Field evaluation of herbicides to control itchgrass (*Rottboellia exaltata*) in sugarcane[1,2]

Antonio Vélez-Ramos[3] *and Nelson Semidey*[4]

ABSTRACT

Registered herbicides for use in sugarcane, ametryn, diuron, asulam, hexazinone, metribuzin, non-registered terbutryn, pendimethalin, and imazapyr were evaluated to control itchgrass (*Rottboellia exaltata*) in sugarcane in field experiments at the Lajas Substation with plant and ratoon crops.

Imazapyr, together with pendimethalin, terbutryn and ametryn, provided good itchgrass control in the plant crop, comparable to the hand weeded treatment. In the ratoon crop most herbicides used showed good control, though the *Rottboellia* population before herbicide application was much lower than for the plant crop. Imazapyr caused chlorosis in sugarcane shoots; chlorosis was more severe in the ratoon crop. These herbicides at the recommended rates of 0.28, 1.78, 2.69 and 4.49 kg/ha, respectively, produced sugar yields ranging from 14.92 to 17.02 tons/ha that were statistically not different from those of the hand weeded plots (17.59 tons/ha) but significantly higher than those of the diuron, asulam and the unweeded check plots in the plant crop. The combined plant and ratoon crop for sugar production for pendimenthalin (1.78 kg/ha) was as good as for the hand weeded plots, but not statistically better than the rest of the herbicide treatments, except for hexazinone and imazapyr.

RESUMEN

Evaluación de herbicidas para el control de *Rottboellia exaltata* en caña de azúcar

Durante 1986-89 se llevó a cabo un estudio de campo en la Subestación de Lajas para evaluar los herbicidas registrados ametryn, diuron, asulam, hexazinone (Velpar) y metribuzin y los no registrados terbutryn, pendimethalin e imazapyr para controlar la yerba peluda (*Rottboellia exaltata*) en caña de azúcar en cultivos sucesivos de plantilla y primer retoño.

Imazapyr, pendimethalin, terbutryn y ametryn a las dosis recomendadas de 0.28, 1.78, 2.69 y 4.49 kg/ha. controlaron la yerba peluda con efectividad comparable al desyerbo a mano en caña de plantilla. En el retoño todos los herbicidas usados demostraron una efectividad mayor debido, posiblemente, a una menor población del yerbajo. El herbicida imazapyr causó fitotoxicidad a las plántulas de caña, la cual fue más severa en el retoño. Las parcelas tratadas con los herbicidas mencionados produjeron rendimientos de azúcar por hectárea para la plantilla entre 14.92 y 17.02 toneladas comparables estadísticamente con el tratamiento de desyerbo a mano (17.5 tons/ha.), pero superiores significativamente a los de tratamientos de diuron, asulam y el testigo sin desyerbo.

[1]Manuscript submitted to Editorial Board 8 November 1990.

[2]Partially supported by a research grant from American Cyanamid Co.

[3]Researcher, Department of Agronomy and Soils.

[4]Assistant Researcher, Department of Crop Protection.

La producción de azúcar por ha. para el retoño siguió más o menos el mismo patrón que en la plantilla, excepto que las parcelas tratadas con asulam y diuron produjeron más y las tratadas con imazapyr y ametryn produjeron menos.

La producción combinada de azúcar de la plantilla y el retoño en el tratamiento con pendimethalin fue estadísticamente igual que para el desyerbo a mano, pero solo significativamente superior a hexazinone, imazapyr y el tratamiento sin desyerbar.

INTRODUCTION

Although sugarcane production in Puerto Rico has steadily declined for the last 30 years, it still remains an important agricultural commodity both in gross income and as a labor market for unskilled laborers. During the 1989 harvest season, 1,216,412 tons of cane was produced on 54,651 acres of prime farming land, with a total of 91,249 tons of sugar. The gross income from sugar and molasses was $24.6 million for the same period (3).

