Indian Journal of Weed Science **47**(1): 46–49, 2015

Weed management in spring-planted sugarcane

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Received: 5 January 2015; Revised: 14 March 2015

ABSTRACT

A field experiment was conducted during 2008-09 and 2009-10 at the Agricultural Research Farm of C.C.R. (P.G.) College Muzaffarnagar (U.P.) to study the integration of chemical and cultural weed management practices in spring planted sugarcane. The experiment consisted of ten treatments laid out in randomized block design with three replications. *Cyperus rotundus*, *Cynodon dactylon* and *Sorghum halepense* were observed as major weeds in both the year. All the weed management practices led to significant reduction in density and dry matter of weeds when compared to weedy check. Hoeing done at 30, 60, 90 DAP recorded lowest weed density (23.77 and 22.07/m^2) and dry matter (8.71 and 8.34 g/m^2) with mean WCE of 57.0% and was found at par with the application of glyphosate 1.0 kg/ha as pre-emergence + atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP (density 24.14 and 23.29/m^2, dry matter 10.99 and 10.61 g/m^2 and WCE 45.5%). The mean reduction in cane yield ranged from 39.0% under weedy conditions to 8.0% with the crop received 03 hoeing at 30, 60 and 90 DAP and it was closely followed by the glyphosate 1.0 kg/ha as pre-emergence + atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP and atrazine 2.0 kg/ha as pre-emergence + one hoeing at 60 DAP**.** Further, the cane yield was recorded highest (88.8 t/ha) when crop raised with 3 hoeing at 30, 60, 90 DAP which was closely followed (87.9 t/ha) by glyphosate 1.0 kg/ha as pre- emergence + atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP.

Key words: Cane yield, Chemical control, Herbicide, Sugarcane, Weed management,

The projected requirement of sugar in 2030 is 36 million tonnes, which is about 50% higher than the resent production. To achieve this target, sugarcane production should be about 500 million tonnes from the current 350 million tonnes for which the production has to be increased by 7-8 million tonnes annually. This increase in production has to be achieved from the existing area through increased productivity and sugar recovery (Anonymous 2011). Though, there are several pre-requisites to realize full potential of the crop but minimizing the weed menace is of utmost importance.

Delayed germination, slow initial growth and lateral spread, wide row space and adequate supply of nutrients and moisture in sugarcane provide favorable environment for weed infestation. Sugarcane suffers from weed competitions which reduces its yield to the tune of 15-75% and even more, if not managed effectively. Further in sugarcane, a number of weed species belonging to the broad-leaf weeds, grassy weeds and sedges morphology infest the crop.

Hand hoeing in sugarcane has been the most widely practiced method of weed control by farmers. However, in recent years, its practical and economic feasibility has been limited by unfavourable weather conditions, unavailability of laborer during critical period of weeding and also their high wages. Therefore, chemical control of weeds is considered economical in sugarcane (Kumar *et al.* 2014). Several herbicides have been tried in sugarcane with varying degree of success, but information on combined use of chemical and cultural practices are scarce. Keeping this in view, the present investigation was undertaken to study the integrated weed management practices in spring planted sugarcane.

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MATERIALS AND METHODS

A field experiment was conducted during 2008-09 and 2009-10 at the Agricultural Research Farm of C.C.R. (P.G.) College Muzaffarnagar (U.P.) to study the integration of chemical and cultural weed management practices in spring planted sugarcane. The soil of the experimental site was sandy loam of Indo-Gangetic alluvial origin, very deep (>2m), well drained, flat and classified as non-calcareous mixed hyperthemic *Udic Ustochrept*, having pH 7.6 and was low in organic carbon (0.46%), medium in available P (15 kg/ha) and K (198 kg/ha) with available nitrogen of 152.0 kg/ha. The experiment consisted of ten treatments, *viz.* weedy check (T_1), weed free (T_2), three hoeings at 30, 60 and 90 days after planting

(DAP) (T_3), atrazine 2.0 kg/ha as pre-emergence + 2, 4-D 1.0 kg/ha at 60 DAP (T_4), atrazine 2.0 kg/ha as pre-emergence after 1st irrigation followed by 2, 4-D 1.0 kg/ha at 60 DAP (T_5), glyphosate 1.0 kg/ha as pre-emergence to sugarcane + atrazine 2.0 kg/ha after 1st irrigation+ hoeing at 90 days after planting (T_6), paraquat dichloride 500 ml/ha + atrazine 2.0 kg/ha after 1st irrigation (T_7), atrazine 2.0 kg/ha as pre-emergence+ one hoeing at 60 DAP (T_8), metribuzin 1.0 kg/ha as pre-emergence after 1st irrigation followed by 2,4- D 1.0 kg/ha at 60 DAP (T_9) and metribuzin 1.0 kg/ha as pre- emergence + one hoeing at 60 DAP (T_{10}) were laid out in randomized block design with 3 replications.

