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Article

Management of Resistant *Conyza* spp. During Soybean Pre-sowing

*Manejo de **Conyza** spp. Resistente em Pré-Semeadura da Soja*

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ABSTRACT- Horseweed (*Conyza* spp.) is a weed with a considerable presence and frequency throughout Brazilian crops, as well as presenting difficult chemical control. The objective of this study was to evaluate the efficiency of herbicide management, through single and sequential applications, in controlling *Conyza* spp., at two development stages with 4 to 6 leaves (3 to 5 cm) and 20 leaves (15-20 cm). The analyzed variables were: control percentage (7, 14, 21, and 28 days after application), dry matter content (28 days after application) and regrowth percentage (21 days after application). Data were submitted to analysis of variance at 5% probability and when there was a difference, the means were submitted to the Scott-Knott test. For *Conyza* spp. plants with a height between 3 and 5 cm and 4 to 6 leaves, the best treatments were T4, T8, T9, T10, T11, T12, T13, and T14, presenting a control percentage above 90%, 7 days after application. For *Conyza*spp. plants with a plant development of 15 cm in height and 15 to 20 leaves, the highest control percentages and lowest regrowth percentages were with treatments T9, T13, and T14.

Keywords: early management, regrowth, sequential, saflufenacil, 2,4-D.

*RESUMO - A buva (**Conyza** spp.) é uma planta daninha com considerável presença e frequência nas lavouras brasileiras, além de apresentar dificuldade no seu controle químico. O presente trabalho objetivou avaliar a eficiência do manejo de herbicidas, em aplicações únicas e sequenciais, no controle de **Conyza** spp., em dois estádios de desenvolvimento: de 4 a 6 folhas (3 a 5 cm) e 20 folhas (15-20 cm). As variáveis analisadas foram porcentagem de controle (7, 14, 21 e 28 dias após a aplicação), massa da matéria seca (28 dias após a aplicação) e porcentagem de rebrote (21 dias após a aplicação). Os dados foram submetidos à análise de variância a 5% de probabilidade e, quando constatada a diferença, as médias foram submetidas ao teste de Scott-Knott. Para **Conyza** spp. com altura de 3 a 5 cm de altura e de 4 a 6 folhas, os melhores tratamentos foram T4, T8, T9, T10, T11, T12, T13 e T14, apresentando uma porcentagem de controle acima dos 90% aos sete dias após aplicação. Para as **Conyza** spp. com desenvolvimento vegetativo de 15 cm de altura e de 15 a folhas, as maiores porcentagens de controle e menores porcentagens de rebrote foram para os tratamentos T9, T13 e T14.*

Palavras-chave: manejo antecipado, rebrote, sequencial, saflufenacil, 2,4-D.

INTRODUCTION

Horseweed (*Conyza* spp.) is an invasive plant belonging to the Asteraceae family, frequently found over the crops of the South, Southeast and Midwest

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regions. It is an annual dicotyledonous plant that reproduces by seeds that germinate in autumn and winter (Owen et al., 2009), closing its cycle in summer and thus characterizing itself as a winter and summer weed (Vargas et al. 2007). Horseweed produces large numbers of seeds, ranging from 150 to 200 thousand per plant, which have characteristics and structures that allow an easy dispersion (Kissmann and Groth, 1992).

In Brazil, three species are predominant: *Conyza bonariensis*, *Conyza Canadensis* and *Conyza sumatrensis*. The similarities between these species, the possibility of hybridization occurring between different species, and the morphological variability of plants have hindered the possibility of a correct identification and a clear distinction among these three species (Santos et al., 2013).

For being a frequent species in Brazilian crops, resistance to herbicides is one of its characteristics. *Conyza bonariensis* shows resistance to glyphosate and chlorimuron-ethyl (Santos et al., 2014), both of which are reported in western Paraná state areas (Vargas et al., 2007).

