

ALTERNATIVES FOR CHEMICAL MANAGEMENT OF SOURGRASS

CONTROLE QUÍMICO DE CAPIM-AMARGOSO

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ABSTRACT: Intensive use of Glyphosate has been selected multiple resistant sourgrass biotypes in the areas of intensive agriculture in Brazil. Thus, it is important that viable management alternatives are evaluated for this invasion, which currently is regarded as the main problem of Brazilian agriculture. The study aimed to evaluate strategies for chemical management of sourgrass. Three trials divided according to the weed development stages were performed: Post-Initial (up to tillering), Post-Delayed (one to four tillers) and Adult-Plant (adult stage characterized by the beginning of the reproductive phase). The sourgrass seeds were collected from biotypes with evidence of Glyphosate tolerance in the municipality of Rio Brillhante – MS. In each trial were evaluated thirteen treatments and one witness, where the treatments were herbicide mixtures applications with subsequent sequential applications at different dates (7, 10 and 14 days after the first application) and the herbicides application without mixtures. Sourgrass plants are tolerant to Glyphosate and Clethodim herbicides. Formulated mixtures of Paraquat + Diuron and Haloxifop are the most suitable for controlling sourgrass plants derived from seeds, regardless of the control period. Treatments that have the Haloxifop herbicide in the first application provided better control when compared to the other treatments with mixtures and sequential applications at all stages of applications.

KEYWORDS: *Digitaria insularis*. Herbicides. Action mechanisms.

INTRODUCTION

Herbicides whose mechanism of action is inhibition of phenol-piruvilshiquimato phosphate synthase (EPSPs) began to be used in Brazilian agriculture in the late 1970s, but its use began to grow only from the end of the 1980s and early 1990s with the increased use of no-till system, where prevails the maintenance of the previous crop straw in soybean, maize and wheat cropping systems (KRUSE et al., 2000). Another factor contributing to the growth of glyphosate use in Brazil was the approval of the Biosafety Law in 2005 that allowed the legalized use of genetically modified crops resistant to the herbicide (KOGER; REDDY, 2005).

Glyphosate herbicide is a product of diversified use compared to other herbicides, because it has low toxicity to animals and environment, broad-spectrum control and low cost. These factors have boosted inappropriate weed management in the farmed environment for decades, where it has selected tolerant biotypes of different weed species (ZANUNCIO et al., 2013; TEODORO et al., 2015). Thus, the study of several management alternatives for such species is important (MONQUERO et al., 2001; GALLI; MONTEZUMA, 2005).

Among all species of weeds with tolerance in Brazil, sourgrass (*Digitaria insularis* (L.) Fedde)

is the principal due to its aggressiveness, with a wide geographical distribution and occurring in the most favorable environments for agriculture (MONDO et al., 2010). It is a perennial, which form clumps with rhizomes, produces high amount of easily dispersing seeds, has a rapid early vegetative development and is highly competitive with other plants (LORENZI, 2014).

The first confirmed case about sourgrass biotypes resistant to glyphosate, was in Paraguay in 2006 and in this same year was also confirmed in Brazil (HEAP, 2011).

According to Gomes Junior and Christoffoleti (2008) the new challenge for agriculture is the management of weeds resistant to herbicides. The main limitations of integrated weed management programs is a lack of knowledge, as the correct phenological stage for application, mixtures of herbicides with synergistic effects and dates for sequential applications, which are considered essential for the development of viable management systems under the agronomic, environmental and economic points of view. The use of tank mixtures with herbicides of different action mechanisms, sequential applications and applications in early stages of development has been carried out consistently in several crops such as soybean, maize and cotton aimed at increasing weed control efficiency (CARVALHO et al., 2002). Melo et al. (2012) studied alternatives to control sourgrass

resistant to glyphosate using post emergent herbicide at different tank mixtures and sequential applications. These authors found that the treatments that have the better results were glyphosate mixed with clethodim complemented by paraquat + diuron 7 days after the first application of glyphosate in combination with clethodim supplemented with ammonium glufosinate 7 days after the first application. Still, glyphosate treatments mixed with haloxyfop, glyphosate + fenoxaprop-p-ethyl + clethodim and glyphosate + tepraloxym showed excellent performance, with single application.

