Pak. J. Weed Sci. Res. 16 (3): 257-265, 2010

EVALUATION OF INTEGRATED WEED MANAGEMENT PRACTICES FOR SUGARCANE

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ABSTRACT

A field study was conducted at Sugarcane Research Institute, Faisalabad during 2008-2009 to evaluate integrated weed management for sugarcane, Randomized Complete Block Design, having three replications was used in the experiment. The treatments including (1) Ametryn + atrazine @ 3.75 kg ha^{-1} (2) Ametryn + atrazine @ 3.75 kg ha^{-1} on cane rows + inter-row cultivation, (3) hand weeding in cane rows + inter-row cultivation (4) inter-row cultivation only (5) hand hoeing twice and (6) weedy check. Statistical analysis of the data showed that weed density as well as yield related parameters were significantly affected by different treatments. In general weed management practices suppressed the weeds and increased the yield related traits. However, Ametryn + atrazine @ 3.75 kg ha^{-1} pre-emergence on cane rows only + inter-row cultivation was the most effective and economical than hand hoeing or inter-row cultivation by tractor. It was further concluded that chemical weed control along with one inter-row cultivation during tillering gave higher cane yield and cost benefit ratio (1:12.85) while the least cost benefit ratio (1:7.25) was observed in hand weeding alone.

Key Words: *Saccharum officinarum*, integrated weed management, chemicals, intercropping.

INTRODUCTION

Weed control is essential for economical crop production. Weeds reduce sugarcane yields by competing for moisture, nutrients, and light during its growing period. Khan *et al.* (2004) reported that cane yield is reduced to the extent of 20-25% due to weed infestation. Weed control prior to crop canopy spread is crucial. Heavy weed infestation hinders sugarcane harvesting by adding unnecessary harvesting expenses. Even a single weed plant growing to maturity may produce seeds that create problems for many years to come (Srivastava *et al.*, 2003). A good and uniform stand of sugarcane crop develops complete canopy that shades the spaces between the cane

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rows, which is very helpful in reducing weed competition. Cultivation can be an economical measure of suppressing weed growth. To ensure that the sugarcane plants get early advantage in the competition for sunlight, a height differential must be established between cane plants and weeds.

Herbicides can be useful and economical tools in increased sugarcane production. It is important that sugarcane crop has the initial competitive advantage against weeds. Pre-emergence herbicide applications, in conjunction with mechanical cultivation, helps to ensure the early season advantage (Chattha *et al.*, 2004), but the development of resistance in weeds and environmental safety are the major concerns against herbicide use.

Sugarcane has a prolonged growing season varying from 10-12 months, thus effective and timely control of weeds is an important component of its management. In its early stages, sugarcane germinates and grows very slowly, while weeds show a rapid growth due to the lack competition from the crop. If not checked timely, early tillering and growth of sugarcane is likely to be affected by weed competition. Singh *et al*. (1980) reported that critical period of weed control was between 30 and 120 days after planting sugarcane in Spring. Punzelan and Cruzz (1981) obtained maximum yield of cane when the crop was kept weed free from one to three months after planting, controlling weeds for longer periods did not enhance yields. It was further observed that weeds competition for one month from planting had no adverse effect on cane yields, whereas competition for two months reduced yield by 15% and for the whole season by 55%.

In Pakistan, traditional cultural practices, like hand weeding and inter-row cultivation by bullock drawn implements, are employed to eradicate weeds from cane fields. This practice is more often common with small growers using family labor for cultural operations. In recent past the chemical weed control has been introduced in the country. Several pre- and post-emergence weedicides have been introduced, of which Gesapax Combi (amtry+atrazine) is getting widely popular. Singh *et al*. (2008) observed that simazine (chemical name) and atrazine (chemical name) gave best control of weeds in cane fields and increased tillering. Luke (2007) revealed that Gesapax Combi, effectively controlled weeds in sugarcane and thus resulted in substantial increase in the yield of sugarcane. Beg (1975) reported that Gesapax Combi applied at 2.2-2.8 kg ha^{-1} controlled all types of broad leaved and narrow leaved weeds in sugarcane. The residual effect of pre-emergence application of Gesapax was observed to last for three months and it was no longer necessary to hoe the crop until the lines had closed up at the advanced stage of growth. Gill (1978) compared the efficiency of different herbicides and mechanical weed

control. Gesapax Combi gave better check on weed population and produced the highest yield of cane and was found economical than hand weeding. Any chemical or mechanical treatment of weed control did not affect the juice quality. Fayadomi (1983) did not find the effect of weedicide on juice quality. There is no sound data available in Pakistan on the comparative efficiency of different weed control methods in sugarcane. The present work was therefore, undertaken to study the economic efficiency of different methods for reducing weeds in sugar-cane fields as well as their effect on crop yield.

