

Control of Atrazine Tolerant 'baans gha' (*Brachiaria reptans*) in Spring Sugarcane

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ABSTRACT

A field study was conducted at Ladhawal, Ludhiana during 2004-05, 2005-06 and 2006-07 to evaluate alternate herbicides for control of atrazine tolerant *Brachiaria reptans* in spring sugarcane. Pre-emergence atrazine 1.0 kg (standard), metribuzin 1.4 kg, diuron 1.6 kg and pendimethalin 1.125 kg/ha alone, tank mix of pendimethalin 0.75 kg with atrazine 0.75 and 1.0 kg, metribuzin 0.875 and 1.4 kg and diuron 1.6 kg/ha, three hand hoeings at 30, 60 and 90 days and unweeded control were evaluated in RBD. Atrazine 1.0 kg/ha recorded *Brachiaria* population and cane yield similar to unweeded control. Metribuzin 1.4 kg and diuron 1.6 kg/ha alone, tank mixing of pendimethalin 0.75 kg with metribuzin 0.875 kg or atrazine 1.0 kg/ha reduced *Brachiaria* population by 82 to 96% and increased cane yield by 16 to 28% than alone atrazine 1.0 kg/ha. Weed control efficacy under above treatments varied from 67 to 72%, while it was only 12% with atrazine 1.0 kg/ha. Pendimethalin 1.125 kg/ha though reduced *Brachiaria* density by 89%; however, its lower activity over time resulted in poor weed control efficacy (45%) and similar cane yield to atrazine 1.0 kg/ha. Metribuzin 0.875 kg+pendimethalin 0.75 kg/ha recorded the highest cane yield (76 t/ha), net returns (Rs 48,200/ha) and benefit : cost ratio (0.840). Different weed control treatments did not influence cane quality. Metribuzin 1.4 kg and diuron 1.6 kg/ha alone, and tank mix of pendimethalin 0.75 kg either with metribuzin 0.875 kg or atrazine 0.75 kg/ha were very effective for control of *B. reptans* and attaining the highest productivity and profitability in spring sugarcane.

Key words : *Brachiaria*, sugarcane, metribuzin, diuron, pendimethalin, atrazine

INTRODUCTION

Successful weed control is essential for economical sugarcane production. Weeds can reduce cane yields by competing for moisture, nutrients and light during the growing season. The losses in cane yield vary from 12 to 72% depending upon the severity of weed infestation (Verma, 2000). Weed control is most critical early in the season prior to sugarcane canopy closure over the row middles. Mechanical or manual weeding itself is a problem, particularly at the time when weeds are luxuriantly growing in sprouting cane and the growers are busy in the management of other crops at that time. Moreover, demand for higher wages of the labour force is another serious problem faced by the growers. Thus, under these circumstances the only alternative left for the growers to deal effectively with weeds is to use herbicides. Pre-emergence herbicide applications help to ensure the early season advantage. Atrazine is a widely used herbicide by farmers of Punjab state for the control of annual weeds in sugarcane. This herbicide worked very well for about 25 years. However,

from last 4-5 years, 'baans gha' (*Brachiaria reptans*)—a hardy weed—has started appearing in large numbers at farmers' fields having continuous exposure to this herbicide. This weed was present earlier also but its intensity was too low to consider it a major weed of sugarcane. Due to effective control of all other annuals with atrazine, intensity of this weed continued to increase and has now become a major nuisance for cane grower of the state as it results in heavy crop losses. There is an urgent need to identify alternate herbicides or tank mix herbicide combinations having different mode of action for its effective control in spring sugarcane.

