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Glyphosate doses in the suppression of *Megathyrsus maximus* cv. BRS Quênia intercropped with transgenic maize[1]

Doses de glifosato na supressão de *Megathyrsus maximus* cv. BRS Quênia consorciado com milho transgênico

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HIGHLIGHTS:

Doses of glyphosate below 240 g acid equivalent [a.e.] ha^{-1} cannot suppress forage growth and yield.
Megathyrsus maximus *cv. BRS Quênia without glyphosate application increases the number of bedridden plants of maize.*
The presence of M. maximus *cv. BRS Quênia in intercropping with maize exerts crop control on weeds.*

ABSTRACT: In the intercropping of maize with *Megathyrsus maximus*, the application of herbicides is a technique that can be used to reduce competition between intercrops. This study aimed to evaluate the effect of different glyphosate doses on suppressing the growth of *Megathyrsus maximus* cv. BRS Quênia intercropped with maize, as well as in weed control. The randomized block experimental design was used and conducted in the field. The treatments consisted of the application of six glyphosate doses, 0; 48; 96; 240; 480; 960 g acid equivalent [a.e.] ha^{-1}, and a maize treatment without the forage with 960 g acid equivalent [a.e.] ha^{-1}. The dose of 260.87 g a.e. ha^{-1} provides a 50% response to the forage production variable; therefore, it has the potential to suppress *M. maximus* cv. BRS Quênia. The presence of forage reduces the density and dry mass of weeds, with the species in the weed community: *Ricinus communis*, *Eleusine indica*, *Alternanthera tenella*, *Commelina benghalensis*, *Conyza* sp., and *Digitaria horizontalis*.

Key words: *Zea mays*, *Panicum maximum*, glyphosate underdose, weed control, phytointoxication

RESUMO: No consórcio de milho com *Megathyrsus maximus*, para reduzir a competição entre as culturas consortes, a aplicação de herbicidas é uma técnica que pode ser utilizada. O objetivo deste estudo foi avaliar o efeito de diferentes doses de glifosato para supressão do crescimento de *Megathyrsus maximus* cv. BRS Quênia em consórcio com milho, bem como no controle de plantas daninhas. O trabalho foi conduzido a campo, em delineamento experimental de blocos casualizados. Os tratamentos consistiram na aplicação de seis doses de glifosato, 0; 48; 96; 240; 480; 960 g equivalente ácido [e.a.] ha^{-1} e um tratamento de milho sem a forragem com 960 g equivalente ácido [e.a.] ha^{-1}. A dose de 260,87 g e.a. ha^{-1} fornece 50% de resposta à variável produção de forragem; portanto, tem potencial para supressão de *M. maximus* cv. BRS Quênia. A presença da forrageira reduz a densidade e massa seca das plantas daninhas, sendo as principais espécies na comunidade infestante: *Ricinus communis*, *Eleusine indica*, *Alternanthera tenella*, *Commelina benghalensis*, *Conyza* sp. e *Digitaria horizontalis*.

Palavras-chave: *Zea mays*, *Panicum maximum*, subdose de glifosato, controle de plantas daninhas, fitointoxicação

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Introduction

The use of forage grasses intercropped with annual crops can reduce the occurrence of weeds and increase the production and presence of straw in the soil for a no-till system (Borghi et al., 2008; Oliveira et al., 2019; Marques et al., 2021), which is desirable in environments with rapid decomposition of dry matter, such as the Cerrado.

The presence of straw at an adequate level protects against the evaporation of water in the soil and provides high levels of organic matter, resulting in greater yield (Ryschawy et al., 2017). In addition to these attributes, the use of intercropping may favor soybean planting in succession due to the suppression of weed emergence by the rapid growth of forage grasses after harvesting the predecessor crop since weeds can reduce soybean yield (Borghi et al., 2008; Gazziero et al., 2019).

Forage species of the genus Megathyrsus have the potential for use as cover crops in intercropping systems (Costa et al., 2020a; Costa et al., 2020b; Costa et al., 2020c; Dias et al., 2020; Pereira et al., 2021). However, it is necessary to suppress this grass for no competition between it and the grain crop (Adegas et al., 2011).

