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Post-emergent herbicides for weed management in soybean cultivation in Sobradinho Farm (Uberlândia-MG)

Post-emergent herbicides for weed management in soybean cultivation at Sobradinho Farm (Uberlândia-MG)

Post-emergent herbicides for the management of heavy bags in soybean cultivation on the Farm Sobradinho (Uberlândia-MG)

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Abstract: Soybean *(Glycine max* (L.) Merrill) is of great economic importance to Brazilian agribusiness; however, weed interference is one of the main limiting factors to crop productivity. In this context, chemical management with post-emergent herbicides becomes an important tool for reducing competition for water, light, nutrients, and space. Thus, this study aimed to evaluate the efficiency of post-emergent herbicides in weed management in soybean cultivation at the Sobradinho Farm, IFTM Campus Uberlândia, in Uberlândia-MG. The experiment was conducted in a randomized block design, with six treatments and four replications. The treatments consisted of: control; glyphosate; fluazifop + fomesafen; chlorimuron + haloxyfop; glyphosate + (fluazifop + fomesafen) + chlorimuron; and glyphosate + haloxyfop. The phytosociological survey of the weed community, the percentage of weed control, phytotoxicity to the soybean crop, 100-grain weight, and grain yield were evaluated. The predominant species in the experimental area were *Alternanthera tenella, Urochloa decumbens ,* and *Commelina benghalensis.* Treatments containing glyphosate, alone or in combination, showed high weed control rates, exceeding 96% 10 days after application. Treatments with fluazifop + fomesafen showed initial symptoms of phytotoxicity, but without permanent damage to the crop. Soybean yield was significantly influenced by herbicide treatments, with the highest values observed in the treatment composed of glyphosate + (fluazifop + fomesafen) + chlorimuron.

It is concluded that post-emergence chemical management was efficient in controlling weeds in the experimental area, reducing interference from the weed community and contributing to maintaining the productive potential of the soybean crop.
Keywords: *Glycine max;* chemical management; herbicides; weeds; productivity.

Abstract: Soybean *(Glycine max* (L.) Merrill) is highly important for Brazilian agribusiness; however, weed interference is one of the main limiting factors for crop productivity. In this context, chemical management with post-emergence herbicides is an important tool for reducing competition for water, light, nutrients, and space. Therefore, this study aimed to evaluate the efficiency of post-emergence herbicides in weed management in soybean cultivation at Fazenda Sobradinho, IFTM Campus Uberlândia, Uberlândia-MG, Brazil. The experiment was conducted in a randomized block design with six treatments and four replications. The treatments consisted of: control without herbicide application; glyphosate; fluazifop + medosafen; chlorimuron + haloxyfop; glyphosate + (fluazifop + medosafen) + chlorimuron; and glyphosate + haloxyfop. The evaluated variables were the phytosociological survey of the weed community, weed control percentage, phytotoxicity to soybean plants,

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weight of 100 grains, and grain yield. The predominant weed species in the experimental area were *Alternanthera tenella, Urochloa decumbens,* and *Commelina benghalensis.* Treatments containing glyphosate alone or in combination with other herbicides achieved high weed control efficiency, exceeding 96% at 10 days after application. Treatments containing fluazifop + medosafen caused initial phytotoxicity symptoms, although without permanent damage to soybean plants. Soybean yield was significantly influenced by herbicide treatments, with the highest values observed in the treatment composed of glyphosate + (fluazifop + medosafen) + chlorimuron. It was concluded that post-emergence chemical management was effective in controlling weeds in the experimental area, reducing weed interference, and helping maintain
soybean yield potential.
Keywords: *Glycine max;* chemical management; herbicides; weeds; yield.

1. INTRODUCTION

Soybeans *(Glycine max* (L.) Merrill) are a crop of great economic importance in
In Brazil and worldwide, however, weed interference is one of the main problems.
Challenges to achieving high yields. These plants compete with soybeans for
Essential resources, such as water, nutrients, light, and space, can be reduced, which can result in shortages.
significant in productivity. In addition, some weed species act as
hosts of pests and pathogens, which increases the incidence of diseases in the crop (Silva *et al.*
al., 2009).

