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Article

Weed Management with *Urochloa ruziziensis* in Three Sowing Methods

*Manejo de Plantas Daninhas com **Urochloa ruziziensis** em Três Métodos de Semeadura*

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ABSTRACT - This research aimed at investigating which sowing method is more suitable for the deployment of *Urochloa ruziziensis* to suppress the weed community in no-tillage. The design was a randomized block ones, with a 3 x 2 factorial design, in which the first factor was composed of three sowing methods (broadcast, broadcast with incorporation or line sowing) and factor B consisted in the application and non-application of the herbicide 2,4-D. On day 30 and 60 after sowing (DAS), the relative importance of the present plant species was determined. On day 120 and 180 DAS, the accumulation of biomass and the plant cover percentage on the soil provided by the cover crop and weed species were determined. Moreover, on day 180 DAS, the density of the existing weeds was determined. The weed with the highest occurrence in the area was *Conyza canadenses*, and the lowest percentage of soil covering by signalgrass and the greates occurrence of weeds occurred with broadcast seeding. It is possible to conclude that the broadcast seeding with the incorporation of signalgrass seeds and line sowing methods provide enough plant cover to suppress weed species, avoiding the application of the herbicide 2,4-D in order to suppress the infesting community.

Keywords: *Brachiaria ruziziensis*, *Conyza* sp., no-tillage, 2,4-D.

RESUMO **-** *Nesta pesquisa, objetivou-se investigar métodos de semeadura de braquiária ruziziensis (**Urochloa ruziziensis**) no intuito de suprimir a infestação de plantas daninhas em plantio direto. O delineamento experimental adotado foi o de blocos casualizados em arranjo fatorial 3 x 2, no qual o fator A foi composto por três métodos de semeadura (a lanço, a lanço com incorporação e em linha) e o fator B, pela aplicação e não aplicação do herbicida 2,4-D a 1.005 g ha^{-1} de i.a. Aos 30 e 60 dias após a semeadura (DAS), determinou-se a importância relativa das espécies de plantas presentes. Aos 120 e 180 DAS, foi determinado o acúmulo de biomassa e a porcentagem de cobertura vegetal sobre o solo proporcionada pela planta de cobertura e pelas espécies de plantas daninhas. Ainda, aos 180 DAS, foi determinada a densidade de plantas daninhas existentes. A planta daninha de maior ocorrência na área foi a buva, e a menor porcentagem de cobertura do solo pela braquiária e a maior ocorrência de plantas daninhas ocorreram na semeadura a lanço. Conclui-se que os métodos de semeadura a lanço com incorporação das sementes de braquiária e em linha proporcionam cobertura vegetal suficiente para a supressão das espécies de plantas daninhas, dispensando a aplicação do herbicida 2,4-D para que ocorra supressão da comunidade infestante.*

Palavras-chave: *Braquiária ruziziensis*, *Conyza* sp., plantio direto, 2,4-D.

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INTRODUCTION

In order to adopt no-tillage, a good vegetation cover on the soil surface is essential before the crop is introduced (Timossi et al., 2007). According to Moda (2009), wastes produced by commercial crops are generally not enough to provide proper soil covering. Thus, choosing cover crops with a proper biomass production is an essential factor for the formation of straw/plant cover.

In no-tillage areas, the appearance of difficult-to-control weeds has become one of the factors causing great interference in productivity. Weeds compete directly for resources that are basic to the development of crops, either for water, light, nutrients and growth space, and they compete indirectly, since they may damage crop plants due to the release of allelopathic substances, or for hosting pests and diseases, causing serious damages to the culture (Osipe et al., 2013).

According to Dan et al. (2013), horseweed (Conyza spp.), previously considered a secondary weed species, has become one of the main weeds all over the world. Plants from this species stand out due to their adaptability, reproductive ability and genetic diversity, helping the emergence of herbicide-resistant biotypes, which makes their management difficult. Among the management forms of this species, the adoption of signalgrass for the formation of plant cover may help in reducing the infestation.

Among cover plants, *Urochloa ruziziensis* has become accepted because it shows high tolerance to water deficit, tillering and soil cover ease (Mateus, 2010), as well as being easily controlled by herbicides adopted during desiccation (Silva et al. , 2013). In addition to a good amount of plant cover on the soil and greater facility in controlling weeds, signalgrass helps implanting the crop-livestock integration system, being able to produce enough plant mass to feed animals in the off-season period and residues to establish the no-tillage (Lima et al., 2014).

