Indian Journal of Agronomy **52** (3) : 239–242 (September 2007)

Yield and economics of sweet corn (*Zea mays*) as affected by plant population and fertility levels

S.C. SAHOO* AND P.K. MAHAPATRA[1]

Regional Research and Technology Transfer Sub-station, Orissa University of Agriculture and Technology, Jashipur, Orissa 757 091

Received : April 2007

ABSTRACT

A field experiment was conducted at Jashipur, Orissa during *rabi* (dry) season of 2002-03 and 2003-04 to study the effect of plant population (111.1, 83.3, 66.7 and 55.6 x 10^3/ha) and fertility levels (0-0-0, 40-8.7-16.7, 80-17.5-33.3 and 120-26.2-50 kg NPK/ha) on yield and economics of sweet corn (*Zea mays* L.). Application of 120-26.2-50 kg NPK to 83.3 x 10^3 plants/ha produced 16.48 t/ha green cobs, which was 7.6% more than of 66.7 x 10^3 plants/ha with same level of fertility. It gave the maximum net profit of Rs 54,453/ha, followed by Rs 49,439/ha with 66.7 x 10^3 plants/ha fertilized with 120-26.2-50 kg NPK/ha. The benefit : cost ratio was the maximum with 83.3 x 10^3 plants fertilized with 120-26.2-50 kg NPK/ha. The increase in fertility level linearly increased the green-fodder yield. Maximum fodder yield (37.49 - 41.56 t/ha) was attained with application of 120-26.2-50 kg NPK/ha. Hence, a plant population of 83.3 x 10^3/ha with fertility level 120-26.2-50 kg NPK/ha should be adopted to obtain the maximum green-cob yield and net profit from sweet corn in Orissa.

Key words: Economics, Fertility level, Plant population, Sweet corn, Yield

Corn (*Zea mays* L.) is a versatile crop, which finds a place in the human food, animal feed, fodder and industrial raw material. Recently speciality corns such as baby corn and sweet corn have emerged as alternative food sources, especially for the affluent society. Sweet corn is used as a human food in the soft dough stage with succulent grain. The higher content of a water-soluble polysaccharide in the kernel adds texture and quality in addition to sweetness (Venkatesh *et al.*, 2003). Sweet corn is gaining popularity both in rural and urban areas because of its high sugar and low starch content. It has a great market potential and high market value in India. In Orissa the tribal farmers consume a sizeable quantity of green cob, which generates potential for sweet corn cultivation in the area. As it is harvested at the green-cob stage, much before the maturity of grain, the requirement of plant population and fertility level need to be rescheduled for this crop. Effect of these factors on yield and economics of sweet corn are not known. With advent of sweet corn agronomy, it can be a profitable crop for the farmers, particularly for those residing in peri-urban areas. There are diversified reports about the effect of plant population and fertility level on its yield. Viswanatha *et al.* (2000) reported maximum green-cob yield with planting at 60 cm x 30 cm spacing, whereas Raja (2001) recommended a population of 88,888 with 120 kg N/ha to get its maximum yield. Keeping these facts in view, an experiment was conducted to work out the effect of plant population and fertility level on yield and economics of sweet corn.

MATERIALS AND METHODS

The experiment was conducted at Regional Research and Technology Transfer Substation, Jashipur, District Mayurbhanj in the North Central Plateau Zone of Orissa during *rabi* (November to February) season of 2002-03 and 2003-04. The soil was well-drained, sandy clay-loam in texture, with pH 5.6. The available N, P and K content of the soil was 181, 21.6 and 120 kg/ha, respectively. The experiment was laid out in split-plot design having 4 plant population, viz. 111.1, 83.3, 66.7 and 55.6 x 10^3 plants/ha, with spacing of 60 cm x 15 cm, 60 cm x 20 cm, 60 cm x 25 cm and 60 cm x 30 cm respectively in main plots; and 4 fertility levels, viz. 0-0-0, 40-8.7-16.7, 80-17.5-33.3 and 120-26.2-50 kg NPK/ha in subplots, and was replicated thrice. The sweet corn composite 'Madhuri' was sown on 15 November 2002 and 6 November 2003 in plot size of 14.4 m^2. Full P and K with 25% N as per treatment were

***Corresponding author** (Email: akaskanya@yahoo.co.in)

Present address: [1]College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Orissa 751 003

applied basal in furrows. The 50% N was applied at knee-high stage and the remaining N was applied at early tasseling stage.