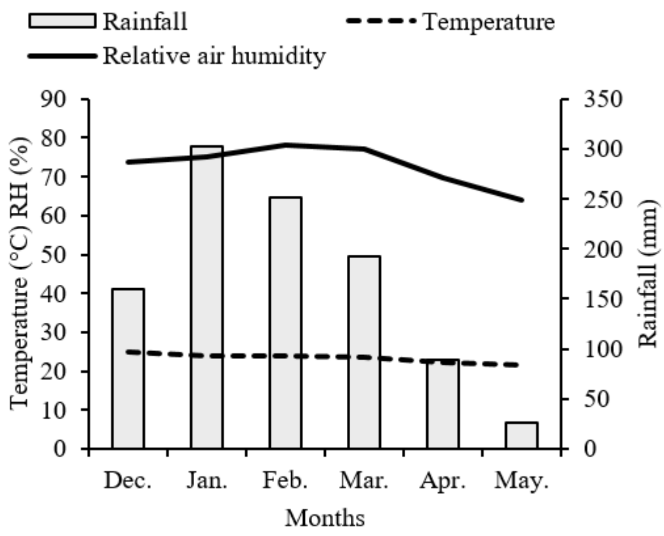
For this, some techniques can be used, and the main alternative is the application of underdoses of herbicides to suppress the initial growth of forage. With the development of genetically modified Roundup Ready® (RR) maize hybrids, the herbicide glyphosate has acquired the potential to be used in the management of forage species intercropped with maize (Albrecht et al., 2014). However, it is still necessary to obtain information about the suppression of forage species of the genus Megathyrsus since the new cultivars present different responses to glyphosate application (Cruvinel et al., 2021). Therefore, this study aimed to evaluate the effect of glyphosate doses on suppressing the growth of *Megathyrsus maximus* cv. BRS Quênia intercropped with maize, as well as in weed control.

Material and Methods

The experiment was conducted during the 2020/2021 crop season under field conditions at Instituto Federal Goiano, Rio Verde campus (17° 48' 67" S, 50° 54' 18" W, and altitude of 754 m). There was no water restriction during the experimental period. Data on rainfall, temperature, and relative air humidity are shown in Figure 1.

The soil in the area is classified as an Oxisol (United States, 2014), corresponding to a Latossolo Vermelho-Amarelo in the Brazilian Soil Classification System (EMBRAPA, 2018). Soil fertility was evaluated by chemical analysis of the 0-20 cm depth layer. The results were pH($CaCl_2$): 4.5, phosphorus 11.94 mg dm^{-3}, potassium: 141 mg dm^{-3}, calcium: 0.95 $cmol_c$ dm^{-3}, magnesium: 0.69 $cmol_c$ dm^{-3}, aluminum: 0.15 $cmol_c$ dm^{-3}, base saturation: 34.5%, and organic matter: 39.1 g dm^{-3}. The results of the particle-size analysis were 51, 4, and 45% of sand, silt, and clay, respectively.

The maize used (DKB360PRO3) has Roundup Ready® (RR) and VTPRO3 technologies, enabling glyphosate application and providing protection to the main caterpillars in the shoot. The maize was sown on 12/19/2020, with a sowing rate of 60,000 plants ha^{-1}; simultaneously, forage (BRS Quênia) was sown by broadcast seeding using 10 kg ha^{-1} of pure, viable seed (PVS).



RH - Relative air humidity

Figure 1. Rainfall, average temperature, and relative humidity during the experimental period.

At the V4 stage, around 20 days after the emergence (DAE) of maize, the top dressing was applied using 150 kg N. According to the monitoring carried out, pest control was conducted at 7, 12, and 27 DAE, with the insecticides Teflubenzuron (Nomolt®150) at a concentration of 150 g L^{-1}; Chlorpyrifos (Capataz®) + Teflubenzuron (Nomolt®150) at concentrations of 480 and 150 g L^{-1} and Thiamethoxam + Lambda-Cyhalothrin (Engeo Pleno™ S) at concentrations of 141 and 106 g L^{-1}, respectively. Close to the tasseling stage, fungicide Trifloxystrobin + Tebuconazole (Nativo®) was applied at 100 and 200 g L^{-1} concentrations.