The gradual increase of horseweed infestation in soybean-cultivated areas in southern Brazil made it one of the main weeds of this crop (Lamego et al., 2013). Thus, horseweed has caused serious damages to soybean crops – around 35% – when no management is carried out during soybean pre-seeding (Lamego et al., 2013). According to Bruce and Kells (1990), *Conyza canadensis*, at a density of 150 plants m^{-2}, reduced 83% of the soybean yield in a no-tillage system. Therefore, it is extremely important to carry out a proper management to control this weed, avoiding possible damages to soybean crops; the desiccation management during the pre-sowing of the crop is one of the tools that must be used. Based on this assumption, choosing the herbicides to be used in weed management before sowing the crop for straw formation is very important in the no-tillage system, with an emphasis on desiccants with no residual effect (Carvalho et al., 2002).

Soybean productivity is compromised by this weed, and its control is crucial to the development of the crop. In addition to glyphosate resistance and to the loss in post-emergence control efficiency for soybean with RR technology, an option would be herbicide management in controlling this weed during the pre-sowing of soybean, which would guarantee an ideal growth and initial development for these plants. The objective of this work was to evaluate the efficiency of herbicide management, in single and sequential applications, at two stages of *Conyza* spp. plant development.

MATERIAL AND METHODS

To evaluate the efficiency of the herbicides in controling *Conyza* spp., four experiments were conducted on the field, in which treatments simulated different management possibilities, under different environments of agricultural production and development phenology of the target species. In all experimental areas, plant and phytosociological development stage surveys were carried out, in order to obtain the density of *Conyza* spp. in each area. For the phytosociological survey, the square inventory methodology of 0.50 x 0.50 m (0.25 m^2) was used, and then density was extrapolated to m^2.

Experiment 1

The first experiment was conducted on the field in 2013, in the city Marechal Cândido Rondon - Paraná (24°42’13.4" S and 54°07’53.8" W), in a soil classified as very clayey eutrophic Red Latosol (Embrapa, 2006). In this area, the plant development stage of *Conyza* spp. was from 4 to 6 leaves, and the average height from 3 to 5 cm, with a density of 55.2 plants per m^2. Treatments from this experiment are shown in Table 1.

Experiment 2

A second field experiment was conducted in 2013, in the city of Palotina - Paraná (24°21’21.0” S e 53°53’33.1” W), located at about 50 km from the first city. The soil of the experiment site is classified as a very clayey eutrophic Red Latosol (Embrapa, 2006). In this area, *Conyza* spp. was at a plant development stage with 15 to 20 leaves and an average height from 15 to 20 cm, with a density of 54.92 plants m^2. Treatments (Table 1) were the same as those applied in experiment 1.

Table 1 **-** Treatments and doses of active ingredients used as treatments to control *Conyza* spp. for experiments 1 and 2 in 2013

Treatment	Dose (g ha^{-1})$^{(4)}$
T1 - Control treatment	0
T2 - Glyphosate$^{(1)}$ *	1035
T3 - Glyphosate$^{(1)}$ + 2,4-D*	1035 + 703.5
T4 - Glyphosate$^{(1)}$ + Saflufenacil**	1035 + 60
T5 - Glyphosate$^{(1)}$ + Chlorimuron - ethyl*	1035 + 20
T6 - Glyphosate$^{(1)}$ + Cloransulam-methyl*	1035 + 60
T7 - Glyphosate$^{(1)}$ + Cloransulam-methyl + Chlorimuron-ethyl *	1035 + 60 + 20
T8 - Glyphosate$^{(1)}$ + 2,4-D* + / Diuron + Paraquat*	1035 + 703.5 + 103 + 206
T9 - Glyphosate$^{(1)}$ + 2,4-D* + / Saflufenacil**	1035 + 703.5 + 60
T10 - Glyphosate$^{(2)}$ + 2,4-D* + / Diuron + Paraquat*	1035 + 703.5 + 103 + 206
T11 - Glyphosate$^{(3)}$ + Saflufenacil**	2520 + 60
T12 - Saflufenacil **	60

$^{(1)}$ (isopropylanine salt), $^{(2)}$ (potassium salt), $^{(3)}$ (ammonium salt), $^{(4)}$ (glyphosate in g a.e. ha^{-1} and other herbicides in g a.i. ha^{-1}). * 0.5% fulltec was used. ** Dash was used at the dose of 500 (mL ha^{-1}). / = sequential after 7 days.