In order to suppress weed infestation in agricultural areas, the goal of this study was to investigate the most appropriate sowing method for the implantation of *Urochloa ruziziensis*, plus the influence of applying 2,4-D herbicide.

MATERIAL AND METHODS

The species evaluated as plant cover was *Brachiaria ruziziensis* (*Urochloa ruziziensis*), implanted on 04/02/2013, after the harvest of soybean. Climatological data from the research period (Figure 1) were obtained at the INMET agrometeorological station (Instituto Nacional de Meteorologia).

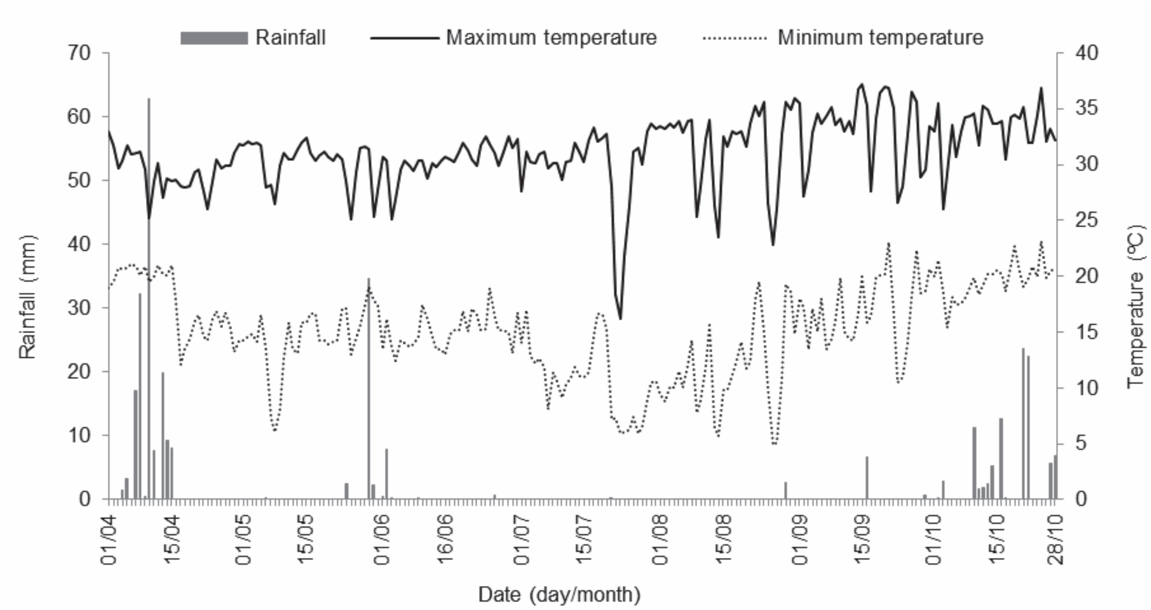

Figure 1 **-** Average maximum and minimum air temperature and total rainfalls, in ten-day periods, during the conduction of the experiment (INMET, 2013).

The used experimental design was the randomized block one, in a 3 x 2 factorial design, totaling six treatments with four replications. Factor A was composed of three signalgrass sowing methods (broadcast, broadcast with closed leveling disc harrow incorporation and line sowing), and factor B consisted in the application and non-application of the herbicide 2,4-D. The area of each experimental plot was 4 m wide x 12 m long, totaling 48 m^2.

The sowing rate of *Brachiaria ruziziensis* followed the recommendation of cultural value (CV) points: for broadcast seeding, 400 CV ha^{-1} points were adopted, simulating adverse conditions; 320 CV ha^{-1} points for incorporated broadcast seeding, considering intermediate situations; and 240 CV ha^{-1} points for line sowing (Lima, 2013). In the two broadcast seeding methods, seeds were sowed manually all over the area. In the treatment with seed incorporation, a light harrowing operation with 'closed' leveling grid was performed, incorporating the seeds at the depth of up to 0.05 m. As for line sowing, nine rows were sown in each plot, spaced 0.45 m apart, adopting a depth of 0.05 m.

