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Application of herbicides and sugar cane straw on controlling of *Mucuna aterrima* L. in peanut crop

Heitor Lopes Sartori[1], Augusto Guerreiro Fontoura Costa[2*], Valdinei Sofiatti[2], Pedro Luís da Costa Aguiar Alves[3]

[1]**Universidade Estadual de Campinas, 13083-970, Campinas - SP, Brazil**
[2]**Empresa Brasileira de Pesquisa Agropecuária, Embrapa Algodão, 58428-095, Campina Grande-PB, Brazil**
[3]**Universidade Estadual Paulista Júlio de Mesquita Filho, 14884-900, Jaboticabal-SP, Brazil**

***Corresponding author: augusto.costa@embrapa.br**

Abstract

Peanut crop is normally cultivated in sugar cane renewal areas in Brazil, where velvet bean (*Mucuna aterrima*) is a troublesome weed, in which the control is essential. The goal was to evaluate herbicide efficacy associated with sugar cane harvest residues on *M. aterrima* control. In absence and presence of sugar cane straw, herbicides were applied in pre-emergence (imazapic, imazethapyr + flumioxazin, diclosulan, s-metolachlor, clomazone, sulfentrazone and sulfentrazone+diuron) and in post-emergence of *M. aterrima* (imazapic, imazethapyr, bentazon, bentazon + imazamox, lactofen, fomesafen, cloransulan-methyl, carfentrazone and 2,4-D). The treatments sulfentrazone and sulfentrazone + diuron resulted in control higher than 95% in straw absence, causing the highest reductions on aerial part (92%) and root (64%) drought mass of *M. aterrima*. The presence of sugar cane straw reduced the effect of herbicides applied in pre-emergence. The 2,4-D resulted in weed control higher than 70% and the applications with 2,4-D and carfentrazone caused the highest reductions on weed plant height (28%), aerial part (45%) and root (42%) drought mass. It was possible to conclude that the highest control levels of *M. aterrima* were obtained with sulfentrazone and sulfentrazone + diuron applied at pre-emergence, in absence of sugar cane straw and, with 2,4-D and carfentrazone, applied in post-emergence, regardless of straw presence.

Keywords: weed, chemical control, velvet bean, *Arachis hypogaea* L., *Saccharum officinarum* L.
Abbreviations: CEC_cation-exchange capacity; DAA_days after application; OM_organic matter.

Introduction

The weed occurrence in peanut crops can cause yield losses higher than 80% (Agostinho et al., 2006; Nepomuceno et al., 2007; Everman et al., 2008). Furthermore, weed presence at the end of crop season can interfere with harvest process, which increases the production costs, hindering the drying peanut. It also contributes to grain contamination due to high mycotoxins level which is not allowed by sanitary legislation and consumer markets (Suassuna et al., 2009; Yamauti et al., 2010; Esposti et al., 2017; Tofoli et al., 2017).
Considering that peanut is frequently cultivated in sugar cane renewal areas in Brazil (Fiesp, 2021; Sampaio and Fredo, 2021), the weed management has become even more complex. The sugar cane straw over the soil can interfere with weed germination and emergence due to imposed physical, chemical and biological limitations to plants. This mulch can serve as barrier to weed emergence and solar radiation, in addition to reducing the thermal amplitude on soil surface and contributes for microbial population, changing the weed flora. However, weeds as velvet bean [*Mucuna aterrima* (Piper & Tracy) Holland], are shown as adapted to this condition, because they have seeds with high amount of reserves, hard integument, longevity, dormancy and are able to emerge from deeper layers, in addition to producing high biomass amount (Silva et al., 2013; Kanatas et al., 2020). Different densities of *M. aterrima* living during all crop cycle indicated that the yield of peanut pods and grains can be reduced up to 76% from one *M. aterrima* plant m^{-2} (Silva et al., 2020). In this way, this specie has been highlighted as one of the most troublesome and difficult to control in sugar cane production areas in Brazil (Silva et al., 2015a, b; Ferreira et al., 2020). Due to several emergence flows of *M. aterrima* throughout peanut cycle, it is common to do complementary control through hoeing, which excessively increase the production costs.
To avoid the weed interference, chemical control is the most common practice due to high efficacy, agility, and lowest cost. The correct herbicide usage has been proved efficient against several mono and dicot plants (Jat et al., 2011). When comparing the herbicide quantities used in peanut crops in major producing and exporting countries like the USA (Ferrel et al., 2015) and Argentina (Daita et al., 2017), along with the quantity of active ingredients approved for soybean and bean crops in Brazil (Brasil, 2023), it becomes clear that the available herbicide options for managing weeds in peanut crops are inadequate. Nowadays, there are 13 herbicide molecules registered for the crops at the Brazilian Ministry of Agriculture. Within them, five have predominant action on monocot: trifluralin, pendimethalin and pyroxasulfon for pre-emergence applications and, quizalofop-p-ethyl and clethodim for post-emergence. The other are herbicides used for controlling monocot and eudicot weeds: glyphosate for post-emergence before peanut sowing (desiccation); alachlor, s-metolachlor, sulfentrazone and the mixture flumioxazyn + imazethapyr

