Original Article: Effect of pre and post emergence herbicides on weed management in Sweet corn *(Zea mays sacharata* sturt.)

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ABSTRACT

This experiment was conducted during the 2019 curriculum at Post Graduate Research Farm, Agronomy Section, College of Agriculture, Dhule. The trial consists of ten treatments that are randomly placed in blocks of three meanings. Experiment results revealed that the experimental site was infested with broad-leaved weeds, grasses and sedges. Amongst broad-leaved weeds, *Comelina benghalensis* was the dominant while in grasses, *Cynodon dactylon* was most prevalent and sedge weed *Cyprus rotundus* occurred. From the results, it is concluded that sequential application of pendimethalin 1000 g a.i ha^{-1} (PE) fb tembotrione 120 g a.i ha^{-1} (30 DAS)(T_6) not only reduced the total weed population, weed dry weight at different crop growth stages and weed index but also increased the weed control efficiency and grain yield and was found at par with pendimethalin 1000 g a.i ha^{-1} (PE) fb 2,4-D dimethyl amine 1000 g a.i ha^{-1} (PoE) (T_7). The highest net returns of 117368 ha-1 was obtained with the treatment pendimethalin 1000 g a.i ha^{-1} (PE) fb tembotrione 120 g a.i ha^{-1} (30 DAS) (T_6) and BC ratio of 2.97 was obtained with the treatment pendimethalin 1.00 kg a.i ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg a.i ha^{-1} (PoE) (T_7) (2.97) followed by the treatment pendimethalin 1000 g a.i ha^{-1} (PE) fb tembotrione 120 g a.i ha^{-1} (30 DAS) (T_6) (2.92) weed-free check (T_2) (2.71).

Introduction

Weeds are one of the most important limiting factors for the yield and quality of agricultural crops (Mehdizadeh, 2016; Mehdizadeh and Mushtaq, 2020). Sweet corn is the latest crop that is very important for diversification, income generation and value addition and the growth of the Indian agricultural sector. In India, sweet corn is grown in a very small area to meet the needs of many industries (Mushtaq et al. 2019). It can be incorporated into a cotton-based pruning system, as it is a short-lived plant, ripening in 70 to 75 days. Cobs have good market potential. Sweet corn is gaining popularity among many urban dwellers in terms of nutrition and health awareness in India.

Serious weed infestation is one of the major barriers to producing a good sweet corn crop. Wider spacing and slow growing nature of the crop during the first 3-4 weeks provide enough opportunity for weeds to invade and offer severe competition resulting in 30-100 % yield reduction (Dey et al. 2017). Weeds emerge fast and grow rapidly competing with the crop severally for growth resources *viz.*, nutrients, moisture, sunlight and space during vegetative and early reproductive stages of sweet corn. It is well established that 20 to 60 DAS is the most critical period for crop-weed competition in maize. Hence, managing weeds during this period is most critical for obtaining higher yields. The use of herbicides can make weed control more acceptable to farmers and weed control using herbicides has become a cheaper alternative to manual labor. This study was aimed to evaluating the effects of pre and post emergence herbicides on weed management in Sweet corn (*Zea mays* saccharata sturt.).

Materials and Methods

An experiment for evaluating the effects of pre and post emergence herbicides on weed management in Sweet corn (*Zea mays* saccharata sturt.) was conducted during the 2019 curriculum at Post Graduate Research Farm, Agronomy Section, College of Agriculture, Dhule, India. The treatments were including T_1: Weedy check, T_2: Weed free check, T_3: Atrazine 1000 g ha^{-1} (PE) fb halosulfuron-methyl 90 g ha^{-1} (PoE), T_4: Atrazine 1000 g ha^{-1} (PE) fb 2,4-D dimethyl amine 1000 g ha^{-1} (PoE), T_5: Pendimethalin 1000 g ha^{-1} (PE) fb halosulfuron-methyl 90 g ha^{-1} (PoE), T_6: Pendimethalin 1000 g ha^{-1} (PE) fb tembotrione 120 g ha^{-1} (30 DAS), T_7: Pendimethalin 1000 g ha^{-1} (PE) fb 2,4-D dimethyl amine 1000 g ha^{-1} (PoE), T_8: Halosulfuron-methyl 90 g ha^{-1} (PoE), T_9: Tembotrione 120 g ha^{-1} (PoE), and T_{10}: 2,4-D dimethyl amine 1000 g ha^{-1} (PoE).

