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Agronomic aspects of second-crop corn as a function of glyphosate doses.

Agronomic aspects of second-crop with a function of glyphosate doses

Agronomic aspects of second harvest corn depending on glyphosate doses

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SUMMARY

Weeds reduce crop productivity due to competition for water, light, nutrients, and space. Timely chemical control has been crucial for maximizing corn yield by reducing weed competition. However, due to...

Due to factors inherent to the farm's routine, herbicides are applied at late phenological stages. Thus, the objective of this study was to evaluate the weed control efficiency and corn productivity as a function of late spraying of glyphosate doses in the crop. The experiment was conducted in the second corn crop of 2025, at the Sobradinho Farm of IFTM Campus Uberlândia. A randomized block design was used, with five treatments and four replications. The treatments consisted of: control without weeding; control with weeding; 960 g ai haÿ¹; 1440 g ai haÿ¹ and 1920 g ai haÿ¹. In the week that the corn reached the V6 phenological stage, a phytosociological survey of weeds was carried out using an inventory square (0.5 m x 0.5 m). Immediately after the survey, the spraying of glyphosate doses was carried out. Weed control was evaluated 7 and 14 days after herbicide application. At the end of the corn crop cycle, plant height, height of the first ear insertion, stem diameter, number of grains per ear, 100-grain weight, and grain yield were also evaluated. The application of glyphosate, at doses of 960, 1440, and 1920 g haÿ¹, to the SHU3303 corn hybrid at the V6 phenological stage, provided weed control. However, the herbicide contributed to a reduction in the 100-grain weight and grain yield of the corn cultivated in the second crop season at the Sobradinho Farm of IFTM Campus Uberlândia.

Keywords: Productivity; Herbicide; Weeds; *Zea mays* L.

Abstract: Weeds reduce crop productivity due to competition for water, light, nutrients, and space. Chemical control applied at the appropriate time has been fundamental to maximizing corn yield by reducing weed competition. However, due to some factors inherent to farm routine, herbicides are applied at late phenological stages. Thus, the objective of this study was to evaluate the efficiency of weed control and corn productivity as a function of the timing of late-season glyphosate applications in the crop. The experiment was conducted in the second corn crop of 2025 at the Sobradinho Farm of IFTM Campus Uberlândia. A randomized block design with five treatments and four replications was used. The treatments consisted of: control without weeding; control with weeding; 960 g ai haÿ¹; 1440 g ai haÿ¹ and 1920 g ai haÿ¹. During the week when the corn reached the V6 phenological stage, a phytosociological survey of weeds was conducted using a quadrat inventory (0.5 mx 0.5 m). Immediately after the survey, glyphosate was sprayed. Seven and 14 days after herbicide application, weed control was evaluated. At the end of the corn crop cycle, plant height, height of the first ear insertion, stem diameter, number of grains per ear, 100-grain weight, and grain yield were also evaluated. The application of glyphosate at doses of 960, 1440, and 1920 g.haÿ¹ in the SHU3303 corn hybrid at the V6 phenological stage provided weed control. However,

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the herbicide reduced the 100-grain weight and grain yield of corn cultivated in the second crop at the Sobradinho Farm of IFTM Campus Uberlândia.
Keywords: Productivity; Herbicide; Weeds; *Zea mays L.*

INTRODUCTION

Global demand for food presents agriculture with the challenge of increasing productivity. of crops without the need to expand cultivated areas, seeking greater productive efficiency. and reducing the impacts on the environment. In the Brazilian context, the efficiency of agriculture is associated with investments in technical training, scientific research and proper management (Oliveira *et* al., 2015).

Corn *(Zea mays* L.) cultivation plays a fundamental role in the agribusiness of country, being present in human and animal food and showing potential for use in The alcohol industry demands that producers pay attention to every stage of cultivation, from preparation onwards. from the soil to post-harvest (Fontes; Gonçalves, 2009). Among the fundamental practices to achieve Maximum yield depends on soil correction and fertilization, as well as pest control. Weeds and diseases (Balbinot Junior *et al.,* 2011).

