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REDUCED RATES OF HERBICIDES APPLIED TO IMIDAZOLINONE-RESISTANT SUNFLOWER CROSS-BRED WITH *Brachiaria ruziziensis*

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SUMMARY

The aim of this study was to evaluate the tolerance of sunflower (*Helianthus annuus*) to acetolactate synthase (ALS)-inhibiting herbicides and to temporarily delay the growth of *Brachiaria ruziziensis*, avoiding competition and allowing pasture reestablishment. Experiment 1 consisted of a randomized complete block design, with four replicates. Hybrid Paraiso 102 CL (Clearfield®, resistant to ALS-inhibiting herbicides) was a subject of the following treatments:

I) 30 g ai ha^{-1} imazethapyr; II) 70 g ai ha^{-1} imazethapyr; III) 75 g ai ha^{-1} imazapyr; IV) 125 g ai ha^{-1} imazapyr; V) 7.5 g ai ha^{-1} chlorimuron-ethyl; VI) 12.5 g ai ha^{-1} chlorimuron-ethyl; VII) 8 g ai ha^{-1} nicosulfuron; VIII) 20 g ai ha^{-1} nicosulfuron; IX) unhoed check and X) hoed check.

Experiment 2 consisted of a split-plot design with randomized complete blocks and four replicates. Two genotypes, Paraiso 102 CL and Embrapa 122 (susceptible to ALS-inhibiting herbicides), were sowed on the plots and subplots were submitted to the following treatments:

I) hoed check, II) unhoed check, III) 100 g ai ha^{-1} imazethapyr, IV) 250 g ai ha^{-1} imazapyr, V) 25 g ai ha^{-1} imazapyr, VI) 60 g ai ha^{-1} nicosulfuron, and VII) 4 g ai ha^{-1} nicosulfuron.

Imazethapyr (30, 70 and 100 g ai ha^{-1}), imazapyr (25, 75 and 125 g ai ha^{-1}) or nicosulfuron (4, 8 and 20 g ai ha^{-1}) had no phytotoxic effects on imidazolinone-resistant sunflower (Paraiso 102 CL). However, chlorimuron-ethyl (7.5 and 12.5 g ai ha^{-1}), imazapyr (250 g ai ha^{-1}) and nicosulfuron (60 g ai ha^{-1}) were highly phytotoxic to Paraiso 102 CL. All herbicide treatments produced marked injury symptoms on Embrapa 122. Pasture reestablishment was observed for all herbicide treatments, except for imazapyr (125 and 250 g ai ha^{-1}) and nicosulfuron (60 g ai ha^{-1}).

Key words: **Clearfield®, integrated crop-livestock systems, sustainable intensification**

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INTRODUCTION

The degradation of agroecosystems and its implications and consequences have resulted in the challenge to establish production systems that increase energy efficiency and promote environmental conservation, as well as to create new technological paradigms based on sustainability. Within this new concept, farming systems that involve crop-livestock integration (CLI) have been shown to be important and effective for tropical and subtropical regions, contributing to the natural recovery of these systems and the reduction of different types of misuse, as well as to preservation of natural resources (Brighenti *et al*., 2007).

CLI is characterized by the aggregation of diverse production systems of crops, fibers, meat and milk in order to increase the rentability of rural activities while maintaining the sustainability of the production system as a whole. Another objective of this technique is the recovery of degraded areas, including pastures with low forage production and fields with low crop yield. CLI can also be applied to the formation of soil cover using forage species that serve as mulch for the implementation of no-till systems (Brighenti *et al*., 2008). The mulch present on soil exerts physical and chemical effects on weeds, significantly reducing the occurrence and establishment of these species, especially winter weeds (Cobbuci *et al*., 2001). Mulch also contributes to reduction of the intensity of disease attacks, such as white mold caused by *Sclerotinia sclerotiorum* and root rot caused by *Rhizoctonia solani* and *Fusarium solani* f. sp. *phaseoli* in bean crops (Kluthcouski *et al*., 2000). A lower incidence of insects-pests and nematodes has also been reported (Vilela *et al*., 1999). These results have led to a significant reduction in the quantities of agrochemicals applied (Oliveira *et al*., 2001), with a consequent substantial decrease in production costs.