The crop was harvested when the cobs had dried silk, green-husk cover and soft kernel. The cost of cultivation was calculated by taking the cost of labour Rs 50/day. The prevailing price of N was taken Rs 10.91/kg, P Rs 21.06/kg, K Rs 7.72/kg, green cob Rs 4/kg and green fodder Rs 100/t. The net profit and benefit : cost ratio were calculated by taking the difference and ratio between value of produce and expenditure incurred, respectively.

RESULTS AND DISCUSSION

Yield

The maximum number of cobs (86.0 x 10^3 /ha during 2002-03 and 84.5 x 10^3 /ha during 2003-04) were produced at the highest population (111.1 x 10^3 plants/ha) in both the years. But owing to mutual competition for nutrients, water and sunlight; there were maximum number of barren plants (18.1 - 19.3%) at 111.1 x 10^3 plants/ha. Densely populated plants (111.1 x 10^3 plants/ha) produced lighter cobs (125 - 131.9 g/cob) with less number of grains/cob (279 - 289) than widely spaced crop (83.3, 66.7 and 55.6 x 10^3 plants/ha) (Table 1). With increase in planting density, many kernels did not develop into full size owing to limitations in assimilation capacity, which caused kernel and ear abortion. There was less cob yield (9.49 - 9.59 t/ha) at 55.6 x 10^3 plants/ha, owing to lower number of cobs/ unit area. The population of 83.3 x 10^3 /ha had more number of cobs than 66.7 and 55.6 x 10^3 plants/ha. Although 111.1 x 10^3 plants/ha produced the highest number of cobs (84.5 - 86.0 x 10^3/ha), the effect was not reflected in the yield due to light weight of the cob. The green-cob yield was the maximum (11.29 - 12.30 t/ha) at 83.3 x 10^3 plants/ha, which was 32 and 23% more than that at 111.1 x 10^3 plants/ha during 2002-03 and 2003-04, respectively. This is in close conformity with the earlier findings by Raja (2001) from Hyderabad, who recommended a plant population of 88,888/ha for obtaining maximum sweet corn yield. Huseyin *et al.* (2003) also recommended 90 x 10^3 plants/ha for the maximum grain yield in maize.

The increase in plant population led to significantly higher green fodder yield. Maximum population of 111.1 x 10^3 plants/ha produced the maximum green fodder of 32.80 to 32.88 t/ha. The highest number of plants/unit area (111.1 x 10^3 plants/ha) contributed significantly towards green-fodder yield. Widdicombe and Thelen (2002) also observed that increase in plant density increased the fodder yield linearly.

The maximum green-cob yield of 14.42 t/ha in 2002-03 and 14.04 t/ha in 2003-04 was obtained with application of 120-26.2-50 kg NPK/ha due to more (91.0 to 93.9 x 10^3/ha) and heavy cobs (183.3 to 205.9 g/cob) with fewer barren plants (5.5 to 6.4 %). Earlier Sahoo and Mahapatra (2004) also recommended 120 kg N/ha for maximum green-cob yield. Yield attributes like number of cobs/plant, cob weight and number of grains/cob increased with fertilizer supply. In the absence of fertilizer, there were more number of non-bearing plants (27.6 - 28.9%), light cobs (67.3 - 100.8 g/cob) and fewer (142 - 146 /cob) kernels due to poor nutrition. All these resulted in low cob yield (3.16 - 3.26 t/ha) in the control plots. The green-cob yield was relatively more during 2002-03 than 2003-04 due to more number of cobs/unit area. The highest quantity of green fodder (37.49 - 41.56 t/ha) was produced at 120-26.2-50 kg NPK/ha.

The crop responded to higher level of fertility with in-

Table 1. Effect of plant population and fertility on yield and yield attributes of sweet corn