Brazil, the world's third-largest corn producer, produced 110.46 tons in its second harvest. millions of tons, according to the National Supply Company (Conab, 2025), the which corresponds to the main share of the national grain production, which was 138.60 million tons, helping to reduce seasonality and stabilize supply in the market. However, Intensive farming systems favor the establishment and proliferation of communities. Weed management is a major challenge, making it a significant obstacle to weed control.

Weeds are considered to be plant species that negatively interfere with... crop development, competing for light, water, nutrients, and space. Causing a reduction in vegetative potential, grain yield components, and limiting the estimated production of culture (Rossi et al., 1996; Nedeljkoviÿ et al., 2025; Sah et al., 2020).

Among the weeds that infest corn, pigweed *(Amaranthus* spp.) has shown... population increase, being a highly competitive C4 plant, which reduces the productivity of Corn due to the decrease in the plant's photosynthetic area (Vazin, 2012). The species *Eleusine indica* (Goosegrass) is also a major problem in agriculture due to the rapid emission of offshoots, which gives it a high competitive advantage and reduces the availability of resources. for the crop of interest, which is concerning due to recent cases of herbicide resistance, such as glyphosate (Vargas *et al.,* 2006; Heap, 2026).

Glyphosate (N-(phosphonomethyl)glycine) is a herbicide used in plant management.

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Weeds in various crops, mainly due to their broad spectrum of action and character.
Systemic. This active ingredient inhibits the EPSPS enzyme (5-enolpyruvylshikimate 3-phosphate synthase).
compromising the synthesis of aromatic amino acids and affecting protein synthesis, leading to failure.
in plant growth and death (Imran *et* al., 2017).

Although chemical control is widely used in weed management in
In corn cultivation, operational factors often hinder the application of these products.
ideal moment. In many field situations, delays due to weather conditions or
Logistical limitations may result in management occurring at more advanced stages of crop development.
and weeds, compromising the effectiveness of control. Furthermore, in this scenario, the
Weeds may not be controlled effectively due to the "umbrella effect".
during spraying, in which the leaf area of corn plants in advanced phenological stages
reduces the contact of herbicide droplets with the target to be controlled (Santos *et* al., 2025).

Therefore, given the importance of chemical control in crop protection, this study had
with the objective of evaluating the efficiency in weed control and the agronomic effects of
Late application of different doses of glyphosate in the SHU3303 corn crop, in the second growing season of
2025, at the Sobradinho Farm of the IFTM Campus in Uberlândia, Minas Gerais.

MATERIALS AND METHODS

The experiment was conducted at the Sobradinho Farm of the Federal Institute of the Triângulo Mineiro.
Mineiro Campus Uberlândia, whose area is located at the geographic coordinates 18°46'23"
south latitude and 48°17'27" west longitude, with an altitude of 644 m and a climate classification of Aw,
according to Köppen-Geiger (Peel; Finlayson; McMahon, 2007).

The soil at the site was classified as eutrophic Red Latosol. The corn cultivated there
The second-crop planting method was sown on April 24, 2025.

Before sowing, furrows were opened with hoes for the application of 120
kg haÿ¹ of PÿOÿ. Then, the fertilizer was covered with a layer of approximately 3 cm of
soil. For sowing, a manual planter was used, adjusted to distribute 3
seeds per linear meter, with the goal of reaching 60,000 plants per hectare, given the rate of
The emergence of the SHU3303 corn hybrid was 100% in a test conducted in a sand plot.
The spacing between the rows of plants was 0.5 m. Each experimental plot consisted of 4
rows of crops, each 4 m long.

In the V4 and V6 phenological stages, topdressing fertilization with urea was carried out.
applying the equivalent of 60 kg haÿ¹ of N in each.

