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Effect of plant population and weed management practices on productivity of sweet corn

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ABSTRACT

Experiment was carried out under heavy black clay soil (vertisol) at the Experimental Farm, N.M. College of Agriculture, Navsari Agricultural University, Navsari during two successive seasons of 2007-08 and 2008-09 to study the effect of varying plant population and weed management practices on weed flora and productivity of sweet corn (*Zea mays* L. Saccharata). Weed density and biomass was significantly lower with crop population of 1,11,111 plants/ha. Significantly higher green cob (9.5 t/ha) and green fodder (14.9 t/ha) yield with net return (₹ 75,779/ha) and benefit: cost ratio (5.36) was produced with plant population of 1,11,111 plants/ha and was at par with crop population of 83,333 plant/ha. Significantly lowest weed biomass was recorded in weed free check which recorded highest yield of green cob (10.7 t/ha) and fodder (17.1 t/ha). Application of atrazine 1 kg/ha + hand weeding at 40 days after sowing was remunerative with higher net return (₹ 88,873/ha) and benefit: cost ratio (6.72).

Key words: Atrazine, Hand Weeding, Pendimethalin, Plant population, Sweet corn

Sweet corn is gradually becoming an important vegetable crop in India, as it forms a useful ingredient in the preparation of salad and other food ingredient both at home and in hotels. To augment higher crop yield per unit area, proper plant density and weed management are the most important factors which cause marked effect on the growth and eventually the yield of a crop. Determining sweet corn plant population response is a recurrent area of study but it is very inconsistent across different environment and management practices. A detailed analysis of effect of plant population density on sweet corn does not exist in the pre-reviewed literature. While numerous authors have examined various aspects of population-mediated effects in field corn (Stanger and Lauer 2006), This type of information has little application to sweet corn because of the many different genes that affect all phases of plant growth, the different crop production practices used, and the different traits that are important to yield and marketability (Azanza *et al.* 1996).

Further, weed causes huge losses, and the magnitude of losses largely depends upon the composition of weed flora, period of crop-weed competition and its intensity. The season-long weed competition caused considerable yield losses in maize (Dalley *et al*. 2006). Weeds reduce crop yield by competing for light, water, nutrients and carbon dioxide, interfere with harvesting and increase the cost involved in crop production (Oerke 2005). If weed growth is minimized during critical period of crop-weed competition, the yield can be equivalent to that of weed free yield. Considering the above facts and views, the present experiment is planned to study the effect of plant population and weed management on sweet corn (*Zea mays* L. *saccharata*) production.

MATERIALS AND METHODS

The study was conducted at Instructional Farm, Navsari Agricultural University, Navsari situated between 20º 57' N latitude, 72º 54 E longitude and has an altitude of about 10 m to study effect of crop population and weed management practices on weed flora and sweet corn yield. The soil was clay in texture having 7.4 pH, 0.50% organic carbon, low in available nitrogen (165 kg/ha) and available phosphorus (31.6 kg/ha) and rich in potassium (372 kg/ha). The study involved twenty-four treatment combinations consisting of three plant populations, *viz.* 1,11,111 plants/ha, 83,333 plants/ha and 74,074 plants/ha and eight weed management practices, *viz.* weedy check, weed free check (three hand weeding at 20, 45 and 60 days after sowing), atrazine 1 kg/ha as pre-emergence, atrazine 1 kg/ha as pre-emergence + HW at 40 DAS, pendimethalin