Still more information is needed to assess the efficacy of herbicides and / or mixtures in control of sourgrass plants at different stages. Thus, this study aimed to evaluate strategies for chemical management of sourgrass.

MATERIAL AND METHODS

The study was carried out in a greenhouse at the Phytosanity Laboratory of the Universidade Estadual de Mato Grosso do Sul – Unit of Aquidauana, State of Mato Grosso do Sul - MS (20°27'S and 55°40'W).

Three trials divided according to the weed development stages were performed: Post-Initial (until the beginning of tillering), Post-Delayed (one to four tillers) and Adult Plant (adult stage characterized by the beginning of the reproductive phase) (LORENZI, 2014). Sourgrass seeds were collected from biotypes with evidence of tolerance to glyphosate in agriculture area with a history of soybean/maize for more than ten years in the municipality of Rio Brilhante - MS (21°45'S e 54°52'W), on October 10, 2014.

Trials in a completely randomized design, with six replications were conducted. In each trial were evaluated thirteen treatments and a witness, where the treatments consisted of herbicide mixtures application with posterior sequential applications at different dates (7, 10 and 14 days after the first application) and by herbicides unmixed application (Table 1). The herbicides used were Verdict® (Haloxyfop) at 60 g a.i./ha, Select® (Clethodim) at 108 g a.i./ha, Roundup® Original (Glyphosate) at 1,440 g a.i./ha and Gramocil® (Paraquat + Diuron) at 300 + 150 g a.i./ha. We used Nimbus® mineral oil at 0.5% v/v in all applications in association with herbicides and mixtures.

Table 1. Description of the treatments.

1° Application	2° Application	Sequential (DAFA)
Glyphosate + Clethodim	Haloxyfop	7
Haloxyfop + Glyphosate	Clethodim	7
Haloxyfop + Clethodim	Glyphosate	7
Glyphosate + Clethodim	Haloxyfop	10
Haloxyfop + Glyphosate	Clethodim	10
Haloxyfop + Clethodim	Glyphosate	10
Glyphosate + Clethodim	Haloxyfop	14
Haloxyfop + Glyphosate	Clethodim	14
Haloxyfop + Clethodim	Glyphosate	14
Paraquat + Diuron	-	-
Haloxyfop	-	-
Clethodim	-	-
Glyphosate	-	-
Sem aplicação	-	-

DAFA: Days after the first application.

Sowing was performed into 5 liter pots, using subsurface soil, classified as dystrophic Ultisol sandy texture, with the following features: pH (H₂O) = 4,8; Al trocável (cmol_c dm⁻³) = 0,4; Ca+Mg (cmol_c dm⁻³) = 0,97; P (mg dm⁻³) = 1,8; K (cmol_c dm⁻³) = 0,05; H+Al (cmol_c dm⁻³) = 5,7; Organic matter (g dm⁻³) = 0,8; V (%) = 15,1. Soil correction was not performed.

Pots were irrigated and identified until reaching the field capacity, and subsequently, the

seeds were deposited on the substrate and covered by a thin layer of the same substrate. In the post-initial trial, four plants per pot were maintained, and in post-delayed and adult plant trials two plants per pot were maintained, thus each pot was the experimental unit.

Applications were performed using a costal spray pressurized for CO₂, equipped with six-pointed bar, type jet range (XR 11002), spaced 0.50 m, adjusted to spray volume of 150 L ha⁻¹.