Table 1. Effects of herbicides applied in pre-emergence and sugar cane straw on control and height of *M. aterrima*, at 7 and 15 days after application (DAA).

Treatments	Control (%)				Height (cm)		
	7 DAA		15 DAA		7 DAA		15 DAA
	AS	PS	AS	PS	AS	PS	---
Control	0.0 Da[1]	0.0 Ca	0.0 Ea	0.0 Ba	5.4 Ab	9.5 Aa	30.8 A
Imazapic	15.1 Ca	1.3 Ca	10.3 Da	0.5 Bb	5.4 Ab	9.5 Aa	19.7 A
Imazethapyr+Flumioxazin	94.3 Aa	13.8 Bb	47.0 Ba	1.0 Bb	2.0 Cb	8.4 Aa	29.3 A
Diclosulan	0.8 Da	0.5 Ca	0.6 Ea	0.5 Ba	5.0 Ab	10.0 Aa	23.9 A
S-metolachlor	44.5 Ba	12.0 Bb	23.5 Ca	2.4 Bb	3.4 Bb	8.9 Aa	30.3 A
Clomazone	13.5 Ca	0.5 Ca	2.5 Ea	0.5 Ba	5.7 Ab	8.8 Aa	24.1 A
Sulfentrazone	98.8 Aa	37.0 Ab	98.5 Aa	70.1 Ab	1.0 Cb	7.2 Aa	5.4 B
Sulfentrazone+diuron	97.8 Aa	27.5 Ab	95.5 Aa	56.8 Ab	1.6 Cb	8.1 Aa	7.8 B
F_{value} Straw	75.2*		77.4*		306.2*		11.4*
F_{value} Herbicide	45.9*		127.4*		11.0*		9.4*
F_{value} Straw *Herbicide	6.3*		9.4*		2.3*		1.9[ns]
CV (%)	28.9		21.2		18.8		42.7

AS: absence of straw; PS: presence of straw; [1] For each evaluation date, means followed by the same capital letter in the column and lower case in the line does not differ significantly from each other by Scott Knott test (p ≤ 0.05). * Significant at 5% of probability; [NS] not significant.

in pre-emergence; imazapic in pre-and post-emergence, imazethapyr, bentazon and bentazon + imazamox in post-emergence (Brasil, 2023).

In addition to registered herbicides, information available in literature indicates possibilities of expanding research on application of broadleaf herbicides on peanut crop such as diclosulan, chlorosulan-methyl, 2,4-D, fomesafen and lactofen (Ferrel et al., 2015; Esposti et al., 2017; Sperry et al., 2017; Toffoli et al., 2017; Zanardo et al., 2018). However, studies on control of *M. aterrima* are scarce, and it is necessary to research management of this specie in peanut cultivation areas.

Another important issue to be considered in peanut production in sugarcane reform areas is the interference of straw on herbicide applications, mainly as pre-emergence, as they intercept and retain the applied product, and most of which can be adsorbed, reducing its action on weeds (Araldi et al., 2015; Matos et al., 2016).