The inclusion of forage species substantially increases the organic matter content of soil since these grasses are effective in accumulating biomass. This increased organic matter content exerts a positive effect on the activity of the macro- and microfauna of the soil and improves particle aggregation, facilitating the infiltration of water into the soil profile and consequently reducing erosion and surface runoff (Palm *et al*., 2001). In addition, the higher organic matter content increases porosity and reduces soil compaction. It also increases the effective cation exchange capacity and thus increases the storage and retention of nutrients in soil (Vilela *et al*., 2003). Furthermore, forage species effectively contribute to increase in the population of native mycorrhizal fungi and the capacity of these microorganisms to absorb nutrients from soil, especially phosphorus (Miranda *et al*., 2001).

Studies regarding CLI have demonstrated that the application of reduced rates of herbicides permits the intercropping of crops and forage species (Silva *et al*., 2004; Silva *et al*., 2006). The objective of the application of sublethal rates of the herbicide is to temporarily delay the growth of the forage species, thus reducing its competitive ability against the annual crop (Jakelaitis *et al*., 2005). This approach

permits to obtain economically feasible yields of annual crops and, at the same time, to provide forage for cattle feed as a function of reestablishment of the forage grass.

Other crop alternatives for the CLI system are required, with sunflower (*Helianthus annuus*) being an excellent option. The identification of sunflower populations that are resistant to acetolactate synthase (ALS)-inhibiting herbicides (Al-Khatib *et al*., 1998) and the introduction of these resistance genes into common sunflower have led to the emergence of new imidazolinone-resistant cultivars on the market. In this respect, the correct management of these herbicides in the sunflower and forage intercrops is necessary.

The objective of the present study was to evaluate the tolerance of sunflower (*Helianthus annuus*) to ALS-inhibiting herbicides and to temporarily delay the growth of the forage grass (*Brachiaria ruziziensis*) in order to prevent competition and to permit subsequent pasture reestablishment.

MATERIALS AND METHODS

Experiment 1. The experiment was installed on June 5, 2008, on the Experimental Field of Embrapa Dairy Cattle, municipality of Valença (22°21'28" S and 43°41'45" W), Rio de Janeiro State, Brazil. A randomized complete block design with four replicates was used. The following treatments were applied:

I) 30 g ai ha^{-1} imazethapyr; II) 70 g ai ha^{-1} imazethapyr; III) 75 g ai ha^{-1} imazapyr; IV) 125 g ai ha^{-1} imazapyr; V) 7.5 g ai ha^{-1} chlorimuron-ethyl; VI) 12.5 g ai ha^{-1} chlorimuron-ethyl; VII) 8 g ai ha^{-1} nicosulfuron; VIII) 20 g ai ha^{-1} nicosulfuron; IX) unhoed check and X) hoed check.

For the treatments with chlorimuron-ethyl, 0.05% (v/v) mineral oil was added. The soil was ploughed and harrowed and 15 kg ha^{-1} *B. ruziziensis* seeds (cultural value of 33%) were manually sowed and incorporated with a harrow. The area was furrowed with a 0.70-m space between rows and fertilization at the time of sowing consisted of 300 kg ha^{-1} NPK formulation (8-28-16) plus 1.2 kg ha^{-1} boric acid, distributed inside the furrows. Sunflower (Paraiso 102 CL) was sown and a plant stand of 55,000 plants ha^{-1} was maintained. Side-dressing was performed with 250 kg ha^{-1} NPK (20-05-20), applied 25 days after sowing. The herbicide treatments were applied on July 2, 2008, with a hand sprayer kept at a constant pressure of compressed CO_2 of 196 kPa. The sprayer bar was 1.5 m long and consisted of four flat-fan 110 02 nozzles spaced 0.5 m apart, with a spray volume of 170 l ha^{-1}. On the occasion of herbicide application, the forage grass presented two tillers and a mean height of 15-20 cm and the sunflower plants were at phenological stage V_6. The percentage of phytotoxicity to the sunflower crop and percentage of *B. ruziziensis* control were evaluated at 9, 30 and 44 days after herbicide application (DAHA), with zero corresponding to any visual injury symptom on the sunflower plants and no forage control, and 100% corresponding to death of the sunflower and forage plants (SBCPD, 2005). The height of the sunflower plants was measured 57 and 110 days after sowing (DAS). In addition, the density and height of the forage plants

were evaluated at 57 and 80 DAS, respectively. Fresh matter was collected from the forage grass at 95 DAS in a square area measuring 0.25 m^2. The material was weighed and dried in a forced ventilation oven at 65°C to constant mass. The dry matter was weighed and the results were transformed into kg ha^{-1}. Dry phytomass and seed productivity of sunflower were obtained in an area of 8.4 m^2 and the results were transformed into kg ha^{-1}. Dry phytomass of the forage grass was again determined 25 days after sunflower harvest to evaluate the capacity of pasture reestablishment. The data were submitted to ANOVA and means were compared by the Scott-Knott test at a level of probability of 5%.