Application of all treatments was conducted under environmental conditions recommended for spraying, according to the treatments. The first applications were made at 25 days after sowing in Post-Initial, 37 days after sowing in Post-Delayed and 60 days after sowing in the Adult Plant stage. Sequential applications were performed from the counting days depending on these dates.

Assessments of control by herbicides were performed at 7, 14, 21, 28 and 35 days after the first herbicides application (DAFA). For this, we used the visual percentage scale ranging from 0 to 100%, wherein zero corresponds to no symptoms and 100 to the total control of sourgrass using the rating scale (Table 2) proposed by Asociación Latinoamericana de Malezas (ALAM, 1974).

Table 2. Rating scale proposed by ALAM (1974) for evaluating the percentage of control of sourgrass (*Digitaria insularis*).

Percentage	Degree of control
0 – 40	Absent or poor
41 – 60	Regular
61 – 70	Sufficient
71 – 80	Good
81 – 90	Very Good
91 - 100	Excellent

ALAM: Asociación Latinoamericana de Malezas.

For being data in percentage, they were transformed into \sqrt{x} . Subsequently, they were subjected to analysis of variance, followed by Scott and Knott test for clustering of averages, both at 5% probability using the Sisvar 5.3 statistical program (FERREIRA, 2011).

RESULTS AND RESULTS

Treatments influenced ($p \leq 0.05$) in post-initial sourgrass control at 7, 14, 21, 28 and 35 DAFA (Table 3). Machado et al. (2006) and Gemelli et al. (2012) reported that beginning of the sourgrass plants development is the period of highest sensitivity, because the plants have a lower lignin content in the tissue, facilitating the control in the early stages, which was observed in this study when compared to more advanced development stages of the plants.

Table 3. F-values of ANOVA for the control variables of sourgrass in Post-Initial at 7, 14, 21, 28 and 35 days after the first herbicides application (DAFA).

Sources of variation	DF	DAFA7	DAFA14	DAFA21	DAFA28	DAFA35
Treatmentes	13	65.24*	53.03*	45.02*	43.75*	43.17*
CV (%)	---	20.77	9.74	8.96	7.94	7.86

* significant at 5% probability by F test; CV: coefficient of variation.

At 7 DAFA in Post-Initial, still without the effect of sequential applications, a formulated mixture of Paraquat + Diuron and Haloxifop, in addition to variations in treatments Haloxifop + Glyphosate which would be complemented with Clethodim at 7 and 14 DAFA and Haloxifop + Clethodim which would be complemented with Glyphosate at 7, 10 and 14 DAFA provided sourgrass plants control superior to 80% (Table 4) and were classified as very good or excellent, according to the rating scale (ALAM, 1974).

At 7 DAFA, Haloxifop herbicide provided control classified as very good. According to

Gemelli et al. (2012), ACCase inhibiting herbicides, effectively control sourgrass plants in the early developing stages, producing the characteristic symptom of necrosis of the growth areas due to blockage of lipid synthesis.

In the assessments at 14, 21, 28 and 35 days after the first application all combinations of treatments, Haloxifop herbicides and the formulated mixture paraquat + diuron provided 100% control of sourgrass plants being classified as excellent, according to the rating scale (ALAM, 1974).

Table 4. Sourgrass control in Post-Initial at 7, 14, 21, 28 and 35 days after the first herbicides application (DAFA).