MATERIALS AND METHODS

The study was conducted to ascertain the effect of integrated weed management practices on sugarcane yield and yield related parameters in the research area of Sugarcane Research Institute, Faisalabad. The study was conducted during 2008-09 on cane variety CPF-246. The experiment was planted during March and laid out in randomized complete block design with three replications having a plot size of 10 x 4.8 m^2 keeping 1.2 meter apart double row strips. A seed rate of 50,000 triple budded setts (TBS) ha^{-1} and NPK fertilizer dose of 168-112-112 kg ha^{-1} was used. The treatments included in the experiment were Ametryn + atrazine @ 3.75 kg ha^{-1} + earthing up Ametryn + atrazine @ 3.75 kg ha^{-1} on cane rows only + inter-row cultivation + earthing up, Hand weeding in cane rows + inter-row cultivation + earthing up, Inter-row cultivation only + earthing up, Hand weeding twice + earthing up and the Weedy check

The Ametryn + atrazine @ 3.75 kg ha^{-1} was applied as pre-emergence weedicide with knapsack sprayer within 14-15 days after planting, spray volume was approximately 350 L ha^{-1}. Weed control in each treatment was evaluated by recording the weed density data Four quadrats (1 m^2) were randomly placed in each treatment and the weeds were counted and pooled. Subsequently, mean m^{-2} was obtained for individual weed species. Data were recorded on germination, tillers per plant, number of millable canes and cane yield per plot. Cane juice was analyzed for Brix, Pol, CCS and recovery %age. The data were analyzed statistically by analysis of variance and least significance difference test was applied to compare the differences in treatment means (Steel & Torrie, 1980). The input costs of weed control treatments were also computed to compare the economic efficiency of each treatment.

RESULTS AND DISCUSSION

Weed density (m^{-2})

The data on weed density and biomass (Table-1) showed significant differences among different treatments. The weedy check

showed the largest weed density. Ametryn + atrazine @ 3.75 kg ha^{-1} on cane rows only + inter-row cultivation + earthing up offered an effective control of weeds followed by Ametryn + atrazine @ 3.75 kg ha^{-1} + earthing up. The data also showed that the *Cyperus rotundus* was not completely controlled by Ametryn + atrazine and re-sprouted after hand weeding or cultivation. Weeds other than nutsedge were eliminated to variable extent. These include mostly dicots like *Trianthema portulcastrum*, *Convolvulus arvensis* and *Euphorbia helioscopia*. It was however, observed that weed density of nutsedge though not completely checked but its growth was curtailed. Plants turned pale and weak and did not compete with the growth of cane plants. Hand weeding alone could not control weeds as effectively as herbicide alone. Hand weeding also could not control or check the growth of new weeds after irrigation. Ametryn + atrazine suppressed the further growth of weeds till a complete canopy cover was achieved. These findings are in a great analogy with the work of Khan *et al.* (2001) who reported an effective control of weeds with application of Gesapax Combi and reported better control of *Conyza stricta* with 2,4-D as compared to Gesapax Combi.

Table-1. Effect of different weed management practices on the weed density (m^{-2}) and biomass in sugarcane crop during 2008-09.