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Before the application of glyphosate to the corn crop, which was in the phenological stage... V6, a phytosociological survey of weeds was carried out in the experimental area. There was the identification and quantification of sampled weeds using a quadrat of Inventory (0.5 x 0.5 m), placed in the center of the usable area of each plot. With the data collected In the field, the phytosociological parameters proposed by Mueller-Dombois were calculated and Ellenberg (1974):

Frequency (repetition index of species in the squares):

u *and* *and*

F = _____

Density (index of the number of individuals of the same species in all squares):

i *and*

D = _____

THE

Abundance (grouping of species at different points in the total area):

i *and*

A = _____

and

Relative frequency:

and *and* *100*

Fr = _____

and *and*

Relative density:

and *100*

Dr = _____

and

Relative abundance (relates a species to all other species found in the area):

the *and* *100*

Air = _____

the *and*

Importance value index:

IVI = + +

All the results obtained were presented in a table for descriptive analysis of

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Profile of the weed community present in corn cultivation.

The experimental design adopted for the initial implementation of plant control strategies.

The experimental design for weed control at the V6 phenological stage of maize was randomized blocks, with five... treatments and four repetitions. The treatments consisted of two controls (with and without (weeding) and three doses of glyphosate, as shown in Table 1.

Table 1. Treatments used in the experiment to evaluate weed control and agronomic aspects of the SHU3303 corn hybrid grown in the second crop season. Sobradinho Farm, Uberlândia-MG. 2025 crop season.

Treatments	Description
T1	Witness without weeding
T2	Witness with weeding
T3	Glyphosate – 960 g a haÿ¹
T4	Glyphosate – 1440 g ai haÿ¹
T5	Glyphosate – 1920 g a haÿ¹

The treatments were applied to the experimental plots at the V6 phenological stage of the corn cultivation, with the aid of a sprayer equipped with a CO2 cylinder and boom.

Spraying with 4 fan-type nozzles (MAGNO® 110 03), spaced 0.5 m apart.

The equipment was adjusted to apply a spray volume of 150 L haÿ¹.

The same spraying equipment was used for the application of the Galil® insecticide. (imidacloprid + bifenthrin), at a dose of 200 mL haÿ¹, for the control of the *Dalbulus* population. *maidis.* Two applications were performed. One in V4 and another in V7.

Evaluations of plant control were carried out 7 and 14 days after application.

Weed control was assessed visually in the field, comparing the weeds to an unweeded control plot. and assigning the control percentage.

Upon reaching physiological maturity, the corn plants were analyzed for height. (distance between the ground surface and the tip of the male inflorescence); insertion height of the first ear (distance between the soil surface and the insertion of the upper ear); and diameter of the culm (measured at the first internode above the plant collar). These variables were obtained by starting from 5 plants randomly sampled from the usable area of each experimental plot, in which the Heights were measured using a graduated tape measure, and the diameter of the culm was measured with...

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a caliper. Biometric agronomic assessments were carried out between the stages
reproductive R1 and R2 of the culture.

Next, in R6, 10 ears of corn were collected from each experimental plot.
with 3 m² of usable area, for determining the number of grains per ear, number of rows per
ear size and number of grains per row are measured, and subsequently subjected to a mechanical thresher for the...
Grain extraction and productivity measurement.

A sample of 100 grains from each plot was evaluated in the laboratory for
wet mass and dry mass were determined using the oven method at 105 °C for 24 h.
of the moisture content of the grains.

The collected data were analyzed in SISVAR (Ferreira, 2011) using the F-test.
Analysis of Variance was performed at a 5% probability level, and the treatments were compared using the test.
Tukey's test, also at a 5% probability.

RESULTS AND DISCUSSION

The weed community identified in the cultivation area of the SHU3303 corn hybrid, in
The second crop modality (2025) was composed of 12 species of weeds.
predominantly broadleaf (Table 2).

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 in the cultivation of the SHU3303 corn hybrid.
Sobradinho Farm, Uberlândia-MG. 2025 Harvest.