Treatment	DAFA7	DAFA14	DAFA21	DAFA28	DAFA35
Glyp + Clet → Halo (7) ²	40.0 c	100.0 a	100.0 a	100.0 a	100.0 a
Halo + Glyp → Clet (7) ²	82.5 a	100.0 a	100.0 a	100.0 a	100.0 a
Halo + Clet → Glyp (7) ²	97.8 a	100.0 a	100.0 a	100.0 a	100.0 a
Glyp + Clet → Halo (10) ²	22.2 c	100.0 a	100.0 a	100.0 a	100.0 a
Halo + Glyp → Clet (10) ²	73,2 b	100.0 a	100.0 a	100.0 a	100.0 a
Halo + Clet → Glyp (10) ²	97,7 a	100.0 a	100.0 a	100.0 a	100.0 a
Glyp + Clet → Halo (14) ²	52,5 b	100.0 a	100.0 a	100.0 a	100.0 a
Halo + Glyp → Clet (14) ²	88,3 a	100.0 a	100.0 a	100.0 a	100.0 a
Halo + Clet → Glyp (14) ²	95,2 a	100.0 a	100.0 a	100.0 a	100.0 a
(Paqt + Diur) ¹	99,5 a	100.0 a	100.0 a	100.0 a	100.0 a
Halo	89,2 a	100.0 a	100.0 a	100.0 a	100.0 a
Clet	33,3 c	62.2 b	74.2 b	79.2 b	80.0 b
Glyp	5,0 e	21.0 c	48.3 c	56.7 c	63.3 c
Witness	0,0 e	0.0 d	0.0 d	0.0 d	0.0 d

Means followed by the same lower case belong to the same group according to the Scott and Knott test at 5% probability. glyp = glyphosate; clet = clethodim; halo = haloxyfop; paqt = paraquat; diur = diuron; ¹ formulated mixture of products; ² days for sequential application.

Clethodim and Glyphosate herbicides, applied in isolation, generated the smaller controls of the trial, achieving good control only after 35 DAFA, which is a confirmation that the plants used in this study were tolerant to these herbicides. Regarding the Clethodim, this result differs those results reported by Adegas et al. (2010), who obtained excellent control of sourgrass plants derived from seeds and up to three tillers, using this herbicide for its control in Londrina, State of Paraná. For glyphosate, the results found in this study corroborates the results obtained by Melo et al. (2012), which found that sourgrass plants used in their work were tolerant to this herbicide after evaluating different herbicides for management of this weed in maize and found only 65% of control at 28 days after application.

Regarding the Gramocil® herbicide, Oliveira Júnior et al. (2011), reported that the herbicides that have their action mode by inhibition of photosystem I (Paraquat), can drastically to decrease the leaf area of this plant, causing a rapid control in the early stages. This occurs because its application leads to hydrogen peroxide formation in cellular content and subsequently occurs the degradation of cytoplasmic membrane and leakage of cellular contents, causing cell death and accelerating the plant death (MAGALHÃES et al., 2001).

For controlling sourgrass plants at 14, 21, 28 and 35 DAFA, except Clethodim and Glyphosate herbicides, all treatments were efficient (Table 4). These results indicate that formulated mixture of Paraquat + Diuron herbicides and the Haloxyfop isolated were the most suitable, since they require only one application, thus reducing control costs.

Weed control at Post-Initial stage is higher when compared to Post-Delayed and Adult Plant controls, because during the Post-Initial stage, there is better absorption and translocation of herbicides due to lower lignification of plant tissues (OLIVEIRA JÚNIOR et al, 2011). However, the control of this species at the tillering is extremely difficult, as from this stage there is an exponential increase in dry matter and lignification of plant tissues, hindering their control when compared to control in early development stages.

Treatments conducted influenced the control in Post-Delayed ($p \leq 0.05$) at 7, 14, 21, 28 and 35 DAFA (Table 5).

Only the formulated mixture Paraquat + Diuron provided 100% control of sourgrass plants at 7 DAFA in Post-Delayed stage, differing from the other treatments and is considered excellent according to the rating scale (ALAM, 1974) (Tabela 6).

Table 5. F-values of ANOVA for the variable control of sourgrass plants in Post-Delayed at 7, 14, 21, 28 and 35 days after the first herbicides application (DAFA).

Sources of variation	DF	DAFA7	DAFA14	DAFA21	DAFA28	DAFA35
Treatmentes	13	53.99*	44.47*	47.88*	46.78*	46.41*
CV (%)	---	14.37	7.94	6.48	5.48	5.08

* significant at 5% probability by F test; CV: coefficient of variation.

