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Efficacy of weed control measures and soil persistence of atrazine in sugarcane (*Saccharum officinarum*) as influenced by irrigation and nitrogen

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ABSTRACT

The results of the field experiment conducted at Lucknow from 1994 to 1996 revealed that varying levels of irrigation and nitrogen as well as different weed control measures significantly affected the weed growth and the yield attributes and yield of sugarcane (*Saccharum officinarum* L.). The highest cane yield (77.1 tomes/ha) was obtained with atrazine + 2,4-D + 1 hoeing treatment, however, the benefit : cost ratio (1.69) was highest with the use of chemicals alone. Juice quality remained unaffected due to various treatments. Significant increase in nitrate reductase activity due to weed control measures was also observed. Atrazine persisted in soil varying from 45 to 60 days and its content declined with increasing moisture and nitrogen levels.

Key words : Sugarcane, Atrazine, Irrigation, Nitrogen, Persistense, Weed control

Sugarcane faces tough competition with weeds for moisture and nutrients during its early stages. Depending upon the density and composition of weed flora, the loss in yield varies between 15 and 75% (Singh and Moolani, 1975). Various weed control methods have been developed to minimize crop-weed competition. Nevertheless, considering the inadequacy of any single method, integrated weed management strategy involving chemical, mechanical and cultural methods have been devised. However, water and nutrient management techniques exert an overriding effect on the efficacy of weed control methods in general and of herbicides in particular (Chaudhary and Mani, 1973). Moreover, the persistence of herbicides in soil is governed by the levels of these inputs which alter the microbial population responsible for degradation of chemicals. Since information on these aspects is meagre, the present investigation was carried out to assess the effect of varying soil moisture regimes and nitrogen levels on the efficacy of chemical, mechanical and integrated methods of weed management in

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sugarcane and also on the persistence of atrazine in soil.

MATERIALS AND METHODS

The field experiment was conducted during 1994–96 on sugarcane variety 'CoS 767' at the Research Farm of Indian Institute of Sugarcane Research, Lucknow, by planting the crop during spring season. Soil of the experimental field was sandy loam in texture having 169.6 kg available N, 12.8 kg available P and 156 kg exchangeable k/ha with pH 7.8. The experiment was laid out in a 3 times replicated split-plot design, where main plot received combination of 2 soil moisture regimes (irrigation at 75 and 50% available soil moisture-ASM) and 4 nitrogen levels (0,75 150 and 225 kg/ha), whereas 4 weed control measures (weedy, 3 manual hoeings, sequential spray of atrazine 2 kg/ha (pre-emergence)+ 2,4-D 1.0 kg/ha 60 days after planting (DAP) and the same with 1 hoeing 90 DAP) were assigned to subplots. The data on various characters were pooled over the years and analysed. Data on weed density were subjected to square root $\sqrt{X+1}$ transformation before analysis. The *in-vivo* nitrate reductase activity in third leaf from

Table 1. Effect of various treatments on weed density and dry weight during critical period of crop-weed competition

Treatment	Weed density (No./m²)		Weed dry weight (g/m²)	
	65 DAP	120 DAP	65 DAP	120 DAP
Irrigation regime				
75% ASM	25.84	20.12	49.48	70.88
50% ASM	22.12	19.68	46.56	80.08
CD (P = 0.05)	2.28	SN	NS	NS
N level (kg/ha)				
0	23.16	17.60	39.56	84.60
75	23.80	19.00	43.08	92.40
150	24.12	21.32	50.48	102.92
225	24.88	21.80	61.36	123.00
CD (P = 0,05)	NS	NS	10.56	17.36
Weed control				
Weedy	46.72	22.72	153.60	175.36
Three hoeings	13.60	13.92	13.92	62.28
Atrazine + 2, 4-D	18.20	16.28	10.24	93.60
Atrazine+ 2,4-D+ 1 hoeing	17.44	16.16	14.32	69.64
CD (P = 0.05)	3.28	1.84	9.76	24.40

DAP, Days after planting; ASM, available soil moisture

the top was estimated 120 days after planting by following the method described by Jaworski (1971).