Given the potential for cultivating peanuts without disturbing the soil in areas where sugar cane is being renewed and the necessity for research focused on managing problematic weeds, this study aimed to assess the effectiveness of herbicides combined with sugar cane straw in controlling *M. aterrima* in peanut crops.

Results and Discussion

Application of pre-emergence herbicides and sugar cane straw to control velvet bean

The variance analysis for the control of *M. aterrima* at 7 and 15 DAA and plant height at 7 DAA indicated significant interaction between sugar cane straw and the herbicides (Table 1). For the plant height of *M. aterima* at 15 DAA, there was no interaction between the factors. In the absence of straw, the control level was excellent for the two treatments containing sulfentrazone, in both evaluations, with percentage ranging from 96 to 99%. Silva et al. (2012) reported 42% reduction in *M. aterrima* using sulfentrazone (800 g ha^{-1}) when applied as pre-emergence directly on the soil. Silva et al. (2015b) also verified that application of sulfentrazone at doses of 300 and 600 g ha^{-1} in the absence of straw, resulted in 90% control of *M. aterrima*. Although these authors performed the applications at the true two-leaf stage, sulfentrazone is recommended for pre-emergence applications because it is mainly absorbed by the roots and is translocated in a limited way by the phloem (Rodrigues and Almeida 2018; Brasil, 2023).

In the presence of straw, the treatments with sulfentrazone had lower effect compared to the absence condition, where controlled 37 and 70% when sulfentrazone applied alone, and to 28 and 57% for sulfentrazone + diuron, at 7 and 15 DAA, respectively. In addition to the time required for the herbicides to act on the plant, this increment of control can be related to the water/irrigation effect on herbicide leaching to the soil, making it more available to root uptake.

Simoni et al. (2006), found that 20 millimeters of precipitation was adequate for leaching sulfentrazone to effectively controlling *Cyperus rotundus*, when applied at a rate of 800 grams per hectare along with sugar cane straw quantities of 10 and 20 tons per hectare.

Araldi et al. (2015) found that 23 mm of precipitation were necessary to remove 90% of the diuron herbicide applied on 10 t ha^{-1} of straw (Table 1).

For the mixture containing imazethapyr + flumioxazin, the highest weed control was occurred without the presence of straw at 7 DAA (94%), which reduced to 48% at 15 DAA (Table 1). In the presence of straw, the observed control was only 14% at 7 DAA. Ferreira et al. (2020) indicated that flumioxazin applied at 250 g ha^{-1} in pre-emergence resulted in less than 25% control of *M. aterrima* at 23 DAA, regardless of absence or presence of sugar cane straw (10 t ha^{-1}). In the present study, s-metolachlor controlled the weed by 45% and 24% at 7 DAA at 15 DAA, respectively, at straw absence, while it was only 12% in the presence of straw at 7 DAA. Therefore, it was possible to verify that the presence of plant residues markedly reduced the herbicide action on *M. aterrima* for the treatments imazethapyr + flumioxazin and s-metolachlor.

In relation to the plant height at 7 DAA (Table 1), the straw absence resulted in the highest values for all the treatments. The untreated control also presented this result due to straw factor. At least part of this effect is due to the sugar cane residue on the plant initial growth, which can be related to soil humidity maintenance and another factors, like nutrients released from sugar cane harvest residue (Bennet et al., 2012). The effect of herbicides on plant height at 7 DAA occurred in the absence of straw, with higher magnitude for imazethapyr + flumixazin and both sulfentrazone treatments, which corresponded to 71% of reduction in relation to the control treatment.

Table 2. Effect of herbicides applied in pre-emergence and sugar cane straw on plant number, shoot and root drought mass of *M. aterrima*, at 15 days after application (DAA).

