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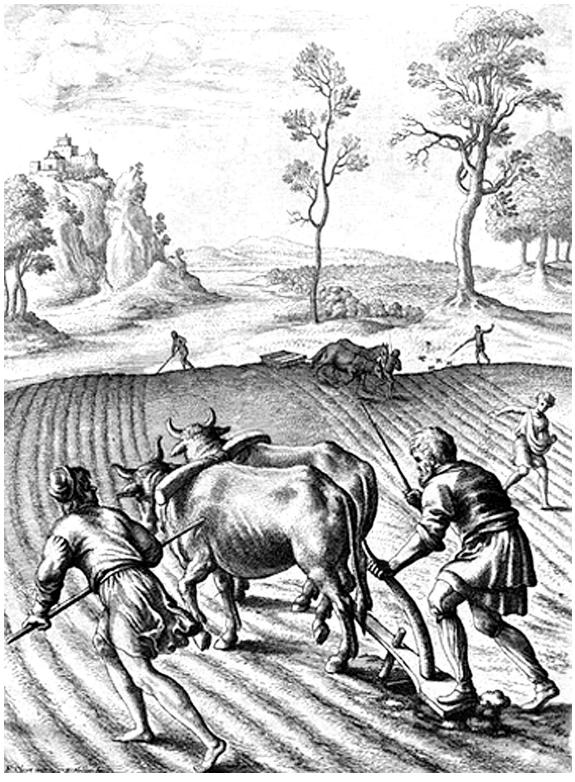

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Influence of Early Post Emergence Sulfonylurea Herbicides on Growth, Yield Parameters, Yield and Weed Control Efficiency in Sugarcane

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Abstract: Sugarcane is a slow growing long duration crop. Inefficient weed control is the major and important threat to sugarcane productivity. Weed control at early stage is important to increase the yield of the crop. Hence, the field study was conducted from October 2011 to August 2012 in sugarcane at Tamil Nadu Agricultural University, Coimbatore to find out the influence of early post emergence Sulfonylurea herbicides on growth, yield parameters, yield and weed control efficiency in Sugarcane. The study was laid out in a randomized block design with three replications. The treatments included four doses of halosulfuron methyl (60, 90, 120, 180 g ha^{-1}), chlorimuron ethyl (24, 36, 48 and 72 g ha^{-1}) and combi (60, 90.120 and 180 g ha^{-1}) compared with atrazine (2000 g ha^{-1}) hand weeding and unweeded control. The results of the study showed that, post emergence application of combi at 120 and 180 g ha^{-1} and chlorimuron ethyl at 48 and 72 g ha^{-1} offered better weed control and resulted in increased plant growth and yield attributes which resulted in increased cane yield. This was comparable with recommended weed control methods of pre emergence application of atrazine at 2000 g ha^{-1} and two hand weedings. With regard to sedge control (*Cyperus rotundus*), halosulfuron at 90, 120 and 180 g ha^{-1} was found to be promising in sugarcane cultivation. The herbicides doses did not show any phytotoxicity effect on sugarcane.

Key words: Sugarcane, halosulfuron methyl, chlorimuron ethyl, weed control efficiency, sulfonyl urea herbicides

INTRODUCTION

Sugarcane is the most adaptable plant under varied ecological conditions. In tropical agriculture weeds are the major threat in crop production which affects the crop yields considerably. The average productivity of sugarcane in tropics is around 80 t h^{-1} while in the subtropics, it is around 50 t h^{-1} (Nair, 2011). Many sugarcane workers have reported that there is a wide yield gap between the actually harvested and estimated potential and the gap is estimated to be around 20.3% (Singh *et al*., 2009).