For assessing the persistence of atrazine in field, soil samples were drawn from 0-15 cm soil depth after 0, 15, 30, 45, 60 and 75 days after herbicide spray. Atrazine content was determined following the mehod of a single step extraction (Kulshreshtha *et al.*, 1973).

RESULTS AND DISCUSSION

Weed flora

Predominant weeds infesting the sugarcane crop were *Cyperus rotundus, Cynodon dactylon, Trianthema portulacastrum, Sorghum halepense, Chenopodium album, Digera arvensis, Echinochloa colonum, E. crus-galli, Setaria* spp., *Panicum* spp., *Ageratum conyzoides, Euphorbia* spp., *Amaranthus* spp. At germination and tillering stages, the crop was infested with *Cyperus rotundus, Trianthema portulacastrum* and *S. halepense.* However, during elongation phase *Echinochloa* spp., *Panicum* spp., and *Setaria* spp. were most dominant.

Weed density and dry weight

Irrigation at 75% ASM produced significantly higher number of weeds than

Table 2. Effect of various treatments on growth, yield and juice quality of sugarcane

Treatment	Germination (%) 45 DAP	Tiller count ('000/ha) 120 DAP	Nitrate reductase activity (µm/g/hr) 120 DAP	No. of millable canes ('000/ha)	Yield (tonnes/ha)	Pol (%)	Benefit : cost ratio
Irrigation regime							
75% ASM	31.8	121.45	483.6	93.4	73.2	17.7	1.42
50% ASM	30.9	99.32	410.3	84.3	63.2	17.8	1.27
CD (P = 0.05)	NS	12.81	22.2	4.6	3.7	NS	
N level (kg/ha)							
0	31.3	114.72	424.6	81.8	60.1	17.9	1.26
75	31.5	111.17	434.8	87.7	66.1	17.6	1.34
150	30.0	108.11	441.4	92.0	71.4	17.7	1.40
225	30.5	107.55	487.1	94.9	74.2	17.8	1.40
CD (P = 0.05)	NS	NS	31.4	6.6	5.3	NS	
Weed control							
Weedy	30.2	55.15	312.0	63.2	47.3	17.8	0.86
Three hoeings	30.4	134.92	444.9	150.3	76.6	17.7	1.34
Atrazine + 2, 4-D	32.8	135.58	514.3	96.8	72.9	17.8	1.69
Atrazine + 2, 4-D + 1 hoeing	31.6	139.88	516.6	101.3	77.1	17.7	1.53
CD (P = 0.05)	NS	10.22	20.5	4.3	3.2	NS	

DAP, Days after planting; ASM, available soil moisture

50% ASM at 65 DAP and the difference subsided by 120 DAP. Effect of moisture regime on weed dry weight was not conspicuous (Table 1). The levels of nitrogen could not exert significant effect on weed density, however, application of 150 and 225 kg N/ha produced significantly higher weed dry weight as compared to control treatment at 65 and 120 DAP. The enchanced uptake of N by weeds under higher levels of N application might have caused increased dry-matter accumulation, as they are more efficient users of applied resources than the crop plants.

Three manual hoeings proved significantly superior to atrazine + 2,4-D and atrazine + 2,4-D + 1 hoeing treatments with respect to weed density at 65 and 120 DAP, however, these 3 treatments remained at par as far as weed dry weight was concerned. Interactions were not significant.

Sugarcane growth

Sprouting of sugarcane buds at 45 DAP ranged between 30 and 32.8% with various treatments, indicating no adverse effect of herbicides and hoeing on germination of sugarcane. At 120 DAP irrigation at 75% ASM produced significantly higher number of tillers as compared to the irrigation at 50% ASM. However, the effect of nitrogen levels on tillering was not significant. This might be due to increase of weed dry weight which masked the positive effect of higher nitrogen availability for tillering in sugarcane. However, all the weed control treatments brought about significant increase in the number of tillers over weedy check (Table 2).