On day 30 and 60 DAS, the specific composition of the present plant species was determined. A 0.50 m x 0.50 m metal frame was randomly cast three times, totaling 0.75 m^2 per experimental plot. In this evaluation, plants were identified and cut close to the soil; they were separated by species, placed in paper bags and dried in a forced air circulation chamber at 65 ^oC, where they remained until constant weight. This material was adopted to determine dry matter, so as to subsequently determine the relative importance (RI), according to the methodology proposed by Mueller Dombois and Ellenberg (1974).

On day 60 after the sowing (DAS) of *Brachiaria ruziziensis*, the herbicide 2,4-D was applied at 1,005 g ha^{-1} of active ingredient in a 200 L ha^{-1} spraying volume, using a research sprayer with six-nozzle bars and DG 11002 tips, spaced 0.5 m apart and maintained at constant pressure by CO_2. The application was performed in the afternoon period, from 2:40 p.m., with air temperature of 31.3 ^oC, relative air humidity of 48% and mean wind speed of 2.0 km h^{-1}.

The production of plant mass provided by the plant cover and the soil covering percentage were evaluated on day 120 and 180 after sowing (DAS). In order to sample the plant mass accumulation, a 0.50 m x 0.50 m metal frame was launched randomly three times, totaling 0.75 m^2 per experimental plot. As for the percentage of plant cover on the soil, provided by *Brachiaria ruziziensis* and weed species, the visual analysis technique was adopted, in which the grade 100 was adopted for total plant cover on the soil and 0 for cover absence. Also, on day 180 DAS, the density of weeds in coexistence with the cover plant was surveyed. To do so, a 12 m^2 rectangular area (3 m x 4 m) was used, in the usable area of each experimental plot, where weed counting was performed.

For data about the relative importance, the descriptive analysis was used. For the other results, the analysis of variance was used, with mean comparison by Tukey's test at 5% significance.

RESULTS AND DISCUSSION

The most infesting weeds in the experimental area were: *Conyza canadensis* (horseweed), *Commelina benghalensis* (Benghal dayflower), *Digitaria horizontalis* (crabgrass) and *Eleusine indica* (Indian goosegrass).

The graphs presented in Figure 2 represent the relative importance (RI) of weeds and *Brachiaria ruziziensis* found in the experimental area, following their respective sowing methods determined on day 30 and 60 DAS, consecutively. On day 30 DAS, horseweed presented a larger population in relation to the other evaluated weed species, regardless of the signalgrass sowing method. In this period, it is possible to observe that the relative dominance of horseweed was superior to the signalgrass one in broadcast seeding. On day 60 DAS already, it is possible to observe a significant increase in the dominance of signalgrass over the infesting community, in any of the sowing methods.

On day 30 DAS, with broadcast seeding, *Brachiaria ruziziensis* (BRARU) presented a similar RI to that of *Conyza canadensis* (ERICA). This factor may be explained by the fact that the signalgrass plant cover is smaller than the weed cover, indicating that it presents a slow initial growth