MATERIALS AND METHODS

A field study was conducted on spring sugarcane during 2004-05, 2005-06 and 2006-07 at Sugarcane Research Farm of Punjab Agricultural University at Ladhawal, Ludhiana. Ladhawal (latitude 30°56' N, longitude 75°52' E, altitude 247 metres above sea level) represents sub-tropical and semi-arid climate. Soil was loam, OC 0.78%, medium in P (19.0 kg/ha)

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and high in K (510 kg/ha), EC 0.30 dS/m and pH 8.6. Pre-emergence atrazine 1.0 kg, metribuzin 1.4 kg, diuron 1.6 kg and pendimethalin 1.125 kg/ha alone, tank mix application of pendimethalin 0.75 kg with atrazine 0.75 and 1.0 kg, metribuzin 0.875 and 1.4 kg and diuron 1.6 kg/ha, three hand hoeings at 30, 60 and 90 days after sowing and unweeded control were evaluated in a randomized block design with three replications. CoJ 83, an early maturing and high sugar content variety of sugarcane, was planted in rows 75 cm apart using 50,000 three-budded setts/ha on 21 March 2004, 15 March 2005 and 18 March 2006 and harvested on 15 December 2004, 22 December 2005 and 05 November 2006, respectively. All the herbicides were applied within 2- 3 days of planting with a knapsack sprayer fitted with flat fan nozzle using 500 l water/ha. Recommended package of practices were followed for raising the crop. Data on weed population and dry matter accumulation were recorded from an area of 0.5 × 0.5 m by using a quadrat at 60 days. Shoot population was recorded at maximum tillering stage (120 days). Five canes were randomly selected from each plot for estimation of yield attributes viz., millable canes, cane length and juice quality parameters (pol % juice, brix % and purity %) before harvesting. Commercial cane sugar (CCS) per cent was calculated by using the formula $[CCS \text{ per cent} = \{S - (B - S) 0.4\} \times 0.73]$ where, S=pol % juice and B=Brix. Data on cane yield were recorded at time of crop harvest. The prevailing market prices of inputs and outputs were taken into account for economic analysis of different treatments. Statistical analysis was done using standard statistical tools to calculate critical difference at 5% level of significance in order to compare differences due to treatmental means.

Major weed flora in the field included *Cyperus rotundus*, *Brachiaria reptans*, *Digitaria sanguinalis*, *Trianthema portulacastrum*, *Eleusine aegyptiacum*, *Digera arvensis*, *Amaranthus viridis*, *Euphorbia hirta*, *Tribulus terrestris* and *Eragrostis tenella*. A general spray of 2,4-D sodium salt 1.0 kg/ha was made at 60 days for controlling *C. rotundus*.

RESULTS AND DISCUSSION

Effect on Weeds

On an average, tank mix application of metribuzin 0.875 kg+pendimethalin 0.75 kg/ha reduced *Brachiaria* population by 95.7% as compared to atrazine

1.0 kg/ha; however, it was at par to tank mixing of pendimethalin 0.75 kg with either of metribuzin 1.4 kg and diuron 1.6 kg/ha (Table 1). Metribuzin 1.4 kg, diuron 1.6 kg and pendimethalin 1.125 kg/ha alone also gave effective control of this weed and recorded weed population similar to three hoeings. *Brachiaria* population with atrazine 1.0 kg/ha alone was similar to unweeded control. However, tank mixing of pendimethalin 0.75 kg+atrazine 1.0 kg/ha reduced this weed pressure by 81.6% than atrazine 1.0 kg/ha alone, as pendimethalin controlled this weed effectively. All the weed control treatments, including atrazine 1.0 kg/ha; however, effectively controlled other annual weeds and reduced their population significantly as compared to unweeded control. Mahajan *et al.* (2004) recorded effective control of *B. reptans* with pendimethalin 0.75 kg/ha pre-emergence in blackgram (*Vigna mungo*) intercropped spring sugarcane. Blackgram has spreading habit and exerts its smothering effect on weeds which may be the reason for effective control of weeds with pendimethalin alone at lower dose of 0.75 kg/ha. Metribuzin 1.0 kg/ha pre-emergence effectively controlled *B. ramosa*, while atrazine 2.0 kg/ha did not provide satisfactory control (Tomar *et al.*, 2002). Atrazine 2.0 kg, metribuzin 1.0 kg and diuron 1.0 kg/ha pre-emergence effectively controlled *B. mutica* (Singh *et al.*, 2003). These studies indicated that atrazine had differential effect on different species of *Brachiaria* and in ours case it was ineffective.