Moisture regimes, nitrogen levels and weed control treatments exerted significant effect on the nitrate reductase activity in sugarcane leaves at 120 DAP. Data in Table 2 would reveal that wet moisture regime

Table 3. Effect of irrigation regimes and nitrogen levels on persistence of atrazine in soil

Treatment	Atrazine residue (ppm) (days after spray)					
	0	15	30	45	60	75
Irrigation regime						
75% ASM	0.041	0.023 (43)	0.014 (34)	0.009 (21)	ND	ND
50 % ASM	0.045	0.025 (44)	0.019 (42)	0.012 (26)	ND	ND
N level (kg/ha)						
0	0.064	0.037 (58)	0.023 (35)	0.016 (24)	0.010 (15)	ND
75	0.050	0.025 (50)	0.019 (30)	0.011 (22)	0.008 (16)	ND
150	0.033	0.018 (55)	0.014 (42)	0.009 (27)	ND	ND
225	0.026	0.016	0.011	0.006	ND	ND

ND, Not detectable; Figures in parentheses represent percentage of initial concentration

accelarated the nitrate reductase activity significantly over dry regime. This is in conformity with the findings of Todd (1972). Nitrogen nutrition up to 225 kg/ha enhanced the enzyme activity significantly. Conspicuous increase in nitrate reductase activity was also noticed with different weed control treatments over the weedy. Pre-ponderance of NO_3 in both the conditions might have resulted in the enhanced nitrate reductase activity. Level of nitrate reductase activity in herbicide applied plots was conspicuously higher than that in manually hoed plots. This indicates the growth-stimulating effect of herbicides (atrazine and/or 2,4-D) on sugarcane plant. Dixit and Gautam (1994) also reported the similar effect of atrazine on winter maize.

Yield and juice quality of cane

Irrigation at 75% ASM produced significantly more number of millable canes than 50% ASM which resulted in15.8% higher cane yield. Increasing levels of nitrogen up to 225 kg/ha significantly increased the number of millable canes and cane yield. However, 150 and 225 kg N/ha remained statistically at par.

The weed control treatments caused significant increase in number of millable canes and yield, as compared to weedy check (Table 2). The highest yield (77.1 t/ha) and number of millable canes (101.3 thousand/ha) were recorded with the spray of atrazine (2.0 kg/ha PE) + 2,4-D (1 kg/ha 60 DAP) followed by hoeing at 90 DAP. Three manual hoeings at 30,60 and 90 DAP also produced statistically similar result. Reduction in yield due to weeds was found to be 38.6%, however, juice quality remained unaffected due to various treatments. It is in conformity with the findings of Mehra and Brar (1993).

Economics

Benefit : cost (B:C) ratio at 1996 prices clearly indicated that wet moisture regime (75% ASM) and nitrogen levels (75 to 225 kg/ha) proved more remunerative than dry regime without nitrogen. Application of herbicides proved most cost effective with the highest B:C ratio of 1.69 (Table 2). Despite yield advantages, the hoeing treatments could not prove cost effective because of the higher labour cost.

Persistence of atrazine in soil

The content of atrazine residue in soil declined with the increasing levels of nitrogen and moisture regime (Table 3). This could be attributed to the faster degradation of atrazine in soil under high soil moisture and fertility conditions, as reported by Mithyantha (1973). Persistence of atrazine in soil was detectable up to 45 days after spray under both the irrigation regimes and with higher nitrogen levels of 150 and 225 kg/ha. However, atrazine persisted and was detectable up to 60 days after spray under no nitrogen and 75 kg N/ha. It may, therefore, be concluded that atrazine application poses no residue problem in sugarcane-based cropping systems.

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