Experiment 3

A third field experiment was conducted in the municipality of Palotina - Paraná (24^{o}13'39.7" S and 53^{o}52'12.4" W) in 2014, where the soil is classified as a very clayey eutrophic Red Latosol (Embrapa, 2006). In this area, *Conyza* spp. was at a plant development stage from 15 to 20 leaves and a mean height from 15 to 20 cm, with a density of 20.4 horseweed plants per m^2. Treatments are shown in Table 2.

Table 2 **-** Treatments and doses of the active ingredients used to control *Conyza* spp. in both areas, in experiments 3 and 4, in 2014

Treatment	Doses a.i. (g ha^{-1})
T1 - Control treatment	0
T2 - Glyphosate$^{(1)}$ *	1035
T3 - Glyphosate$^{(1)}$ + 2,4-D*	1035 + 703,5
T4 - Glyphosate$^{(1)}$ + Saflufenacil**	1035 + 60 + 500
T5 - Glyphosate$^{(1)}$ + Chlorimuron - ethyl*	1035 + 20
T6 - Glyphosate$^{(1)}$ + Cloransulam-methyl*	1035 + 60
T7 - Glyphosate$^{(1)}$ + Cloransulam-methyl + Chlorimuron-ethyl *	1035 + 60 + 20
T8 - Glyphosate$^{(1)}$ + 2,4-D* + / Diuron + Paraquat*	1035 + 703.5 + 103 + 206
T9 - Glyphosate$^{(1)}$ + 2,4-D* + / Saflufenacil**	1035 + 703.5 + 60
T10 - Glyphosate$^{(2)}$ + 2,4-D* + / Diuron + Paraquat*	1035 + 703,5 + 103 + 206
T11 - Glyphosate$^{(3)}$ + Saflufenacil**	2520 + 60
T12 - Saflufenacil **	60
T13 -2,4-D* + / Glyphosate$^{(1)}$ + Saflufenacil** // Paraquat*	703.5 + 1035 + 60 + 400
T14-2,4-D + Glyphosate$^{(1)}$+ Saflufenacil** / Glyphosate$^{(1)}$ + Saflufenacil**	703.5 + 1035 + 60+ 1035 + 60.

$^{(1)}$ (isopropylanine salt), $^{(2)}$ (potassium salt), $^{(3)}$ (ammonium salt), $^{(4)}$ (glyphosate in g a.e. ha^{-1} and other herbicides in g a.i. ha^{-1}). * 0.5% fulltec was used. ** Dash was used at the dose of 500 (mL ha^{-1}). / = sequential after 14 days.

Experiment 4

The fourth experiment was conducted in 2014, in the city of Terra Roxa - Paraná (24^{o}13'17.7" S and 53^{o}58'54.4" W), presenting a soil classified as a very clayey eutrophic Red Latosol (Embrapa, 2006). *Conyza* spp. was at a plant development stage from 4 to 6 leaves and with an average height from 3 to 5 cm, with a density of 87.2 horseweed plants per m^2. The treatments (Table 2) were the same as those applied in experiment 3.

For experiments 1, 2 and 3, the analyzed variables were the control percentage and the dry matter of horseweed plants per m² 28 days after application (DAA). Control percentage was evaluated with an injury grade, on a scale from 0 to 100, with 0 as no control and 100 as complete death (Table 3), according to the SBCPD scale concepts (1995). In experiment 4, only the control percentage of the treatments was evaluated.

Table 3 - Description of the concept values used for the visual control evaluations applied in the scale to SBCPD (Sociedade Brasileira da Ciência das Plantas Daninhas)

% Control or damage	Concept description
100 to 90 %	Excellent control. No effect on the culture.
89 to 80 %	Good control, acceptable for the infestation of the areas.
79 to 40 %	Moderate control, not enough for the infestation of the area.
39 to 10 %	Deficient or inexpressive control.
< 10 %	Control absence.

In addition to these variables, the regrowth percentage was evaluated at 21 DAA in experiment 3. The evaluation of the regrowth percentage was carried out using a square inventory of 1 m², which was randomly casted in all plots, totaling four replications per treatment. The number of *Conyza* spp. plants found in the inventory square was counted and, among them, it was possible to verify how many had sprouts and how many were completely dead.