Competition between soybeans and weeds is influenced by several factors.
including the type of photosynthetic metabolism of the species involved. While soybeans have
C3 metabolism, many weeds exhibit C4 metabolism, which gives them
greater efficiency in the use of light and water under conditions of high irradiance and temperature. This
Metabolic differences can result in a competitive disadvantage for soybeans in the absence of control.
appropriate weed control (Christofoletti *et* al., 2019).

Weed management in soybean cultivation has traditionally been based on...
Use of herbicides. However, the improper or repeated application of herbicides with the same...
The mechanism of action has led to the emergence of resistant weed populations.
as is the case with horseweed *(Conyza spp.)* and sourgrass *(Digitaria insularis)* (Heap, 2021).
These resistant species make chemical control difficult and can compromise the
Sustainability of production systems.

Given this scenario, integrated weed management (IWM) emerges as a
An effective approach to controlling these species. MIPD combines different methods of
control, including cultural, mechanical, biological and chemical practices, aimed at reducing
Keep weed populations to levels that do not cause significant economic damage.

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(López-Ovejero; Christofolleti, 2014). Among the cultural practices, the rotation of stands out.
crops, the use of competitive cultivars, and the maintenance of soil cover, which help
in the suppression of weeds and promote a more favorable environment for development.
of soybeans (Pacheco *et* al., 2016).

Chemical control, when used in an integrated and rational way, remains a
An important tool in weed management. The proper selection of herbicides,
considering the spectrum of control and the mechanism of action, as well as the application at the time.
In a timely manner, they are fundamental for the effectiveness of control and for the prevention of resistance.
(Oliveira *et* al., 2019). Studies have shown that the application of herbicides in pre-
Emergency applications, followed by post-emergence applications, can provide satisfactory control.
of various species of weeds, contributing to the maintenance of productivity of
soybean (Martins *et* al., 2021).

Considering the importance of proper weed management for the
To address the sustainability of soybean production, the objective of this study was to determine the best...
Post-emergent herbicides for weed management in soybean cultivation on the farm.
Sobradinho, in Uberlândia-MG.

2. MATERIALS AND METHODS

The experiment was developed in the soybean production area of the Sobradinho Farm.
IFTM Campus Uberlândia, in Uberlândia-MG, located at coordinates 18º46'34" latitude
south and 48º17'37" west longitude. The altitude of the location is 703 meters and the climate classification is
Aw, according to Köppen-Geiger (Peel; Finlayson; McMahon, 2007). The soil at the site is classified
such as eutrophic Red Latosol.

The experimental design used was a randomized block design with 6 treatments.
and 4 repetitions. The treatments consisted of: 1: control; 2: glyphosate; 3: fluazifop +
hungersafen; 4: chlorimuron + haloxyfop; 5: glyphosate + (fluazifop + medosafen) + chlorimuron; 6:
Glyphosate + haloxyfop. Specifications of the amount of active ingredient applied per
The hectares are listed in Table 1.

Table 1. Specifications of the herbicides used in the experiment.

Active ingredient (g.ha-1)	**Commercial product**	**PC dose haÿ¹**
Glyphosate (1731)	Roundup Original Plus®	3 L

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Fluazifop + Fomesafen (250 + 250)	Fusiflex®	2 L
Chlorimuron + haloxyfop (20 + 62.1)	Classic® + Verdict Max®	80g + 115ml
Glyphosate + fluazifop + medosafen + chlorimuron (1731 + 250 + 250 + 20)	Roundup Original Plus® + Fusiflex® + Classic®	3L + 2L + 80g
Glyphosate + haloxyfop (1731 + 62.1)	Roundup Original Plus® + Verdict Max®	3L + 115ml

Source: The authors.

Initially, the area destined for soybean cultivation was desiccated with glyphosate + 2,4-D. Two weeks after desiccation, the soybean cultivar was sown. CZ37B39I2X, adding 14 seeds per linear meter and 240 kg haÿ¹ of formulated fertilizer. 08-28-26, with a spacing between furrows of 0.5 m.

The experimental plots consisted of 4 rows of soybeans, each 5 meters long. length. The usable area of the experimental plot was comprised of the two central rows, excluding 0.5 m from the ends of each row. Between the experimental plots And between the blocks, there were 1 m borders.