Table 6. Control sourgrass plants in Post-Delayed, at 7, 14, 21, 28 and 35 days after the first herbicides application (DAFA).

Treatment	DAFA7	DAFA14	DAFA21	DAFA28	DAFA35
Glyp + Clet → Halo (7) ²	13.7 c	67.2 b	77.5 b	82.3 b	91.3 a
Halo + Glyp → Clet (7) ²	55.8 b	90.5 a	97.7 a	100.0 a	100.0 a
Halo + Clet → Glyp (7) ²	68.3 b	78.3 b	99.3 a	100.0 a	100.0 a
Glyp + Clet → Halo (10) ²	16.0 c	40.8 d	54.2 c	68.0 c	81.0 b
Halo + Glyp → Clet (10) ²	53.0 b	68.3 b	80.8 b	94.8 a	98.3 a
Halo + Clet → Glyp (10) ²	65.8 b	75.0 b	96.5 a	99.2 a	100.0 a
Glyp + Clet → Halo (14) ²	11.3 c	37.5 d	49.2 c	61.7 c	74.2 b
Halo + Glyp → Clet (14) ²	63.5 b	73.0 b	85.0 b	93.2 a	98.0 a
Halo + Clet → Glyp (14) ²	73.0 b	86.7 a	92.3 a	98.5 a	100.0 a
(Paqt + Diur) ¹	100.0 a	100.0 a	100.0 a	100.0 a	100.0 a
Halo	65.8 b	79.7 b	91.2 a	100.0 a	100.0 a
Clet	10.8 c	33.3 d	52.5 c	65.8 c	80.8 b
Glyp	8.3 d	15.0 e	17.8 d	26.3 d	30.8 c
Witness	0.0 e	0.0 f	0.0 e	0.0 e	0.0 d

Means followed by the same lower case belong to the same group according to the Scott and Knott test at 5% probability. glyp = glyphosate; clet = clethodim; halo = haloxyfop; paqt = paraquat; diur = diuron; ¹ formulated mixture of products; ² days for sequential application.

At 7 DAFA, yet without the effect of sequential applications, Glyphosate and Clethodim in isolated form obtained the worst results, which can be classified as absent or poor according to the rating scale (ALAM, 1974).

At 14 DAFA, variations of the treatments Haloxyfop + Glyphosate complemented by an application of Clethodim to 7 days after the first application and Haloxyfop + Clethodim that would be complemented with an application of glyphosate at 14 days after the first application also provided excellent control of sourgrass (ALAM, 1974), além do herbicida Paraquat + Diuron.

At 21 DAFA, the formulated mixture Paraquat + Diuron, Haloxyfop herbicide, the combinations Haloxyfop + Clethodim complemented by an application of glyphosate at 7, 10 and 14 days, and the combination Haloxyfop + Glyphosate complemented with an application of Clethodim at 7 days obtained excellent control according to the rating scale (ALAM, 1974).

At 28 DAFA, Clethodim and Glyphosate and the associations Glyphosate + Clethodim complemented with one application of Haloxyfop at 7, 10 and 14 were the worst controls, not reaching excellent control (ALAM, 1974). At 35 DAFA, we verified that the Glyphosate herbicide obtained just 30.8% of control, being considered as absent or poor, while the other treatments provided controls close to 100%. This difficulty in sourgrass control is related tolerance that they have to this herbicide due to mutations in plants, which cause changes in uptake, translocation and even sites of action (CORREIA et al., 2010).

It is worth mentioning that the Haloxyfop herbicide provided 100% control at 28 and 35 DAFA (Table 6). This reveals that the action of this herbicide in sourgrass plants at Post-Delayed is late, but effective.