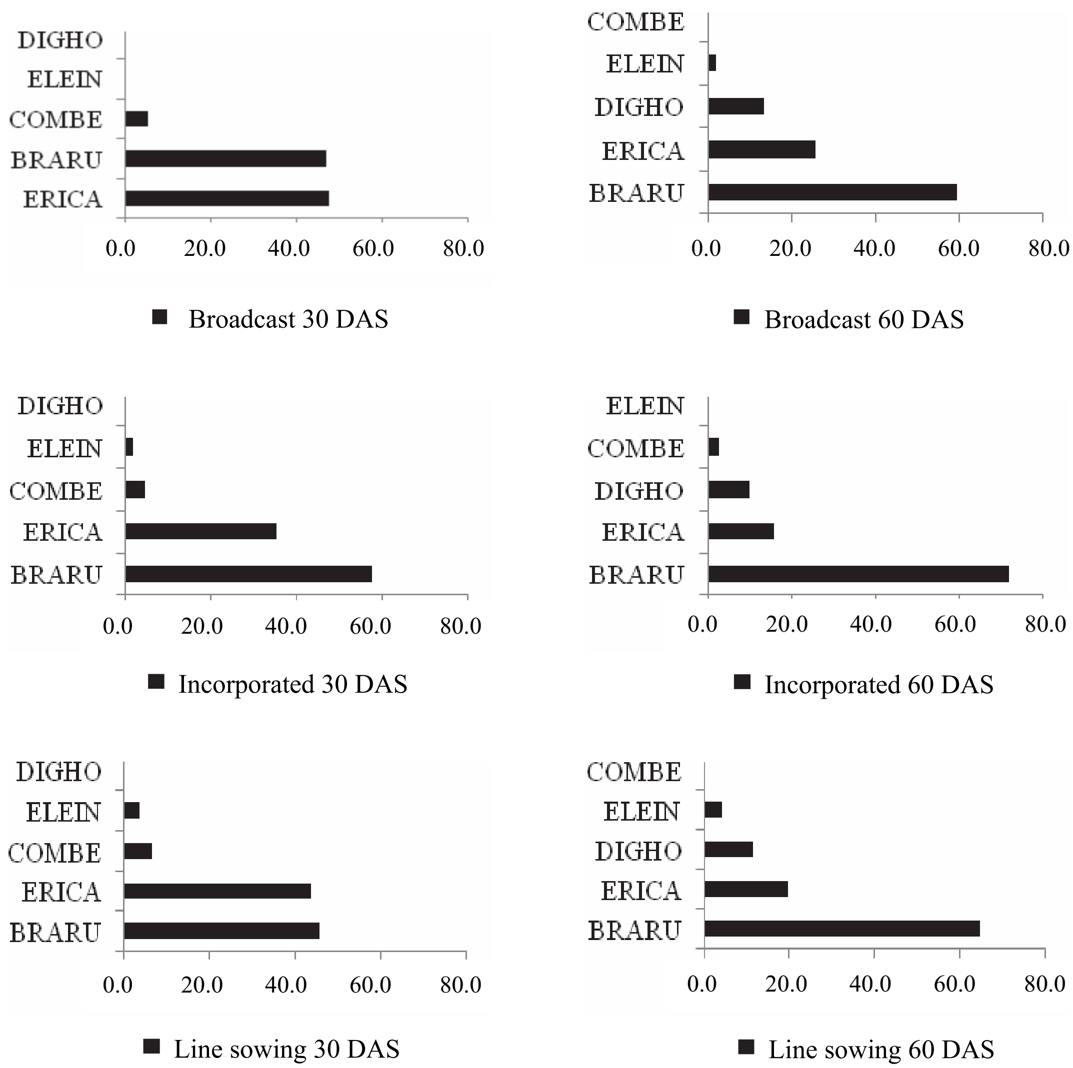

Figure 2 - Relative importance (RI) of *Conyza canadensis* (ERICA), *Commelina benghalensis* (COMBE), *Eleusine indica* (ELEIN), *Digitaria horizontalis* (DIGHO) and *Urochloa ruziziensis* (BRARU) determined on day 30 and 60 after sowing.

compared to the weed community. It was also verified that broadcast seeding takes more time for the establishment of signalgrass, due to the great exposure of seeds on the soil. In this seeding type, there are more attacks from birds and other predators that may feed on them, as well as the deposition of seeds on the residual straw from the previous culture, which can lead to unevenness in the establishment of the plant cover. When seeds were incorporated, in both situations, the anticipation of the plant cover on the soil by signalgrass was remarkable (Table 1).

Table 1 - F values and variation coefficients (VC%), applied to the percentage means of total soil covering, on day 120 and 180 after sowing (DAS)

	Variable	Total soil covering (%)	
		120 DAS	180 DAS
F	Sowing (S)	25.84*	23.99*
	Herbicides (H)	7.71*	3.74^{ns}
	S x H	6.42*	8.36*
VC (%)		13.85	9.17

Means followed by the same letter, in the same column, did not differ by Tukey's test ($p<0.05$).

Conyza canadensis presented higher RI than all the present weeds, both on day 30 and 60 DAS. According to Santos et al. (2013) and Neto et al. (2013), horseweed seeds do not present dormancy, and are ready to germinate after their dispersion, as well as showing a high potential of competition with the other plants, due to its easy adaptation and to the fact that it interferes in the development of other species by releasing allelopathic compounds. This premise supports the results obtained in the research, where the infestation increased with the beginning of the fall/winter season.

Commelina benghalensis (COMBE) showed greater RI on day 30 DAS. On the other hand, on day 60 DAS a decrease was observed, indicating that this species presents a low power of competition with *Brachiaria ruziziensis*, and can be easily suppressed by it.