Together with a net loss of total land area planted to sugarcane, a significant reduction in tons of cane and sugar per acre has been observed. Poor weed control and general field management practices seem to be the major causes of such low yields. The infestation of sugarcane fields with itchgrass (*Rottboellia exaltata*) has worsened the situation according to farmers and field personnel (4, 5, 6).[5] Therefore, the main objective of this study is to evaluate the effectiveness and the effect on sugar yield of non-registered products together with registered herbicides for controlling *R. exaltata* in sugarcane.

MATERIALS AND METHODS

A field experiment was established at the Lajas Substation in 1986 with a gran cultura (18-month plant crop) sugarcane crop with variety PR 67-1070. Twelve treatments were arranged in a randomized complete block design with six replications. Field plots consisted of four cane rows 1.67 m apart and 6.1 m long with 1.5 m alleys between plots. Herbicides were applied to a Fraternidad soil (order Vertisols) as early post-emergence treatment early in the morning to avoid side drifting.

Treatment consisted of the registered herbicides for use in sugarcane; ametryn, N-ethyl-N^1-(1-methylathyl)-6-(methylthio)-1, 3, 5-triazine-2, 4-diamine; diuron, N^1-(3, 4-dichlorophenyl)-N, N- dimethylurea; asulam, methyl [(4-aminophenyl) sulfonyl] carbamate; hexazinone, 3-cyclohexyl-6-(dimethylamino)-1-methyl-1, 3, 5-triazine-2, 4 (1H, 3H)-dione; metribuzin, 4-amino-6-(1, 1-dimethylethyl)-3-(methylthio)-1, 2, 4-triazine-5 (4H)-one, and the nonregistered: terbutryn, N-(1, 1-dimethylethyl)-N-ethyl-6-(methylthio)-1, 3, 5-triazine-2, 4-diamine; pendimethalin, N-(1 ethyl-

[5]Personal Communication.

propyl)-3, 4-dimethyl-2, 6-dinitrobenzenamide, and imazapyr, (±)-2-[4, 5-dihydro-4-methyl]-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl)-3-pyridine-carboxylic acid at 0.28 kg/ha. Hand weeded and unweeded checks were also included.

Broadcast herbicide applications were made with a CO_2 pressurized stainless steel 1-gal pump preset at 35 psi for a volume of spray equal to 560 L/ha. Pendimethalin was incorporated into the soil with a hand rake. No additional herbicides were applied during the crop cycle, except for one postemergence application of 2, 4-D to control morning glory (*Ipomoea* spp.) and other broadleaf-weeds. Pest control, fertilization and other cultivation practices followed those recommended for commercial sugarcane production (2). Periodical field observations were made to evaluate the effect of treatments on weeds and crop. Percentage itchgrass control was based on a scale where 0 = no control and 100 = perfect control. Grass weeds were separated by species in two categories: *Rottboellia exaltata* and others, which included *Echinochloa colona, Sorghum halepense, Digitaria sanguinalis* and *Eleusine indica*, mainly.

The plant crop was harvested February 1988 and sugarcane yield and quality data were recorded. Cane trash and remaining weeds were burnt after harvesting and the experiment continued for one ratoon crop (12 months). Early postemergence herbicide treatment application was made 6 weeks later in a manner similar to that in the plant crop. Supplementary irrigation was supplied as needed. The ratoon crop was harvested March 1989 and cane yield and quality data were collected. Sugar yield and quality was determined at the Central Analytical Laboratory by Pol-ratio method (1).