Mid-late maturing sugarcane (*Cos 97264*) was planted 75 cm apart in the first fortnight of March during both the years using a seed rate of 50,000 three budded setts/ha. All the recommended agronomic practices were followed throughout the cropping period. Herbicides as per treatments were applied as spray using 700 liters of water per hectare with the help of knapsack sprayer. The crop was harvested in during 1st fortnight of March during both the years of experimentation. Data pertaining to density and dry matter accumulation by weeds were subjected to square root transformation prior to statistical analysis.

RESULTS AND DISCUSSION

Cyperus rotundus, *Cynodon dactylon* and *Sorghum halepense* were observed as major weeds in both the year. Other weeds present in the field were *Euphorbia hirta, Cleome viscosa, Phyllanthus niruri, Cannabis sativa, Luffa graveolans, Trichosanthes cucumerina* and *Physalis minima.*

Effect on weeds

The density and dry matter accumulation of weeds decreased significantly due to weed control treatments compared to un-weeded check (Table 1). As expected, three hoeing at 30, 60, 90 DAP recorded lowest weed density (23.77 and 22.07/m^2) at 120 DAP which was significantly superior to rest of the treatments during 1st year. During 2nd year, application of glyphosate 1.0 kg/ha as pre-emergence + atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP and atrazine 2.0 kg/ha as pre-emergence + one hoeing at 60 DAP were found to be at par with three hoeing at 30,60,90 DAP. The remaining treatments, significantly reduced weed density by 32.5 and 36.2% during 2008-09 and 2009-10, respectively when it was compared to unweeded check. The results corroborated with the findings of Raskar (2004) and Pratap *et al.* (2013).

Total dry matter accumulation by weeds also followed a similar trend and was lowest (8.71 and 8.34 g/m^2) under three hoeing at 30, 60, 90 DAP when compared to rest of the treatments. Among the integration of herbicides + cultural practice, minimum accumulation of dry matter (10.99 and 10.61 g/m^2) in weeds was observed with the application of glyphosate 1.0 kg/ha as pre-emergence + atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP followed by atrazine 2.0 kg/ha as pre-emergence + one hoeing at 60 DAP, paraquat dichloride 500 kg/ha+ atrazine 2.0 kg/ha after 1st irrigation and metribuzin 1.0 kg/ha as pre-emergence + one hoeing at 60 DAP over un-weeded check. Reduction in weed density and total dry matter accumulation may be due to removal of weeds at critical stage with repeated hoeing and pre-emergence application of herbicides followed by one hoeing at appropriate time (Table 1). The results were in close conformity with the findings of Singh and Lal (2008). The highest weed control efficiency (mean 57.0 %) was observed under three hoeing at 30, 60, 90 DAP followed by glyphosate 1.0 kg/ha as pre-emergence + atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP (mean 45.5%) and atrazine 2.0 kg/ha as pre-emergence + one hoeing at 60 DAP (mean 39.5%) treatment.

Effect on sugarcane

Data on cane yield (Table 2) revealed that it ranged from 58.9 t/ha under weedy check to 96.5 t/ ha under weed free conditions. Further, cane yield was highest (88.8 t/ha) when crop was raised with 3 hoeing at 30, 60, 90 DAP. It was closely followed by glyphosate 1.0 kg/ha as pre-emergence + atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP (87.9 t/ha), atrazine 2.0 kg/ha as pre-emergence + one hoeing at 60 DAP (87.2 t/ha), paraquat dichloride 500 kg/ha+ atrazine 2.0 kg/ha after 1st irrigation (86.6 t/ha) and metribuzin 1.0 kg/ha as pre-emergence + one hoeing at 60 DAP (86.1 t/ha). Higher cane yield was due to the generation of higher yield attributes, *viz*. number of millable canes, cane girth and length. Lowest value of millable canes was recorded with weedy check being significantly lower than weed free, three hoeing at 30, 60, 90 DAP and glyphosate 1.0 kg/ha as pre-emergence + atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP, respectively. The cane length and girth followed the same trends as NMC. Application of herbicides *fb* cultural practices removed weeds effectively during critical weed crop competition stage resulting in profuse tillering and their conversion in more number of millable canes with increased length and girth.