The experimental design was in randomized blocks with four replicates. The treatments consisted of the application of six glyphosate doses, 0, 48, 96, 240, 480, and 960 g acid equivalent [a.e.] ha^{-1}, and a maize treatment without the forage and with 960 g acid equivalent [a.e.] ha^{-1}. Along with all treatments, mixed with glyphosate, the herbicide atrazine (1500 g a.e. ha^{-1}) was applied to control dicotyledonous weeds.

The treatments were applied 18 days after maize emergence when the forage had four tillers. A pressurized carbon dioxide backpack sprayer was used, using a constant pressure of 2.3 bar. The spray nozzle used was a double fan (11002), and the spray volume was 200 L ha^{-1}. The temperature, wind speed, and air humidity conditions were, respectively, 28 °C, 2.2 km h^{-1}, and 45.7%, monitored punctually during application with a thermo-hygro-anemometer. The experimental units consisted of nine rows of maize 5 m in length, and the useful area of each plot corresponded to the four central rows.

At 60 days after emergence (DAE), maize plants were evaluated for plant height, ear insertion, and stem diameter. Five plants were selected inside the useful area of each plot. The ear insertion height was determined by measuring the distance between the ground and the ear insertion. Plant height was considered the distance between the ground and the insertion of the flag leaf. In both variables, a wooden ruler graduated in centimeters was used. The stem diameter was determined using a digital caliper.

Weed control evaluations were conducted 38 and 112 days after the application of treatments (DAA), with a frame square measuring 0.25 m^2. Weeds were collected from four random samples, totaling 1 m^2 per plot. Samples were separated in number and species, taken to an oven at 65 °C to constant mass, and weighed to obtain density and dry mass. The description given by the relative importance (RI) of each species, which characterizes a weighted percentage measure of frequency, density, and dry mass accumulation of weed species, was performed according to the methodology described by Piatelli (2000).

At the time of maize harvest, 128 DAE, evaluations were conducted regarding yield components, such as the number of rows per ear, number of grains per row, ear length, and thousand grain weight. Five ears per useful area of the plots were used for such determinations. Grain yield was obtained from threshing the ears harvested in the useful area of the plots (four rows of three meters in length) in a threshing machine and subsequent weighing of grains. The values were converted to kg ha^{-1} and corrected to 13% moisture. The total number of plants in the useful area of each plot was counted, as well as the number of lodged plants to obtain the final stand of plants and the percentage of lodged plants.

At the time of maize harvest, forage height was measured using a ruler graduated in centimeters, and later the plants were harvested using a cleaver, in 2 m^2, in the useful area of each plot at the height of approximately 30 cm from the ground.

Forage yield was determined by weighing the collected material and taking an aliquot of 0.5 kg. Samples were separated into leaves and stems and dried in an air-forced circulation oven at 65 °C until they reached constant mass. In this way, the leaf/stem ratio and the dry mass production of the forage were evaluated.

Data on weed density and dry mass at 38 and 112 days after application of treatments (DAA), as well as height, leaf/stem ratio, forage production, and the number of rows in maize ears, were not normal by the Shapiro Wilk test; therefore, they were transformed into the root of x + 0.5. Subsequently, data were submitted to the analysis of variance (ANOVA) using the F-test. When a significant effect was detected, regression analysis was applied using the SISVAR 5.6 software. The probability level adopted was 5% (Ferreira, 2011).