The total area of sugarcane is about 19 million hectare and the production is about 12 million tons of sugar. Today India maintains the second position, next to Brazil. The reduction in cane yield due to weeds ranged from 40-60% (Kadam *et al*., 2011). Weeds are considered as a major biotic constraint for high production and the critical period of crop-weed competition has been recorded to be 60-120 days after planting in spring cane and 150 days in autumn cane (Singh *et al*., 2011). Risk in labour cost and availability warrant for alternate effective and economic weed control practices. Weed control spectrum of widely used herbicides like atrazine and metribuzin is quite narrow. Continuous use of herbicides with similar mode of action may lead to the shifting of weed flora and also herbicide resistance. Over dose of the herbicide will also result in phytotoxicity in the crop. In the view of the above facts, it is necessary to fix the optimum dose of herbicide and its effect on plant growth and yield parameter need to be evaluated. Hence, this study was planned to evaluate the efficacy of Sulfonylurea herbicides and to study its effect on growth and yield parameters of sugarcane.

MATERIALS AND METHODS

Field location and soil status: The study was conducted from October 2011 to August 2012 in sugarcane at Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore with the variety CO 86032. The soil of the study field was of clay loam in texture with moderate drainage. The soil was classified taxonomically as *Typic Haplustalf*. The soil fertility status of the study

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site was low in available nitrogen (253 kg ha^{-1}), medium in available phosphorus (22.3 kg ha^{-1}) and high in available potassium (688 kg ha^{-1}). The soil was alkaline in reaction and the pH is 9.13.

Treatment details: The treatments included were, halosulfuron methyl at 60 g ha^{-1} (T_1), halosulfuron methyl at 90 g ha^{-1} (T_2), halosulfuron methyl at 120 g ha^{-1} (T_3), halosulfuron methyl at 180 g ha^{-1} (T_4), combi at 60 g ha^{-1} (T_5), combi at 90 g ha^{-1} (T_6), combi at 120 g ha^{-1} (T_7), combi at 180 g ha^{-1} (T_8), chlorimuron ethyl at 24 g ha^{-1} (T_9), chlorimuron ethyl at 36 g ha^{-1} (T_{10}), chlorimuron ethyl at 48 g ha^{-1} (T_{11}), chlorimuron ethyl at 72 g ha^{-1} (T_{12}), atrazine at 2000 g ha^{-1} (T_{13}), two hand weedings (T_{14}) and unweeded control (T_{15}). Product combi is combination of halosulfuron methyl and chlorimuron ethyl.

The studies were laid out in a Randomized Block Design (RBD) with three replications. Calculated quantity of early post emergence herbicides (T_1-T_{12}) for the respective treatment plot was diluted in water at the rate of 750 L ha^{-1} and sprayed with a knapsack sprayer fitted with fan type nozzle at 20 Days After Planting (DAP), maintain optimum soil moisture in the field. Atrazine as pre emergence herbicide (T_{13}) was applied at 3 DAP. In hand weeding treatment (T_{14}) two hand weedings were given at 30 and 60 DAP. The unweeded control plots were kept undisturbed during the entire cropping period. All the treatments received partial earthing up at 60 DAP and following all recommended package of practices.

Statistical analysis: The data were analyzed in RBD as per procedure suggested by Snedecor and Cochran (1968). The data on total weed population was subjected to $\sqrt{(X+2)}$ transformation. Wherever, the comparisons were significant as per 'f' test, critical difference at five per cent level of probability was computed for comparison of treatment means. Treatment differences that were non significant are denoted as NS.

RESULTS AND DISCUSSION

Weed flora: The weed flora was grouped into grasses, sedges and broad leaved weeds. Major broad leaved weeds of the study fields were *Trianthema portulacastrum*, *Digeria arvensis*, *Amaranthus viridis* and *Parthenium hysterophorus*. Among the grasses *Dactyloctenium aegyptium*, *Echinochloa colonum* were the predominant weeds. *Cyperus rotundus* was the predominant sedge observed in the study field.

