sweet corn is that after the harvest of green ears, the crop remains at green stage and it is fit for feeding cattle as green fodder. Due to its short duration, it is finding place in different cropping systems. It has been tried in different low canopy crops like groundnut, greengram, blackgram and high canopy crops like redgram of varying durations as intercrop and found most suitable.

Since the production technology is not available for sweet corn in relation to suitable cultivars, optimum plant densities and nutrient management in the state of Rajasthan and in particular Udaipur region of agroclimatic zone IV a (Sub-Humid Southern Plain and Aravalli Hills), the trial was conducted.

RESEARCH PROCEDURE

The field experiment was conducted at the Instructional Farm (Agronomy), Rajasthan College of Agriculture, MPUAT, Udaipur (Rajasthan) during the *Kharif*, 2001 and 2002. The soil of experimental site was clay loam in texture and alkaline in reaction (pH 7.8). It was medium in available nitrogen (277.24 kg/ha) and available phosphorus (18.98 kg/ha) and high in available potassium (365.64 kg/ha). The experiment was laid out in Randomized Block Design with four replications. The treatments comprised of three cultivars (Mahi Kanchan, JKSCH-211 and Madhuri), three plant population (55, 65 and

75 thousand plants/ha) and three fertility levels (60 : 30, 90 : 45 and 120 : 60 kg N : P_2O_5 /ha). The fertilizer full dose of phosphorus and one-third dose of nitrogen was applied through DAP and urea at sowing by drilling in furrows at 5 cm below the seeding depth. The remaining two-third dose of nitrogen was applied through urea as top dressing in two equal splits, at knee high and initiations of tasseling stages of crop growth. The crop was sown on 5th July, 2001 and 9th July, 2002 during two years. The sweet corn crop was sown for green cobs purpose the crop was harvested about 75 days after sowing during both the years.

RESEARCH ANALYSIS AND REASONING

The results of the present study as well as relevant discussions have been presented under following sub heads:

Growth parameters :

Among cultivars Mahi Kanchan significantly recorded maximum plant dry matter accumulation at 25 and 50 DAS and at harvest and plant height at harvest. Among plant population, 55 thousand plants ha^{-1} recorded maximum dry matter $plant^{-1}$ at 25 DAS, 50 DAS and at harvest, where as higher plant population recorded significantly taller plants and on pooled basis 75000 plants ha^{-1} recorded 5.84 and 3.05 per cent, respectively higher plant height over 55 and 65 thousand plants ha^{-1}. Varying fertility levels significantly affected dry matter accumulation $plant^{-1}$ and plant height of sweet corn. Application of 90:45kg N:P_2O_5 ha^{-1} recorded maximum dry matter at 25 and 50 DAS and at harvest however, it was found to remain at par to 120:60 kg N:P_2O_5 ha^{-1} . On pooled basis, 120:60 kg N:P_2O_5 ha^{-1} recorded maximum plant height. The per cent increase was to the tune of 19.32 and 1.39 over 60:30 and 90:45 kg N:P_2O_5 ha^{-1}, on pooled basis. Application of 90:45 kg N:P_2O_5 ha^{-1} level of fertility also recorded 18.18, 18.95, 20.01 and 17.69 per cent significantly higher dry matter accumulation and plant height over lowest level *i.e* 60:30 kg N:P_2O_5 ha^{-1}(14.25, 57.57 and 92.94 g and 171.10 cm, respectively).

The results are in accordance with the population treatments and the differences in plant population were the results of variation in stand geometry used as per the level of the population. An increase in plant population with reduced inter and intra row spacings has also been reported by Meena (2000). The significant increase in plant height with increased population densities seems to be the resultant of mutual shading due to over crowding of plants, it reduced the availability of light within the crop canopy and accelerated the elongation at lower internodes resulting into plant height. Increase in plant population decreased dry matter $plant^{-1}$. The observed inverse relationship between higher plant density and dry matter accumulation seems to be on account of increased competitive interaction among the plants for the want of various growth inputs from below and above ground *i.e* nutrients and solar radiation. Profound influence of balanced and increased fertilization comprising combinations of N and P on crop growth seems to be due to maintaining congenial nutritional environment of plant system on account of their greater availability from soil media. Improvement in growth of metabolic and enzymatic reaction due to better nutritional conditions with balanced fertilization seems to have increased

Table 1: Effect of plant population and fertility level on growth and yield attributes of sweet corn cultivars (Pooled data of 2 years)