Experiment 2. The experiment was installed on the Experimental Field of Embrapa Dairy Cattle, municipality of Coronel Pacheco (21° 33' 22" S and 43° 16' 15" W), Minas Gerais State, Brazil. A randomized block design arranged in split-plots with four replicates was used. Two sunflower genotypes, one resistant (Paraiso 102 CL, Clearfield®) and one susceptible (Embrapa 122) to ALS-inhibiting herbicides, were sown on the plots. The following treatments were applied to the subplots:

I) hoed check, II) unhoed check, III) 100 g ai ha^{-1} imazethapyr, IV) 250 g ai ha^{-1} imazapyr, V) 25 g ai ha^{-1} imazapyr, VI) 60 g ai ha^{-1} nicosulfuron, and VII) 4 g ai ha^{-1} nicosulfuron.

Each subplot consisted of four rows of 5 m each spaced 0.70 m apart, with three plants per linear meter. The experiment was installed on May 25, 2009. The experiment was implemented and conducted using the same procedures as described for Experiment 1. The herbicides were applied on July 1, 2009 with a CO_2-pressurized backpack sprayer kept at a constant pressure of 196 kPa and calibrated to a spray volume of 150 l ha^{-1}. The sprayer bar was 1.5 m long and consisted of four flat-fan 110 015 nozzles spaced 0.5 m apart. Phytotoxicity to the sunflower plants was evaluated 14 and 21 DAHA using the percent scale described above. Fresh and dry mass of the forage grass was obtained at 110 DAS according to the procedures described for Experiment 1. Fresh mass of sunflower was obtained by harvesting two rows of plants (row distance of 5 m) at 110 DAS and the results were transformed into kg ha^{-1}. Statistical analysis was the same as that described for Experiment 1.

RESULTS AND DISCUSSION

Experiment 1. None of the herbicide treatments had a phytotoxic effect on the sunflower plants, except for chlorimuron-ethyl (Table 1). Although chlorimuron-ethyl exhibits the same mechanism of action as the other herbicides applied, it inhibited sunflower growth and development. The plants presented a stunted growth, curled leaves and necrosis at the tips of the leaf blade. The application of herbicide rates of 7.5 and 12.5 g ai ha^{-1} resulted in a high percentage of phytotoxicity (51.7% and 62.5%) at 9 DAHA. Recovery of the plants was observed, but the values continued to be high even on the last evaluation at 44 DAHA. Similar results have been reported by Baumgartner *et al.* (1999) who observed resistance of sunflower populations to imazethapyr and imazamox, whereas this genotype was only

slightly resistant to chlorimuron. Studying sunflower populations near Howard, South Dakota, White *et al*. (2002) found that application of a 39- and 9-times higher rate of imazethapyr and chlorimuron, respectively, was necessary to obtain the same level of inhibition of the ALS enzyme in the resistant genotype when compared to the susceptible population.

Table 1: Mean percentage of phytotoxicity to sunflower plants and percent control of *B. ruziziensis* forage grass at 9, 30 and 44 days after herbicide application (DAHA)