Growth parameters: All the weed control treatments showed significantly positive influence on sugarcane plant height and tillers at all the stages. The highest plant height of 143 cm was recorded at 60 days after planting with early post emergence application (EPOA) of combi at 180 g ha^{-1}. This was on par with combi 120 g ha^{-1} which recorded the plant height of 138.7 cm. These treatments were comparable with pre emergence application of atrazine at 2000 g ha^{-1} (138.8 cm), chlorimuron ethyl at 72 g ha^{-1} (139.3 cm) and two times hand weeding (138.6 cm) (Table 1). These results were in coincidence with the findings of Smith *et al*. (2008). He reported that application of atrazine at 1700 g ha^{-1} followed by the post emergence application of ethoxysulfuron at 80 g ha^{-1} at 15, 30 and 45th day after planting recorded an

Table 1: Effect of treatments on growth parameters of Sugarcane (2011-12)

	Plant height (cm)			No. of tillers (000 ha^{-1})		
Treatments	60 DAP	90 DAP	120 DAP	60 DAP	90 DAP	120 DAP
T_1-EPOE-Halo. 60 g ha^{-1}	118.9	149.3	180.8	241.0	193.7	163.7
T_2-EPOE-Halo. 90 g ha^{-1}	120.9	152.8	184.4	240.0	198.3	167.7
T_3-EPOE-Halo. 120 g ha^{-1}	121.1	153.4	185.2	246.8	197.7	176.3
T_4-EPOE-Halo. 180 g ha^{-1}	122.3	156.2	186.8	251.8	203.0	178.7
T_5-EPOE-Combi. 60 g ha^{-1}	122.4	149.9	179.8	238.0	203.7	168.3
T_6-EPOE-Combi. 90 g ha^{-1}	126.3	153.2	184.7	245.7	202.7	187.0
T_7-EPOE-Combi. 120 g ha^{-1}	138.7	166.4	197.6	279.2	226.4	194.0
T_8-EPOE-Combi. 180 g ha^{-1}	143.0	169.4	203.4	283.3	230.3	195.0
T_9-EPOE-Chlori. 24 g ha^{-1}	121.1	148.3	182.3	235.2	203.7	171.7
T_{10}-EPOE-Chlori. 36 g ha^{-1}	123.5	153.1	183.6	241.0	202.7	176.0
T_{11}-EPOE-Chlori. 48 g ha^{-1}	131.8	157.2	192.6	261.0	220.3	177.7
T_{12}-EPOE-Chlori. 72 g ha^{-1}	139.3	165.5	198.7	280.1	227.4	181.3
T_{13}-PE-Atrazine 2.0 kg ha^{-1}	138.8	166.2	201.4	282.1	229.7	185.3
T_{14}-HW twice (30 and 60 DAP)	138.6	165.9	199.4	275.4	228.9	183.0
T_{15}-Unweeded control	110.1	133.2	156.6	200.3	174.3	150.3
SEd	5.630	6.150	6.977	10.74	9.946	6.355
CD (p = 0.05)	11.53	12.60	14.29	22.00	20.37	13.01

DAP: Days After Planting, Halo: Indicates halosulfuron methyl, EPOE: Early Post Emergence, HW: Hand Weeding, PE: Pre Emergence, Chlori, Indicates chlorimuron ethyl, Combi is combination of halosulfuron methyl and chlorimuron ethyl

Table 2: Effect of treatments on yield parameters at harvest of sugarcane (2011-12)

Treatments	Millable cane (000 ha^{-1})	Cane length (cm)	Cane girth (cm)	Number of internodes	Internode length (cm)
T_1-EPOE-Halo. 60 g ha^{-1}	137.0	113.1	6.987	12.33	12.30
T_2-EPOE-Halo. 90 g ha^{-1}	140.7	127.8	7.283	14.00	12.67
T_3-EPOE-Halo. 120 g $^{-}$ha^{1}	146.7	136.7	7.653	14.67	13.67
T_4-EPOE-Halo. 180 g ha^{-1}	147.7	143.7	7.667	15.00	14.34
T_5-EPOE-Combi. 60 g ha^{-1}	138.9	115.5	7.553	12.00	13.01
T_6-EPOE-Combi. 90 g ha^{-1}	143.8	129.3	7.817	16.67	14.76
T_7-EPOE-Combi. 120 g ha^{-1}	164.0	155.3	8.517	17.00	16.07
T_8-EPOE-Combi. 180 g ha^{-1}	167.9	160.0	9.500	18.00	16.83
T_9-EPOE-Chlori. 24 g ha^{-1}	136.6	126.0	6.997	14.00	13.54
T_{10}-EPOE-Chlori. 36 g ha^{-1}	143.0	138.4	7.907	14.67	13.67
T_{11}-EPOE-Chlori. 48 g ha^{-1}	154.3	158.3	8.377	15.33	15.15
T_{12}-EPOE-Chlori. 72 g ha^{-1}	167.3	155.2	8.707	17.33	15.94
T_{13}-PE-Atrazine 2.0 kg ha^{-1}	158.6	154.3	8.663	17.33	15.01
T_{14}-HW twice (30 and 60 DAP)	157.4	155.0	8.740	17.00	15.63
T_{15}-Unweeded control	133.3	96.0	6.760	9.00	11.63
SEd	7.683	7.734	0.456	1.324	0.807
CD (p = 0.05)	15.73	15.84	0.937	2.713	1.655