Treatments	Dry matter accumulation (g/plant)			Plant height at harvest (cm)	No. of cobs /plant	Length of cob (cm)	Girth of cob (cm)	No. of grain rows/cob	Fresh weigh of cob/plant (g)	
	25 DAS	50 DAS	At harvest						With husk	Without husk
Cultivar										
Mahi Kanchan	16.26	65.91	106.62	193.25	1.05	19.08	13.17	14.68	144.40	125.59
JKSCH-211	15.83	63.98	104.55	190.74	1.05	18.56	12.75	14.27	141.62	123.28
Madhuri	16.05	65.14	105.47	192.64	1.09	18.80	12.89	14.39	142.29	123.83
C.D. (P=0.05)	0.194	1.596	1.158	1.886	NS	NS	NS	NS	NS	NS
Plant population (plants/ha)										
55000	16.29	65.96	108.75	186.89	1.05	19.16	13.12	14.65	147.41	127.98
65000	16.11	65.33	105.62	191.94	1.08	18.93	12.96	14.53	141.95	124.33
75000	15.75	63.73	102.28	197.80	1.07	18.34	12.73	14.16	138.95	120.39
C.D. (P=0.05)	0.194	1.596	1.158	1.886	NS	NS	NS	NS	4.22	3.53
Fertility level (N:P_2O_5 kg/ha)										
60 : 30	14.25	57.57	92.94	171.10	1.04	16.70	11.30	12.64	127.37	110.34
90 : 45	16.84	68.48	111.54	201.36	1.06	19.81	13.70	15.30	150.10	131.00
120 : 60	17.06	68.98	112.17	204.16	1.09	19.93	13.81	15.40	150.84	131.36
C.D. (P=0.05)	0.194	1.596	1.158	1.886	NS	0.61	0.40	0.46	4.22	3.53

NS= Non=significant

photosynthetic efficiency resulting in higher production of dry matter and it affects the sum of the growth factor mainly plant height and LAI. The significant improvement in overall growth of the crop under the influence of N and P fertilization is in the close conformity with the findings of Mehta (2002), Dadarwal (2008), Joshi (2011) and Meena (2012) .

Yield attributes :

Maize cultivars did not significantly influence the yield attributes *viz*., cobs per plant and fresh weight of cobs per plant both with and without husk (Table 1).

Plant population at varying densities from 55 thousand plants/ha to 75 thousand plants/ha had no significant effect on cobs per plant, length of cob, girth of cob and grain rows per cob (Table 1). Significant differences in fresh weight of cob per plant both with and without husk under varying plant population were noted (Table 1). Population at 55 thousand plant/ha gave the highest fresh weight of cob/plant with and without husk 147.41 and 127.98 g, respectively which was found significantly higher over population at 65 and 75 thousand plants/ha. The improvement in fresh weight of cobs per plant with and without husk under 55 thousand plants/ha might be due to vigorous growth of individual plant as reflected by increased total dry matter production/plant. It is an established fact that in the crops, availability of assimilates (source) and storage organ (sink) exert an important regulatory function on the complex process of yield formation. In maize crop, the synthesis of photosynthates at later stages of crop growth exerts profound influence on growth and development of storage structures. Population at 55 thousand plants/ha might have resulted in higher photosynthesis and have maintained adequate supply of metabolites for development of various yield components. These findings are in agreement with those of Nema *et al.* (1987).

Application of 90 kg N + 45 kg P_2O_5/ha level was found at par with 120 kg N + 60 kg P_2O_5/ha level and both these fertility levels gave significantly higher length of cob, girth of cob, number of grain rows per cob, fresh weight of cob with and without husk over 60 kg N + 30 kg P_2O_5/ha level. The increased availability of photosynthates with increased fertility levels might have enhanced number of flowers and their fertilization resulting in higher number of filled cobs and grains 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. In present investigations better nutrient concentrations and their uptake with fertilization might have resulted in increased fresh weight of cob with and without husk further indicating positive response of various yield parameters to balanced and higher level of fertilization. The results are in conformity with the findings of Singh *et al.* (2000) and Turgut, (2000).

Yield :

The test cultivars were observed at par with each other in respect of green cob yield as well as green fodder yield (Table 2).