In all applications, a CO_2 pressurized backpack sprayer with a constant pressure of 2 bar (or 29 PSI) was used, at a flow rate of 0.65 L min.$^{-1}$, equipped with six fan-type tips from the Teejet series, type XR 110 02, at a height of 50 cm from the target and at a speed of 1 m second^{-1}, providing a spray volume of 200 L ha^{-1}. The applications of the treatments were made under the climatic conditions described in Tables 4 and 5.

Table 4 - Meteorological conditions during the application of experiments 1 and 2 in 2013

Climate data	Experiment 1		Experiment 2	
Application	Single application	Sequential application	Single application	Sequential application
Wind (m s^{-1})		1.5	1.0	0.0
Temperature (ºC)	25.5	27.0	26.2	28.7
Relative air humidity (%)	51.8	61.2	61.5	62.9

Table 5 - Meteorological conditions during the application of experiments 3 and 4 in 2014

Climate data	Experiment 3		Experiment 4	
Application	Single application	Sequential application	Single application	Sequential application
Wind (m s^{-1})	1.4	1.2	0.7	1.0
Temperature (ºC)	24.0	26.3	27	28
Relative air humidity (%)	60.5	59.7	64.5	60.3

The experimental design was in randomized blocks with four replications, in six meter long and three meter wide plots, in all the experiments, totaling a useful area of 10 m², where 0.50 m were subtracted from each side of the plot.

Data were analyzed according to Pimentel-Gomes and Garcia (2002). The analysis of variance was performed and, when significant, means were compared by the Scott-Knott test ($p<0.05$). All parameters were analyzed using the statistical package Sisvar (Ferreira, 2011).

RESULTS AND DISCUSSION

Experiment 1

In the first experiment, the best treatments in terms of control percentage were T4, T11, and T12, differing statistically from the control treatment and from the other used treatments, with lower dry matter at 28 DAA (Tables 6 and 7). Saflufenacil showed better horseweed control, and this is due to the fact that it has a rapid desiccation action, just as the other protoporphyrinogen oxidase (Protox) inhibitors, due to its weak acid character; it also shows a certain translocation, limited to the phloem, but very evident by the xylem. These characteristics of saflufenacil have provided satisfactory results for weed control (Grossmann et al., 2011).

Table 6 - Evaluation of the control percentage (%) of *Conyza* spp. at 7, 14, 21, and 28 DAA, at the 4 to 6 leaf stage (3 to 5 cm), in experiment 1, Marechal Cândido Rondon - Paraná state, 2013

Treatment	7 DAA	14 DAA	21 DAA	28 DAA
T1	0.00 G	0.00 F	0.00 G	0.00 F
T2	15.00 F	47.50 E	57.50 F	60.00 E
T3	66.25 C	88.75 B	90.00 C	92.50 B
T4	100.00 A	100.00 A	100.00 A	100.00 A
T5	22.50 E	66.25 C	73.75 E	77.50 D
T6	12.50 F	58.75 D	83.75 D	88.75 C
T7	36.25 D	85.00 B	92.50 B	100.00 A
T8	93.75 B	100.00 A	100.00 A	100.00 A
T9	93.75 B	100.00 A	100.00 A	100.00 A
T10	95.00 B	100.00 A	100.00 A	100.00 A
T11	100.00 A	100.00 A	100.00 A	100.00 A
T12	100.00 A	100.00 A	100.00 A	100.00 A
Mean	61.25	78.85	83.12	84.89
VC%	5.71	5.10	1.84	1.63

Means followed by equal capital letters do not present significant differences at 5% probability by the Scott-Knott mean test.

At 14 and 21 DAA, the best treatments in terms of control percentage were T4, T8, T9, T10, T11, and T12 (Table 6). According to Constantin et al. (2013), another observed point is that even in areas such as those in western Paraná, where the resistance of *Conyza* spp. is already confirmed, the association of products with glyphosate in the management of *Conyza* spp. has been adopted because horseweed does not occur in isolation and because of the broad control spectrum of this herbicide. Another important point of the association of glyphosate with other products is that, when associated, it was possible to observe a considerable improvement in the performance of certain herbicides, thus providing better weed control compared to the isolated application of these herbicides (Constantin and Oliveira Júnior, 2005).

