



Efficacy of new herbicide on weeds and profitability of spring planted sugarcane (*Saccharum officinarum*) under subtropical Indian condition

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ABSTRACT

A field experiment was conducted to effect of sequential application of herbicide on weeds in spring planted sugarcane (*Saccharum officinarum* L.) during the spring seasons of 2011-12 and 2012-13 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. Results clearly revealed that weed biomass at 90 DAP, weed control efficiency at 90 DAP, weed index and cane yield (132.43 tonnes/ha in 2011-12 and 138.21 tonnes/ha in 2012-13) were significantly with conventional practice (Three hoeings) at 30, 60 and 90 DAP. However, the conventional practice (Three hoeings) at 30, 60 and 90 DAP significantly increased the profitability of sugarcane such as cost of cultivation, gross return, net return and B:C ratio (2.96 and 3.13 in 2011-12 and 2012-13, respectively) and second best treatment was sequential application of ametryne @ 2.4 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP of sugarcane.

Key words: 90 DAP, Ametryne, B:C ratio, Conventional practice, Spring planted sugarcane

Sugarcane (*Saccharum officinarum* L.) is the most important sugar crop in the world for sugar production which plays pivotal role in Indian economy by contributing 0.67% of national GDP because of its wider adaptability over varying agro-climatic condition (Dev *et al.* 2011). It is a chief raw material for Indian sugar industry. This industry is the second largest agro-based industry after textiles industry which ranks India second, among sugarcane producing countries and sharing 20% of the world sugarcane area. It is the main source of sugar in India and holds an important agricultural commercial cash crop (Dev *et al.* 2013) which provides gainful employment to large number of people. Sugarcane occupies an area of about 5.06 million ha with a production of 334.54 million tonnes of canes. In India, 26.34 million tonnes of sugar produced with a recovery of 10.25%. Its productivity in India is low (66.08 tonnes/ha) compared with that in many other sugarcane growing countries namely Egypt (121.14 tonnes/ha) and Colombia (100.42 tonnes/ha). Uttar Pradesh ranks first both in area (2.21 mha) and production (130.51 mt) of sugarcane contributing 43.68 and 39.01%, respectively at the national level. This gap in the acreage and production is because of poor cane productivity in the state being 59.00 tonnes/ha which is even less than the national average (IISR 2013). Among various factors needed to exploit the full potential

of the crop, minimizing the weed menace is of utmost importance. Reduction in cane yield due to uncontrolled weeds has been reported to vary between 43.40% (Tomar *et al.* 2003) to 73.70% (Verma 2000) and depend upon the nature and density of weeds and stage of crop growth at which keenest competition take place (Chauhan and Srivastava 2002). It has been reported that continuous use of atrazine have given rise to resistant biotypes of 58 weeds out of total 113 reported in the world so far (Le Baron 1992). Identification of new herbicides is vital and urgently needed to reduce the possibility of evolution of resistant biotype of weeds and getting higher sugarcane yield.

MATERIALS AND METHODS

The present investigation was conducted during two consecutive spring seasons of 2011-12 and 2012-13 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. The physico-chemical properties of soil of the experimental site were sandy clay loam in texture (Typical Ustochrept) with pH 7.64. It was moderately fertile being low in organic carbon (0.36%), available nitrogen (187.00 kg/ha), whereas available phosphorus (21.03 kg/ha) and potassium (227.00 kg/ha) were medium. The experiment was laid out in randomized complete block design with three replications. Twelve combinations, viz. T₁-Weedy, T₂-Conventional practice (Three hoeings) at 30, 60 and 90 DAP, T₃-Ametryne @ 1.6 kg a.i./ha at 30 DAP, T₄-Ametryne @ 2.0 kg a.i./ha at 30 DAP, T₅-Ametryne @ 2.4 kg a.i./ha

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at 30 DAP, T₆-Atrazine @ 1.0 kg a.i./ha at 30 DAP, T₇-Ametryne @ 1.6 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP, T₈-Ametryne @ 2.0 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP, T₉-Ametryne @ 2.4 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP, T₁₀-Atrazine @ 1.0 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP, T₁₁-Atrazine @ 1.0 kg a.i./ha at 30 DAP fb Carfentrazone+Glyphosate @ 1.0 kg a.i./ha at 60 DAP and T₁₂-Carfentrazone+Glyphosate @ 1.0 kg a.i./ha at 60 DAP were allotted to plot. The treatments were allocated randomly to each plot. Urea, diammonium phosphate and muriate of potash were used as a source of nitrogen, phosphorus and potassium. The crop was uniformly fertilized with 120 kg N, 60 kg P₂O₅ and 40 kg K₂O per ha giving half of the nitrogen and full dose of phosphorus and potassium as basal in furrows. Remaining nitrogen was top dressed in two equal splits at 60 and 90 DAP. Seed canes were taken from healthy crop of CoS 98231, suitable for spring season. Canes were cut in to 3 budded pieces. Setts showing any symptom of disease were rouged out and healthy setts were dipped in 0.25% solution of Emisan for 15 minutes to prevent any fungal infection. The treated setts were placed