At the V3 phenological stage, the weeds present were sampled with a A square inventory (1 m x 1 m) was positioned within the usable area of each plot, and the following was recorded. The number of individuals of each weed species that emerged in the area. The parameters Phytosociological characteristics of the weed community were determined as proposed by Mueller-Dombois and Ellenberg (1974).

When the crop reached the V4 phenological stage, all treatments were applied. using a backpack sprayer equipped with a CO2 cylinder and a bar with 4 nozzles. Fan-type spraying. The equipment was adjusted to spray a volume of 200 L haÿ¹. of a spray solution with an application speed equivalent to 5 km hÿ¹.

While the plant was still at the V4 phenological stage, topdressing fertilization with chloride was carried out. potassium.

Phytotoxicity analysis was performed 10 and 20 days after herbicide application. in soybean plants using the rating scale proposed by the EWRC (1964), as follows:

1 = absence of phytotoxicity symptoms.

2 = minor changes (discoloration and deformation) visible in some plants

3 = small visible changes in many plants (chlorosis and curling).

4 = severe discoloration or reasonable deformation, without necrosis.

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5 = necrosis of some leaves, accompanied by deformation in leaves and shoots.

6 = reduction in plant size, leaf curling and necrosis.

7 = more than 80% of the leaves destroyed.

8 = extremely severe damage, leaving only small green areas on the plants.

9 = death of the plants.

Disease management was carried out with the application of Unizeb Gold fungicides (3 kg). pc/ha or 2250 g of mancozeb/ha) and Priori Top (300 mL pc/ha or 60 g of azoxystrobin/ha + 37.5 g of difenoconazole/ha), applied from the R3 phenological stage, with the first The first application was done with Unizeb Gold and the second with Priori Top.

After reaching physiological maturity, the soybean plants in the usable area were counted, uprooted, and packed into sacks for grain harvesting. The grains The mass of the samples obtained was measured to estimate grain productivity per hectare.

A sample of 100 grains from each plot was evaluated in the laboratory. Regarding wet and dry mass, the oven method at 105 °C for 24 h was used. Determining grain moisture content. The mass of 100 grains and grain yield per The hectares were corrected to 13% moisture.

The collected data were analyzed in SISVAR (Ferreira, 2011) using the *F* -test. From the Analysis of Variance, at a 5% probability level; the treatments were compared to each other by Tukey's test, also at a 5% probability level.

3. RESULTS AND DISCUSSION

The weed community present in soybean cultivation, at the phenological stage. V4 was analyzed using the phytosociological survey presented in Table 2. The three species with the highest frequency, density, and abundance values (absolute or relative) were: *Alternanthera tenella, Urochloa decumbens* and *Commelina benghalensis.*

Table 2. Number of individuals present (NQ), number of individuals (NI), frequency (F), density (D), abundance (A), relative frequency (Fr), relative density (Dr), relative abundance (Ar) and importance value index (IVI) of weed species at the V4 phenological stage of the soybean cultivar CZ37B39I2X. Sobradinho Farm, Uberlândia-MG. 2024/2025 crop season.

Species	NI	NQ	F	Dr	D	THE	Fr		Air
Alternanthera tenella	213	7	0.58	17.75	30.43	24.14	56.20		55.35
Urochloa decumbens	118	10	0.83	9.83	11.80	34.48	31.13		21.46
Commelina benghalensis	30	8	0.67	2.50	3.75	27.59	7.92		6.82

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Macroptilium atropurpureum	13	2	0.17	1.08	6.50	6.90	3.43	11.82
Sida glaziovii	5	2	0.17	0.42	2.50	6.90	1.32	4.55
Total	379	12	2.42	31.58	54.98	100.00	100.00	100.00

Source: The authors.

The results of the phytosociological survey demonstrated a predominance of species *Alternanthera tenella, Urochloa decumbens* and *Commelina benghalensis* in the area experimental. The species Alternanthera tenella showed the highest density values. relative (56.20%) and relative abundance (55.35%), indicating a high capacity to The infestation is uniform and distributed across the cultivated area. These results highlight the high... The competitive potential of this species in relation to soybean cultivation, mainly due to competition by water, light and nutrients (Kozlowski; Koehler; Pitelli, 2009).