RESULTS AND DISCUSSION

Table 1 shows data on germinated sugarcane and grass weed shoots. A drastic reduction in itchgrass population in the experimental site is evident as shown by the unweeded check. From an estimated itchgrass population of 140 plants per 9.3 m^2 (100 ft^2) at the beginning of the plant crop it was reduced to 57.7 plants in the ratoon crop equal to a 58.8% reduction. Environmental conditions may have delayed germination of seeds from the past generation, as it is well known that itchgrass seeds may remain dormant for several years. Another possible explanation may be the high population of fire ants in the field which consume the seeds as gourmet food. Best *Rottboellia* and over all grass growth suppression was provided by imazapyr followed by terbutryn, pendimethalin and ametryn. Sugarcane shoot germination was not appreciably affected by herbicide treatments, except in plots treated with hexazinone and asulam, which seemed to be the result of high weed competition rather than a direct effect. In sugarcane shoots imazapyr caused chlorosis of the

TABLE 1.—*Effect of early postemergence herbicides on cane and grass seeds*

Herbicide	Rate	Germinated shoots, for[1] Cane	*R. exaltata*[2]	Other grasses[3]	Total grasses
	kg/ha	*(6.1m row)*		*(9.3 m²)*	
Imazapyr	0.28	189	7.4	10.0	17.4
Terbutryn	5.38	197	12.1	10.2	22.3
Pendimethalin	3.56	200	2.8	27.8	30.6
Hand weeded	–	203	10.0	27.0	37.0
Pendimethalin	1.78	206	4.7	37.2	41.9
Ametryn	4.49	218	16.7	32.5	49.2
Terbutryn	2.69	230	14.9	42.7	57.6
Asulam	3.75	133	30.7	88.3	119.0
Diuron	4.49	177	47.4	81.7	129.1
Metribuzin	4.49	208	47.4	97.5	144.9
Hexazinone	0.60	128	38.1	130.1	168.2
Unweeded check	–	75	57.7	211.8	269.5
Average[4]		189.9	21.1	45.8	743

[1]Lajas, one month after plant crop harvest.
[2]Original itchgrass (*R. exaltata*) population estimated at 140 plants per 100 ft² or 9.3 m².
[3]Include *Echinochloa colona, Sorghum halepense.*
[4]Unweeded check not included.

plant crop, which was more severe in the ratoon crop, resulting in death in many cases.

Tables 2 and 3 show the effect of herbicides in controlling itchgrass in plant and ratoon crops. Imazapyr, terbutryn (5.38 kg/ha) and ametryn gave very good itchgrass control until the plant crop closed in (16 weeks); pendimethalin, terbutryn (2.9 kg/ha) and diuron were intermediate, whereas asulam, hexazinone and metribuzin were less effective. Higher itchgrass control ratings up to 11 weeks, were observed in the ratoon crop in all treatments, a finding which agrees with the lower population of the weed reported earlier.

Tables 4 and 5 show sugarcane yield components data for plant and ratoon crops, arranged in descending order of tons of sugar/ha produced. The highest yield in the plant crop, as defined by tons of sugar (sucrose 96° polarization content) per hectare, was obtanied with the hand weeded treatment and significantly higher ($P=0.05$) to asulam, diuron, hexazinone, metribuzine and the unweeded check. There were no significant differences among herbicide treatments in sugar yield except for asulam and diuron, which treatments yielded lowest. Cane yield followed a trend similar to sugar yield. As expected, there was a little variation in sucrose content among treatments.

In the ratoon crop the weeded plots, together with that with pendimethalin (3.56 kg/ha), ranked significantly higher than the rest of the

TABLE 2.—*Effect of herbicide treatments on the control of* Rottboellia exaltata *plant crop Lajas*

Herbicide	Rate kg/ha	Weeks after treatment application		
		3	7	16
		Percent control		
Imazapyr	0.25	98.1[1]	99.0	90.5
Terbutryn	5.38	98.7	92.5	80.8
Ametryn	4.49	96.7	87.3	79.2
Pendimethalin	3.56	92.3	80.2	71.2
Terbutryn	2.69	96.3	78.3	68.3
Pendimethalin	1.78	84.2	74.2	66.6
Diuron	4.49	82.8	68.3	60,5
Metribuzin	4.49	88.8	64.0	–[2]
Hexazinone	0.60	88.5	57.5	–
Asulam	3.75	65.0	–	–

[1]100 percent = perfect control, o = no control.
[2]Less than 50% control.

treatments, except for the asulam plot, which yielded surprisingly high. In general, the observed cane and sugar yields in all treatments, except for the unweeded check, for both plant and ratoon crops, can be considered from good to very good according to local experience. However, the sucrose content obtained was generally much higher than those reported in commercial operations. This difference is due, mainly, to the controlled conditions by which population samples are collected and processed in research as compared to conditions for commercial field data.