Species	NI	NQ	F	D	THE	Fr	Dr	Air
Amaranthus spinosus	600	12	130	9	1.00	50.00	0.75	50.00 21.82 71.09 14.44 16.36	58.48
Amaranthus viridis					10.83	0.92	5.25	15.40 5.73 20.00 7.46 3.50	16.89
Eleusine indicates	63	11	0.50	1.75	0.33	10.91	2.49	2.50	7.27	1.18	6.70
Richardia brasiliensis	21	6	0.83	0.25	0.83	3.33	5.45	1.18	1.00	3.64	4.09
Portulaca oleracea	10	4	0.17	0.17	0.17	0.24	1.00	3.64	0.24	1.00	2.92
Ageratum conyzoides	10	3	0.17	0.17	0.17	3.64	0.24	1.00	1.82	0.12	3.90
Digitaria insularis	2	2	0.17	0.08	0.08						1.17
Commelina benghalensis	2	2									1.17
Sida rhombifolia	2	2									1.17
Phyllanthus tenellus	2	2									1.17
Melampodium paniculatum	1	1									1.17
Solanum viarum	1	1	0.08			1.00	1.82				0.12
Total	844	12	4.58	70.33	0.08			85.51	100.00	100.00	100.0 0

Source: The authors (2026).

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The species *Amaranthus spinosus* (spiny amaranth) showed the highest number of individuals (600), highest density (50), highest abundance (50), highest relative frequency (100%), the highest relative density (71.09%) and the highest relative abundance (58.48%), highlighting, Thus, its dominance in the studied area is demonstrated by the highest IVI value (151.4%) among the species. diagnosed in the field. In second place, *Amaranthus viridis* (spotted amaranth) stood out . with 130 individuals and a high importance value index (48.7%). Although the survey The phytosociological study has shown a predominance of broadleaf weeds in the post-emergence phase of In the cornfield, the grass Eleusine indica (goosegrass) was present, with a high value of importance (34.2%). These three species stood out for their adaptability, high rate of occurrence and competitive potential, which indicates the need for priority attention to its control.

Although *Eleusine is only the third most prevalent species in the area, attention should be paid to it. Special attention should be paid* to the management of this weed in future strategy planning for the mitigating this phytosanitary problem. Especially since it is a highly sensitive species. It is competitive with corn cultivation and difficult to control with herbicides. Furthermore, there are already... Reports of resistance to glyphosate in crabgrass, resulting from a mutation that confers a an almost fourfold increase in the amount of glyphosate needed to inhibit 50% of the activity of the EPSPS enzyme, as discussed in the work of Takano *et al.* (2019).

In general, the other species showed lower values for frequency, density, and While abundant, its presence should not be overlooked. *Digitaria insularis* (bittergrass) and *Commelina benghalensis* (dayflower), although they showed a low IVI (5.0% for both). the species), may increase their importance in the cultivated area over time, mainly if glyphosate is used exclusively for weed management in agricultural crops. Like the Glyphosate does not show satisfactory action in controlling goosegrass and dayflower; these The species will reach the reproductive phase and may contribute to an increase in the number of seeds. deposited in the soil of the Sobradinho Farm, in Uberlândia-MG, thus hindering the future control of the weed community in the local agroecosystem.

When comparing the results of the present study to the data obtained by Nunes et al. (2025), who analyzed the phytosociology of weeds in the second corn crop (“safrinha”). In 2024, using the same area as the Sobradinho Farm, a difference in composition is observed. of the weed community from one crop to the next. In the previous year (2024), the *Chamaesyce* species *Amaranthus hirta, Amaranthus spinosus ,* and *Amaranthus viridis* presented the highest IVIs, dominating the The agricultural environment requires priority attention in chemical and cultural control. In 2025, also In the second corn crop, the amaranth species maintained their high IVIs, but the Santa's herb-

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Luzia was practically not found at the location. This discrepancy reinforces the importance of the factor.
Time (harvest season) as a determining factor in the occurrence and distribution of plant species.
Weeds. The difference in floristic composition between the crop of one agricultural year and that of another implies
variations in temperature, water regime, light intensity and agricultural practices, which
They affect the spatial and temporal distribution dynamics of weed species.