Similar results to this study was obtained by Adegas et al. (2010), who verified that the applying Gramoxone® (Paraquat) and Verdict® (Haloxyfop)

in sourgrass plants with up to two tillers is possible to achieve control levels greater than 90%.

However, when dealing with contact herbicides, Gemelli et al. (2012) reported that its application should be avoided during the reproductive stage of weeds, as they are not able to act in lignified tissues and storage organs. Thus,

even if the plants yet have few tillers, it is possible that they already have begun training its rhizomes and, therefore, they already have the ability to issue new tillers using the stored reserves in the rhizomes.

Treatments influenced the sourgrass control at Adult Plant ($p \leq 0.05$) at 7, 14, 21, 28 and 35 DAFA (Table 7).

Table 7. F-values of ANOVA for the variable control of sourgrass plants in Adult Plant stage at 7, 14, 21, 28 and 35 days after the first herbicides application (DAFA).

Sources of variation	GL	DAFA7	DAFA14	DAFA21	DAFA28	DAFA35
Treatments	13	29.78*	33.04*	35.95*	40.10*	41.90*
CV (%)		14.70	10.06	8.33	7.40	6.56

* significant at 5% probability by F test; CV: coefficient of variation.

According to Gemelli et al. (2012), control of adult weeds is only possible with the use of herbicides with different action mechanisms and use strategies (translocation until the rhizomes and destruction of leaf area). Therefore, in many cases, the management of this weed will not be

successfully performed only with a single herbicide application, as it is a perennial species, able to establish itself throughout the year, and management actions should be carried out the entire year in an integrated manner.

Table 8. Control of sourgrass in Adult Plant stage 7, 14, 21, 28 and 35 days after the first herbicide application (DAFA).

Treatment	DAFA7	DAFA14	DAFA21	DAFA28	DAFA35
Glyp + Clet → Halo (7) ²	6.7 d	26.7 d	37.5 e	48.3 d	60.0 c
Halo + Glyp → Clet (7) ²	21.7 c	36.8 c	54.2 d	68.3 c	80.8 b
Halo + Clet → Glyp (7) ²	36.7 b	54.2 b	78.3 b	95.2 a	99.7 a
Glyp + Clet → Halo (10) ²	9.2 d	16.7 e	32.5 e	46.7 d	60.0 c
Halo + Glyp → Clet (10) ²	20.0 c	37.5 c	50.8 d	77.2 b	80.0 b
Halo + Clet → Glyp (10) ²	28.3 c	50.0 b	68.3 c	83.0 b	94.3 a
Glyp + Clet → Halo (14) ²	7.5 d	18.3 e	48.3 d	65.0 c	77.5 b
Halo + Glyp → Clet (14) ²	27.2 c	45.0 c	63.3 c	77.5 b	88.8 a
Halo + Clet → Glyp (14) ²	20.0 c	38.3 c	59.2 c	76.7 b	91.7 a
(Paqt + Diur) ¹	85.8 a	96.0 a	99.7 a	100.0 a	100.0 a
Halo	39.2 b	60.8 b	77.5 b	91.3 a	95.5 a
Clet	10.0 d	21.7 d	35.0 e	50.0 d	69.2 b
Glyp	6.3 d	11.3 f	19.2 f	25.5 e	30.8 d
Testemunha	0.0 e	0.0 g	0.0 g	0.0 f	0.0 e

Means followed by the same lower case belong to the same group according to the Scott and Knott test at 5% probability. glyp = glyphosate; clet = clethodim; halo = haloxyfop; paqt = paraquat; diur = diuron; ¹ formulated mixture of products; ² days for sequential application.

At 7, 14 and 21 DAFA, just the Gramocil® (Paraquat + Diuron) herbicide presented satisfactory control (85.8%) and is considered very good in the evaluation at 7 days and excellent at 14 and 21 days (ALAM, 1974) (Tabela 8).