At 28 DAA (Table 6), it was possible to observe that eight treatments reached satisfactory control (above 90%); when

Table 7 - Dry matter evaluation (g) of *Conyza* spp. at 28 DAA, at the 4 to 6 leaf stage (3 to 5 cm), in experiment 1, Marechal Cândido Rondon - Paraná state, 2013

Treatment	Dry Matter (g)
T1	36.45 G
T2	20.51 E
T3	18.21 D
T4	6.05 A
T5	25.85 F
T6	14.80 C
T7	12.32 C
T8	10.03 B
T9	12.62 C
T10	9.46 B
T11	5.35 A
T12	8.32 B
Mean	14.99
VC%	14.89

Means followed by equal capital letters do not present significant differences at 5% probability by the Scott-Knott mean test.

horseweed is at a stage from 3 to 5 cm, it is possible to use a wide range of treatments that present control efficiency, which facilitates management and hinders the selection of resistance, providing the herbicide rotation management in the system.

Experiment 2

In the second experiment, at 7 DAA, the treatment that obtained the best result in terms of control percentage was T11, differing significantly from the control treatment and from the other treatments, which was highlighted when dry matter was also analyzed (Tables 8 and 9). The control presented by the association of these two herbicides may be the result of the recommended adjuvant for the application of saflufenacil. Ashigh and Hall (2010) observed that the use of mineral oil as an adjuvant for this herbicide, when associated with glyphosate, resulted in an increase by 6% in the absorption of the acid equivalent of this herbicide in *C. canadensis* plants. On the other hand, the use of this adjuvant may decrease glyphosate translocation within the plant, but increased glyphosate absorption highlights the synergism of this association (Eubank et al., 2013).

Table 8 **-** Evaluation of the control percentage (%) of *Conyza* spp. at the 15 to 20 leaf stage (15 to 20 cm), in experiment 2, Palotina - Paraná state, 2013

Treatment	7 DAA	14 DAA	21 DAA	28 DAA
T1	0.00 J	0.00 G	0.00 F	0.00 H
T2	25.00 H	25.00 F	40.00 D	50.00 G
T3	67.50 F	67.50 D	82.25 C	90.00 C
T4	87.50 C	88.75 C	91.25 B	95.00 B
T5	20.00 I	25.00 F	32.50 E	57.50 E
T6	30.00 G	30.00 E	42.50 D	55.00 F
T7	30.00 G	30.00 E	42.50 D	65.00 D
T8	85.00 E	93.75 B	100.00 A	100.00 A
T9	90.00 B	100.00 A	100.00 A	100.00 A
T10	86.25 C	91.25 C	100.00 A	100.00 A
T11	95.00 A	100.00 A	100.00 A	100.00 A
T12	85.00 D	90.00 C	90.00 B	90.00 C
Mean	58.43	61.77	68.43	75.20
VC%	2.20	3.05	3.03	1.11

Means followed by equal capital letters do not present significant differences at 5% probability by the Scott-Knott mean test.

At 14 DAA, two treatments were superior as for the control percentage of *Conyza* spp.: T9 and T11, differing statistically from the control treatment and from the other treatments (Table 8). At 21 and 28 DAA, four treatments presented greater efficiency in their control percentage: T8, T9, T10, T11 (Table 8); these treatments were significantly superior in relation to the control treatment and to the other treatments. The use of diuron + paraquat in sequential applications (T8 and T10) behaved in an expected manner in the management of RR soybean weeds; Petter et al. (2007) observed the control efficiency of *Alternanthera tenella*, *Chamaesyce hirta*, *Euphorbia heterophylla* and *Spermacoce latifolia* with applications of glyphosate + 2,4-D (14 days before sowing) with sequential diuron + paraquat at the time of RR soybean sowing, without compromising its productivity. The sequential management of herbicide application acts as the main tool to reduce weed resistance to glyphosate, especially those belonging to the genus *Conyza* spp. As Petter et al. (2007) highlight, the use of glyphosate at more advanced stages of weeds in the RR soybean crop caused a "forgetfulness" of the coexistence periods of the crop with weeds; over time, the resistance to this herbicide prevailed, forcing farmers to opt for sequential applications in order to control weeds during soybean pre-sowing.

