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Effect of row-spacing and weed management practices on yield and economics of Sweet corn (*Zea mays* L. *saccharata*)

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Abstract
The experiment was conducted during the *Rabi* season 2019 at Prayagraj to study the Effect of row-spacing and weed management practices on yield and economics of Sweet corn (*Zea mays* L. *saccharata*). The experiment comprised of 2 factors and 10 treatments *viz*. Row spacings (40 cm and 50 cm) and weed management practices (Weedy check, Weed free check, Atrazine a.i @ 1.0 kg/ha PRE fb Hand weeding at 20 DAS, Tembotrione a.i @ 120 g/ha PoE and Atrazine a.i @ 1.0 kg/ha PRE fb Tembotrione a.i @ 120 g/ha PoE. Results revealed that application of 50 cm + Weed free check gave maximum no. of cobs/plant (1.28), no. of grains/cob (819.67). Whereas the maximum green cob yield (10.51 t/ha) was obtained with the application of 40 cm + Weed free check. Stover yield (21.33 t/ha) was maximum with the application of 40 cm + Atrazine a.i. @ 1.0 kg/ha PRE fb hand weeding at 20 DAS. Highest Weed control efficiency (98.63%) was observed with 40 cm + Weed free check followed by Atrazine a.i. @ 1.0 kg/ha PRE + Tembotrione a.i. @ 120 g/ha PoE (91.63%) and Atrazine a.i. @ 1.0 kg/ha PRE fb by Hand weeding at 20 DAS (85.12%).Whereas lowest Weed index was observed with 40 cm + Weed free check (0%), followed by 40 cm + Atrazine a.i. @ 1.0 kg/ha PRE followed by Hand weeding at 20 DAS (3.50%) and Atrazine a.i. @ 1.0 kg/ha PRE + Tembotrione a.i. @ 120 g/ha PoE (10.15%). Maximum gross returns (142906.5 Rs /ha) obtained with the application of 40 cm + Weed free check, maximum net returns (93211.34 Rs/ha) were obtained with the application of Atrazine a.i. @ 1.0 kg/ha followed by Hand weeding at 20 DAS and Maximum B: C ratio (1.90) was recorded with application of Atrazine a.i. @ 1.0 kg/ha followed by Hand weeding at 20 DAS.

Keywords: Sweet corn, rabi, atrazine, tembotrione, weed control efficiency, weed index, row-spacing

Introduction
Sweet corn (*Zea mays* corn *var. sacharata*) is a variety of maize with high sugar content. 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. Sweet corn is one type of maize and contains 13 to 15% sugar in immature grains.

Generally, the most appropriate spacing is one, which enables the plants to make the best use of the conditions at their disposal (Lawson and Topham, 1985; Malik *et al.*, 1993) [7, 9]. Too close spacing interferes with normal plants development and increase competition resulting in yield reduction, while too wide spacing may result in excessive vegetative growth of plant and abundant weed population due to more feeding area available. Optimum spacing allows for easy of field operations and minimizes competition among plants for light, water, and nutrients.

Although maize (*Zea mays* L.) plant is vigorous and tall growing in nature, yet it is very sensitive to weed competition at early stages of growth (Mabasa *et al.*, 1995 Kumar and Sundari, 2002) [8, 6]. The commonly reported losses due to weeds in maize are greater than 30% (Rehman, 1985) [12]. Manual weeding alone is not sufficient to ensure adequate weed control in maize field. It should be supplemented with chemical or herbicide for effective weed control. Use of Pre-emergence and post-emergence application of herbicides would make herbicidal weed control more acceptable to farmers which will not change the existing agronomic practices but will allow for complete control of weeds. Pre-emergence herbicides ensure significant promising weed control and save crop from initial weed competition and nutrient drain. Similarly, the post emergence herbicide also has a significant role in reducing the crop

weed competition at the time of critical growth stages of the crop.

Materials and Methods

The experiment was conducted during the Rabi season of 2019 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (U.P.) India. Soil was sandy clay loam having pH 7.2, organic carbon around 0.42%, available nitrogen at 245 kg/ ha, available P2O5 at 14.8 kg/ ha and K2O at 343.2 kg/ ha. The experiment was laid out in Randomized Block Design consisting of 10 treatment combinations each replicated three times. Different Row spacings I.e. 40 cm (S1) and 50 cm (S2) and Weed Management Practices (Weedy check (W1), Weed free check (W2), Atrazine a.i @ 1.0 kg/ha PRE fb Hand weeding at 20 DAS (W3), Tembotrione a.i @ 120 g/ha PoE (W4) and Atrazine a.i @ 1.0 kg/ha PRE fb Tembotrione a.i @ 120 g/ha PoE (W5). Treatments were randomly arranged in each replication. Sugar-75 was sown at 20 cm plant spacing and row spacing as per the treatment. Recommended doses of nitrogen, phosphorous and potassium were applied. The weeds collected from two randomly selected quadrates (0.5 m x 0.5 m) were used to estimate the dry matter of weeds. Observations were recorded at 20, 40, 60, 80, 100, at harvest. Pre- emergence application of herbicides was done one day after sowing while post-emergence herbicide was applied at 20 days after sowing. Total weed density was transformed using square root transformation $\sqrt{(x+1)}$ for the statistical analysis. All the data were analyzed statistically by Fisher's least significant difference method at 5% level of significance using IBM SPSS 24.0 software package developed by IBM Crop (2016). Data on different growth parameters, yield attributes and yield were recorded from randomly selected ten tagged plants from net plot.