TABLE 3.—*Effect of herbicide treatment on the control of* Rottboellia exaltata *ratoon crop, Lajas*

Herbicide	Rate kg/ha	Weeks after treatment application		
		4	7	11
Imazapyr	0.25	97.3	96.3	76.5
Terbutryn	5.38	97.9	94.5	82.4
Ametryn	4.49	95.8	90.0	80.4
Pendimethalin	3.56	95.5	95.3	82.8
Terbutryn	2.69	95.0	91.5	77.4
Pendimethalin	1.78	95.3	92.3	81.0
Diuron	4.49	94.0	90.0	80.5
Metribuzin	4.49	92.0	90.0	76.5
Hexazinone	0.60	90.3	88.0	75.9
Asulam	3.75	95.3	94.0	84.6

TABLE 4.—*Effect of herbicide treatments on sugarcane yield components, plant crop, Lajas*

Herbicide	Rate kg/ha	Yield components		
		Tons cane/ha	% sucrose	Tons sugar/ha
Hand Weeded	–	147.7 a	11.92 a	17.59 a[1]
Pendimethalin	3.56	146.7 a	11.65 a	17.02 ab
Terbutryn	5.38	149.7 a	11.29 ab	17.02 ab
Ametryn	4.49	151.4 a	11.09 ab	16.80 ab
Imazapyr	0.25	137.3 a	11.71 a	16.80 ab
Terbutryn	2.69	133.1 ab	11.36 ab	14.99 ab
Pendimethalin	1.78	133.1 abc	11.25 ab	14.92 abc
Metribusin	4.49	114.1 bc	11.63 ab	13.27 bcd
Hexazinone	0.28	104.5 bc	11.71 a	12.08 bcd
Diuron	4.49	122.2 abc	9.78 b	11.66 cd
Asulam	3.75	83.7 d	11.99 a	10.05 d
Unweeded Check	–	31.6 e	10.33 ab	3.09 e

[1]Treatment means with letters in common are not significant at P = 0.05.

Table 6 summarizes combined sugarcane yields for both plant and ratoon crops are summarized in table 6. The hand weeded treatment, together with pendimethalin and ametryn, produced significantly higher sugar per ha than the rest of the treatments. A comparison of the average cane yields per ha shows no significant difference among pendimethalin, terbutryn, ametryn and the hand weeded treatment, but these yields were significantly higher than those with asulam, imazapyr, hexazinone

TABLE 5.—*Effect of herbicide treatment on sugarcane yield components, ratoon crop, Lajas*

Treatment		Yield components		
Herbicide	Rate kg/ha	Tons cane/ha	% sucrose	Tons sugar/ha
Hand weeded	–	105.0 a	13.59 a	14.67 a[1]
Pendimethalin	3.56	103.2 a	13.70 a	13.88 a
Terbutryn	5.38	65.2 bc	12.62 ab	8.00 bc
Ametryn	4.49	74.3 c	12.49 abc	9.33 b
Imazapyr	0.25	48.9 cd	10.93 c	5.36 c
Terbutryn	2.69	73.1 b	12.84 ab	9.50 b
Pendimethalin	1.78	82.7 ab	13.62 a	11.23 ab
Metribusin	4.49	76.8 b	13.23 a	10.15 b
Hexazinone	0.28	46.2 c	12.49 ab	5.76 c
Diuron	4.49	82.5 ab	13.05 ab	10.77 c
Asulam	3.75	80.5 ab	14.01 a	11.38 ab
Unweeded check	–	40.7 d	11.47 bc	4.94 d