Treatment	*Cyperus rotundus*	*Trianthema portulcastrum*	*Convolvulus arvensis*	*Euphorbia helioscopia*	Weed Biomass 75 DAS(g m^{-2})
Ametryn + atrazine @ 3.75 kg ha^{-1} + earthing up	72d	8cd	6c	10b	255 d
Ametryn + atrazine @ 3.75 kg ha^{-1} on cane rows only + inter-row cultivation + earthing up	78c	10c	5cd	5c	248 d
Hand weeding in cane rows + inter-row cultivation + earthing up	80c	8cd	5cd	3c	286 c
Inter-row cultivation only + earthing up	87b	29b	10b	10b	358 b
Hand hoeing twice + earthing up.	70d	5d	3d	0d	258 d
Weedy check	120a	70a	15a	15a	405 a
$LSD_{0.05}$	4.52	3.38	3.38	2.29	35

Dry biomass (g m^{-2}) 75 days after sowing

Weed biomass was significantly affected by different weed management practices (Table-1). Maximum dry weed biomass (405 g m^{-2}) was recorded in weedy check followed by inter-row cultivation and no weeding in cane rows by producing 358 g m^{-2} while third position with respect of dry biomass was occupied by hand weeding in cane rows + inter-row cultivation. Minimum weed biomass was in T_1 and T_2 and T_5 treatments which were statistically at par with respect to dry biomass production and also produced better cane yield than rest of the weed management practices under study (Table-2).

Germination %

Germination %age data in Table-2 showed that germination was not affected by different weed control practices hence the differences among the different treatments are non-significant. The application of herbicides and other treatments thus, had no effect on germination of sugarcane.

Number of tillers $plant^{-1}$

The data presented in Table-2 revealed that high weed density depressed the tillering significantly in the weedy check, which produced the lowest No. of tillers (2.39) $plant^{-1}$. However, the variation among the various treatments could reach the statistical significance level.

Number of millable canes

The data on millable canes (Table-2) showed that cane density was almost inversely proportional to weed density. Weeds have direct bearing on tillering and ultimately production of millable canes. Thus weedy check produced the minimum number of millable canes. Millable canes were also reduced when only inter-row cultivation was given. The weeds left in intra-row spaces affected the millable canes adversely. The highest millable canes were produced by Ametryn + atrazine @ 3.75 kg ha^{-1} on cane rows only + inter-row cultivation + earthing up, but at par with all other treatments included in the study except weedy check and Inter-row cultivation only + earthing up. These finding are corroborated with the previous work of Raskar (2004) who obtained highest cane yield with the sequential application of 2,4-D as post after the pre-emergence application of metribuzin.

Cane yield tons ha^{-1}

The cane yield data presented in Table-2 revealed significant differences among different management practices as compared to the weedy check which produced the lowest yield of cane. The highest cane yield was determined where Ametryn + atrazine was applied followed by inter-row cultivation at tillering while cane yield in rest of the treatments was higher than the weedy check, but non-significant to one another.

Yield data showed that highest percentage of 44.6 of Gain in yield was obtained in treatment Ametryn + atrazine @ 3.75 kg ha^{-1} + inter-row cultivation and earthing up in May, while hand hoeing twice + earthing-up gave 41.6% increase as compared to weedy check. While Ametryn + atrazine @ 3.75 kg ha^{-1} + earthing up and hand hoeing in cane rows + inter-row cultivation and earthing up both gave 35% increase over weedy check. Thus combination of herbicide Ametryn + atrazine as pre-emergence and inter-row cultivation at tillering + earthing in May was found to be the most effective for control of weeds in sugarcane. The findings of Beg (1975), Gill (1978), Luke (2007) and Singh *et al*., (2008) also support the effectiveness of Gesapax Combi (ametryn + atrazine) as selective herbicides for sugarcane.

Table-2. Effect of different weed management practices on cane density and yield of sugarcane during 2008-09.

Treatment	Germination %	No. of Tillers plant-^{1}	No. of Mill able canes (000 ha^{-1})	Cane Yield in tons ha^{-1}	% Gain in yield.
Ametryn + atrazine @ 3.75 kg ha^{-1} + earthing up	40	2.79	91,400 ab	75.60 ab	35
Ametryn + atrazine @ 3.75 kg ha^{-1} on cane rows only + inter-row cultivation + earthing up	42	3.01	1,06,667 a	81.00 a	44.6
Hand weeding in cane rows + inter-row cultivation + earthing up	39.5	2.75	91,445 ab	75.56 ab	34.9
Inter-row cultivation only + earthing up	39.5	2.61	83,593 b	70.45 b	25.8
Hand hoeing twice + earthing up.	42	2.67	93,757 ab	79.30 ab	41.6
Weedy check	39	2.39	67,026 c	56.00 c	-
$LSD_{0.05}$	**NS**	**NS**	**15,270**	**9.3**	

Cane juice quality

The cane juice analysis for Brix, Pol, purity, CCS and recovery CCS are presented in Table-3. The data in respect of different management practices on cane juice quality revealed that various treatments did not show marked differences in quality of cane. However, cane yield variation, if any would deficiently affect the

sugarcane yield per hectare. The results are in conformity with those of Fayadomi (1983) and Gill (1978).