At 28 DAFA, in addition to the formulated mixture Paraquat + Diuron, the herbicide Haloxyfop and the association Haloxyfop + Clethodim

complemented by one application of Glyphosate at 7 days after the first application also showed excellent control.

At 35 DAFA, besides Haloxyfop and Paraquat + Diuron, the combinations Haloxyfop + Clethodim complemented by one application of Glyphosate at 7, 10 and 14 days and Haloxyfop + Glyphosate complemented by one application of

Clethodim at 14 days provided satisfactory controls ranging from very good to excellent. At all development stages of sourgrass plants, treatments with tank mixtures and sequential applications that had the herbicide Haloxifop in the first application provided better control when compared to the other treatments with mixtures and sequential applications.

For all evaluation dates, Glyphosate herbicide showed unsatisfactory control, getting just 30.8% of control at 35 DAFA, being considered as absent or poor (ALAM, 1974). Sourgrass tolerance to Glyphosate and Clethodim were proven at every application stages, as it has not been observed the death of any evaluated plant even in the early development stage.

Like the other application stages of the different treatments, for Adult Plant the formulated mixture Paraquat + Diuron herbicides provided the greatest control percentages (Table 8), regardless of the evaluation period. Procópio et al. (2006) observed control levels at just 50% in adult plants of sourgrass with the use of this herbicide and reported a high incidence of regrowth.

The formulated mixture Paraquat + Diuron provides excellent control of sourgrass in Adult Plant stage, but in this study controlled plants were derived from seeds, i.e., weeds without prolonged cycle. According to Oliveira Júnior et al. (2011), the control provided by the action of Paraquat occurs only in weeds without prolonged cycle, since it only has contact action on non-lignified tissues (desiccation).

CONCLUSIONS

Sourgrass plants are tolerant to Glyphosate and Clethodim herbicides, due to low control levels provided in all weeds development stages.

Formulated mixtures of Paraquat + Diuron and Haloxifop are the most suitable for controlling sourgrass plants derived from seeds, regardless of the control period.

Treatments that have the Haloxifop herbicide in the first application provided better control when compared to the other treatments with mixtures and sequential applications at all stages of applications.

RESUMO: O uso intensivo do herbicida glyphosate tem selecionado vários biótipos resistentes de capim-amargoso nas áreas de agricultura intensiva no Brasil. Dessa forma, é importante que sejam estudadas alternativas viáveis de manejo para esta invasora, que hoje é considerada como um dos principais problemas da agricultura brasileira. O trabalho teve como objetivo a avaliação de estratégias para o manejo químico de capim-amargoso. Foram realizados três experimentos divididos em função dos estágios de desenvolvimento da planta daninha: Pós-inicial (até o perfilhamento), Pós-tardio (um a quatro perfilhos) e Planta Adulta de capim-amargoso (estágio adulto, caracterizado pelo início da fase reprodutiva). As sementes de Capim-amargoso foram coletadas de biótipos com indícios de tolerância ao herbicida Glyphosate no município de Rio Brillhante – MS. Em cada experimento foram avaliados treze tratamentos e uma testemunha, onde os tratamentos foram constituídos por aplicações de misturas de herbicidas com posteriores aplicações sequenciais com diferentes datas de aplicações da sequencial (7, 10 e 14 dias após a primeira aplicação) e pela aplicação de herbicidas sem misturas. As plantas de Capim-amargoso apresentam tolerância aos herbicidas Glyphosate e Clethodim. A mistura formulada dos herbicidas Paraquat + Diuron e o herbicida Haloxifop foram os melhores para o controle de plantas de capim-amargoso provenientes de sementes, independente da época de controle. Os tratamentos que possuem o herbicida Haloxifop na primeira aplicação proporcionaram melhores controles quando comparados aos demais tratamentos com misturas e aplicações sequenciais em todos os estágios de aplicações.

PALAVRAS-CHAVE: *Digitaria insularis*. Herbicidas. Mecanismos de ação. Resistência a herbicidas.

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