Results and Discussion

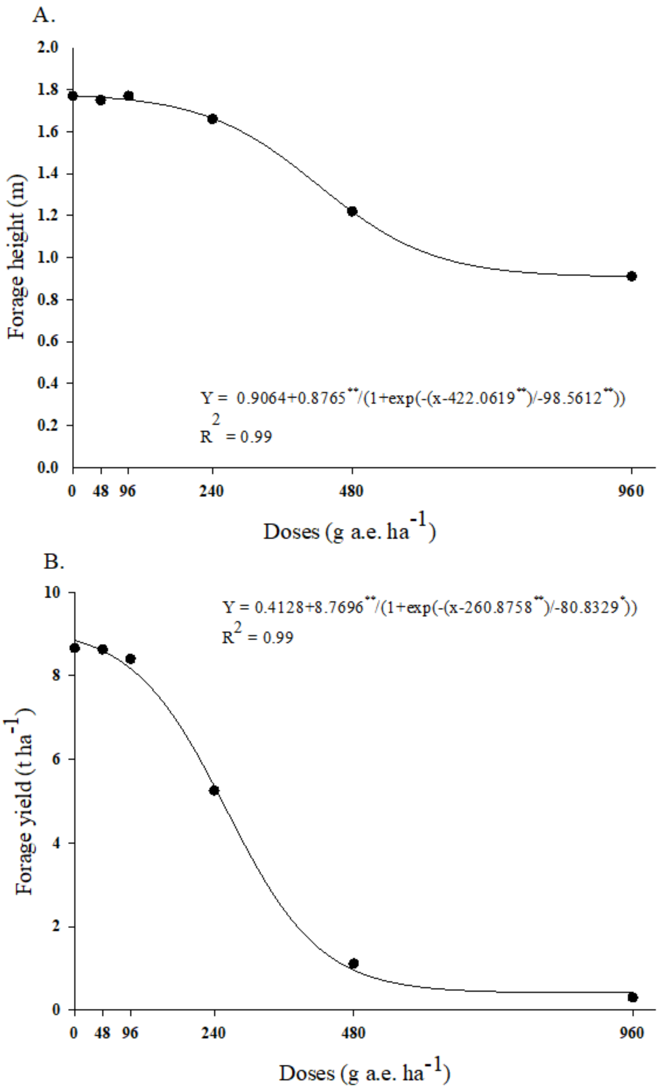
According to the results of the analysis of variance, there were significant effects on the variables forage height, forage yield, and leaf/stem ratio of the forage according to the glyphosate doses (Table 1). The variability in height and forage yield are shown in Figures 2A and B, respectively.

Up to the dose of 240 g a.e. ha^{-1} was not enough to suppress forage height, which presented values close to those treatments that did not receive glyphosate (1.77 m). The dose that reduced forage height by 50% was 422.06 g a.e. ha^{-1} of glyphosate, reaching an average height of 1.34 m. It is worth noting that it is interesting to keep the forage at a height that does not harm

Table 1. Summary of analysis of variance for the variables forage height (HEI), leaf/stem ratio (L/S), and forage yield (FYIEL)

SV	DF	Mean squares		
		HEI	FYIEL	L/S
Treatment	5#	0.0715**	3.6016**	0.6422**
Block	3	0.0015^{ns}	0.1748*	0.0421^{ns}
Error	15	0.0021	0.0505	0.3884
C.V. (%)		3.27	9.96	10.68

**, *, and ns - Significant at p ≤ 0.01and p ≤ 0.05 and non-significant by F-test, respectively. SV - Source of variation; DF - Degrees of freedom; # - Value referring to the six doses used in the intercropping



**; *- Significant at p ≤ 0.01 and p ≤ 0.05 by the F-test, respectively

Figure 2. Forage height (A) and forage yield (B) of *M. maximus* BRS Quênia intercropped with maize according to the glyphosate doses

the mechanized harvest of maize by obstructing the harvester and that this height does not excessively exceed the maize ear height, which in this test was 1.1 m. In this case, the herbicide dose was above the dose that manifested 50% of the dose-response (422.06 g a.e. ha^{-1}).

It is important to understand that there are variations in the response between *M. maximus* cultivars when subjected to herbicide applications - Matias et al. (2019) with *M. maximus* cv. Tamani found that the application of doses ranging from 58 to 116 g a.e. ha^{-1} had a potential for suppression of this forage intercropped with maize, which is lower than that found here for the cultivar BRS Quênia.