Although the infesting community was composed mostly of species In broadleaf plants, *Urochloa decumbens* showed a high relative frequency (34.48%) and significant The importance index indicates widespread dissemination in the experimental field. A significant presence of this grass can compromise the initial development of soybeans. due to high aggressiveness and rapid vegetative growth (Vargas; Peixoto; Roman, 2006).

Commelina benghalensis already showed intermediate frequency values and density, however, its presence deserves attention due to this species' known tolerance to certain herbicides, especially glyphosate. The continuous use of herbicides with The same mechanism of action favors the selection of tolerant and resistant species (Takano et al. al., 2019). Thus, the data obtained reinforce the need to adopt strategies. integrated management strategies, with combinations of herbicides with different mechanisms of action, for greater efficiency in control.

The weed community identified in the soybean crop consisted of predominantly by broadleaf species. However, the grass *U. decumbens* showed high importance value (Figure 1).

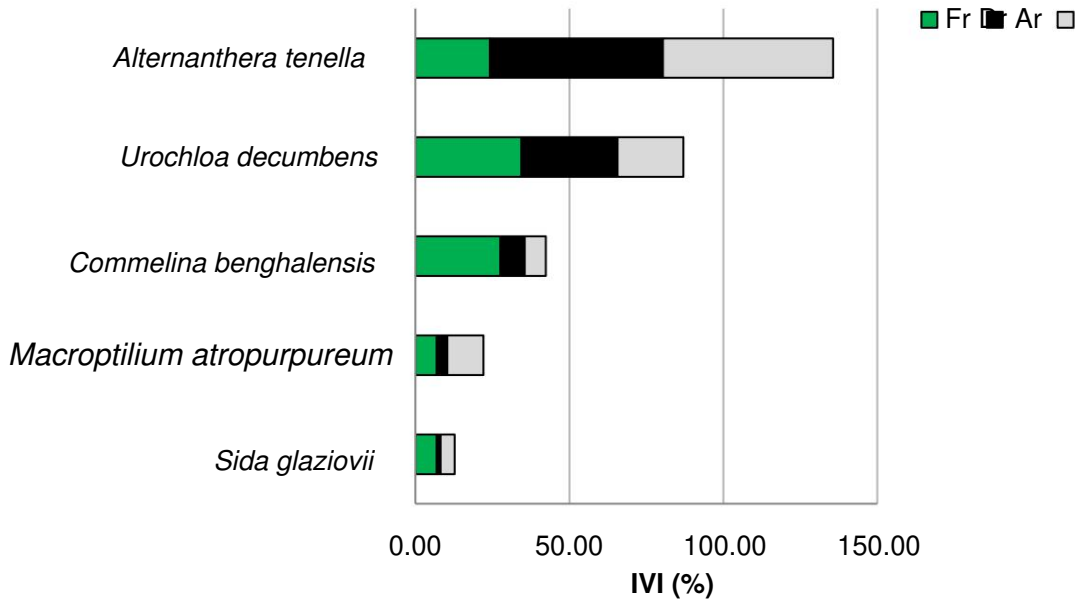
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Figure 1. Phytosociological survey of weeds in soybean cultivation, cultivar CZ37B39I2X, at the V4 phenological stage, at the Sobradinho Farm, IFTM Campus Uberlândia, in Uberlândia, Minas Gerais. 2024/2025 crop season. Fr: relative frequency (%); Dr: relative density (%); Ar: relative abundance (%); IVI: importance value index (%).



Source: The authors.

The phytosociological analysis presented in Figure 1 demonstrates that the community The weed population in the experimental area was predominantly composed of broadleaf species. *Alternanthera tenella* stood out , exhibiting the highest density values. relative abundance and importance value index (IVI). These results indicate high adaptation of the species to the edaphoclimatic conditions of the experimental area and great competitive potential in relation to soybean cultivation, especially due to its high capacity for occupation of space and use of available resources (Kozlowski; Koehler; Pitelli, 2009).

The species *Urochloa decumbens* also showed a high IVI, associated mainly due to the high relative frequency observed. The wide distribution of this grass in The experimental area demonstrates its capacity for establishment and competitive aggressiveness. which can significantly interfere with the initial development of soybeans (Vargas; Peixoto; Roman, 2006).

Commelina benghalensis, on the other hand, showed lower IVI values compared to... predominant species; however, their occurrence deserves attention due to their natural tolerance to certain herbicides, a characteristic that makes chemical handling difficult and favors their permanence in agricultural areas (Takano *et* al., 2019).