Treatment	Cobs/ha (x 10^3)		Barrenness (%)		Weight of green cob (g)		Grains/cob		Green-cob yield (t/ha)		Green-fodder yield (t/ha)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Plant population (x 10^3 plants/ha)												
111.1	86.0	84.5	19.3	18.1	125.0	131.9	279	289	9.32	9.19	32.80	32.88
83.3	82.9	80.5	13.0	12.6	162.5	152.2	323	325	12.30	11.29	30.42	28.74
66.7	70.3	69.5	12.1	11.3	170.4	156.9	327	326	11.00	10.03	25.86	23.07
55.6	66.9	63.9	11.2	12.4	171.3	160.4	329	325	9.59	9.49	20.99	20.27
SEm±	1.3	0.9	0.6	0.9	2.2	5.4	6	10	0.24	0.21	1.08	0.97
CD (P=0.05)	4.7	2.9	2.2	3.2	7.5	18.7	21	NS	0.84	0.71	3.74	3.36
Fertility (N-P-K kg/ha)												
0-0-0	46.0	46.9	28.9	27.6	100.8	67.3	146	142	3.16	3.26	9.01	10.82
40-8.7-16.7	79.2	77.7	13.5	12.3	166.3	154.8	329	330	10.94	10.03	25.04	23.83
80-17.5-33.3	87.0	82.9	7.6	8.0	178.8	173.5	373	378	13.69	12.68	34.47	32.83
120-26.2-50	93.9	91.0	5.5	6.4	183.3	205.9	410	415	14.42	14.04	41.56	37.49
SEm±	2.2	1.3	0.8	0.9	3.7	5.1	8	13	0.21	0.27	0.90	1.04
CD (P=0.05)	6.5	3.9	2.2	2.5	10.7	14.9	25	37	0.60	0.79	2.62	3.03

crease in plant density up to 83.3 x 10^3 plants/ha. Application of 120-26.2-50 kg NPK/ha to 83.3 x 10^3 plants/ha resulted in the maximum green-cob yield (16.48 t/ha), which was 7.6% more than that of 66.7 x 10^3 plants/ha with same level of fertility (Fig. 1). Compared with no fertilizer treatment, application of 120-26.2-50 kg NPK/ha to the population of 111.1, 83.3, 66.7 and 55.6 x 10^3 plants/ha increased the cob yield by 211, 374, 369 and 495%, respectively. Application of 40-8.7-16.7, 80-17.5-33.3 and 120-26.2-50 kg NPK/ha to 83.3 x 10^3 plants/ha increased the green-cob yield by 246, 337 and 374%, respectively over the control plots.

Nutrient uptake

A population of 83.3 x 10^3 plants/ha removed 56.3 kg N and 23.1 kg P/ha, which was significantly higher than of other populations (Table 2), whereas it removed 96.8 kg K/ha, which was on a par with that of 111.1 x 10^3 plants/ha. The highest yield of green cob could be obtained when the crop removed the maximum N, P and K at the population of 83.3 x 10^3 plants/ha. As maize is a heavy feeder, the uptake of NPK increased with application of every additional unit of fertilizer. High yield was associated with maximum uptake of 76.9 kg N, 32.0 kg P and 127.6 kg K/ha through application of 120-26.2-50 kg NPK/ha. Sofi *et al.* (2004) also observed maximum uptake of nutrients (97 kg N, 24 kg P and 108 kg K/ha) with application of 160 kg N and 80 kg K/ha. Poor root growth and low dry-matter production in the control plots resulted in less uptake of nutrients. Agronomic nutrient-use efficiency decreased with subsequent higher doses of fertilizer. Utilization of additional amount of nutrients decreased with subsequent