Regarding the management of the weed community in this study, it was found that...
Weed control began 7 days after glyphosate application, regardless
of the dose used; however, the result was inferior to that obtained with weeding. After 14 days of application,
The control group with weeding and the treatments with 1440 g ai haÿ¹ and 1920 g ai haÿ¹ showed
statistically equal results in weed control (Table 3).

Table 3. Percentage of weed species control in the second crop of the SHU3303 corn hybrid. Sobradinho Farm, Uberlândia-MG.
Harvest of (2025).

Treatments	Control (%)	
	7 DAA*	14 DAA*
1. Witness without weeding	00.00 c	0.00 c
2. Control with weeding 3.	100.00 to	100.00 to
Glyphosate (960 g ai ha-1)	51.25 b	88.75 b
4. Glyphosate (1440 g ai ha-1)	60.00 b	98.50 a
5. Glyphosate (1920 g ai ha-1)	57.50 b	99.75 a

*Means followed by different letters in the column differ from each other by Tukey's test at the 5% level. probability. CV7DAA = 13.80%. CV14DAA = 2.92%.

The doses of 1440 g IAH-1 and 1920 g IAH-1 at 14 DAA had an observed efficacy of
98.50% and 99.75%, respectively, and presented statistical values similar to the treatment.
referred to as "witness with weeding". This high efficiency in controlling the community
The increase in weed control through the application of the highest doses of glyphosate can be explained by the overcoming
of the “umbrella” effect as a function of foliar uptake of a minimum quantity of molecules of
herbicide, but significantly enough to cause a lethal effect on weeds (Santos)
et al., 2025).

Stem diameter, plant height, and height of insertion of the first ear (Table 4)
They were not influenced by the different strategies for controlling the infestation community.

Table 4. Stem diameter (DC), height of insertion of the first ear (AIE) and plant height (AP) of the corn hybrid SHU3303, grown in the second crop, as a function of weed control strategies. Sobradinho Farm, Uberlândia-MG. 2025 crop season.

Treatments	DC (mm)[1]	AIE (cm)[1]	AP (m)[1]

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1. Control without weeding 2.	21.87	68.35	1.97
Control with weeding 3.	22.18	67.30	1.91
Glyphosate (960 g ai ha-1)	22.78	72.75	2.06
4. Glyphosate (1440 g ai ha-1)	23.42	72.25	2.00
5. Glyphosate (1920 g ai ha-1)	25.82	73.85	2.02

1. No significant difference was found according to the F-test of the Analysis of Variance at a 5% significance level. CVDC = 11.65%. CVAIE = 8.89%. CVAP = 5.57%.

The absence of significant differences between treatments may be associated with Spatial variability of the weed community. Where is the distribution of weeds in areas? Agricultural development occurs heterogeneously, affected by environmental variables, and can result in... Differences in the intensity of competition between experimental plots can obscure detection. of the effects of treatments on the morphological variables evaluated (Lessa *et al.,* 2023; Shiratsuchi; Christoffoleti; Fontes, 2003).

Furthermore, considering the absence of statistically significant differences between the Of the components evaluated, high concentrations of herbicides can affect development. vegetative growth of plants, including in cases of drift (Magalhães *et* al., 2001). However, corn It exhibits rapid vegetative growth after the V6 stage and a high capacity for compensation. physiological, which minimizes the impacts of initial stresses resulting from competition with weeds (Wang *et al.,* 2024).

The number of rows, number of grains per row, and total grains (Table 5) do not They showed a difference between the treatments.

Table 5. Number of rows per ear (NF), number of grains per row (NGF) and number of grains per ear (NGE) in SHU3303 corn hybrid, grown in the second crop season, as a function of weed control strategies. Sobradinho Farm, Uberlândia-MG. 2025 crop season.