horizontally in 15 cm deep furrows opened at 75 cm distance. After planting, the setts were covered with loose soil and finally the field was planked. Data for weed components were subjected to square root transformation ($\sqrt{X+0.5}$) for uniformity. Data were assessed by Duncan's multiple range test (DMRT) (Duncan 1955) with a probability of $P < 0.05$ by using SAS (Statistical Analysis System) software (version 9.2).

RESULTS AND DISCUSSION

It is evident from the analyzed result (Table 1) that the effect of various weed control treatments were significant on weed biomass and their weed control efficiency at 90 days after planting and cane yield during both the years of investigation. Critical examination of data reveals that three hoeings at 30, 60 and 90 DAP (conventional practice) recorded minimum weed biomass and highest weed control efficiency at 90 DAP and cane yield which was significantly superior over rest of the treatments during both the years of experimentation. Among herbicidal treatments, ametryne @ 2.4 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP (T₉) recorded minimum weed biomass and maximum

Table 1 Weed biomass, weed control efficiency and cane yield as influenced by weed control treatments in sugarcane

Treatment	Dose (kg/ha)	Time (DAP)	Weed biomass (g/m ²)		Weed control efficiency (%)		Cane yield (tonnes/ha)	
			90 DAP		90 DAP		90 DAP	
			2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Weedy			26.90 (723.25) a	26.23 (687.33) a	0.00 d	0.00 d	64.31 g	66.53 f
Conventional practice (Three hoeings)		30, 60 and 90	6.88 (46.78) e	5.69 (31.85) f	93.53 a	95.37 a	132.43 a	138.21 a
Ametryne	1.6	30	16.82 (282.41) b	16.05 (257.15) bc	60.95 c	62.59 c	102.17 ef	108.38 de
Ametryne	2.0	30	16.58 (274.36) b	15.69 (245.58) bc	62.07 c	64.27 c	105.31 def	109.43 de
Ametryne	2.4	30	16.28 (264.47) b	15.14 (228.60) c	63.43 c	66.74 c	108.26 cdef	113.25 cde
Atrazine	1.0	30	17.15 (293.49) b	16.48 (271.17) b	59.42 c	60.55 c	100.87 ef	107.84 de
Ametryne fb 2,4-D	1.6 fb 1.0	30 fb 60	10.92 (118.72) cd	9.74 (94.41) de	83.59 b	86.26 b	116.27 bcd	120.38 bcd
Ametryne fb 2,4-D	2.0 fb 1.0	30 fb 60	10.65 (112.95) cd	9.36 (87.19) e	84.38 b	87.31 b	118.73 bc	122.65 bc
Ametryne fb 2,4-D	2.4 fb 1.0	30 fb 60	10.31 (105.81) d	8.91 (78.95) e	85.37 b	88.51 b	121.24 b	126.09 b
Atrazine fb 2,4-D	1.0 fb 1.0	30 fb 60	11.19 (124.74) cd	9.98 (99.12) de	82.75 b	85.58 b	114.73 bcd	119.15 bcd
Atrazine fb Carfen + Glypho [†]	1.0 fb 1.0	30 fb 60	11.79 (138.49) c	10.85 (117.14) d	80.85 b	82.96 b	109.67 cde	114.07 bcde
Carfen + Glypho [†]	1.0	60	16.46 (270.41) b	15.41 (237.06) bc	62.61 c	65.51 c	97.84 f	101.94 e
P=0.05			*	*	*	*	*	*
CV			5.26	5.14	6.12	5.74	5.58	6.01

[†]Carfentrazone + Glyphosate (Ready mix formulation) – Carfen + Glypho, Values are subjected to square root transformation ($\sqrt{X+0.5}$), Original data given in parenthesis. Means with same letters are not statistically significant by DMRT ($P < 0.05$), * Significant