DAP: Days After Planting, Halo. Indicates halosulfuron methyl, EPOE: Early post emergence, HW: Hand weeding, PE: Pre emergence, Chlori. Indicates chlorimuron ethyl, Combi is combination of halosulfuron methyl and chlorimuron ethyl

increased cane height of 50% as compared to unweeded check. Test herbicides did not show any phytotoxicity symptoms even at higher doses. Hence, there was no reduction in growth parameters like plant height. The highest number of tillers viz., 283.3, 230.3 and 195 was recorded in combi at 180 g ha^{-1} at 60, 90 and 120 days after planting, respectively. This was comparable with combi at 120 g ha^{-1}, chlorimuron ethyl at 48 and 72 g ha^{-1}, atrazine at 2000 g ha^{-1} and two times hand weeding. Unweeded control recorded the lowest number of tillers and plant height at all the stages of crop growth. The results are same as that of the Zafar *et al.* (2010).

Effect of herbicide on yield parameters: The yield parameters like cane length, cane girth, number of internodes and internode length were significantly influenced by the weed control treatments over unweeded control. Among the test herbicides, combi at 180 g ha^{-1} recorded the highest cane length (cm), number of internodes and internode length (cm) of 160, 18 and 16.83 at harvest stage of the crop (Table 2). This was on par with combi at 120 g ha^{-1} and higher doses of chlorimuron ethyl at 48 and 72 g ha^{-1}. This was also comparable with existing pre emergence herbicide like atrazine at 2000 g ha^{-1}. This was due to effective control of weeds which resulted in increased growth promoting attributes. There was no significant difference in cane girth among the treatments. The results are in agreement with the findings of Singh *et al.* (2011). Patel *et al.* (2003) also reported that all the weed control treatments favorably influenced the yield contributing characters such as number of millable cane, cane length and diameter. Singh *et al.* (2011) observed that increased number of internodes, higher can length and cane weight of sugarcane was observed with weed free situation.

Weed control efficiency (%): Analysis of weed control efficiency is important because it is directly correlated with yield. Higher weed control efficiency of 79.9 and 79.36% was recorded in combi at 180 g ha^{-1} and atrazine at 2000 g ha^{-1}, respectively at 30 days after planting. This was comparable with combi at 120 g ha^{-1} which recorded the weed control efficiency of 74.09%. These treatments were also comparable with chlorimuron ethyl at 48 and 72 g ha^{-1} and two hand weeding (Table 3). This might be due to lower weed dry weight in combi and chlorimuron ethyl. During the early stage of the crop (30 DAP) pre emergence application of atrazine performed better. The total weed dry weight was lower in atrazine at 2000 g ha^{-1} because of its application time where as at later stages it was comparable with the test herbicides. Singh *et al.* (2003) also observed that atrazine at 2000 g ha^{-1} provided efficient weed control, gave the lowest weed dry matter and stood at par with application of metribuzin at 1000 g ha^{-1} and diuron at 1000 g ha^{-1}.