The soil was Vertisols (dark brown soil moderately) and was moderately rich in available nitrogen (202.34 kg ha^{-1}), phosphorus (17.32 kg ha^{-1}) and potassium (465.45 kg ha^{-1}) with a pH of 7.5. The trial consists of ten treatments that are randomly placed in blocks of three meanings. (Table 1). Sweet corn hybrid Sugar-75 was planted with a recommended spacing of 60 x 20 cm. Monitoring of weed intensity, weed dry matter and weed control efficiency were recorded at 30, 45 and 60 days after sowing (DAS). The yield was also recorded. Weed index and economic indicators have been used in this study.

Results and Discussion

Large weeds emerged from the experimental field at all viewing stages including *Cyperus rotundus* L. among sedges; *Commelina benghalensis, Parthenium hysterophorus, Amaranthus polygamous, Lactua rucinata* among broad leaved weeds; *Cynodon dactylon, Dinebra arabica, Echinochloa colona, Bracharia ruciformis*, among grassy weeds. Details of the effect of different herbicides on weed intensity 30, 45 and 60 DAS and weed dry weight of maize are given in Tables1 and 2.

Table 1. Effect of different herbicides on weeds intensity at 30, 45 and 60 days after sowing and weed dry weight of Sweet corn

Treatments	Weed intensity (No. m^{-2})			Dry weight of weed (g m^{-2})
	30 DAS	45 DAS	60 DAS	
T_1	8.80	9.77	10.36	112.36
T_2	0.00	0.00	0.00	0.00
T_3	5.34	6.36	6.88	48.88
T_4	4.18	5.15	6.03	37.03
T_5	5.24	6.52	6.96	49.96
T_6	2.73	4.05	4.94	24.76
T_7	3.52	4.52	5.70	32.70
T_8	6.89	7.78	8.69	78.69
T_9	4.74	5.87	6.51	44.51
T_{10}	6.04	7.18	7.90	64.90
S.E.(m) ±	**0.11**	**0.10**	**0.18**	**2.76**
C.D. at 5 %	**0.33**	**0.31**	**0.54**	**8.19**
General mean	**4.75**	**5.72**	**6.40**	**49.38**

Effects of pre and post emergence herbicides on weeds

Weed intensity

Experimental results have shown that weed control practices have significantly impacted weed intensity (Table 1). Significantly higher weed numbers were recorded under the treatment of weedy checks (T_1) at 30 (8.80 No. m^{-2}), 45 (9.77 No. m^{-2}) and 60 (10.36 No. m^{-2}) DAS. The free weed check (T_2) did not record any weed intensity at 30, 45 and 60 DAS and saw the highest quality treatment. Among herbicides, the use of pendimethalin 1.00 kg ai ha^{-1} (PE) fb tembotrione 120 g ai ha^{-1} (30 DAS) (T_6) (2.73, 4.05 and 4.94 No m^{-2} in 30, 45 and 60 DAS, respectively) recorded the lowest weed population compared to other weed control methods. The next best treatment is pendimethalin 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_7) (3.52, 4.52 and 5.70 No. m^{-2} in 30, 45 and 60 DAS, respectively) followed by atrazine 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_4) (4.18, 5.15 and 6.03 No. m^{-2} to 30, 45 and 60 DAS, respectively). The results are consistent with Sivamurugan *et al* (2017) and Kumar *et al*., (2019).

Dry weight of weeds

Details of the dry weed weight (g m^{-2}) recorded during harvest are presented in Table. 1. Data analysis (Table 1) revealed that the dry weed weight varied greatly with different weed treatments. Weed-free check (T_2) has recorded the lowest dry weed weight. Among the chemical weed control methods, pendimethalin 1.00 kg ai ha^{-1} (PE) fb tembotrione 120 g ai ha^{-1} (30 DAS) (T_6) (24.76 g m^{-2} and 247.6 kg ha^{-1}) recorded very low dry weed weight during the sweet corn harvest than complete weed treatment available in proportion to pendimethalin 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_7) (32.70 g m^{-2} and 327.00 kg ha^{-1}). Significantly the heaviest weed weights (112.36 g m^{-2} and 1123.60 kg ha^{-1}) were detected under a weedy check (T_1). These findings are consistent with the findings of Kumar *et al*. (2019).

Table 2. Weed control efficiency (%) and weed index (%) as influenced periodically by different treatment.