Treatments	Plant number		SDM (g)		RDM (g)
	AS	PS	AS	PS	---
Control	20.8 Aa[1]	18.3 Aa	0.50 Ab	0.62 Aa	0.37 A
Imazapic	19.3 Aa	22.0 Aa	0.39 Ba	0.48 Ba	0.22 B
Imazethapyr+Flumioxazin	22.3 Aa	20.0 Aa	0.20 Cb	0.47 Ba	0.26 A
Diclosulan	16.8 Aa	22.3 Aa	0.52 Aa	0.49 Ba	0.17 B
S-metolachlor	20.0 Aa	20.8 Aa	0.46 Ba	0.52 Ba	0.32 A
Clomazone	20.3 Aa	22.0 Aa	0.42 Ba	0.50 Ba	0.28 A
Sulfentrazone	1.8 Bb	15.8 Aa	0.01 Db	0.20 Ca	0.12 B
Sulfentrazone+diuron	5.5 Bb	20.0 Aa	0.07 Db	0.22 Ca	0.15 B
F_{value} Straw	19.5*		44.7*		2.4^{ns}
F_{value} Herbicide	11.2*		48.7*		3.8*
F_{value} Straw *Herbicide	5.8*		3.4*		1.3^{ns}
CV (%)	21.8		18.3		5.0

SDM and RDM: shoot and root drought mass, respectively; AS: absence of straw; PS: presence of straw; [1] For each characteristic evaluated, means followed by the same capital letter in the column and lower case in the line does not differ significantly from each other by Scott Knott test (p ≤ 0.05). * Significant at 5% of probability; [NS] not significant.

However, at 15 DAA, the height decrease was observed only for sulfentrazone treatments (79% on average), regardless of the straw presence.

The number of plants and the shoot dry mass of *M. aterrima*, showed significant interaction with the herbicides and presence or absence of straw. It was observed that the treatments with sole sulfentrazone or in combination with diuron reduced the plant number by 82%, compared to the control without straw (Table 2). When sulfentrazone and sulfentrazone + diuron were applied on straw, the average reduction of shoot dry mass was 67% lower than the control, compared to 92% decrease observed in the straw absence. Bressanin et al. (2015) reported that sulfentrazone (600 g ha^{-1}) applied in the absence of straw may diminish the shoot dry mass of *M. aterrima* by 95% at 120 DAA. In the current study, the treatment imazethaphyr + flumioxazin caused intermediate decrease of 60% to this characteristic without straw. The s-metolachlor and clomazone effects were much less remarkable, with 12% of average reduction. In relation to the root dry mass, the significant herbicide effects occurred only for sulfentrazone and sulfentrazone + diuron, with 64% of decrease, regardless of straw absence or presence.

In general, it can be observed that sulfentrazone (450 g ha^{-1}) and sulfentrazone + diuron (245 + 490 g ha^{-1}) applied in pre-emergence, in absence of sugar cane straw, resulted in the highest weed control levels, as well in the highest reductions on plant number and dry mass of *M. aterrima* (Tables 1 and 2). Despite sulfentrazone doses are different, the verified effects were like these treatments. Nonetheless, Silva et al. (2015b) found an increased control of *M. aterrima* due to higher doses of sulfentrazone (between 150 and 900 g ha^{-1}). Regarding the other pre-emergent herbicide treatments, the mixture of imazetaphyr + flumioxazin applied in the absence of sugar cane straw, resulted in intermediate effects on *M. aterrima* growth, especially when the results of dry mass accumulation are considered. Therefore, as sulfentrazone and the association imazetaphyr + flumioxazin are registered by the Brazilian Ministry of Agriculture (Brasil, 2023) to peanut crop, these herbicides can be considered to control *M. aterrima* management in Brazil, mainly if associated to post-emergence herbicides and another control methods.

Research has shown that the presence of straw negatively affects the effectiveness of pre-emergence herbicides. This occurs because the herbicides get caught and held within the plant material on the soil, leading to decreased leaching of specific active ingredients through the straw. This reduction in herbicide availability subsequently lowers its contact with and absorption by weeds (Ferreira et al., 2016; Tropaldi et al., 2019; Ferreira et al., 2020). In the studies carried out with sulfentrazone (Simoni et al., 2006; Carbonari et al., 2016) and diuron (Araldi et al., 2016), it has been verified that its retention by sugar cane straw is dependent on factors like the amount of plant residues on the soil, the period without precipitation and the rain volume after application (Matos et al., 2016). Thus, with potential for adopting of the no- tillage peanut system on sugar cane straw, better attention should be given to the different factors that can affect the dynamics and, consequently, biological action of pre-emergence herbicides to control *M. aterrima* and other common weed species in this crop.