TABLE 6.—*Effect of herbicidal treatment on sugarcane yield components, plant and ratoon crops, Lajas*

Treatment		Yield components		
Herbicide	Rate kg/ha	Tons cane/ha	% sucrose	Tons sugar/ha
Hand weeded	–	126.5 a[1]	12.79 a	16.13 a
Pendimethalin	3.56	124.7 a	12.83 ab	15.81 ab
Pendimethalin	1.78	108.0 abc	12.52 abcd	13.45 abc
Ametryn	4.49	112.8 abc	11.84 abcd	13.11 bc
Terbutryn	5.38	107.4 abc	11.97 abcd	12.84 cd
Terbutryn	2.69	103.7 bc	11.88 abcd	12.45 cd
Metribuzin	4.49	95.4 c	12.45 abc	11.86 cd
Diuron	4.49	102.3 bc	11.15 cd	11.66 cd
Asulam	3.75	82.3 d	12.90 a	10.69 cd
Imazapyr	0.25	93.1 d	11.32 bcd	10.55 de
Hexazinone	0.60	75.3 d	12.33 abc	9.11 e
Unweeded check	–	36.1 e	11.03 d	3.09 f

[1]Treatment means with letters in common are not significant at P = *0.05*.

and the unweeded check. Mean significant differences in the percentage of sucrose may be associated with an accumulated effect of higher fiber content resulting from sugarcane growing under stress caused by higher weed competition. In the pol-ratio method for determining % sucrose or rendiment 96° in cane (1), the fiber content in cane is an important factor to consider since.

$$\text{Rendiment } 96° = \text{Factor } [S - 0.3\,(B + 0.1\,fc)]$$

$$F = \frac{R}{S - 0.3\,(B + 0..1\,fc)}$$

where:

R = Rendiment 96 °

S = Sucrose (Pol) % cane

B = Brix % cane

fc = fiber + insoluble foreign matter in cane

Furthermore, an increased fiber content in cane will also affect the yield of sugar per ha, since it is obtained by multiplying of tons cane by rediment 96°.

The results reported here were obtained at Lajas Substation in a Fraternidad clay soil and a semi-arid climate with an average annual rainfall of 890 mm and where supplementary irrigation water is needed for optimum commercial sugarcane production. Under these conditions the following conclusion may be advanced from the present study: good control of *R. exaltata*, without crop phytotoxicity can be obtained with the use of ametryn, pendimethalin and terbutryn at recommended rates, and as a result of their use sugarcane yields can be comparable to those from hand weeding.

LITERATURE CITED

1. Anonymous. El uso de la pala mecánica "Core Samples" para el muestreo directo de las cañas entregadas por los colonos para molienda, su análisis y cálculos de rendimiento para fines de liquidación. Junta Azucarera de Puerto Rico.
2. Anonymous. 1983. Conjunto Tecnológico para la Producción de Caña de Azúcar. Est. Exp. Agric. Univ. P. R. Publicación 103 (Revisada).
3. Antoni, M., M. Cortés, G. L. González y S. Vélez, 1990. Empresas Agrícolas de Puerto Rico en 1987-88. Situación y perspectivas. Esta. Exp. Agric. Univ. P. R.
4. Fontenot, D. B. and D. Sanders, 1985. Louisiana Guide to Controlling Johnson and Annual Weeds in Sugarcane. Louisiana Cooperative Extension Service. pp. 12.
5. Semidey, N. and L. Almodóvar, 1986. Asulam and other post-emergence herbicides for sugarcane. *J. Agric. Univ. P. R.* 70: 235-43.
6. Vélez-Ramos, A., N. Semidey and N. M. Acín-Díaz, 1990. Candidate herbicides to control itchgrass (*Rottboellia exaltata*) in sugarcane fields. *J. Agric. Univ. P. R.*, 74: 145-52.