The highest individual cane weight and cane yield of 1.6 kg and 120.1 t h^{-1} was recorded with combi at 180 g h^{-1} and this was followed by atrazine at 2000 g ha^{-1}, hand weeding twice. These treatments were on par with combi at 120 g h^{-1} and chlorimuron ethyl at 72 g ha^{-1} which recorded the cane yield of 119.1 and 116.9 t h^{-1}, respectively. This was due to effective control of weeds which resulted in good soil aeration. It enhanced the uptake of nutrients by crop coupled with growth characters and yield favouring attributes. According to Chauhan and Srivastava (2002), the increase in cane yield of 52.7% observed in weed free condition due to better crop environment. This might be due to the effective control of weeds, which produced favorable environment to the crop. Pre emergence application of atrazine provided effective control of weeds at the early

Table 3: Effect of treatments on weed control efficiency, weed index, individual cane weight and cane yield

Treatments	Weed control efficiency (%) 30 DAP	Individual cane weight (kg)	Cane yield (t ha^{-1})	Weed index (%)
T_1-EPOE-Halo. 60 g ha^{-1}	31.73	0.833	96.78	19.41
T_2-EPOE-Halo. 90 g ha^{-1}	43.73	1.050	98.15	18.27
T_3-EPOE-Halo. 120 g ha^{-1}	48.81	1.073	99.92	16.80
T_4-EPOE-Halo. 180 g ha^{-1}	52.78	1.167	101.7	15.28
T_5-EPOE-Combi. 60 g ha^{-1}	44.64	1.200	96.95	19.27
T_6-EPOE-Combi. 90 g ha^{-1}	62.09	1.367	98.38	18.08
T_7-EPOE-Combi. 120 g ha^{-1}	74.09	1.423	119.1	0.790
T_8-EPOE-Combi. 180 g ha^{-1}	79.91	1.600	120.1	0.000
T_9-EPOE-Chlori. 24 g ha^{-1}	45.27	1.090	96.16	19.93
T_{10}-EPOE-Chlori. 36 g ha^{-1}	51.82	1.233	101.2	15.77
T_{11}-EPOE-Chlori. 48 g ha^{-1}	60.09	1.410	112.7	6.150
T_{12}-EPOE-Chlori. 72 g ha^{-1}	66.16	1.447	116.9	2.690
T_{13}-PE-Atrazine 2.0 kg ha^{-1}	79.36	1.467	116.1	3.300
T_{14}-HW twice (30 and 60 DAP)	0.000	1.473	120.0	0.070
T_{15}-Unweeded control	-	0.773	83.52	30.45
SEd		0.068	5.75	-
CD (p = 0.05)		0.139	11.77	-

DAP: Days after planting, Halo. Indicates halosulfuron methyl, EPOE: Early Post Emergence, HW: Hand Weeding, PE: Pre Emergence, Chlori. Indicates chlorimuron ethyl, Combi is combination of halosulfuron methyl and chlorimuron ethyl

stages so that it increased the yield of the crop. The same results were obtained by El-Shafai *et al.* (2010).

Two hand weeding and atrazine was on par with higher dose of test herbicides like combi at 120 and 180 g ha^{-1} and chlorimuron ethyl at 48 and 72 g ha^{-1}. Ramesh and Sundari (2006) also reported that application of atrazine recorded higher cane yield which might be due to the effective control of weeds. Weed index gives the magnitude of yield reduction due to weed competition. The weed index was zero at combi at 180 g ha^{-1}. It was lower in treatments viz., combi at 120 g ha^{-1} and hand weeding twice which recorded the weed index of 0.790 and 0.070, respectively. This was comparable with chlorimuron ethyl at 48 and 72 g ha^{-1} and atrazine. Kalaiyarasi (2012) also reported that weed index was lower in herbicide applied plots when compared to unweeded control. This might be due to effective control of weeds which enhanced the yield of the crop in combi and chlorimuron ethyl applied plots (Table 3).

CONCLUSION

It can be concluded that early post emergence application of combi at 120 and 180 g ha^{-1} provided better weed control and resulted in increased growth attributes, yield attributes and yield of sugarcane. This was followed by chlorimuron ethyl at 48 and 72 g ha^{-1}. Herbicide treatments increased the yield significantly compared to unweeded control. These test herbicides were also comparable with recommended weed control methods like two hand weedings and pre emergence application of atrazine at 2000 g ha^{-1}.

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