Table-3. Effect of different weed management practices on cane juice quality of sugarcane variety CPF-246 during 2008-09 (cane juice analysis).

Treatment	Brix %	Pol %	Purity %	Fiber %	CCS %	Recovery CCS %
Ametryn + atrazine @ 3.75 kg ha^{-1} + earthing up	20.93	17.74	84.77	12.75	13.85	13.01
Ametryn + atrazine @ 3.75 kg ha^{-1} on cane rows only + inter-row cultivation + earthing up	20.87	17.44	83.56	12.85	13.90	13.07
Hand weeding in cane rows + inter-row cultivation + earthing up	21.00	17.45	83.10	12.99	13.90	13.07
Inter-row cultivation only + earthing up	22.00	18.60	84.49	13.01	13.80	12.97
Hand hoeing twice + earthing up.	21.60	17.90	82.87	12.87	13.95	13.11
Weedy check	20.80	17.50	84.13	13.10	12.93	12.15
$LSD_{0.05}$	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Cost: benefit ratio of different weed management practices

The gross value of increased yield over weedy check and cost: benefit ratio of various weed control treatments are presented in Table-4. The data revealed that hand hoeing is more expensive than the use of herbicide alone. The highest cash return were obtain in Ametryn + atrazine @ 3.75 kg ha^{-1} on cane rows only + inter-row cultivation + earthing up. Cost benefit ratio of 1:12.85 and 1:11.46 was observed in Ametryn + atrazine @ 3.75 kg ha^{-1} on cane rows only + inter-row cultivation + earthing up and Ametryn + atrazine @ 3.75 kg ha^{-1} + earthing up treatments, respectively as against 1:7.25 in hand weeding twice alone which shows economic efficiency of herbicide application for control of weeds and the yield increment in sugarcane.

CONCLUSION

From the foregoing discussion it could be concluded that use of Ametryn and atrazine @ 3.75 kg ha^{-1} as pre-emergence herbicide is most effective means of weed control in sugarcane fields. The chemical control of weeds is also cheaper than manual / mechanical control

measures as the former method showed high cost benefit ratio than the later ones.

Table-4. Economics of different weed management practices and their cost benefit ratio in sugarcane crop during 2008-09.

Treatment	Mean yield t ha^{-1}	Increase over check plot in t ha^{-1}	Gross value of increased yield (Rs.ha^{-1})	Added Cost in Rs. ha^{-1}	Increase in cash return over weedy check	Cost benefit ratio
Ametryn + atrazine @ 3.75 kg ha^{-1} + earthing up	75.60	19.60	39200	3145	36055	1:11.46
Ametryn + atrazine @ 3.75 kg ha^{-1} on cane rows only + inter-row cultivation + earthing up	81.00	25.00	50000	3608	46392	1:12.85
Hand weeding in cane rows + inter-row cultivation + earthing up	75.56	19.56	39120	4700	34420	1:7.32
Inter-row cultivation only + earthing up	70.45	14.45	28900	2500	26400	1:10.56
Hand hoeing twice + earthing up.	79.30	23.30	46600	5650	40940	1:7.25
Weedy check	**56.00**	**-**	**-**	**-**	**-**	**-**

Cane @ Rs. 80/ 40 Kg or Rs. 2000 /ton.
Ametryn + Atrazin @ 3.750 kg ha^{-1} @ Rs. 420/ kg + 1 man day for application charges @ Rs. 220 ha^{-1} & rent of sprayer Rs. 100 ha^{-1}
One hoeing with 10 men day ha^{-1} @ Rs. 220 per man day
One inter row cultivation with tractor Rs. 1250 ha^{-1}
Hand weeding 10 men day @ Rs. 220 per man day.

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