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1 kg/ha as pre-emergence, pendimethalin 1 kg/ha as pre-emergence + HW at 40 DAS, atrazine 0.50 kg/ha + pendimethalin 0.25 kg/ha as pre-emergence by tank mixture and hand weeding at 20 DAS + inter culturing at 40 DAS. The experimental plots were 3.6 m wide and 4.2 m long, laid out according to factorial randomized block design with each treatment replicated three times. Sowing was done manually. '*Madhuri*' sweet corn variety was used. Seeds were treated with Thiram 3 g/kg of seeds and sown evenly. The crop was fertilized with recommended dose of fertilizer (120:40:00 kg N:P_2O_5:K_2O kg/ha). The shallow furrows were opened manually in each plot as per treatments and entire quantity of phosphorous (40 kg P_2O_5/ha) in the form of single super phosphate and 50% dose of nitrogen (60 kg N/ha) in the form of urea were manually applied uniformly before sowing of sweet corn crop in both the years. Remaining 50% nitrogen (60 kg N/ha) in the form of urea was applied at 30 days after sowing when irrigation was applied. The package of recommended practices was adopted to maintain the crop. After sowing, immediately a light irrigation was given to the crop for uniform germination and next day the herbicide was spray according to treatment. All the herbicides were applied as pre emergence using knapsack sprayer fitted with flat fan nozzle using in 500 litre water/ha. Data on weeds population were recorded 20 days after sowing. The observations of weed density and their dry matter were taken randomly from 1.0 m^2 quadrate from net plot area from each treatment. Same were harvested and then oven dried for 48 hours at 70^0C.

To calculate the cost of weed control, the cost of each treatment was determined and then compared with each other according to the prevailing market prices of maize grains. Data on weed density and dry weight was subjected to square root transformation before analysis. Treatment effects in both years were same so pooled analysis of data was made. The data were statistically analyzed using MSTATC software. The purpose of analysis of variance was to determine the significant effect of treatments on weeds and maize. LSD test at 5% probability level was applied when analysis of variance showed significant effect for treatments (Steel and Torrie 1980).

RESULTS AND DISCUSSION

Weed flora

The predominant weed flora of the weedy plot included : *Echinochloa crusgalli* and *Cynodon dactylon* among monocot, *Cyperus rotundus* among sedges, and *Amaranthus viridis*, *Digera arvensis*, *Portulaca oleracea*, *Alternenthara sessili* and *Trianthema* sp. among dicot weeds during both the years of investigation.

Effect on weeds

Lower weed density was observed under plant population of 1,11,111 plant/ha (Table 1). Similar trend was followed in case of weed biomass at harvest. However, significantly higher weed density and biomass were recorded with plant population of 74,074 plant/ha. This might be due to more space in lower crop population, which leads to luxurious growth of weeds in these treatments resulted in the higher dry matter accumulation by weeds while higher crop population recorded lowest weeds dry weight due to better crop stand in higher crop population.

Among the weed management treatments, weed free check (W_2) did not scrub the density of weeds because weeding was done at 20 DAS, whereas weeds biomass at harvest was significantly lowest with this treatment. However, marked reduction in weed density was observed with pre-emergence application of atrazine 0.5 kg/ha coupled with pendimethalin 0.25 kg/ha (W_4) followed by application of pre-emergence atrazine 1.0 kg/ha (W_3) and proved superior rest of other treatments.

Crop growth attributes

All treatments of crop population differed significantly among each other and independent in their effect on sweet corn plant height and dry matter accumulation and remain in $P_3>P_2>P_1$ order of their significance. Further, crop population of 74,074 plants /ha and 83,333 plants /ha were statistically on par but found significantly superior to crop population of 1,11,111 plants/ha in case of 50% silking. The increase in sweet corn plant dry matter with reducing crop population might be due to increase in sweet corn plant growth, ultimately lead to production of more photosynthates. The probable reasons for higher growth in lower crop plant density might be due to greater light interception, efficient utilization of soil moisture and the nutrients under lower degree of inter-plant competition. These results are in accordance with the findings of Sukanya *et al.* (1999).