Results and Discussion: Yield parameters

Cobs/plant

Maximum no. of cobs/plant obtained with the application of 50 cm + Weed free check (1.28 cobs/plant) which was statistically at par with 50 cm + Atrazine @ 1.0 a.i kg/ha PRE followed by hand weeding at 20 DAS (1.26 cobs/plant). Highest no. of cobs/plant with 50 cm x 20 cm row spacing might be due to less competition for space, moisture and nutrients which accelerate normal photosynthesis activity owing to more interception of sunlight. These findings are sustained with those reported by Bhatt (2012) [1] and Golada *et al*. (2013) [3] Highest no. of cobs/plant with weed free check might be due to significant reduction in crop weed competition due to effective control of weeds under this treatment reflected in better growth and development of the crop. These results are in close conformity with the findings of Nadiger *et al.* (2013) [11] and Mathukia *et al*. (2014) [10].

Grains/plant

Maximum no. of grains/cob obtained with the application of 50 cm + Weed free check (819.6667 grains/cob) which was statistically at par with 50cm + Atrazine @ 1.0 kg/ha followed by Hand weeding at 20 DAS (765 grains/cob) except with other treatments. This might be because of more the spacing more the area for canopy aeration, reduced shade effect, less competition for moisture and added nutrients through chemical fertilizers, which in turn reflected in improved yield contributing characteristics of sweet corn. Similar results have been reported by Chougale, (2003) [2] and (1998). Highest no. of grains/cob with weed free check might be due to significant reduction in crop weed competition due to effective control of weeds under this treatment reflected in better growth and development of the crop. These results are in close conformity with the findings of Nadiger *et al.* (2013) [11] and Mathukia *et al*. (2014) [10]

Green Cob Yield

Maximum green cob yield was obtained with the application of 40 cm + Weed free check (10.51 t/ha) which was significantly superior over rest of the treatments except with 40cm x 20cm + Atrazine 1 kg/ha PRE + Hand weeding at 20 DAS (10.48 t/ha) which was statistically at par with40 cm + Weed free check. Higher the crop spacing higher the crop population utilized the production resources more efficiently towards plant development. These findings are in agreement with those of Kar *et al*., (2006) [4]. Higher green cob yield with weed free check might be due to significant reduction in crop weed competition due to effective control of weeds under this treatment reflected in better growth and development of the crop. These results are in close conformity with the findings of Nadiger *et al*. (2013) [11] and Mathukia *et al.* (2014) [10].

Stover Yield

Maximum stover yield obtained with the application of 40 cm x 20cm + Atrazine a.i. @ 1 kg/ha PRE + Hand weeding at 20 DAS (21.33 t/ha) which was significantly superior over rest of the treatments except with 40 cm + Weed free check (21.25 t/ha) which was statistically at par with 40cm x 20cm + Atrazine 1 kg/ha PRE + Hand weeding at 20 DAS. The remarkable increase in stover yield under 40 cm + weed free was mainly due to increased plant population these results are in accordance with those of Thakur *et al.* (1991) [16], Sukanya *et al*. (2000) [15], and Bhatt (2012) [1].

Table 1: Effect of Row-Spacing and Weed Management Practices on yield and yield

Treatment Combinations	No. of cobs/plant	No. of grains/cob	Green cob yield (t/ha)	Stover Yield (t/ha)
40cm x 20 cm + Weedy check	1.05	354	7.85	17.23
40cm x 20 cm + Weed free check	1.15	733.66	10.51	21.25
40cm x 20cm + Atrazine 1 kg/ha fb Hand weeding at 20 DAS	1.16	698.33	10.48	21.33
40cm x 20cm + Tembotrione 120 g/ha at 20DAS	1.09	538.33	9.39	18.42
40cm x 20cm + Atrazine 1 Kg/ha fb Tembotrione 120 g/ha	1.09	562.66	9.49	19.86
50cm x 20 cm + Weedy check	1.16	328.66	6.72	14.65
50cm x 20 cm + Weed free check	1.28	819.66	9.93	16.80
50cm x 20 cm + Atrazine 1 kg/ha fb Hand weeding at 20 DAS	1.26	765	8.94	16.77
50cm x 20cm + Tembotrione 120 g/ha at 20DAS	1.16	544	8.20	16.67
50cm x 20cm + Atrazine1 Kg/ha fb Tembotrione 120g/ha	1.25	720	8.91	16.67
S.Em±	0.018	21.20	0.13	0.21
CD (P=0.05)	0.05	62.99	0.39	0.64