The species *Digitaria horizontalis* (DIGHO) was practically non-existent on day 30 DAS and, on day 60 DAS, presented large infestations, without, however, differentiating between the sowing methods. This situation may have occurred due to the emergence flows of the species (Kissmann and Groth, 1997). The same occurs with *Eleusine indica* (ELEIN), which initially showed a low infestation level in the area (30 DAS), but presented an increase in its population on day 60 DAS. Generally speaking, the evaluated weed species diminished their importance as signalgrass began to grow more quickly.

Table 2 shows data about the dry matter production of *Brachiaria ruziziensis*, determined on day 120 and 180 DAS. The application of the herbicide 2,4-D on day 60 influenced the accumulation of biomass only on day 180 DAS. This difference may be related to the presence of horseweed, since it was the only species that coexisted with the fodder plant.

Table 2 **-** F values, LSD and variation coefficients (VC%), applied to the dry matter production means (kg ha^{-1}) of *Brachiaria ruziziensis* (*Urochloa ruziziensis*) on day 120 and 180 after sowing (DAS)

	Variable	*Brachiaria ruziziensis* dry matter (%)	
		120 DAS	180 DAS
F	Sowing (S)	4.83 *	16.14 *
	Herbicides (H)	2.05 *	4.97 *
	S x H	0.92 ^{ns}	1.35 ^{ns}
H	With	1793.54 A	2722.72 B
	Without	2033.50 A	2998.02 A
LSD		357.03	263.26
S	Boradcast	1603.81 B	2445.54 B
	Incorporated	2240.47 A	3303.69 A
	Line	1896.28 AB	2831.88 B
LSD		533.16	393.14
VC (%)		21.44	10.58

Means followed by the same letter, in the same column, did not differ by Tukey's test ($p<0.05$).

As for the sowing method, it was possible to observe that the broadcast method provided less plant mass on day 120 and 180 DAS, without, however, differing from line sowing. In broadcast seeding, the lower plant mass of signalgrass may be possibly explained by the large amount of seeds that did not germinate because of the exposure to weather and the presence of predators and/or residues of straw from previous crops. When suppressing weeds, according to Borges et al. (2013), a good layer of straw on the soil surface is very important, due to the physical effect that limits the passage of light, hindering the germination of the seeds and the initial growth of the seedlings. In line sowing, during the initial growth period of signalgrass, the exposed spaces between the rows allowed the germination and emergence of weeds, generating competition among plants; this may have influenced the development of *Brachiaria ruziziensis*.

Table 1 shows data about the total soil covering, referring to cover plant and weeds, in the sowing methods with and without the herbicide 2,4-D.

Tables 3 and 4 show the results obtained on day 120 and 180 DAS, since there was a significant interaction between sowing method and herbicide application. The incorporated broadcast and line sowing, in all the evaluation periods without herbicide application, provided better total soil covering in relation to the broadcast method.

On day 120 and 180 DAS, in the incorporated broadcast method, it is possible to observe that the herbicide application caused a decrease in the total plant covering, due to the control of broadleaf weeds (eudicots) (Tables 3 and 4). It was remarkable that the irregularity in seed distribution allowed greater broadleaf weed infestation, which were controlled with the application of the herbicide 2,4-D, causing a decrease in the plant cover.

Figures 3, 4 and 5 illustrate the sowing methods by comparing the influence of the application and non-application of 2,4-D. It is possible to observe that only in the broadcast seeding there is a significant weed infestation when the herbicide is not applied. In the other situations, the fodder plant itself is already enough to manage weeds.

According to Lima (2013), the low signalgrass stand may provide lower soil cover, requiring a longer period for total cover, and, consequently, there is a higher weed infestation. This statement

Table 3 - Unfolding of the significant interaction of total covering on day 120 DAS, as for sowing methods of *Brachiaria ruziziensis* (*Urochloa ruziziensis*) and application of the herbicide 2,4-D

Sowing (S)	Total covering (%)	
	With 2,4-D	Without 2,4-D
Broadcast	59.50 B a	58.50 B a
Incorporated	57.75 B b	91.75 Aa
Line	95.50 A a	98.75 A a
LSD (5%)		
S within H	19.59	
H within S	16.06	

Averages on the same line followed by the same lowercase letters and, in the same column, followed by the same capital letters do not differ by Tukey's test (p<0.05).