Treatment	% Phytotoxicity			% Control of *B. ruziziensis*		
	9 DAHA	30 DAHA	44 DAHA	9 DAHA	30 DAHA	44 DAHA
Imazethapyr 30 g ai ha^{-1}	0.00	0.00	0.00	0.0	0.0	0.0
Imazethapyr 70 g ai ha^{-1}	0.00	0.00	0.00	11.0	0.0	0.0
Imazapyr 75 g ae ha^{-1}	0.00	0.00	0.00	20.2	15.2	11.7
Imazapyr 125 g ae ha^{-1}	0.00	0.00	0.00	30.2	44.7	80.2
Chlorimuron-ethyl 7.5 g ai ha^{-1}	51.7	30.2	24.7	0.0	0.0	0.0
Chlorimuron-ethyl 12.5 g ai ha^{-1}	62.5	40.7	34.2	0.0	0.0	0.0
Nicosulfuron 8 g ai ha^{-1}	0.00	0.00	0.00	9.0	5.0	2.7
Nicosulfuron 20 g ai ha^{-1}	0.00	0.00	0.00	18.2	14.5	7.0
Unhoed check	0.00	0.00	0.00	0.0	0.0	0.0
Hoed check	0.00	0.00	0.00	100.0	100.0	100.0

The lowest imazethapyr rate did not affect the forage grass. However, a rate of 70 g ai ha^{-1} resulted in low percent control at 9 DAHA. This mild injury to the forage plants is important for the CLI system since it does not cause death of the plant, permitting to temporarily delay the early growth of the plant and attenuating competition with the sunflower plantation. Application of the two imazapyr rates resulted in high percent control of the forage grass in all evaluations. Although chlorimuron-ethyl drastically affected the sunflower plants, it had no effect on the forage grass whose growth was apparently normal. Nicosulfuron at a rate of 8 g ai ha^{-1} caused leaf yellowing of the forage plants, with a phytotoxicity percentage of 9% at 9 DAHA. The plants had recovered by 44 DAHA, with the observation of low phytotoxicity (2.7%). The nicosulfuron rate of 20 g ai ha^{-1} caused injuries to the forage plants, with the value remaining high even on the last evaluation (7.0%).

The height of sunflower plants was reduced after application of the two rates of chlorimuron-ethyl in both evaluations, with the values differing significantly from the other treatments (Table 2). The lowest imazethapyr rate resulted in short sunflower plants in the second evaluation, with no significant difference when compared to the unhoed check. This herbicide rate was probably not sufficient to delay the growth of the forage grass and thus led to competition with the sunflower plants. The two imazapyr rates also resulted in shorter sunflower plants in the second evaluation compared to the hoed check. The highest rate of imazethapyr and the two nicosulfuron rates did not affect sunflower height.

With respect to forage density, the herbicide treatments did not affect this parameter at 57 DAS. The height of *B. ruziziensis* plants was affected by the two

imazapyr rates and the highest nicosulfuron rate, with the observation of a significant difference when compared to the unhoed check.

Table 2: Mean values of sunflower height at 57 (H1) and 110 (H2) days after sowing (DAS), *B. ruziziensis* density at 57 DAS (BD), *B. ruziziensis* height at 80 DAS (BH), and fresh (FM) and dry phytomass (DM) of *B. ruziziensis* at 95 DAS

Treatment	H1	H2	BD	BH	FM	DM
	(cm)	(cm)	(plants 0.25 m^{-2})	(cm)	(kg ha^{-1})	(kg ha^{-1})
Imazethapyr 30 g ai ha^{-1}	65.27 A	151.1 C	71.75 A	39.40 B	2.420.0 C	340.0 C
Imazethapyr 70 g ai ha^{-1}	72.00 A	181.5 A	75.25 A	32.50 B	1.210.0 C	160.0 D
Imazapyr 75 g ae ha^{-1}	69.79 A	158.7 B	60.25 A	0.00 D	0.0 D	0.0 D
Imazapyr 125 g ae ha^{-1}	70.36 A	166.6 B	55.25 A	0.00 D	0.0 D	0.0 D
Chlorimuron ethyl 7.5 g ai ha^{-1}	45.43 B	120.3 D	74.75 A	45.55 A	4.440.0 B	660.0 B
Chlorimuron ethyl 12.5 g ai ha^{-1}	45.34 B	120.0 D	75.75 A	49.82 A	7.480.0 A	1.100.0 A
Nicosulfuron 8 g ai ha^{-1}	64.93 A	182.5 A	67.00 A	33.42 B	360.0 D	60.0 D
Nicosulfuron 20 g ai ha^{-1}	69.88 A	179.4 A	69.50 A	10.35 C	0.0 D	0.0 D
Unhoed check	59.49 A	143.3 C	67.25 A	39.90 B	2.120.0 C	340.0 C
Hoed check	68.79 A	174.1 A	0.00 B	0.00 D	0.0 D	0.0 D
CV (%)	9.2	7.2	36.7	24.6	79.3	80.6

Means in the same column followed by the same letters did not differ significantly from one another (Scott-Knott test at 5% probability)

Regarding fresh phytomass production of the forage plants at 95 DAS, no effect of either rate of imazethapyr was observed, with any significant difference when compared to the unhoed check. In contrast, the two imazapyr rates and the highest nicosulfuron rate resulted in the death of the aerial part of the forage plants. The highest forage phytomass was observed after the treatments with chlorimuron-ethyl, which caused injury to sunflower growth and thus reduced competition on the forage plant.