Treatments	Weed control efficiency (%)			Weed index (%)
	30 DAS	45 DAS	60 DAS	
T_1	-	-	-	60.10
T_2	100	100	100	-
T_3	63.63	57.89	56.07	22.39
T_4	77.92	72.63	66.36	16.01
T_5	64.93	55.79	55.14	23.65
T_6	90.91	86.32	77.57	06.20
T_7	84.42	78.95	70.09	10.84
T_8	38.96	36.84	29.91	40.31
T_9	68.57	64.21	60.75	21.12
T_{10}	53.24	46.32	42.06	31.57

Weed control efficiency (%)

It was shown in Table 2. Significant differences were observed due to the different treatment options with respect to the weed control efficiency (WCE) at DAS growth rates of 30, 45 and 60 sweet corn crops. A free weed check recorded a high and weed check (T_1) showed effective weed control at all stages of sweet corn growth. Among the herbicide treatments weed control efficiency at 30, 45 and 60 DAS have been identified with pendimethalin 1.00 kg ai ha^{-1} (PE) fb tembotrione 120 g ai ha^{-1} (30 DAS) (T_6) (90.91, 86.32 and 77.57%,) respectively) followed by pendimethalin 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_7) (84.42, 78.95 and 70.09%, respectively) had a positive effect on weed control. Among the various chemical treatments for significantly lowest weed control efficiency at 30, 45 and 60 DAS were observed with halosulfuron-methyl 90 g ai ha^{-1} (PoE) (T_8) (38.96, 36.84 and 29.91% treatments, respectively) and 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_{10}) (53.24, 46.32

and 42.06 %, respectively). These results are consistent with the results reported by Sivamurugan *et al*. (2017), Kumar *et al*. (2019).

Weed index (%)

The data presented in Table 2 show the impact of weed control procedures on the weed index. The weed free check (T_2) had the lowest weed index (0.0%). Among the chemical weed control, the use of pendimethalin 1.00 kg ai ha^{-1} (PE) fb tembotrione 120 g ai ha^{-1} (T_6) (6.20%) recorded a minimum of weed index followed by pendimethalin 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_7) (10.84%), atrazine 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_4) (16.01%), tembotrione 120 g ai ha^{-1} (PoE) (T_9) (21.12%), atrazine 1.00 kg ai ha^{-1} (PE) fb halosulfuron-methyl 90 g ai ha^{-1} (PoE) (T_3) (22.39%), pendimethalin 1.00 kg ai ha^{-1} (PE) fb halosulfuron-methyl 90 g ai ha^{-1} (PoE) (T_5) (23.65%), respectively. Weed check (T_1) recorded a significantly highest weed index (60.10%). These results are consistent with the results reported by Sivamurugan *et al.* (2017), Kumar *et al.* (2019).

Yield

a) Green cob yield

Different weed control treatments strongly influence the green cob crop of sweet corn. The high green corn yield was recorded in the weed free check (157.72 q ha^{-1}). All treatments were found to be significantly higher than the weedy check (T_1). Among the various herbicides, the use of pendimethalin 1.00 kg ai ha^{-1} (PE) fb tembotrione 120 g ai ha^{-1} (30 DAS) (T_6) recorded the largest corn yield (147.94 q ha^{-1}) over the weed control treatment in this study. However, T_6 treatment was obtained in proportion to pendimethalin 1.00 kg ai ha^{-1} (PE) fb 2, 4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) with a green cob product (140.63 q ha^{-1}). This result is consistent with the findings of Dobariya et al. (2014), Kamble et al. (2015) and Kumar et al. (2019).

b) green fodder yield

Weed-free check (T_2) was the highest in all treatments with high yields of sweet corn fodder (324.22 q ha^{-1}). Among the chemical weed control agents, pendimethalin 1.00 kg ai ha^{-1} (PE) fb tembotrione 120 g ai ha-1 (30 DAS) (T_6) (306.97 q ha^{-1}) recorded the highest yields of green fodder followed by pendimethalin 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_7) recorded 294.49 q ha^{-1} green fodder for sweet corn. Significantly, sweet corn's lowest green fodder yield (160.86 q ha-1) was observed under the weedy check (T1). This result is consistent with the findings of Dobariya et al. (2014), Kamble et al. (2015) and Kumar et al. (2019).

Economics

Economics in terms of net returns has a major impact on the use and adoption of technology. Gross returns, net returns and BC ratio vary greatly due to different weed control methods (Table 3).