In the case of the first and second experiments, the difference in horseweed height influenced its control. For experiment 1, where the size was between 3 and 5 cm, eight treatments showed

Table 9 **-** Dry matter evaluation (g) of *Conyza* spp. after 28 DAA, at the 15 to 20 leaf stage (10 to 20 cm) in experiment 2, Palotina - Paraná state, 2013

Treatment	Dry Matter (g)
T1	79.50 G
T2	47.75 D
T3	43.00 D
T4	19.00 A
T5	58.25 C
T6	36.25 C
T7	31.25 C
T8	26.75 B
T9	31.75 C
T10	25.75 B
T11	17.362 A
T12	23.305 B
Mean	36.66
VC%	12.77

Means followed by equal capital letters do not present significant differences at 5% probability by the Scott-Knott mean test.

In relation to the regrowth percentage and dry matter of *Conyza* spp. (Table 11), it was possible to observe that saflufenacil has good control, both in these experiments and in similar results observed by Mellendorf et al. (2013). However, when horseweed is at a development stage above 15 cm, it is possible to observe that treatments using saflufenacil alone or associated with glyphosate in a single application (T4 and T12) allow efficient control; however, in some cases, with high regrowth rates, they cause problems with leaks to the following crop, and this was also highlighted in other treatments. When saflufenacil was used sequentially in association with other herbicides, such as 2,4-D, glyphosate, and paraquat, the regrowth evaluation was zero, being statistically superior to the other treatments. According to Oliveira Neto et al. (2010), horseweed control around 80% allows the regrowth and new growth of plants, causing damages to the following crops.

control efficiency, but when the same treatments were observed in experiment 2, where the size was between 15 and 20 cm, only four treatments presented control efficiency. This influence of the horseweed height was also evidenced by Constantin et al. (2013), for whom the importance of the size of plants at the time of the application has played a fundamental role in the efficiency of herbicides, thus determining which should be used in order to obtain efficient control.

Experiment 3

In the third experiment, as for the control percentage at 7 DAA, the treatments that were statistically superior were: T4, T9, T11, and T13 (Table 10). At 14 DAA, also treatments T14 and T12 were statistically superior. At 21 DAA, also treatment T8 achieved control efficiency, along with treatments that already stood out at 14 DAA (Table 10).

Table 10 **-** Evaluation of the control percentage (%) of *Conyza* spp. at the 15 to 20 leaf stage (15 to 20 cm), in experiment 3, Palotina - Paraná state, 2013

Treatment	7 DAA	14 DAA	21 DAA
T1	0.00 E	0.00 G	0.00 G
T2	6.25 D	41.00 D	42.25 F
T3	39.25 C	63.50 C	65.50 D
T4	96.25 A	100.00 A	100.00 A
T5	6.25 D	33.75 F	49.50 E
T6	6.75 D	37.25 E	49.00 E
T7	7.00 D	40.75 D	62.00 D
T8	91.75 B	94.00 B	98.75 A
T9	96.75 A	96.75 A	96.75 B
T10	88.75 B	92.50 B	93.00 C
T11	98.25 A	100.00 A	100.00 A
T12	94.25 B	98.75 A	100.00 A
T13	99.00 A	99.25 A	100.00 A
T14	92.50 B	99.50 A	100.00 A
Mean	58.83	71.21	75.48
VC%	4.79	3.11	3.30

Means followed by equal capital letters do not present significant differences at 5% probability by the Scott-Knott mean test.

Experiment 4

In the fourth experiment, at 7 DAA, the treatments presenting significant differences and efficient control (above 90%) were: T4, T9, T10, T11, T12, T13, and T14 (Table 12). At 21 DAA, treatments that previously achieved greater control remained the same over time (Table 12). In line with the other experiments, experiment 4 showed that the size of *Conyza* spp. influenced the selection of the herbicide set used in the desiccation management, having a greater number of treatments with an excellent action when horseweed stage was reduced.