Table 3: Mean values of dry phytomass of sunflower (DMS) at 110 days after sowing, sunflower seed productivity (P) and dry phytomass of *B. ruziziensis* (DMB) at 25 days after sunflower harvest

Treatment	DMS (kg ha^{-1})	P (kg ha^{-1})	DMB (kg ha^{-1})
Imazethapyr 30 g ai ha^{-1}	9622.4 A	3453.5 A	1980.0 B
Imazethapyr 70 g ai ha^{-1}	10,400.7 A	3871.4 A	1400.0 C
Imazapyr 75 g ae ha^{-1}	11,294.9 A	4228.5 A	540.0 D
Imazapyr 125 g ae ha^{-1}	10,777.8 A	3996.4 A	0.0 D
Chlorimuron ethyl 7.5 g ai ha^{-1}	7882.0 B	2935.7 B	6020.0 A
Chlorimuron ethyl 12.5 g ai ha^{-1}	7765.9 B	2482.1 B	2820.0 B
Nicosulfuron 8 g ai ha^{-1}	10,668.1 A	4007.1 A	1960.0 B
Nicosulfuron 20 g ai ha^{-1}	11,419.1 A	3700.0 A	1480.0 C
Unhoed check	8900.6 B	3246.4 B	2660.0 B
Hoed check	11,065.6 A	4028.5 A	1260.0 C
CV (%)	15.4	13.6	36.0

Means in the same column followed by the same letters did not differ significantly from one another (Scott-Knott test at 5% probability)

The rates of chlorimuron reduced dry phytomass of sunflower plants, with no significant difference when compared to the unhoed check (Table 3). No effect on this parameter was observed for the other treatments. Sunflower seed productivity was only affected by treatment with the herbicide chlorimuron, with no significant difference when compared to the unhoed check. With respect to pasture reestablishment, all treatments applied permitted recovery of the forage species, except for the highest rate of imazapyr.

Experiment 2. Imazethapyr (100 g ai ha^{-1}) presented low phytotoxicity to sunflower hybrid Paraiso 102 CL at 14 and 21 DAHA (Table 4). Prostko *et al*. (2009) found that the herbicide imazapic, which possesses the same mechanism of action as imazethapyr, did not cause injuries to resistant sunflower. The reduced rates of imazapyr (25 g ai ha^{-1}) and nicosulfuron (4 g ai ha^{-1}) also produced no visual symptom of injury on Paraiso 102 CL plants. However, the rates of imazapyr (250 g ai ha^{-1}) and nicosulfuron (60 g ai ha^{-1}) normally recommended for sugar cane and corn plantations, respectively, were highly phytotoxic to resistant sunflower. Forage reestablishment was observed for all treatments, except for the higher rates of imazapyr and nicosulfuron. Treatment with 25 g ai ha^{-1} imazapyr and 4 g ai ha^{-1} nicosulfuron provided the highest fresh phytomass of resistant sunflower.

Table 4: Mean values of percentage of phytotoxicity to sunflower plants at 14 and 21 days after herbicide application (DAHA), fresh (FMB) and dry phytomass (DMB) of *B. ruziziensis*, and fresh phytomass of sunflower (FMS) at 110 days after sowing obtained for the two sunflower genotypes