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The results shown in Figure 1 reinforce the importance of the survey.
Phytosociological analysis for identifying the predominant species in the cultivated area, allowing for
Adopting more efficient management strategies tailored to the community's reality.
weed present in soybean cultivation.

Herbicide treatments provided high levels of plant control.
Weeds at 10 and 20 days after application (DAA), with the exception of the control and treatment.
composed of chlorimuron + haloxyfop at 10 DAA. Treatments with glyphosate alone,
Fluazifop + fomesafen and glyphosate + haloxyfop showed control greater than 96% in
Initial assessment demonstrating high efficiency in managing the weed community.
present in the area (Table 3).

Table 3. Percentage of weed species controlled in soybean cultivation.
CZ37B39I2X, at the V4 phenological stage. Sobradinho Farm, Uberlândia-MG. 2024/25 crop.

Treatments	Control (%)	
	10 DAA*	20 DAA*
Witness	00.00c	0.00 b
Glyphosate	97.75 to	99.50
Fluazifop + Fomesafen	96.75 to	99.00 a
Clorimuron + Haloxyfop	67.50b	77.00 a
Glyphosate + (Fluazifop + Fomesafen) + Clorimuron	89.50 ab	99.75 a
Glyphosate + Haloxyfop	97.25 a	99 a

* Means followed by different letters in the column differ from each other by Tukey's test at a 5% probability level.
CV10DAA = 13.34%. CV20DAA = 13.34%.
Source: The authors.

The treatment containing chlorimuron + haloxyfop showed lower initial effectiveness.
(67.50%), possibly due to less action on certain predominant species,
mainly the more aggressive broadleaf species observed in the phytosociological survey.
However, at 20 DAA, all herbicide treatments showed effective results.
Statistically similar, indicating an increase in control over time.

The excellent performance of combinations involving glyphosate may be related
due to the broad spectrum of action of the herbicide, combined with the complementary effect of the associated products.
Glyphosate inhibits the EPSPS enzyme, compromising the synthesis of essential amino acids in
plants (Schönbrunn *et* al., 2001). In addition, post-emergence applications carried out in
Appropriate planting times provide high weed control and reduction of
competition with the crop (Gower *et* al., 2003).

The results also demonstrate the importance of the association between different

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mechanisms of action, recommended strategy to increase management efficiency and reduce selection pressure on resistant weeds (Oliveira; Karam; Matrangolo, 2015).

The phytotoxicity symptoms observed at 10 DAA were more intense in treatments containing fluazifop + fomesafen and glyphosate + (fluazifop + fomesafen) + chlorimuron, which presented average scores of 4.00 and 3.25, respectively (Table 4). These symptoms These effects may be primarily related to the action of fomesafen, a herbicide known for to cause chlorosis and temporary necrosis in soybean leaves.

Table 4. Phytotoxicity score for soybean crop, cultivar CZ37B39I2X, as a function of post-emergence herbicide application. Sobradinho Farm, Uberlândia-MG. 2024/25 crop season.

Treatments	Phytotoxicity note	
	10 DAA*	20 DAAns
Witness	1 a	1 a
Glyphosate	1.13 a	1.25 a
Fluazifop + Fomesafen	4.00 b	1.75 a
Clorimuron + Haloxyfop	1.00 a	1.00 a
Glyphosate + (Fluazifop + Fomesafen) + Clorimuron	3.25 b	1.50 a
Glyphosate + Haloxyfop	1.00 a	1.00 a

* Means followed by different letters in the column differ from each other by Tukey's test at a 5% probability level. No significant difference was found by the F-test of ANOVA at a 5% probability level.
CV10DAA = 32.39%. CV20DAA = 31.55%.
Source: The authors.

Despite the initial symptoms, a significant reduction in phytotoxicity was observed at 20 days. DAA, with no statistically significant difference between treatments. This behavior demonstrates the crop recovery capacity after initial stress resulting from application of Herbicides. Temporary symptoms of poisoning in RR crops subjected to herbicide application. Post-emergent herbicides were also observed by Carvalho *et al.* (2015), without definitive impairment of plant development.