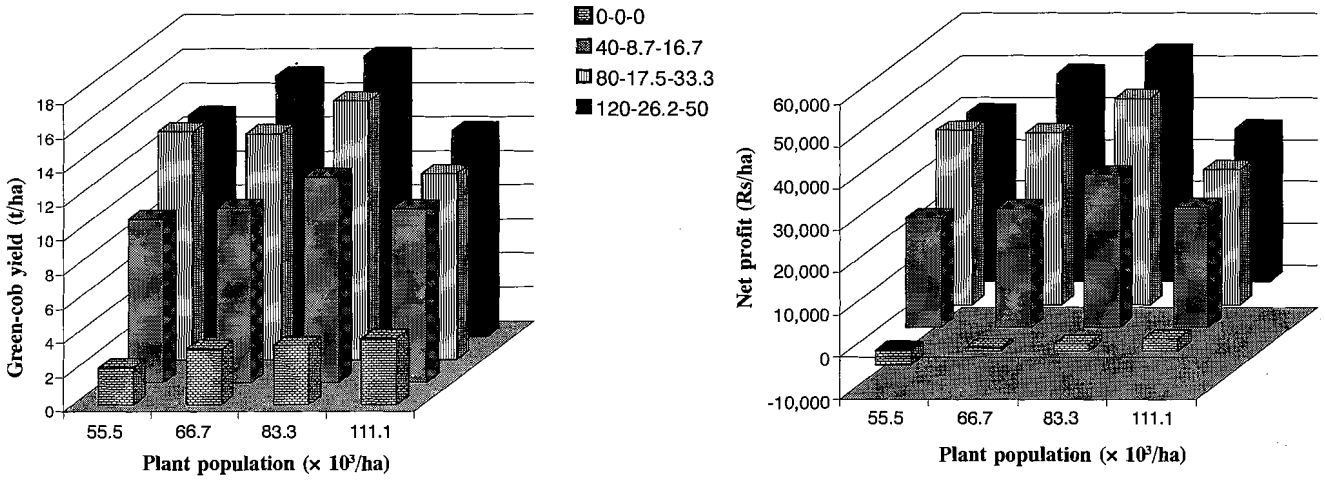

Fig. 1. Effect of plant population and fertility on yield and net profit of sweet corn

Table 2. Effect of plant population and fertility on nutrient uptake and economics of sweet corn

Treatment	Nutrient uptake (kg/ha)*			ANUE* (kg green cob/kg nutrient applied)	Net profit (Rs/ha)		Benefit : cost ratio	
	N	P	K		2002-03	2003-04	2002-03	2003-04
Plant population(x 10^3 plants/ha)								
111.1	50.4	21.0	94.8	63.7	24,874	25,055	2.57	2.62
83.3	56.3	23.1	96.8	95.5	37,345	33,241	3.42	3.18
66.7	49.3	19.9	80.9	81.2	31,680	27,807	3.07	2.85
55.6	46.1	18.2	71.8	84.2	28,352	25,594	2.82	2.72
SEm±	1.2	0.6	2.1	-	1,034	866	0.06	0.06
CD (P=0.05)	3.7	1.8	6.6	-	3,579	2,998	0.22	0.20
Fertility (N-P-K kg/ha)								
0-0-0	18.1	6.6	35.0	-	-166	615	0.99	1.04
40-8.7-16.7	43.0	17.8	72.4	111.3	31,544	27,983	3.14	2.93
80-17.5-33.3	64.1	26.0	109.4	76.3	42,920	38,883	3.81	3.58
120-26.2-50	76.9	32.0	127.6	56.2	45,952	44,215	3.89	3.82
SEm±	1.2	0.4	1.7	-	813	1,073	0.06	0.07
CD (P=0.05)	3.3	1.1	4.7	-	2,374	3,131	0.16	0.21

*Pooled data of 2 years

levels. A plant population of 83.3 x 10^3/ha had the maximum agronomic nutrient-use efficiency of 95.5 kg green-cob yield/kg NPK applied (Table 2).

Economics

The population of 83.3 x 10^3 plants/ha gave the highest net profit of Rs 33,241 to 37,345 /ha due to maximum cob yield (Table 2). This was followed by 66.7 x 10^3 plants/ha, which gave a net profit of Rs 31,680 /ha during 2002-03 and Rs 27,807 /ha during 2003-04. Maximum benefit : cost ratio (3.18 - 3.42) was recorded at the population 83.3 x 10^3 plants/ha, which was significantly higher than other plant population.

The highest level of fertility (120-26.2-50 kg NPK/ha) recorded the maximum net profit of Rs 44,215 - 45,952 / ha, which was significantly higher than other fertility levels. The net profit was 7.1-13.7% higher at 120-26.2-50 kg NPK/ha than at 80-17.5-33.3 kg NPK/ha. The benefit : cost ratio was the maximum (3.89 in 2002-03 and 3.82 in 2003-04) at fertility level 120-26.2-50 kg NPK/ha. The net returns were the lowest from the crop grown without fertilizer. Due to maximum green-cob yield, application of 120-26.2-50 kg NPK/ha to a population of 83.3 x 10^3 plants/ha resulted in significantly higher net profit of Rs 54,453 /ha than other treatments (Fig. 1). It was 10.1% more than the next highest treatment, i.e. 66.7 x 10^3 plants/ha at 120-26.2-50 kg NPK/ha.

It is concluded that to get the maximum yield and net profit, sweet corn should be grown at a population of 83.3 x 10^3 plants/ha with fertility level of 120-26.2-50 kg NPK/ha during *rabi* season under Orissa situation.

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