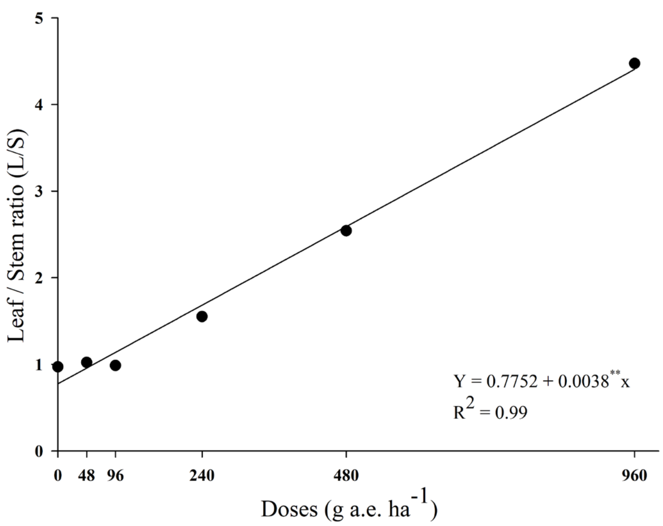
Similar behavior concerning doses was observed for forage yield (Figure 2B), in which the lower doses did not suppress forage yield. The maximum yield of forage intercropped with maize occurred in the absence of glyphosate application, 8.84 t ha^{-1}, while the dose that resulted in a 50% reduction in forage yield was 260.88 g a.e. ha^{-1}, resulting in a yield of 4.82 t ha^{-1}.

Higher forage yield values can result in competition with maize in intercropping; on the other hand, in addition to increasing organic matter, it is directly related to the amount of dry matter that the plant will provide for the formation of straw. According to Oliveira et al. (2001), the straw dry matter yield of 3 t ha^{-1} is sufficient to suppress weed germination in the subsequent crop.

Considering that the presence of weeds in the area is reduced with increasing levels of straw, an efficient alternative for the use of *M. maximus* BRS Quênia is the formation of quality straw to control weeds in successive crops to the intercrop. Oliveira et al. (2001), in a study with straw levels in weed management, showed that for each ton of added straw, there was an increase of approximately 4% in total weed control.

For the leaf/stem ratio, as the glyphosate doses increased, there was a linear increase in the proportion of leaves concerning stems (Figure 3). At the lower doses, there was no suppression in forage height and yield; in these treatments, *M. maximus* BRS Quênia produced more stem. In the absence of glyphosate, the leaf/stem ratio was 0.77, with an increase of 0.0038 per each unit (g a.e. ha^{-1}) of glyphosate used, reaching 4.42 at the highest dose assessed. Forages of the genus *Megathyrsus* have erect and cespitose growth, in addition to great yield potential and regrowth capacity, especially in the rainy season, which was the condition of this experiment. Therefore, as the forage grows, the stem elongates, and the leaf fraction is progressively reduced, reducing the leaf/stem ratio (Almeida et al., 2017).

Due to lower forage quality, values lower than 1.0 for the leaf/stem ratio are not interesting for grazing; higher values of



** - Significant at $p \leq 0.01$ by the F-test

Figure 3. Leaf/stem ratio of *M. maximus* BRS Quênia intercropped with maize according to the glyphosate doses

this ratio result in higher protein value, improve digestibility, and favor the grass with better adaptation to cutting (Rodrigues et al., 2008).

For weeds, considering the evaluations conducted at 38 and 112 DAA of glyphosate doses (Table 2), the occurrence of 17 species divided into 11 botanical families was recorded. The species found were goosegrass: Eleusine indica (ELEIN), southern sandbur: *Cenchrus echinatus* (CENEC), Jamaican crabgrass: *Digitaria horizontalis* (DIGHO), and mission grass: *Pennisetum setosum* (PENSE), belonging to the Poaceae family; Beggar's tick: *Bidens pilosa* (BIDPI), bristly starbur: *Acanthospermum hispidum* (ACAHI), fleabane: *Conyza* sp. (CONBO), Florida tassel-flower: *Emilia fosbergii* (EMIFO) and goatweed: *Ageratum conyzoides* (AGECO), belonging to the Asteraceae family. calicoplant: *Alternanthera tenella* (ALTTE), morning glory: *Ipomoea* spp. (IPOMO), Benghal dayflower: *Commelina benghalensis* (COMBE), castor: *Ricinus communis* (RINCO), apple of Peru: *Nicandra physaloides* (NICPH), tropical Mexican clover: *Richardia brasiliensis* (RICBR), stonebreaker: *Phyllanthus niruri* (PHYNI) and Mexican Pricklepoppy: *Argemone mexicana* (ARGME), belonging to the Amarantaceae, Convolvulaceae, Commelinaceae, Euphorbiaceae, Solanaceae, Rubiaceae, Phyllanthaceae, and Papaveraceae families, respectively.