Table 2 Profitability of sugarcane as influenced by weed control treatments

Treatment	Dose (kg/ha)	Time (DAP)	Cost of cultivation (₹/ha)	Gross return (₹/ha)			Net return (₹/ha)			B:C ratio	
				2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Weedy			92224.55	186499.00 h	192937.00 g	94274.45 h	100712.45 f	1.02 f	1.09 f		
Conventional practice (Three hoeings)		30, 60 and 90	97074.55	384033.62 a	400809.00 a	286958.08 a	303734.45 a	2.96 a	3.13 a		
Ametryne	1.6	30	93706.55	296293.00 fg	314302.00 def	202586.45 efg	220595.45 de	2.16 de	2.35 de		
Ametryne	2.0	30	93931.55	305399.00 efg	317347.00 def	211467.45 ef	223415.45 de	2.25 d	2.38 d		
Ametryne	2.4	30	94156.55	313954.00 def	328425.00 cde	219797.45 def	234268.45 cd	2.33 cd	2.49 cd		
Atrazine	1.0	30	93446.55	292523.00 fg	312736.00 ef	199076.45 fg	219289.45 de	2.13 de	2.35 de		
Ametryne fb 2,4-D	1.6 fb 1.0	30 fb 60	94651.05	337183.00 bcd	349102.00 bc	242531.95 bc	254450.95 bc	2.56 b	2.69 bc		
Ametryne fb 2,4-D	2.0 fb 1.0	30 fb 60	94876.05	344317.00 bc	355685.00 bc	249440.95 b	260808.95 b	2.63 b	2.75 b		
Ametryne fb 2,4-D	2.4 fb 1.0	30 fb 60	95101.05	351589.75 b	365661.00 b	256487.70 b	270559.95 b	2.70 b	2.84 b		
Atrazine fb 2,4-D	1.0 fb 1.0	30 fb 60	94391.05	332717.00 bcde	345535.00 bcd	238325.95 bcd	251143.95 bc	2.52 bc	2.66 bc		
Atrazine fb Carfen + Glypho†	1.0 fb 1.0	30 fb 60	95352.95	318043.00 cdef	330803.00 cde	222690.05 cde	235450.05 cd	2.34 cd	2.47 cd		
Carfen + Glypho†	1.0	60	94130.95	283736.00 g	295626.00 f	189605.05 g	201495.05 e	2.01 e	2.14 e		
P=0.05			NS	*	*	*	*	*	*		
CV			5.07	5.15	5.14	5.37	5.34	5.31	5.28		

†Carfentrazone + Glyphosate (Ready mix formulation) – Carfen + Glypho. Means with same letters are not statistically significant by DMRT ($P < 0.05$). NS, Non Significant, * Significant

weed control efficiency and cane yield was closely followed by ametryne @ 2.0 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP (T_8), ametryne @ 1.6 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP (T_7) and atrazine @ 1.0 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP (T_{10}) both the years. However, the application of atrazine @ 1.0 kg a.i./ha at 30 DAP fb carfen+glypho @ 1.0 kg a.i./ha at 60 DAP (T_{11}) was also at par with T_9 on weed control efficiency at 90 DAP during both the years and cane yield during second year (2012-13). The main reason behind this was mainly due to better control of ametryne against grassy weeds plus inhibiting action of 2,4-D against sedges and broad leaf weeds according to Mishra *et al.* (2003) and Dashora (2012). It might have happened due to effect of various treatments which suppressed the weed biomass. Similar results were obtained by Dashora and Singh (2008), Singh and Lal (2008), Singh *et al.* (2008) and Singh *et al.* (2012).

Perusal of data clearly indicated (Table 2) that highest cost of cultivation (₹ 97 074.55/ha in both the years) was recorded under three hoeings at 30, 60 and 90 DAP (conventional practice) of sugarcane and lowest cost of cultivation (₹ 92 224.55/ha in both the years) was observed under weedy condition. The data further advocated that gross return (₹ 38 4033.62 and 400 809.00/ha in 2011-12 and 2012-13, respectively), net return (₹ 286 958.08 and 303 734.45/ha in 2011-12 and 2012-13, respectively) and B:C ratio (2.96 and 3.13 in 2011-12 and 2012-13, respectively) were found to be highest under three hoeings at 30, 60 and 90 days after planting of sugarcane during both first and second years. The second best treatment was sequential application of ametryne @ 2.4 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP (T_9) significantly higher gross return, net return and B:C ratio than other treatments and it was closely followed by ametryne @ 2.0 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP (T_8), ametryne @ 1.6 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP (T_7) and atrazine @ 1.0 kg a.i./ha at 30 DAP fb 2,4-D @ 1.0 kg a.i./ha at 60 DAP (T_{10}) during both 2011-12 and 2012-13. However, lowest economic returns (gross and net returns and B:C ratio) was recorded under weedy condition during both the years of investigation. The highest gross return, net return and benefit cost ratio was due to highest weed control efficiency and cane yield under these treatments in spring planted sugarcane. Pawar *et al.* (2004), Cheema *et al.* (2010), Kadam *et al.* (2011) and Mishra *et al.* (2012) confirmed the similar findings.

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