Table 4 - Unfolding of the significant interaction of total covering on day180 DAS as for sowing methods of *Brachiaria ruziziensis* (*Urochloa ruziziensis*) and application of the herbicide 2,4-D

Sowing (S)	Total covering (%)	
	With 2,4-D	Without 2,4-D
Broadcast	74.87 B a	66.50 B a
Incorporated	72.62 B b	95.50 A a
Line	95.50 A a	99.25 A a
LSD (5%)		
S within H	14.16	
H within S	11.61	

Averages on the same line followed by the same lowercase letters and, in the same column, followed by the same capital letters do not differ by Tukey's test (p<0.05).

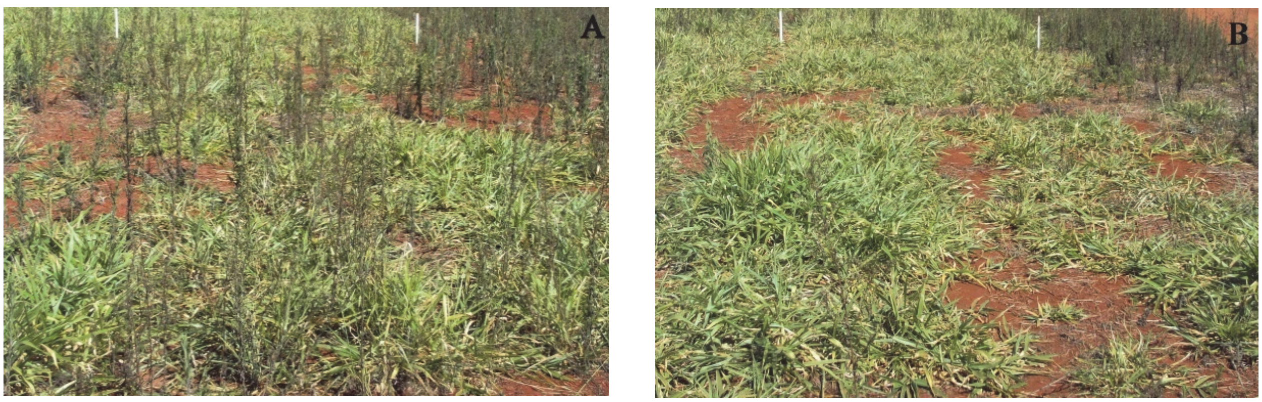

Figure 3 - Broadcast seeding without the application (A) and with the application (B) of 2,4-D herbicide on day 120 DAS.

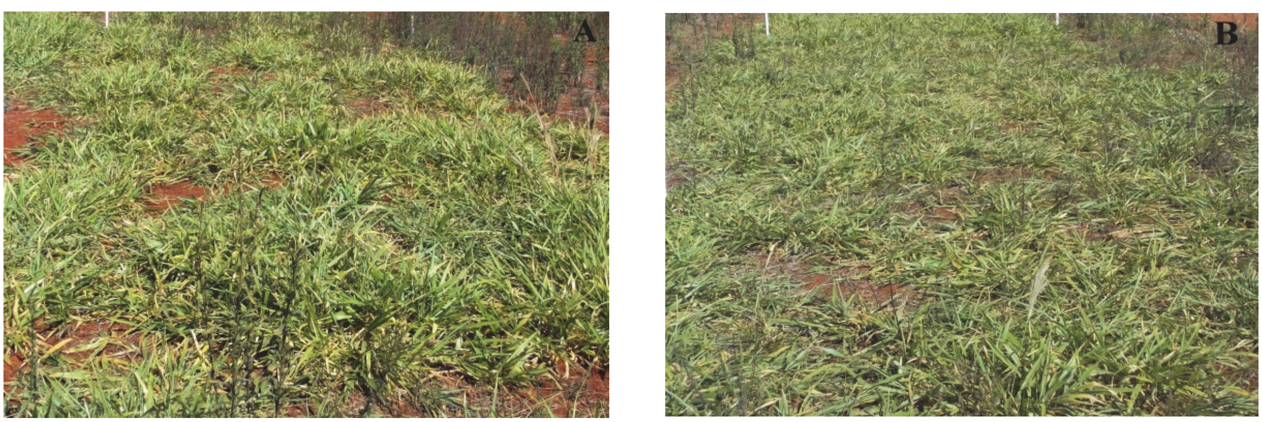

Figure 4 - Incorporated broadcast seeding with no application (A) and application (B) of 2,4-D herbicide on day 120 DAS.

supports what happened with the adoption of the broadcast seeding in this research. According to Ceccon et al. (2011), great weed populations provide greater competition among themselves (intraspecies competition) and with the cultivated plant (interspecies competition), making the tillering of *U. ruziziensis* smaller, which results in a lower accumulation of plant mass.