Table 11 **-** Evaluation of dry matter (g) and regrowth percentage (%) of *Conyza* spp. at 21 DAA at the 15 to 20 leaf stage (15 to 20 cm), in experiment 3, Palotina - Paraná state, 2014

Treatment	Dry matter (g)	Regrowth (%)
T1	41.34 E*	100.00 D
T2	33.42 E	100.00 D
T3	22.57 D	100.00 D
T4	3.45 A	55.83 C
T5	19.20 D	97.50 D
T6	8.68 B	93.69 D
T7	9.69 B	100.0 D
T8	3.82 A	90.75 D
T9	4.01 A	0.00 A
T10	14.91 C	65.37 C
T11	6.32 A	65.90 C
T12	4.81 A	42.83 B
T13	4.62 A	0.00 A
T14	4.01 A	0.00 A
Mean	12.90	65.13
VC%	14.36	12.63

Means followed by equal capital letters do not present significant differences at 5% probability by the Scott-Knott mean test.

Table 12 **-** Evaluation of the control percentage (%) of *Conyza* spp. at the 4 to 6 leaf stage (3 to 5 cm), in experiment 4, Terra Roxa - Paraná state, 2014

Treatment	7 DAA	14 DAA	21 DAA
T1	0.00 D	0.00 D	0.00 E
T2	5.75 D	45.59 C	56.25 D
T3	48.50 C	62.25 B	63.25 D
T4	96.00 A	99.75 A	99.75 A
T5	5.50 D	58.00 C	55.25 E
T6	3.75 D	49.25 C	74.25 C
T7	4.50 D	66.75 B	75.50 C
T8	87.00 B	90.75 A	91.25 B
T9	99.00 A	99.25 A	100.00 A
T10	91.25 B	96.00 A	98.50 A
T11	96.75 A	97.75 A	99.25 A
T12	91.00 B	95.50 A	98.75 A
T13	99.75 A	99.75 A	99.75 A
T14	96.50 A	100.00 A	100.00 A
Mean	58.94	75.75	79.41
VC%	6.85	11.45	3.30

Means followed by equal capital letters do not present significant differences at 5% probability by the Scott-Knott mean test.

The results of the experiments indicate that saflufenacil has great potential in controlling *Conyza* spp., but when the plant is at a development stage above 15 cm and the herbicide is used alone or in association in a single application, the possibility of regrowth is high. Dalazen et al. (2015) observed that the isolated application of saflufenacil resulted in sprouts of *Conyza bonariensis* and this emphasizes that the association of glyphosate + saflufenacil, as well as controlling horseweed, can stop post-application regrowth. However, when saflufenacil is used in a sequential management, the regrowth potential is reduced. This effect shows that the management and selection of herbicides in a sequential form depend on the stage of the target weed.

The best results obtained as for the control and regrowth of *Conyza* spp. were glyphosate + 2,4-D treatments with a sequential application of saflufenacil 7 days after (T9); 2,4-D with a sequential application of glyphosate + saflufenacil 7 days after, and paraquat 14 days after the application of 2,4-D (T13); and 2,4-D with a sequential application of glyphosate + saflufenacil 7 days after, and glyphosate + saflufenacil 14 days after the application of 2,4-D (T14). Thus, it was possible to understand that herbicide and management options are greater when horseweed is at an initial development stage.

Therefore, it is highly important for the success of a satisfactory control to accomplish an early pre-sowing desiccation management, which takes into account the horseweed stage when choosing the sequential treatment. To control *Conyza* spp. plants between 3 and 5 cm in height and 4 to 6 leaves, the most efficient treatments were: T4, T7, T8, T9, T10, T11, T12, T13, and T14. In case of plants at a more advanced development stage, with 15 cm and about 15 to 20 leaves, the best treatments, resulting in the death of plants (100% control) and not presenting regrowth (0% regrowth), were T9, T13, and T14.

REFERENCES

Ashigh JJ, Hall C. Bases for interactions between saflufenacil and glyphosate in plants. J Agric Food Chem. 2010;58:7335-43.

Bruce JA, Kells JJ. Horseweed (*Conyza canadensis*) control in no-tillage soybeans (*Glycine max*) with preplant and pre emergence herbicides. Weed Technol. 1990;3:642-7.

Carvalho FT, Pereira FAR, Peruchi M, Palazzo RRB. Manejo químico das plantas daninhas *Euphorbia heterophylla* e *Bidens pilosa* em sistema de plantio direto de soja. Planta Daninha. 2002;20(1):145-50.