Metribuzin 1.4 kg, diuron 1.6 kg/ha alone as well as tank mixture of metribuzin 0.875 kg+pendimethalin 0.75 kg/ha reduced total weed dry matter accumulation by 68.4, 62.2 and 65.4%, respectively, as compared to atrazine 1.0 kg/ha and were at par with three hoeings (Table 1). Among herbicidal treatments, weeds accumulated 10.6 q/ha dry matter in plots treated with atrazine 1.0 kg/ha which was maximum and significantly higher than all other weed control treatments, as in the absence of other weeds in atrazine alone plots *Brachiaria* made a vigorous growth and accumulated more dry matter. Tank mix application of atrazine 1.0 kg + pendimethalin 0.75 kg/ha reduced total weed dry matter significantly as compared to atrazine 1.0 kg/ha alone, as pendimethalin controlled *Brachiaria* and also other weeds and weed dry matter reduced. This synergistic effect of tank mix combination on total weed dry matter accumulation; however, was not observed with lower dose of atrazine at 0.75 kg/ha, due to reduced efficacy of atrazine at 25% lower than the recommended dose (1.0 kg/ha) which reflected in higher

Table 1. Weed population, dry matter and weed control efficacy of different weed control treatments (Mean of three years)

Herbicide	Dose (kg/ha)	Population (No./m ²)		Dry matter (q/ha)	Weed control efficacy (%)
		<i>Brachiaria reptans</i>	Other annuals		
Atrazine	1.0	3.88 (14.1)	2.38 (4.7)	3.4 (10.6)	12.4
Metribuzin	1.4	1.63 (1.7)	1.68 (1.8)	2.08 (3.34)	72.4
Diuron	1.6	1.64 (1.7)	2.44 (5.0)	2.23 (3.97)	67.2
Pendimethalin	1.125	1.61 (1.6)	2.83 (7.0)	2.76 (6.61)	45.4
Atrazine+Pendimethalin	0.75+0.75	2.16 (3.6)	2.35 (4.5)	2.57 (5.63)	53.5
Atrazine+Pendimethalin	1.0+0.75	1.89 (2.6)	1.73 (2.0)	2.32 (4.38)	63.8
Metribuzin+Pendimethalin	0.875+0.75	1.28 (0.6)	2.49 (5.3)	2.16 (3.66)	69.7
Metribuzin+Pendimethalin	1.4+0.75	1.27 (0.6)	2.64 (6.0)	2.12 (3.50)	71.1
Diuron+Pendimethalin	1.6+0.75	1.41 (1.0)	2.24 (4.0)	2.22 (3.94)	67.4
Three hand hoeings (30, 60 & 90 days)		1.51 (1.3)	2.07 (3.3)	1.95 (2.79)	76.9
Unweeded control		3.48 (11.1)	3.67 (12.5)	3.61 (12.1)	
LSD (P=0.05)		0.20	0.29	0.3	

Data subjected to $\sqrt{X+1}$ transformation. Figures in parentheses are means of original values.

weed dry matter.

Effect on Crop

Tank mixture of metribuzin 0.875 kg+pendimethalin 0.75 kg/ha recorded the highest cane yield (76.1 t/ha) being 28.1% higher than atrazine 1.0 kg/ha and this increase was 26.4 and 17.0% in case of metribuzin 1.4 kg and diuron 1.6 kg/ha, respectively (Table 2). Atrazine 1.0 kg/ha recorded significantly lower cane yield as compared to all other weed control treatments except pendimethalin 1.25 kg/ha alone and

pendimethalin 0.75 kg+atrazine 0.75 kg/ha. However, tank mixing of pendimethalin 0.75 kg+atrazine 1.0 kg/ha increased cane yield by 15.6% over atrazine 1.0 kg/ha alone and was similar to pendimethalin 0.75 kg+metribuzin 0.875 kg/ha as well as three hoeings. Pendimethalin 0.75+atrazine 0.75 kg/ha was statistically inferior to three hoeings, may be due to higher weed dry matter accumulation due to lower efficacy of atrazine at its 25% lower than recommended dose. Weed competition lowered shoot and millable stalk numbers which reflected in cane yield. Metribuzin 1.4 kg and diuron 1.6 kg/ha alone as well as their tank mixture with