Treatments	NF1	NGF1	NGE1
1. Control without weeding 2.	14.75	24.00	354.00
Control with weeding 3.	14.75	26.25	385.75
Glyphosate (960 g ha-1)	15.00	26.50	391.25
4. Glyphosate (1440 g ha-1)	14.75	25.00	362.25
5. Glyphosate (1920 g ha-1) 1 No	15.00	24.75	370.50

significant difference by the F-test of the Analysis of Variance at 5% significance. CVNF = 4.80%. CVNGF = 8.06%. CVNGE = 10.57%.

The absence of a significant difference suggests that the expression of the reproductive potential of The crop was not affected by the application of high doses nor by competition with the plants.

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harmful. This indicates that the interference was not sufficient to compromise structural definitions.
such as the number of rows per ear, which is determined during the vegetative phase, generally between V4 and V8 (Ritchie *et al.,* 2003).

Regarding the mass of 100 grains, it was observed that the controls with weeding (19.99 g) and without weeding (20.39 g) showed the highest values of grain dry matter, with no difference.
between themselves. The treatment with 960 g ai haÿ¹ was intermediate (16.56 g), showing no difference.
statistically significant differences were observed compared to no other treatment. Doses of 1440 and 1920 g ai haÿ¹ showed...
the lowest averages, being statistically inferior to the controls (Table 6).

In terms of productivity, the control treatments without weeding (2.64 t.ha-1) and with weeding (2.67 t.ha-1) showed higher yields, while the treatments with 960 g ha-1 and 1920 g ha-1
They showed intermediate performance. The treatment with 1440 g aia, in turn, showed the lowest yield (1.44 tha-1).

Table 6. 100-grain weight (M100G) and grain yield (PG) of the SHU3303 corn hybrid, grown in the second crop season, as a function of weed control strategies. Sobradinho Farm, Uberlândia-MG. 2025 crop season.

Treatments	M100G (g)*	PG (t.ha-1)*
1. Witness without weeding	19.99	2.64 a
2. Control with weeding 3.	20.39 a	2.67 a
Glyphosate (960 g ai ha-1)	16.56 ab	1.88 ab
4. Glyphosate (1440 g ai ha-1)	14.40 b	1.44 b
5. Glyphosate (1920 g ai ha-1) 1.83 ab Means followed by different letters in the column	15.47 b	

* differ from each other by Tukey's test at the 5% level.
probability. CVM100G = 9.97%. CVPG = 23.67%.

The increase in glyphosate doses did not promote an increase in the productive components of corn.

Even though it is resistant to glyphosate, the hybrid may exhibit reduced productivity.
corn metabolism is related to phytotoxic effects of the herbicide, possibly by altering its metabolism.
secondary plant. According to Carvalho *et al.* (2015), one way to mitigate this problem would be
Investing in higher doses of P2O5 in seed fertilization reduces plant toxicity.
cultivated by reducing the absorption of glyphosate.

The unweeded control group did not show inferior results compared to the treatments with weeding.
The application of glyphosate, except for weed control, demonstrated probable suppression.
corn can control weeds through cultural practices, or a smaller amount.
susceptibility of corn hybrids to weed interference (Kozlowski *et al.,* 2009).

Fontes *et al.* (2025) also obtained similar results in an experiment with corn.

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in which the average grain productivity in treatments with herbicide doses and in control

The mechanical impact was 8,971 kg haÿ¹, with no statistically significant difference. However, as Rodrigues *et al.* (2019)

They observed that the control performed at the V3 stage of corn resulted in a 6.31% increase in

productivity compared to late control.

FINAL CONSIDERATIONS

The application of glyphosate, at doses of 960, 1440 and 1920 g ha-1, in the corn hybrid.

SHU3303 at the V6 phenological stage provided weed control. However, the

The herbicide contributed to a reduction in the 100-grain weight and grain yield of corn.

grown in the second harvest at the Sobradinho Farm of IFTM Campus Uberlândia.

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