Attributes of sweet corn weed studies

Weed control efficiency

At harvest, maximum weed control efficiency (98.63%) was observed in 40 cm + weed free check and 50 cm + weed free check (98.49%). Besides weed free check maximum weed control efficiency (95.63%) observed in 40 cm + Atrazine @ 1.0 kg/ha PRE fb Tembotrione @ 120 g/ha PoE and 50 cm + Atrazine @ 1.0 kg/ha PRE fb Tembotrione @ 120 g/ha PoE (90.01%). However, lowest weed control efficiency (76.12%) observed in 50 cm + Tembotrione @ 120 g/ha PoE. The maximum weed control efficiency might be due to effective control weeds under. In addition to this, dense crop canopy might have suppressed weed growth and ultimately less biomass. The weedy check recorded significantly lowest control efficiency owing to uncontrolled condition favored luxurious weed growth. These findings are in close conformity with those reported by Sinha *et al*. (2003) [13], Kolage *et al*. (2004) [5], and Verma *et al*. (2009) [17].

Weed index: At harvest, lowest weed index (3.50%) observed in 40 cm + Atrazine @ 1.0 kg/ha PRE fb Hand weeding at 20 DAS. However, highest weed index (32.28%) 40 cm + Weedy check. The minimum weed index in weed free and 40 cm + Atrazine @ 1.0 kg/ha PRE fb Hand weeding at 20 DAS might be due to effective control weeds under these treatments. In addition to this, dense crop canopy might have suppressed weed growth and ultimately less biomass. The weedy check recorded significantly highest weed index owing to uncontrolled condition favored luxurious weed growth. These findings are in close conformity with those reported by Sinha *et al*. (2003) [13], Kolage *et al*. (2004) [5], and Verma *et al*. (2009) [17].

Table 2: Effect of Row-Spacing and Weed Management Practices on Weed Control Efficiency and Weed Index of Sweet corn

Treatment Combinations	Weed Control Efficiency (%)	Weed Index (%)
40cm x 20 cm + Weedy check	0	24.46
40cm x 20 cm + Weed free check	98.63	0
40cm x 20cm + Atrazine 1 kg/ha fb Hand weeding at 20 DAS	85.12	3.50
40cm x 20cm + Tembotrione 120 g/ha at 20DAS	77.47	12.06
40cm x 20cm + Atrazine 1 Kg/ha fb Tembotrione 120 g/ha	91.63	11.16
50cm x 20 cm + Weedy check	0	32.28
50cm x 20 cm + Weed free check	98.49	0
50cm x 20 cm + Atrazine 1 kg/ha fb Hand weeding at 20 DAS	80.84	10.00
50cm x 20cm + Tembotrione 120 g/ha at 20DAS	76.12	19.02
50cm x 20cm + Atrazine1 Kg/ha fb Tembotrione 120g/ha	90.01	10.15
S.Em±	0.21	1.09
CD (P=0.05)	0.64	3.24

Economics

Maximum gross returns (142906.5 Rs /ha) obtained with the application of 40 cm + Weed free check, maximum net returns (93211.34 Rs/ha) were obtained with the application of Atrazine a.i. @ 1.0 kg/ha followed by Hand weeding at 20 DAS. Higher gross and net return in these treatments were primarily due to higher green cob yield and straw yields obtained from sweetcorn. Maximum B: C ratio (1.90) was recorded with application of Atrazine @ 1.0 kg/ha followed by Hand weeding at 20 DAS. This might be due to less cost of inputs under 50 cm + Atrazine @ 1.0 kg/ha followed by Hand weeding at 20 DAS.

Table 3: Effect of Row-Spacing and Weed Management Practices on Economics of Sweet corn

Treatment Combinations	Cost of Cultivation	Gross Returns	Net Returns	B:C Ratio
40cm x 20 cm + Weedy check	47391.10	108070.9	60679.84	1.28
40cm x 20 cm + Weed free check	51891.10	142906.5	91015.35	1.75
40cm x 20cm + Atrazine 1 kg/ha fb Hand weeding at 20 DAS	48855.10	142066.4	93211.34	1.91
40cm x 20cm + Tembotrione 120 g/ha at 20DAS	48467.1	127499.4	79032.26	1.63
40cm x 20cm + Atrazine 1 Kg/ha fb Tembotrione 120 g/ha	48731.1	129787.4	81056.26	1.66
50cm x 20 cm + Weedy check	47391.1	92412.8	45021.70	0.95
50cm x 20 cm + Weed free check	51891.1	132633.7	80742.59	1.56
50cm x 20 cm + Atrazine 1 kg/ha fb Hand weeding at 20 DAS	48855.1	120714.8	71859.65	1.47
50cm x 20cm + Tembotrione 120 g/ha at 20DAS	48467.1	111738.9	63271.78	1.31
50cm x 20cm + Atrazine1 Kg/ha fb Tembotrione 120g/ha	8731.1	120342	71610.85	1.47

Conclusion

Based on experimental findings it may be concluded that application of 40 cm + Weed free check gave maximum green cob yield (10.51 t/ha) and Net returns (93,211.34 Rs/ha) and B:C ratio (1.90) were obtained maximum with the application of 40 cm + Atrazine @ 1.0 kg/ha followed by Hand weeding at 20 DAS respectively. Since the findings are based on research done in one season under agro-ecological conditions of Prayagraj it may be repeated for confirmation.

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