Genotype	Treatment	% Phytotoxicity		FMB (kg ha^{-1})	DMB (kg ha^{-1})	FMS (kg ha^{-1})
		14 DAHA	21 DAHA			
Paraiso 102 CL	Hoed check	0.0	0.0	1320.0 C[1]	340.0 C	15,786.4 B
	Unhoed check	0.0	0.0	9820.0 A	2120.0 A	14,682.2 B
	Imazethapyr 100 g ai ha^{-1}	2.2	0.0	4780.0 B	1160.0 B	16,302.0 B
	Imazapyr 250 g ae ha^{-1}	30.0	32.2	0.0 C	0.0 C	9979.1 C
	Imazapyr 25 g ae ha^{-1}	0.0	0.0	2440.0 C	680.0 C	21,255.2 A
	Nicosulfuron 60 g ai ha^{-1}	40.0	44.2	0.0 C	0.0 C	14,364.5 B
	Nicosulfuron 4 g ai ha^{-1}	0.0	0.0	6260.0 B	1280.0 B	20,812.5 A
Embrapa 122	Hoed check	0.0	0.0	320.0 C	120.0 C	16,640.6 A
	Unhoed check	0.0	0.0	4580.0 B	1180.0 B	16,760.4 A
	Imazethapyr 100 g ai ha^{-1}	80.5	90.7	8960.0 A	2880.0 A	1104.16 C
	Imazapyr 250 g ae ha^{-1}	80.0	95.0	0.0 C	0.0 C	0.0 C
	Imazapyr 25 g ae ha^{-1}	50.0	63.7	3560.0 B	900.0 B	6296.8 B
	Nicosulfuron 60 g ai ha^{-1}	60.0	65.7	0.0 C	0.0 C	6140.6 C
	Nicosulfuron 4 g ai ha^{-1}	15.0	25.0	2840.0 B	800.0 B	15,244.7 A
CV (%)				79.3	66.6	26.6

For each genotype, means in the same column followed by the same letters did not differ significantly from one another (Scott-Knott test at 5% probability).

Analysis of genotype Embrapa 122 showed that all herbicides and herbicide rates applied were highly phytotoxic. All treatments permitted pasture reestablish-

ment, except for the higher rates of imazapyr and nicosulfuron. The fresh phytomass of susceptible sunflower was extremely affected by the herbicides. However, although 4 g ai ha^{-1} nicosulfuron caused injury, recovery of the sunflower plants was observed and their fresh phytomass was similar to that of the hoed and unhoed check.

CONCLUSIONS

Treatment with imazethapyr (30, 70 and 100 g ai ha^{-1}), imazapyr (25, 75 and 125 g ai ha^{-1}) or nicosulfuron (4, 8 and 20 g ai ha^{-1}) had no phytotoxic effect on imidazolinone-resistant sunflower (Paraiso 102 CL). However, chlorimuron-ethyl at rates of 7.5 and 12.5 g ai ha^{-1}, 250 g ai ha^{-1} imazapyr and 60 g ai ha ha^{-1} nicosulfuron resulted in a high level of phytotoxicity to sunflower Paraiso 102 CL. All herbicide treatments were highly phytotoxic to sunflower Embrapa 122. Pasture reestablishment was observed for all herbicide treatments, except for 125 and 250 g ai ha^{-1} imazapyr and 60 g ai ha^{-1} nicosulfuron.

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DOSIS REDUCIDAS DE HERBICIDAS EN GIRASOL RESISTENTE A IMIDAZOLINOINAS CONSOCIADO CON *Brachiaria ruziziensis*

RESUMEN

El objetivo de este estudio fue evaluar la tolerancia del girasol a los herbicidas inhibidores de la acetolactato sintasa (ALS) y retardar temporalmente el crecimiento de la especie forrajera (*Brachiaria ruziziensis*), evitando su competición con el girasol y permitiendo el restablecimiento posterior de los pastizales. En el experimento 1 fue utilizado el diseño de bloques al azar con cuatro repeticiones. Los tratamientos aplicados en el híbrido Paraíso 102 CL (Clearfield®, resistente a los herbicidas inhibidores de ALS) fueron:

I) imazetapyr 30 g ai ha^{-1}, II) imazetapyr 70 g ai ha^{-1}, III) y imazapyr 75 g ai ha^{-1}, IV) imazapyr 125 g ai ha^{-1}, V) chlorimuron-ethyl 7,5 g ai ha^{-1}, VI) chlorimuron-ethyl 12,5 g ai ha^{-1}, VII) nicosulfuron 8 g ai ha^{-1}, VIII) nicosulfuron 20 g ai ha^{-1}, IX) testigo sin escardar, X) testigo escardado.