Treatments containing glyphosate alone and glyphosate + haloxyfop showed low Phytotoxicity levels throughout the entire evaluation period, demonstrating greater selectivity. with regard to the soybean cultivar used. Thus, although some treatments have caused Temporary injuries; the symptoms did not persist until the second evaluation.

The mass of 100 grains did not show a significant difference between treatments. (Table 5), indicating that the herbicides used did not directly influence this variable. productive. This demonstrates that grain filling occurred in a similar manner. regardless of the herbicide management approach adopted.

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Table 5. 100-grain weight (CGW) and grain yield (GY) of soybean crop, cultivar CZ37B39I2X, due to the application of post-emergence herbicides. Sobradinho Farm, Uberlândia-MG. 2024/25 crop season.

Treatments	MCG (g)ns	PG (kg.ha-1) *
Witness	15.83	1502.90 c
Glyphosate	15.88	4428.27 ab
Fluazifop + Fomesafen	15.20	4878.20 ab
Clorimuron + Haloxyfop	15.48	2757.40 bc
Glyphosate + (Fluazifop + Fomesafen) + Clorimuron	15,18	4985.48 a
Glyphosate + Haloxyfop	16.40	4641.63 ab

* Means followed by different letters in the column differ from each other by Tukey's test at a 5% probability level. No significant difference was found by the F-test of ANOVA at a 5% probability level.
CV10DAA = 7.71%. CV20DAA = 24.50%.
Source: The authors.

On the other hand, grain productivity was significantly influenced by treatments. The control group showed the lowest productivity (1502.90 kg haÿ¹), evidencing The high competitive potential of weeds when not properly managed. Interference from the infesting community reduces the availability of resources essential to crop, directly impacting productive yield (Rossi *et* al., 1996).

The treatment consisting of glyphosate + (fluazifop + fomesafen) + chlorimuron showed the highest productivity (4985.48 kg haÿ¹), differing statistically from the control. This result can be explained by the high efficiency of control observed in the evaluations. previous factors, resulting in less competition during soybean development.

Treatments with glyphosate alone, fluazifop + fomesafen, and glyphosate + haloxyfop. They also exhibited high productivity, demonstrating satisfactory efficiency in management. of weeds. The treatment with chlorimuron + haloxyfop showed productivity. intermediate, possibly due to the lower initial control observed at 10 DAA.

Overall, the results demonstrate that post-emergence chemical management was fundamental for reducing weed interference and for maintaining the The productive potential of soybean cultivation, contributing to higher agronomic yields. (Oliveira *et* al., 2019).

CONCLUSION

The weed community present in the experimental area consisted of predominantly broadleaf species, with *Alternanthera tenella being a notable example.*

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Urochloa decumbens and *Commelina benghalensis,* which presented high rates Phytosociological and significant competitive potential in relation to soybean cultivation.

The post-emergent herbicides evaluated demonstrated satisfactory efficiency in weed control, especially treatments composed of glyphosate alone, fluazifop +fomesafen, glyphosate + haloxyfop and glyphosate + (fluazifop +fomesafen) + chlorimuron, which provided high percentages of control at 10 and 20 days after the application. Although some treatments have caused initial symptoms of phytotoxicity, Especially those containing fomesafen, crop recovery was observed throughout the The period evaluated showed no significant harm to plant development.

Soybean productivity was directly influenced by the efficiency of chemical management. adopted, highlighting the importance of adequate control of the infesting community for Reducing competition for water, light, nutrients, and space. The treatment consists of glyphosate. The combination of fluazifop and fomesafen plus chlorimuron showed the highest productivity values. demonstrating that combining different mechanisms of action can provide greater Efficient control and improved agronomic performance of the crop.

The results obtained reinforce the relevance of integrated weed management. in soybean cultivation, especially given the increase in tolerant and resistant varieties to Herbicides traditionally used. In this context, studies on the effectiveness of herbicides Post-emergent crops become essential to assist producers and technicians in decision-making. decision, contributing to more sustainable, efficient and economically viable production systems. feasible.

Therefore, it can be concluded that post-emergence chemical management was effective in controlling the pest. controlling weeds present in the experimental area, reducing community interference. weed control and contributing significantly to maintaining the productive potential of cultivar CZ37B39I2X under the edaphoclimatic conditions of Fazenda Sobradinho, in Uberlândia-MG.

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