Post-emergence herbicides and sugar cane straw to control velvet bean

The post-emergence herbicides were not influenced by straw factor. Their interaction with the herbicide factor to control the height of *M. aterrima* was also low (Table 3). The treatments with 2,4-D, carfentrazone, imazethapyr, lactofen and fomesafen resulted in control levels that ranged between 50 and 56% at 7 DAA. The cloransulan-methyl and imazapic applications generated lower control levels at first evaluation (34 and 29%, respectively). The control of 2,4-D was increased at 15 DAA, reaching 76%, followed by percentages ranging between 49 and 56% from lactofen, imazapic and carfentrazone and, control of 42% from fomesafen and cloransulan-methyl. Silva et al. (2012) observed 88% control of *M. aterrima* at 10 DAA with 2,4-D (1.209 g ha^{-1}) applied at weed stage of 7 trefoils. After conducting applications at various growth stages of *M. aterrima*, Bressanin et al. (2015) observed that when 2,4-D (670 g ha^{-1}) and carfentrazone (35 g ha^{-1}) were applied during the stage with two expanded leaves, they achieved control rates of 86% and 74%, respectively. In contrast, when applied during the stage with seven visible side buds, they achieved control rates of 74% and 30%, respectively.

Table 3. Effect of herbicides applied in post-emergence and presence of sugar cane straw on control, plant height, shoot and root drought mass of *M. aterrima*, at 7 and 15 days after application (DAA).

Treatments	Control (%)		Plant Height (cm)		SDM (g)	RDM (g)
	7 DAA	15 DAA	7 DAA	15 DAA	15 DAA	
Absence of straw	30.1[1]	34.8	27.8	24.4	2.0 B	1.9
Presence of straw	32.2	37.0	29.0	24.4	2.5 A	2.4
Control	0.0 E	0.0 F	33.2 A	24.3 A	3.0 A	2.8 A
Imazapic	28.5 B	56.0 B	28.2 A	25.9 A	1.8 B	1.5 B
Imazethapyr	6.3 D	6.8 E	30.6 A	28.7 A	2.7 A	3.0 A
Bentazon	9.6 D	13.1 D	33.0 A	24.8 A	3.1 A	2.7 A
Bentazon+Imazamox	18.6 C	17.9 D	33.2 A	27.2 A	2.8 A	2.9 A
Lactofen	50.4 A	49.4 B	27.3 A	27.8 A	2.0 B	2.3 A
Fomesafen	56.2 A	41.6 C	32.0 A	27.5 A	2.3 A	2.5 A
Cloransulan-methyl	33.6 B	42.4 C	28.2 A	22.8 A	2.2 A	1.6 B
Carfentrazone	56.4 A	56.1 B	23.5 B	20.9 B	1.4 B	1.0 B
2,4-D	56.0 A	75.8 A	15.3 B	14.3 B	0.8 B	1.2 B
F_{value} Straw	0.2^{ns}	1.9^{ns}	0.3^{ns}	0.0^{ns}	4.8^{*}	2.0^{ns}
F_{value} Herbicide	97.2^{*}	92.4^{*}	3.0^{*}	6.8^{*}	4.3^{*}	2.4^{*}
F_{value} Straw *Herbicide	0.2^{ns}	0.7^{ns}	1.4^{ns}	0.8^{ns}	1.4^{ns}	0.5^{ns}
CV (%)	12.9	13.3	32.0	19.1	45.0	22.5

SDM and RDM: shoot and root drought mass, respectively; [1] For each characteristic evaluated and evaluation date, means followed by the same capital letter in the column and lower case in the line does not differ significantly from each other by Scott Knott test ($p \leq 0.05$). * Significant at 5% of probability; [NS] not significant.