Table 1. Effect of weed management practices on weeds at 120 days after planting in spring planted sugarcane

Treatment	Weed population (no./m^2) at 120 DAP										Total weed dry matter (g/m^2) at 120 DAP		Weed control efficiency (%)	
	Cyperus rotundus		*Cynodon dactylon*		*Sorghum halepense*		Other weeds		Total weeds					
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
T_1	2.91 (8.0)	2.62 (6.3)	2.40 (5.2)	2.39 (5.2)	2.55 (6.0)	2.54 (5.9)	2.22 (4.4)	2.21 (4.4)	4.92 (23.7)	4.75 (22.1)	3.02 (8.71)	2.96 (8.3)	56.8	57.1
T_2	2.94 (8.1)	3.02 (8.6)	2.60 (6.3)	2.59 (6.2)	2.78 (7.2)	2.77 (7.2)	2.38 (5.1)	2.37 (5.1)	5.23 (26.9)	5.23 (27.3)	3.80 (13.9)	3.70 (13.2)	30.8	31.9
T_3	2.91 (7.9)	2.96 (8.3)	2.54 (6.00)	2.54 (5.9)	2.72 (6.9)	2.72 (6.9)	2.35 (5.1)	2.35 (5.1)	5.15 (25.9)	5.17 (26.2)	3.71 (13.2)	3.65 (12.8)	34.3	33.7
T_4	2.81 (7.4)	2.66 (6.6)	2.47 (5.6)	2.47 (5.6)	2.62 (6.3)	2.61 (6.3)	2.27 (4.6)	2.26 (4.6)	4.96 (24.1)	4.87 (23.2)	3.38 (10.9)	3.31 (10.6)	45.5	45.4
T_5	2.84 (7.6)	2.86 (7.69)	2.49 (5.7)	2.48 (5.7)	2.67 (6.6)	2.67 (6.6)	2.46 (5.5)	2.45 (5.5)	5.10 (25.5)	5.10 (25.5)	3.62 (12.6)	2.56 (12.2)	37.4	36.9
T_6	2.83 (7.5)	2.69 (6.7)	2.48 (5.7)	2.47 (5.6)	2.64 (6.5)	2.64 (6.4)	2.28 (4.7)	2.78 (4.7)	4.99 (24.4)	4.90 (23.6)	3.55 (12.1)	3.49 (11.7)	39.7	39.3
T_7	2.92 (8.1)	3.01 (8.6)	2.59 (6.2)	2.58 (6.2)	2.75 (7.1)	2.74 (7.1)	2.37 (5.1)	2.37 (5.1)	5.20 (26.5)	5.24 (27.1)	3.69 (13.2)	3.65 (12.8)	34.5	33.9
T_8	2.88 (7.9)	2.86 (7.7)	2.53 (5.9)	2.53 (5.9)	2.70 (6.8)	2.69 (6.7)	2.34 (4.9)	2.33 (4.9)	5.11 (25.6)	5.09 (25.3)	3.66 (12.9)	3.62 (12.6)	35.6	34.8
T_9	0.70 (0.0)	0.70 (0.0)	0.70 (0.0)	0.70 (0.0)	0.70 (0.0)	0.70 (0.0)	0.70 (0.00)	0.70 (0.0)	0.70 (0.0)	0.70 (0.0)	0.70 (0.0)	0.70 (0.0)	-	-
T_{10}	3.72 (13.4)	3.83 (14.2)	3.12 (9.2)	3.12 (9.25)	2.89 (7.8)	2.88 (7.8)	2.38 (5.22)	2.38 (5.20)	6.02 (35.7)	6.07 (36.5)	4.53 (20.1)	4.45 (19.4)	-	-
LSD (P=0.05)	0.28	0.26	0.30	0.31	0.23	0.35	0.33	0.33	0.34	0.33	0.42	0.47	-	-

Figures in parentheses are original values. Data transformed to $(\sqrt{x+0.5})$

T_1- Three hoeing at 30 ,60, 90 DAP , T_2- Atrazine 2.0 kg/ha as pre- emergence + 2,4-D 1.0 kg/ha at 60 DAP, T_3- Atrazine 2.0 kg/ha as pre-emergence after 1st irrigation + 2,4-D 1.0 kg/ha at 60 DAP, T_4- Glyphosate 1.0 kg/ha as pre- emergence + Atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP, T_5- Paraquat dichloride 500 ml/ha+ atrazine 2.0 kg/ha after 1st irrigation T_6- Atrazine 2.0 kg/ha as pre-emergence + one hoeing at 60 DAP T_7- Metribuzin 1.0 kg/ha as pre-emergence after 1st irrigation + 2,4-D 1.0 kg/ha at 60 DAP T_8- Metribuzin 1.0 kg/ha as pre-emergence + one hoeing at 60 DAP T_9- Weed free, T_{10}- Weedy check.

These findings are in corroboration with the results of Singh and Kumar (2013) and Kumar *et al*. (2014).