Increasing population density from 55 thousand to 75 thousand plants/ha brought about significant increases in green cob yield and green fodder yield. Population at 75 thousand plants/ha produced the highest green cob yield of 76.98 q/ha and recorded an increase of 5.9 and 14.9 per cent over 65 thousand and 55 thousand plants/ha, respectively. This seems

Table 2: Effect of plant population and fertility level on yields, nutrient uptake and economics of sweet corn cultivars (Pooled data of 2 years)

Treatments	Yields (q/ha)						Nutrient uptake (kg/ha)		Economics	
	Green cob			Green fodder			Nitrogen	Phosphorus	Net returns (Rs/ha)	B/C ratio
Cultivar	2001	2002	Pooled	2001	2002	Pooled				
Mahi Kanchan	72.44	74.11	73.27	108.67	111.70	110.18	100.92	15.90	29265	3.30
JKSCH-211	70.20	72.13	71.16	105.54	109.38	107.46	97.46	15.42	56045	5.90
Madhuri	71.12	73.27	72.19	106.75	109.98	108.37	99.97	15.76	56941	5.99
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	1829	0.19
Plant population (plants/ha)										
55000	65.89	68.07	66.98	99.25	102.64	100.95	86.99	13.82	43490	4.77
65000	71.73	73.60	72.67	107.12	110.55	108.83	100.10	15.81	47800	5.10
75000	76.13	77.84	76.98	114.59	117.87	116.23	111.26	17.46	50961	5.31
C.D. (P=0.05)	3.31	2.95	2.20	5.11	4.28	3.31	4.96	0.70	1829	0.19
Fertility level (N:P_2O_5 kg/ha)										
60 : 30	62.42	64.03	63.22	96.27	100.11	98.19	83.94	13.04	41155	4.66
90 : 45	75.55	77.60	76.58	112.09	115.17	113.63	104.76	16.68	50694	5.42
120 : 60	75.79	77.88	76.83	112.62	115.78	114.20	109.66	17.36	50401	5.11
C.D. (P=0.05)	3.31	2.95	2.20	5.11	4.28	3.31	4.96	0.70	1829	0.19

NS= Non-significant

to have compensated more than the improvement in performance of individual plant with regard to various growth and yield components suggesting that at this level inter and intra-plant competition was to such an extent which could be compensated by increased number of plants. The results are in conformity with the findings of Ameta (1993).

Varying fertility levels significantly affected green cob and green fodder yield. Application of 90 kg N + 45 kg P_2O_5/ha level produced significantly higher green cob yield over 60 kg N + 30 kg P_2O_5/ha level but was found at par with 120 kg N + 60 kg P_2O_5/ha (Table 2). Application of 120 kg N + 60 kg P_2O_5/ha and 90 kg N + 45 kg P_2O_5/ha levels gave significantly higher green cob yield by 21.5 and 21.1 per cent, respectively over 60 kg N + 30 kg P_2O_5/ha level. The higher yield of sweet corn realization with application of balanced and higher level of plant nutrition could be ascribed to its profound influence on vegetative and reproductive growth of the crop. Raja (2001) also reported the positive response of maize crop to balanced fertilization.

Nutrient uptake :

The test cultivars Mahi Kanchan, JKSCH-211 and Madhuri were found at par with each other with regard to N and P uptake (Table 2).

Increasing plant population density from 55 thousand to 75 thousand plants ha^{-1} brought about significant increases in N and P uptake (Table 2). These significant increases in uptake of nutrients with increasing population could be attributed entirely due to increased biological yield (grain and dry fodder). The findings are in close accordance with findings of Guar *et al.* (1991).

The results indicated that increasing rates of fertilizer upto 90 kg N + 45 kg P_2O_5 ha^{-1} significantly improved N and P uptake by maize crop at harvest. The nutrient uptake by the crop is largely dependent on total biomass production and concentration of nutrient in plant at cellular level. The results confirm the findings of Totawat *et al.* (2001).

Economics :

Cultivars JKSCH-211 and Madhuri were found at par and both these cultivars gave significantly higher net returns and benefit : cost ratio over Mahi Kanchan (check). Madhuri recorded the highest net returns of Rs. 56941/ha and benefit : cost ratio of 5.99.

Significant increases in net returns and benefit : cost ratio were obtained with increasing plant population from 55 thousand to 75 thousand plants/ha. The maximum net returns (Rs. 50961/ha) and benefit : cost ratio (5.31) was recorded at density of 75 thousand plants/ha. Application of 90 kg N + 45 kg P_2O_5/ha gave significant and economically highest net returns and benefit: cost ratio over 120 kg N + 60 kg P_2O_5/ha and 60 kg N + 30 kg P_2O_5/ha levels.

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