Considering plant height, in relation to the control, 2,4-D and carfentrazone caused average reductions of 42% and 28% at 7 and 15 DAA. Concerning dry mass, the straw presence contributed to the shoot growth (Table 3). The herbicides 2,4-D, carfentrazone, lactofen and imazapic similarly decreased shoot dry mass, with 45% on average compared to the control. Regarding root dry mass, 2,4-D, carfentrazone, imazapic and cloransulam-methyl resulted in a similar reduction (42% on average). In relation to these molecules, the imazapic stands out as the best as it is the only herbicide already registered to peanut crop by Brazilian Agriculture Ministry (Brasil, 2023). Therefore, it can be considered as a possibility for new studies aiming at the management of *M. aterrima*, in conjugation with other herbicides and controlling methods.

In general, based on results obtained in the second experiment, the herbicides 2,4-D (456 g ha^{-1}) and carfentrazone (30 g ha^{-1}) applied in post-emergence, resulted in the best control levels and the highest height reductions of *M. aterrima*, compared to the other herbicides regardless of presence of sugar cane straw. However, the control observed with these treatments was lower than those ones found with the other herbicides applied in pre-emergence (sulfentrazone and sulfentrazone + diuron).

In relation to selectivity to peanut crop, some research results indicate that carfentrazone and 2,4-D can cause yield losses (Grichar et al., 2010; Esposti et al., 2017; Price et al., 2021). However, new studies are needed concerning application timing for these compounds. The evaluations involving risks of herbicide residues should also be included mainly for later applications focusing on control of *M. aterrima* and other difficult control weed species.

Despite 2,4-D and imazapic are uptaken through leaves and roots (Rodrigues and Almeida, 2018), no reduction in their action under straw presence condition was observed. This is probably due to predominant leaf uptake in consequence of the post-emergence application mode. In study to evaluate the herbicide residual effect in the soil, Anésio et al. (2018) found that *M. aterrima* was not susceptible to 2,4-D when applied 40 days before sowing. Although, as we verified at the first experiment with pre-emergence applications, the straw presence did not contribute to reducing number of *M. aterrima* plants. In this context, Silva et al. (2015a) also did not observed interference on the emergence of this species, when sown in depth between 0 a 10 cm, under 10 t ha^{-1} of sugar cane straw.

Based on the results from this current study and the herbicides registered for peanut crop in Brazil (Brasil, 2023), the sulfentrazone can control *M. aterrima*. The applications of imazetaphyr + flumioxazion in pre-emergence and imazapic in post-emergence also can contribute to the management of this species. In this framework, new studies involving these and other herbicides that present potential for usage on peanut crop are needed, which can consider mixtures, doses, and application timing, also selectivity aspects to the crop. In addition, other control methods should be associated for improving *M. aterrima* management.

Materials and Methods

Plant material and conduction

Two experiments were carried out in green house located at coordinates 22° 43' 38'' S and 47° 01' 01'' W. The first and second experiments were carried out with pre- and post-emergent herbicides, respectively, during the periods from November to December 2021 and from January to February 2022.

The substrate in both assays were composed of arable layer of soil extract (0 to 20 cm) from a fallow agricultural area, located in Jaguariúna (São Paulo state, Brazil), classified as Red-Yellow Latosol (Embrapa, 2018), containing sand 80.5%, silt 1.5% and clay 18.0%. The chemical characteristics presented were: pH in water = 5.3; Ca^{+2} = 0.9 cmolc dm^{-3}; Mg^{+2} = 0.4 cmolc dm^{-3}; H+Al = 1.6 cmolc dm^{-3}; CEC = 3.3 cmolc dm^{-3}; V = 50.8%; Al^{+3} = 0.0 cmolc dm^{-3}; P = 10.0 mg dm^{-3}; K^{+} = 0.35 cmolc dm^{-3} and OM = 24.0 g kg^{-1}. Subsequently, the soil was sieved by 2 mm mesh, dried under shade, corrected, and fertilized whit dolomitic limestone and monoammonium phosphate, at 1 and 3 kg m^{-}

[3], respectively. The substrate was used to fill plastic vases with 2 L capacity, constituting the experimental plots for both experiments. A dry heat air method for breaking the dormancy of *M. aterrima* seeds was applied through an oven with circulated air at 50° C per 24h (Wutke et al., 1995). The seeds were sown at 1 cm depth, with 40 units per pot. Daily irrigation was carried out to maintain humidity, using a system composed of micro sprinklers with pre-programed activation.