Constantin J, Oliveira Jr. RS, Oliveira Neto AM. editores. Buva: fundamentos e recomendações para manejo. In: Constantin J, Oliveira Jr RS, Oliveira Neto AM, Blainski É, Guerra N. Manejo da buva na entressafra. Curitiba: OmniPax; 2013. p.41-63.

Constantin J, Oliveira Júnior RS. Dessecação antecedendo a semeadura direta pode afetar a produtividade. Potafós: Inf Agron. 2005;109:14-5.

Dalazen G, Kruse ND, Machado SLO, Balbinot A. Sinergismo na combinação de glifosato e saflufenacil para o controle de buva. Pesq Agropec Trop. 2015;45:249-56.

Empresa Brasileira de Pesquisa Agropecuária – Embrapa. Centro Nacional de Pesquisa de Solos. Sistema Brasileiro de Classificação de Solos. 2ª.ed. Rio de Janeiro: Embrapa Solos; 2006.

Eubank TW, Nandula VK, Reddy KN, Poston DH, Shaw DR. Saflufenacil efficacy on horseweed and its interaction with glyphosate. Weed Biol Manag. 2013;13:135-43.

Ferreira DF. SISVAR: a computer statistical analysis system. Cienc Agrotecnol. 2011;35:1039-42.

Grossmann K, Hutzler J, Caspar G, Kwiatkowski J, Brommer CL. Saflufenacil (Kixor™): biokinetic properties and mechanism of selectivity of a new protoporphyrinogen IX oxidase inhibiting herbicide. Weed Sci. 2011;59:290-8.

Kissmann KG, Groth D. Plantas infestantes e nocivas. São Paulo: Basf Brasileira; 1992.

Lamego FP, Kaspary TE, Ruchel Q, Gallon M, Basso CJ, Santi AL Manejo de *Conyza bonariensis* resistente ao Glyphosate: Coberturas de inverno e herbicidas em pré-semeadura da soja. Planta Daninha. 2013;31(2):433-22.

Mellendorf TG, Young JM, Matthews JL, Young BG. Influence of plant height and glyphosate on saflufenacil efficacy on glyphosate-resistant horseweed (*Conyza Canadensis*). Weed Technol. 2013;27:463-7.

Oliveira Neto AM, Constantin J, Oliveira Jr RS, Guerra N, Dan HÁ, Alonso DG, Blainski E, Santos G. Estratégias de manejo de inverno e verão visando ao controle de *Conyza bonariensis* e *Bidens pilosa*. Planta Daninha. 2010;28(Spec):1107-16.

Owen LN, Steckel LE, Koger CH, Main CL, Mueller TC. Evaluation of spring and fall burndown application timings on control of glyphosate-resistant horseweed (*Conyza canadensis*) in no-till cotton. Weed Technol. 2009;23:335-9.

Petter FA, Steckel LE, Koger CH, Main CL. Manejo de herbicidas na cultura da soja Roundup Ready®. Planta Daninha. 2007;25(3):557-66.

Pimentel-Gomes F, Garcia CH. Estatística aplicada a experimentos agronômicos e florestais: exposição com exemplos e orientações para uso de aplicativos. Piracicaba: FEALQ; 2002.

Santos G, Oliveira Jr RS, Constantin J, Francischini AC, Osipe JB. Multiple resistance of *Conyza sumatrensis* to Chlorimuron-Ethyl and Glyphosate. Planta Daninha. 2014;32:409-16.

Santos G, Francischini AC, Gemelli ÉBA, Machado MFPS. Aspectos sobre a biologia e a germinação da buva. In: Constantin J, Oliveira Jr RS, Oliveira Neto AM. Buva: fundamentos e recomendações para manejo. Curitiba: Omnipax; 2013. p.12.

Sociedade Brasileira da Ciência das Plantas Daninhas – SBCPD Procedimentos para instalação, avaliação e análise de experimento com herbicidas. Londrina: 1995.

Vargas L, Bianchi MA, Rizzardi MA, Agostinetto D, Dal Magro T. Buva (*Conyza bonariensis*) resistente ao glyphosate na região sul do Brasil. Planta Daninha. 2007;25(3):573-8.