At the end of the evaluations (180 DAS), the only weed species still competing with signalgrass was the horseweed (*Conyza canadensis*). Table 5 presents the results related to the population survey of this weed species. It is possible to observe that there is a significant interaction between the researched factors, making further explanation necessary.

From the results presented in the unfolding of the interaction between factors about horseweed density (Table 6), it was possible to observe that only broadcast seeding would need the application of the herbicide 2,4-D. In the other situations, signalgrass itself would be enough to suppress the perpetuation of horseweed. In the fallow area, parallel to the experimental area, horseweed presented populations of 116 plants in 12 m^2 on an average, demonstrating high infestation by this species in the area. This proves that the cultivation of signalgrass, even under conditions of low water availability, is still viable to be adopted in an integrated weed management.

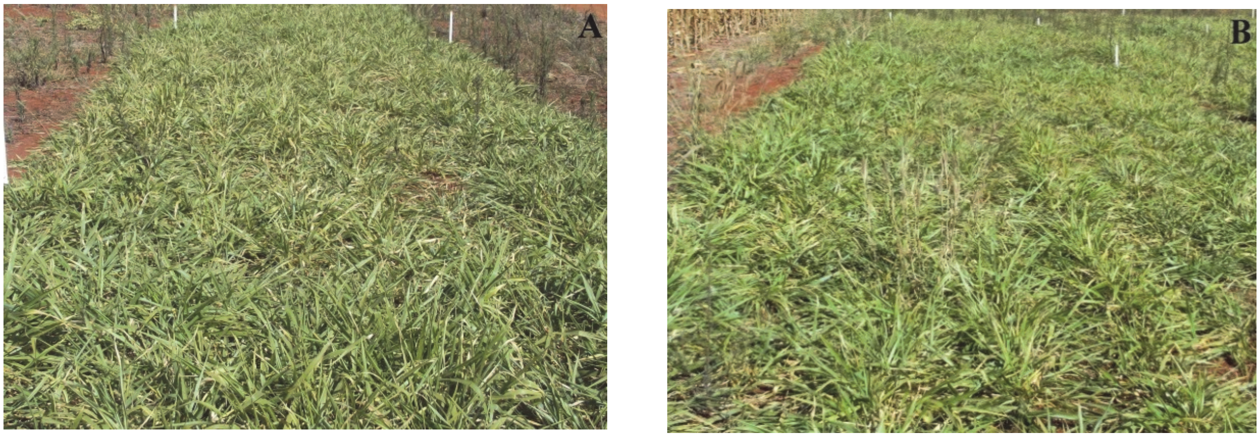

Figura 5 - Line sowing without the application (A) and with the application (B) of 2,4-D herbicide on day 120 DAS.

Table 5 **-** F values and variation coefficients (VC%), applied to the means of horseweed density (*Conyza canadensis*), determined on day 180 after sowing (DAS) signalgrass in 12 m^2

	Variable	Horseweed density 180 DAS
F	Sowing (S)	5.66 *
	Herbicides (H)	12.34 **
	S x H	6.18 **
VC (%)		21.87

* Means followed by the same letter, in the same column, do not differ by Tukey's test ** 1%, * 5% probability.

Table 6 **-** Unfolding of the significant interaction of horseweed density on day 180 DAS

Sowing (S)	Plants in 12 m^2	
	With (H)	Without (H)
Broadcast	4.75 A b	23.00 A a
Incorporated	4.00 A a	7.25 B a
Line	6.25 A a	7.50 B a
LSD (5%)		
S within H	9.54	
H within S	7.85	

Averages on the same line followed by the same lowercase letters and, in the same column, followed by the same capital letters do not differ by Tukey's test at 5% probability.

It is possible to conclude that the line sowing and broadcast with seed incorporation methods are more efficient in suppressing weed than the broadcast seeding method. It is also possible to conclude that when there is a good distribution in the plant cover, it is not necessary to apply the herbicide 2,4-D in order to suppress the weed community.

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