At harvest, treatments weed free check, atrazine 1 kg/ha as pre-emergence + HW at 40 DAS, pendimethalin 1 kg/ha as pre-emergence + HW at 40 DAS and H.W. at 20 DAS + inter culturing at 40 DAS were found equally effective in increasing sweet corn plant height, 50% silking, and dry matter accumulation except hand weeding (HW) at 20 DAS + inter culturing at 40 DAS for dry matter accumulation but significantly superior to rest of the weed management practices. Significantly, lowest value of all said parameters was recorded under weedy check treatment. Moreover, application of herbicides coupled with

Table 1. Effect of crop population and weed management practices on weeds and growth and yield of sweet corn

Treatment	Total weed density/m^2 at 20 DAS	Total weed biomass (g/m^2)	Crop plant height (cm)	Days of 50% silking	DMA (g/plant)	Cob		
						Weight (g)	Length (cm)	Girth (cm)
Plant population								
1,11,111 plants/ha	8.12 (78.27)	13.10 (206.66)	153.2	59.7	84.7	103.9	15.1	11.1
83,333 plants/ha	8.61 (86.54)	14.86 (262.73)	164.7	64.0	96.6	119.1	17.6	14.3
74,074 plants/	8.90 (92.14)	15.16 (272.15)	170.6	65.5	101.9	122.2	19.2	16.0
LSD (P=0.05)	0.36	0.61	5.51	2.29	3.75	6.28	0.76	0.55
Weed management practices								
Weedy check	14.51 (210.83)	29.69 (886.54)	132.0	58.5	62.6	104.1	13.4	10.3
Weed free check	9.30 (87.44)	9.09 (83.47)	177.0	66.9	111.6	121.8	19.3	15.6
Atrazine 1 kg/ha	5.73 (32.89)	14.90 (224.18)	159.0	61.0	87.9	112.8	16.3	13.3
Atrazine 1 kg/ha+ hand weeding 40 DAS	6.00 (36.28)	10.27 (106.38)	173.6	65.8	108.3	122.6	19.2	15.2
Pendimethalin 1 kg /ha	6.81 (46.50)	15.25 (234.93)	157.5	60.3	86.0	110.9	15.8	13.1
Pendimethalin 1 kg/ha+ hand weeding 40 DAS	6.66 (44.39)	10.50 (111.08)	171.8	65.7	106.9	118.7	18.9	14.8
Atrazine 0.5 kg/ha + pendimethalin 0.25 kg/ha	5.24 (27.33)	14.65 (216.23)	160.2	61.2	88.6	111.4	16.8	13.4
HW 20 DAS + inter cultivation 40 DAS	14.12 (199.55)	10.63 (114.65)	171.7	65.0	103.5	118.2	18.7	14.7
LSD (P=0.05)	0.60	0.98	8.72	3.65	5.97	10.06	1.22	0.89

Figures in parentheses refer to actual weed population and those outside are $\sqrt{X + 0.5}$ transformed values

one hand weeding proves superior compared to alone application. This might be due to herbicide application coupled with HW provided better weed control throughout the crop life facilitated the crop plants to make optimum use of available underground and above ground resources. These observations are in agreement with those of Sharma (2007) and Prasad *et al*. (2008).

Yield attributes and yield

Crop population of 74,074 plants/ha proved its superiority by producing higher weight, length and girth of cob compared to other treatments. While significantly the lowest value recorded under the higher crop population of 1,11,111 plants/ha. Data further revealed that crop population exerted their significant effect on green cob and fodder yield being maximum (9.5 and 14.9 t/ha, respectively) and minimum (8.5 and 13.1 t/ha, respectively) with crop population of 1, 11,111 plants/ha and 83,333 plants/ha, respectively. Moreover, crop population of 1, 11,111 plants/ha and 83,333 plants/ha were found equally effective and significantly superior to crop population of 74,074 plants/ha in case of green fodder yield. Though the higher values for almost all the yield attributes were observed under lower crop population of 74,074 plants/ha, it could not compensate the yield loss due to lower plant stand compared to higher plant geometry. Besides, this higher crop population utilized the production resources more efficiently towards plant development. Hence higher and medium crop population of 1,11,111 plants/ha and 83,333 plants /ha increased the cob yield by 10.7 and 6.8%, respectively while green fodder yield by 13.6 and 10.6%, respectively over crop population of 74,074 plants/ha. These findings are in agreement with those of Kar *et al*. (2006).