Table 2. Effect of different weed control treatments on growth, yield, quality and economics of spring sugarcane (Mean of three years)

Herbicide	Dose (kg/ha)	Shoots ('000/ha)	Millable stalks ('000/ha)	Stalk length (cm)	Cane yield (t/ha)	Pol % juice	Purity (%)	Commer- cial sugar (%)	Gross returns ('000 Rs./ha)	Net returns ('000 Rs./ha)	B : C ratio
Metribuzin	1.4	155.7	126.3	156.7	75.1	18.0	86.3	12.3	104.3	46.5	0.806
Diuron	1.6	155.7	116.3	151.0	69.5	17.9	86.6	12.3	96.5	42.3	0.780
Pendimethalin	1.125	146.2	119.1	152.0	63.7	17.9	86.1	12.2	91.0	37.3	0.696
Atrazine+Pendimethalin	0.75+0.75	146.7	118.3	142.3	65.5	18.2	86.9	12.3	90.4	34.7	0.622
Atrazine+Pendimethalin	1.0+0.75	146.7	116.3	147.0	68.7	17.7	86.1	12.1	95.4	40.3	0.732
Metribuzin+Pendimethalin	0.875+0.75	161.0	140.0	152.3	76.1	17.7	84.4	12.0	105.7	48.2	0.840
Metribuzin+Pendimethalin	1.4+0.75	167.3	129.0	147.7	71.7	17.7	85.7	12.1	99.6	41.1	0.702
Diuron+Pendimethalin	1.6+0.75	152.3	119.3	148.7	70.1	18.3	86.7	12.6	97.4	42.0	0.760
Three hand hoeings (30, 60 & 90 days)		161.7	125.3	152.7	73.0	17.9	86.6	12.2	101.4	41.2	0.686
Unweeded control		115.0	93.0	139.3	50.1	17.4	84.7	11.8	68.2	16.3	0.315
LSD (P=0.05)		26.0	21.1	NS	9.1	NS	NS	NS			

NS–Not Significant.

pendimethalin 0.75 kg/ha effectively controlled *Brachiaria* and other annuals and recorded higher weed control efficacy (69.1 to 72.4%) which helped the crop produce more number of shoots, millable stalks and taller canes as reflected in higher cane yield. Though atrazine alone gave effective control of many annual weeds, more pressure of *Brachiaria* reduced its weed control efficacy to 12.4% only which adversely affected crop growth and yield attributes, while pendimethalin 0.75 kg + atrazine 1.0 kg/ha recorded higher weed control efficacy (63.8%) and the cane yield increased. Pendimethalin 1.125 kg/ha alone though gave effective control of *Brachiaria* and other weeds; however, due to its lower soil persistence, weed dry matter increased at later stages which reduced cane yield indicating that a herbicide with lower persistence could not work in a long duration crop like sugarcane. Cane quality (pol % juice, purity % and commercial cane sugar %) was not influenced by different weed control treatments.

Economics

Metribuzin 0.875 kg+pendimethalin 0.75 kg/ha recorded the highest net returns (Rs 48,200/ha) and benefit : cost ratio (0.840) (Table 2). It was immediately followed by metribuzin alone at 1.4 kg/ha (Rs. 46,500/

ha; 0.806). Net returns with metribuzin 1.4 kg and diuron 1.6 kg/ha alone, and tank mixture of pendimethalin 0.75 kg with either of metribuzin 0.875 kg, diuron 1.6 kg and atrazine 1.0 kg/ha were higher by Rs 8,100 to 19,000/ha as compared to atrazine 1.0 kg/ha.

Metribuzin 1.4 kg and diuron 1.6 kg/ha alone, and tank mixture of pendimethalin 0.75 kg with either of metribuzin 0.875 kg and atrazine 0.75 kg/ha were adjudged very effective for control of *B. reptans* and attaining the highest productivity and profitability in spring sugarcane.

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