The highest cost of cultivation (66172 ha^{-1}) was recorded with weed free check (T_2), which was due to the involvement of manual labour to keep the site weed free during the critical weed competition. Among the herbicides, the use of pendimethalin 1.00 kg ai ha^{-1} (PE) fb halosulfuron-methyl 90 g ai ha^{-1} (PoE) (T_5), marked the high cost of cultivation (₹ 62172 ha^{-1}) compared with other methods used in trial due to the high market price of halosulfuron-methyl. . Significantly higher monetary gross returns were observed with weed free check (T_2) (₹190144 ha^{-1}) followed by application of pendimethalin 1.00 kg a.i ha^{-1} (PE) *fb* tembotrione 120 g a.i ha^{-1} (30 DAS) (T_6) (₹178640 ha^{-1}), pendimethalin 1.00 kg a.i ha^{-1} (PE) *fb* 2,4-D dimethyl amine 1.00 kg a.i ha^{-1} (PoE) (T_7) (₹170081 ha^{-1}), atrazine 1.00 kg a.i ha^{-1} (PE) *fb* 2,4-D dimethyl amine 1.00 kg a.i ha^{-1} (PoE) (T_4) (₹160954 ha^{-1}) and tembotrione 120 g a.i ha^{-1} (30 DAS) (T_9) (₹151826 ha^{-1}), respectively. This was due to the high economic yield achieved through these treatments. The highest total recovery was recorded in a weed free check (T_2) (₹ 123972 ha^{-1}) followed by the use of pendimethalin 1.00 kg ai ha^{-1} (PE) fb tembotrione 120 g ai ha^{-1} (30 DAS) (T_6), pendimethalin 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_7), atrazine 1.00 kg ai ha^{-1} (PE) fb

2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_4) and tembotrione 120 g ai ha^{-1} (30 DAS) (T_9) recorded ₹ 117368, 112809, 103932 and 92104 net retrieval ha^{-1}, respectively. High net returns in these treatments can be attributed to higher grain yields, stove yields and lower cost of cultivation. The benefit cost was the highest in the use of pendimethalin 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_7) (2.97) followed by pendimethalin 1.00 kg ai ha^{-1} (PE) fb tembotrione 120 g ai ha^{-1} (30 DAS) (T_6) (2.92), atrazine 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_4) (2.82), free weed check (T_2) (2.71), tembotrione 120 g ai ha^{-1} (30 DAS) (T_9) (2.54). This was due to the low cost of herbicides, high economic yields and net returns. The low BC rating was recorded with a weed check (1.40) which resulted in very low returns due to low yields. These results are consistent with the findings of Dobariya et al. (2014).

Table 3. Effect of weed management practices on yield and economics of Sweet corn

Treatments	Green cob yield (q ha^{-1})	Green cob yield (q ha^{-1})	Green Fodder yield (q ha^{-1})	Green Fodder yield (q ha^{-1})	Total cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
T_1	62.92	62922.5	160.86	16085.83	54922	79008	24086	1.44
T_2	157.72	157722.2	324.22	32422.22	69922	190144	123972	2.71
T_3	122.40	122402.8	265.95	26594.79	61922	148998	87076	2.41
T_4	132.47	132472.2	284.82	28481.53	57022	160954	103932	2.82
T_5	120.42	120423.6	265.62	26561.98	62172	146986	84814	2.36
T_6	147.94	147943.1	306.97	30697.29	61272	178640	117368	2.92
T_7	140.63	140631.9	294.49	29449.38	57272	170081	112809	2.97
T_8	94.14	94138.89	225.93	22593.33	60622	116732	56110	1.93
T_9	124.40	124402.80	274.23	27423.06	59722	151826	92104	2.54
T_{10}	107.92	107923.6	248.62	24861.87	56022	132785	76763	2.37

Note: 1. Total expenditure same for all the treatment except items of weed control in various treatments as above
2. Price of sweet corn: a. Green cob yield: ₹1000 q b. Green fodder yield: ₹1000 ton^{-1}.

Conclusion

It is concluded that among the herbicides, pendimethalin 1.00 kg ai ha^{-1} (PE) fb tembotrione 120 g ai ha^{-1} (T_6) and pendimethalin 1.00 kg ai ha^{-1} (PE) fb 2,4-D dimethyl amine 1.00 kg ai ha^{-1} (PoE) (T_7) has been found to be the most effective weed control method for weed control as it recorded significant values for weed density, dry weight of weed, weed control efficiency, weed index, grain yield, net retrieval and BC ratio .

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