Weed index (%)

Weed index in cane yield ranged from 39.0% under weedy conditions to 8.0% when the crop received 3 hoeings at 30, 60 and 90 days after planting stage and was closely followed by the application of glyphosate 1.0 kg/ha as pre-emergence + atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP and atrazine 2.0 kg/ha as pre-emergence + one hoeing at 60 DAP**.**

Effect on economics

Crop grown under weed free conditions involved highest cost of cultivation of ` 38,000/ha against ` 30,554/ha in weedy check (Table 2). Data on economics revealed that net returns ranged from ` 50,049/ha in weedy check to ` 94,012/ha under weed free conditions. Among the herbicidal treatments. application of glyphosate 1.0 kg/ha as pre-emergence + atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP recorded highest net returns of ` 84,052/ha with B:C ratio of 3.33 followed by atrazine 2.0 kg/ha as pre-emergence + one hoeing at 60 DAP (` 83,534/ ha), paraquat dichloride 500 kg/ha+ atrazine 2.0 kg/ ha after 1st irrigation (` 82,923/ha) and metribuzin 1.0 kg/ha as pre-emergence + one hoeing at 60 DAP (` 82,619/ha). Higher economic returns were due to higher yields.

Thus, the application of glyphosate 1.0 kg/ha as pre-emergence + atrazine 2 kg/ha applied after first irrigation + one hoeing at 90 days after planting was found to be effective for weed control and it produced higher yield attributes and cane yield with higher returns under north Indian conditions. This IWM practice effectively reduced the weed menace during early slow growth period of sugarcane while the

Table 2. Effect of weed management practices on cane yield, yield attributes and weed index in spring planted sugarcane

Treatment	No. of millable canes (x10^3 /ha)		Cane length (cm)		Cane girth (cm)		Cane yield (t/ha)			Weed index (% reduction in yield)	Cost of cultivation (x10^3 `/ha)	Net returns (x10^3 `/ha)	B:C ratio
	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	Mean				
T_1	118.9	119.2	273.6	279.1	7.0	7.2	88.0	89.6	88.8	8.0	36.22	85.30	3.35
T_2	110.1	110.4	245.2	250.1	6.4	6.6	80.3	81.7	81.0	16.1	33.68	77.10	3.29
T_3	114.2	114.6	253.3	258.4	6.5	6.7	84.1	85.5	84.8	12.1	34.97	81.08	3.32
T_4	118.0	118.9	265.9	271.2	6.9	7.1	87.2	88.5	87.9	9.0	36.10	84.05	3.33
T_5	116.2	116.6	260.6	265.8	6.8	7.3	85.9	87.3	86.6	10.3	35.57	82.92	3.33
T_6	117.0	117.4	265.3	270.6	6.8	7.0	86.5	87.8	87.2	9.7	35.71	83.53	3.34
T_7	112.3	112.7	249.4	254.4	6.4	6.6	83.4	84.7	84.1	12.9	34.15	80.82	3.37
T_8	115.1	115.5	256.2	261.3	6.7	7.2	85.6	86.5	86.1	10.8	35.10	82.62	3.36
T_9	120.0	121.0	278.1	283.7	7.0	7.2	95.9	97.1	96.5	-	38.00	94.01	3.48
T_{10}	72.0	72.5	221.0	225.4	5.7	5.9	58.6	59.2	58.9	39.0	30.55	50.05	2.64
LSD (P=0.05)	6.3	9.1	22.1	22.6	NS	0.6	8.3	8.6	8.5	-	-	10.03	0.28

DAP= Days after planting of sugarcane

T_1- Three hoeing at 30 ,60, 90 DAP , T_2- Atrazine 2.0 kg/ha as pre- emergence +2,4-D 1.0 kg/ha at 60 DAP, T_3-Atrazine 2.0 kg/ha as pre- emergence after 1st irrigation + 2,4-D 1.0 kg/ha at 60 DAP, T_4- Glyphosate 1.0 kg/ha as pre- emergence + Atrazine 2.0 kg/ha after 1st irrigation + one hoeing at 90 DAP ,T_5- Paraquat dichloride 500 ml/ha+ atrazine 2.0 kg/ha after 1st irrigation T_6- Atrazine 2.0 kg/ha as pre- emergence + one hoeing at 60 DAP T_7- Metribuzin 1.0 kg/ha as pre-emergence after 1st irrigation + 2,4-D 1.0 kg/ha at 60 DAP T_8-Metribuzin 1.0 kg/ha as pre-emergence + one hoeing at 60 DAP T_9-Weed free, T_{10}- Weedy check.

hoeing done at 90 DAP eradicated residual weed flora from the field. In this way, this approach of chemical weed control fb mechanical weed control proved effective after the sole mechanical weed control method of 3 hoeing at 30, 60 and 90 DAP.

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