Experimental design and treatments

The experiments were installed in an entirely randomized design with four replications. For the first experiment, the treatments were arranged in an 8 x 2 factorial scheme. The factor A, represented by 8 treatments, was consisted by the herbicides imazapic (98 g ha^{-1}), imazethapyr + flumioxazin (120 + 60 g ha^{-1}), diclosulan (35 g ha^{-1}), s-metolachlor (1200 g ha^{-1}), clomazone (1250 g ha^{-1}), sulfentrazone (450 g ha^{-1}), sulfentrazone+diuron (245 + 490 g ha^{-1}) and a control without application. The factor B corresponded to absence and presence of sugar cane straw. The straw composed mainly of leaves was collected from plant material deposited on the soil, immediately after sugar cane harvest, which was subsequently dried in an air circulation oven at 60° C. The straw amount added to the soil immediately after sowing was 10 t ha^{-1}.

In the second experiment, the treatments were arranged in a 10 x 2 factorial scheme. The factor A consisted of the herbicides imazapic (98 g ha^{-1}), imazethapyr (106 g ha^{-1}), bentazon (900 g ha^{-1}), bentazon + imazamox (900 + 42 g ha^{-1}), lactofen (144 g ha^{-1}), fomesafen (250 g ha^{-1}), chloransulan-methyl (40 g ha^{-1}), carfentrazone (30 g ha^{-1}), 2,4-D (456 g ha^{-1}) and a control without application. The Factor B corresponded to absence and presence of sugar cane straw, using the same amount of straw collected in the first experiment on the soil in the pots after sowing.

Herbicide applications

In the first experiment, the applications were carried out two days after sowing (DAS), while in the second, at 20 DAS, when the plants presented between 2 and 3 trefoils. We used a backpack sprayer maintained at CO_2 constant pressure, equipped with four flat fan ST 11002 nozzles in a boom, spaced at 0.5 m apart, positioned at 0.5 m height from the target, constituting consumption of 200 L ha^{-1}. Adjuvants were added in the spray solutions for the post-emergence applications, based on usage recommendations of the herbicides in Brazil (Brasil, 2023): mineral oil (756 g L^{-1}) at concentration of 0.5% (v v^{-1}) for carfentrazone; the mixture of methyl esters, aromatic hydrocarbons and phosphate polyol (933 g L^{-1}) at concentration of 0.2% (v v^{-1}) for fomesafen and chloransulan-methyl; 0.25% for imazapic and 0.5% for bentazon and bentazon + imazamox. The wind speed, temperature and relative humidity data were recorded at the beginning and at the end of the applications by a digital thermo-hygrometer, whose averages corresponded respectively to 0 m s^{-1}, 28°C and 65% in the first experiment and at 0 m s^{-1}, 31°C and 70% in the second experiment. After the herbicide applications, an interval of 10h was adopted for restarting irrigation, with about 4 mm daily for both experiments.

Traits measured

The height and weed control were evaluated at 7 and 15 days after applications (DAA) in both experiments. The height was measured from soil surface to the highest point of the plants. The control was evaluated by visual notes, where 0% meant no damage and 100% the death of the plants, according to SBCPD (1995). In the first experiment, the number of emerged plants was counted at 15 DAA. The dry shoot biomass and roots of the plants were evaluated at 15 DAA for both experiments by drying the plant material in a forced air ventilation oven at 65°C and for a period of 72 hours, until reaching a constant mass, and then weighing it in a semi-analytical balance.

Statistical analysis

The data were subjected to analysis of variance and the means were compared by the Scott Knott test at 0.05 probability.

Conclusion

The herbicides sulfentrazone (450 g ha^{-1}) and sulfentrazone + diuron (245 + 490 g ha^{-1}) applied in pre-emergence, in the absence of sugar cane straw, resulted in the highest control levels of *Mucuna aterrima*. The herbicides 2,4-D (456 g ha^{-1}) and carfentrazone (30 g ha^{-1}) applied in post-emergence, regardless of the presence of sugar cane straw, occasioned the best control levels of *Mucuna aterrima.*

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