Table 2. Sweet corn yield and economics as influenced by various crop population and weed management treatments (pooled)

Treatment	Yield (t/ha)		Cost of production (x10^3 ₹/ha)	Gross realization (x10^3 ₹/ha)	Net realization (x10^3 ₹/ha)	benefit: cost ratio (BCR)
	Green cob	Green fodder				
Plant population						
1,11,111 plants/ha	9.4	14.9	17.38	93.16	75.78	5.36
83,333 plants /ha	9.1	14.5	16.53	90.06	73.53	5.45
74,074 plants /ha	8.5	13.1	16.08	83.75	67.67	5.21
LSD (P=0.05)	3.36	5.70				
Weed management practices						
Weedy check (W_1)	6.5	9.2	12.68	62.71	50.03	4.94
Weed free check (W_2)	10.7	17.1	18.68	105.83	87.15	5.66
Atrazine 1 kg /ha (W_3)	8.5	12.8	13.54	83.14	69.60	6.14
Atrazine 1 kg /ha+ Hand weeding 40 DAS (W_4)	10.6	16.7	15.54	104.42	88.87	6.72
Pendimethalin 1 kg /ha (W_5)	7.9	12.2	14.13	77.67	63.53	5.50
Pendimethalin 1 kg /ha+ Hand weeding 40 DAS (W_6)	9.9	16.3	16.13	98.93	82.80	6.13
Atrazine 0.5 kg /ha+ pendimethalin 0.25 kg /ha (W_7)	8.3	12.9	13.50	82.09	68.59	6.08
HW 20 DAS + inter-cultivation 40 DAS (W_{8+})	9.8	15.9	15.21	97.13	81.92	6.39
LSD (P=0.05)	5.57	9.11				

Selling rate of produce (₹/t)

Green cob : 8000

Green fodder : 1200

A) Total fixed cost (₹/ha) : 12682

B) Variable cost (₹/ha)

P_1 :4700 W_1 : - W_4 : 2860 W_7 : 818

P_2 :3850 W_2 : 6000 W_5 : 1450 W_8 : 2525

P_3 :3400 W_3 : 860 W_6 : 3450

Weed free check proved its superiority by producing the thicker cob with higher value of weight and length compared to other treatments but statistically did not differ with treatments atrazine 1 kg/ha as pre-emergence + HW at 40 DAS, pendimethalin 1 kg/ha as pre-emergence + HW at 40 DAS and HW at 20 DAS + inter culturing at 40 DAS except HW at 20 DAS + inter culturing at 40 DAS for cob girth (Table 2). While, weedy check noted significantly the lowest value of all yield attributes. The pronouncing effect of all said growth parameter reflected on green cob and fodder yield and treatments Weed free check and atrazine 1 kg/ha as pre-emergence + HW at 40 DAS were equally effective for green cob (10.6 and 10.6 t/ha, respectively) and fodder (17.1 and 16.7 t/ha, respectively) yield per hectare, respectively but significantly superior to the rest of weed management practices. Significantly the low value of green cob and fodder yield of 6.5 and 9.2 t/ha, respectively was recorded with weedy check treatment.

Economics

Plant population of 1,11,111 plants/ha secured maximum net realization of ₹ 75,779 /ha with benefit: cost ratio (BCR) of 5.36, which was closely followed by treatments 83,333 plants/ha with net return of ₹ 73,527/ha and BCR 5.45. Data further revealed that maximum net return of ₹ 88,873 with BCR of 6.72 was realized in atrazine 1 kg/ha + HW 40 DAS followed by weed free check with net realization of ₹ 87,149 with BCR value of 5.66. The lowest net return of ₹ 50,029 was noted in weedy check with BCR value of 4.94.

The higher profitable green cob yield of *Rabi* sweet corn cv. '*Madhuri*' can be obtained by sowing the crop either at 45 x 20 cm (1,11,111 plant population/ha) or 60 x 20 cm (83,333 plant population/ha) and applying atrazine 1.0 kg/ha as pre-emergence coupled with hand weeding at 40 DAS or keeping the crop weed free throughout the crop life using three hand weeding at 20, 45 and 60 days after sowing.

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