El experimento 2 consistió en un diseño de parcelas subdivididas con bloques completos al azar y cuatro repeticiones. Dos genotipos de girasol (Paraíso 102 CL-resistentes a imidazolinonas y Embrapa 122-susceptibles a imidazolinona) se sembraron en las parcelas y subparcelas fueron sometidas a los siguientes tratamientos:

I) testigo escardado, II) testigo sin escardar, III) imazetapyr 100 g ai ha^{-1}, IV) imazapyr 250 g ai ha^{-1}, V) imazapyr 25 g ai ha^{-1}, VI) nicosulfuron 60 g ai ha^{-1} y VII) nicosulfuron 4 g ai ha^{-1}.

Los tratamientos con imazetapyr (30, 70 y 100 g ai ha^{-1}), imazapyr (25, 75 y 125 g ai ha^{-1}) y nicosulfuron (4, 8 y 20 g ai ha^{-1}) no causaran daños a las plantas de girasol resistente (Paraíso 102 CL). Chlorimuron-ethyl en dosis de

7,5 y 12,5 g ai ha^{-1}, imazapyr 250 g ai ha^{-1} y nicosulfuron 60 g ai ha^{-1}causaran alto grado de intoxicación a las plantas de girasol. Todos los tratamientos herbicidas causaran elevados síntomas de lesiones al girasol de Embrapa 122. El restablecimiento posterior de los pastizales se observó en todos los tratamientos herbicidas, a excepción de imazapyr (125 y 250 g ai ha^{-1}) y nicosulfuron (60 g ai ha^{-1}).

LES DOSES RÉDUITES D´HERBICIDES APPLIQUÉS SUR LE TOURNESOL RÉSISTANT L`IMIDAZOLINONAS ASSOCIÉ À *B. ruziziensis*

RÉSUMÉ

L'objectif de ce travail a été d'évaluer la tolérance du tournesol aux herbicides inhibiteurs de l'acetolactato sintase (ALS) et retarder, temporairement, la croissance de *Brachiaria ruziziensis*, en évitant sa compétition avec le tournesol et en permettant le rétablissement ultérieur du pâturage. Le délignement expérimental pour l'expérience 1 a été en blocs casualisés, avec quatre répétitions. Les traitements ont été:

I) imazethapyr 30 g ai ha^{-1}, II) imazethapyr 70 g ai ha^{-1}, III) imazapyr 75 g ai ha^{-1}, IV) imazapyr 125 g ai ha^{-1}, V) chlorimuron-ethyle 7,5 g ai ha^{-1}, VI) chlorimuron-ethyle 12,5 g ai ha^{-1}, VII) nicosulfuron 8 g ai ha^{-1}, VIII) nicosulfuron 20 g ai ha^{-1}, IX) temoignant sans desherber et X) temoingant sarcle.

L'expérience 2 a été en blocs casualisés en parties subdivisées avec quatre répétitions. Deux génotypes de tournesol (Paradis 102 CL-résistant l'imidazolinonas et Embrapa 122-susceptible l'imidazolinonas) ont été semés dans les parties. Sur les parties subdivisées ont été appliqués les traitements suivants:

I) temoingant sarcle, II) temoignant sans sarclage, III) imazethapyr 100 g ai ha^{-1}, IV) imazapyr 250 g ai ha^{-1}, V) imazapyr 25 g ai ha^{-1}, VI) nicosulfuron 60 g ai ha^{-1} et VII) nicosulfuron 4 g ai ha^{-1}.

Les traitements avec imazethapyr (30, 70 et 100 g ai ha^{-1}), imazapyr (25, 75 et 125 g ai ha^{-1}) et nicosulfuron (4, 8 et 20 g ai ha^{-1}) n'ont pas causé lésions aux plantes de tournesol résistants (Paradis 102 CL). Cependant, le chlorimuron-éthyle, en doses de 7,5 et 12,5 g ai ha^{-1}, imazapyr 250 g ai ha^{-1} et nicosulfuron 60 g ai ha^{-1} ont causé haut degré d'intoxication aux plantes de tournesol. Tous les traitements herbicides ont causé symptômes de lésions élevées au tournesol Embrapa 122. Tous les traitements herbicides ont permis le rétablissement ultérieur du pâturage, sauf l'imazapyr (125 et 250 g ai ha^{-1}) et le nicosulfuron 60 g ai ha^{-1}.