For the evaluation at 38 DAA, regardless of the doses applied, the species with the greatest relative importance were RINCO, ELEIN, and DIGHO, representing 69.66% RI of the weed community. DIGHO was present in all treatments except for the highest dose of glyphosate (960 g a.e. ha^{-1}). When the evaluation was conducted at 112 DAA, the most important weed species were ALTTE, COMBE, and CONBO, totaling 12.70, 17.02, and 15.19%, respectively, of the RI of the weed community.

According to the analysis of variance for weed evaluations (Table 3) at 38 DAA, glyphosate doses only influenced dry mass but without statistical model fitting (Figure 4B). In the second evaluation, at 112 DAA, the difference was observed for both the density and dry mass of weeds.

For assessment at 38 DAA (Figure 4B), the significant effect was related to the presence of DIGHO, especially when using doses lower than 96 g a.e. ha^{-1}. Since weeds belonging to the Poaceae family are not controlled with atrazine, the low doses of glyphosate were not enough to suppress the growth of invasive plants; on the other hand, the forage did not promote crop control since it was still at the initial phase of the establishment (Dan et al., 2011).

For weed density at 112 DAA (Figure 4A), the results obtained with the application of the lower doses had a similar pattern to that which did not receive glyphosate, with low weed density, due to forage growth. According to the statistical model, the dose accounting for 50% of the response variable was 396 g a.e. ha^{-1}, and with increasing doses and a reduction in forage yield of the grass, there was a sharp increase in weed density, mainly due to the greater incidence of light. Similar results were found for the dry mass of weeds at 112 DAA (Figure 4B), since at the lower doses applied, the total dry mass was lower with a significant increase from the dose of 419.02 g

Table 2. Relative importance (RI) of weed species assessed at 38 and 112 days after application of treatments (DAA)

Species	Doses (g a.e. ha^{-1})							
	MC	0	48	96	240	480	960	Mean (%)
				38 DAA				
ALTTE	11.41	0.00	0.00	0.00	15.76	14.38	20.64	8.88
IPOMO	0.00	0.00	0.00	0.00	10.81	0.00	0.00	1.54
COMBE	11.14	0.00	0.00	7.62	3.33	2.65	16.78	5.93
BIDPI	3.83	0.00	0.00	0.00	1.09	12.54	8.84	3.76
ELEIN	26.53	0.00	0.00	0.00	2.47	37.37	17.18	11.93
RINCO	13.78	5.10	24.83	0.00	1.37	6.77	10.64	8.93
CENEC	4.52	0.00	0.00	0.00	0.00	0.00	14.74	2.75
NICPH	9.54	0.00	0.00	0.00	0.00	0.00	0.00	1.36
RICBR	5.61	0.00	0.00	0.00	2.03	23.92	11.18	6.11
DIGHO	13.63	94.90	75.16	92.37	63.16	2.37	0.00	48.80
				112 DAA				
ALTTE	9.71	8.28	0.00	0.00	34.97	23.69	12.69	12.70
COMBE	14.09	35.95	0.00	0.00	42.14	8.13	18.19	17.02
PHYNI	0.00	14.29	0.00	0.00	0.00	9.46	4.15	4.08
BIDPI	9.86	0.00	0.00	0.00	8.81	4.82	7.95	4.84
ACAHI	4.18	5.38	0.00	0.00	8.91	6.51	3.13	3.96
ELEIN	16.48	2.26	0.00	0.00	9.49	19.12	17.70	9.53
RINCO	5.17	6.64	0.00	0.00	0.00	8.66	7.91	4.57
CONBO	29.94	7.70	0.00	0.00	15.44	17.50	35.10	15.19
NICPH	6.75	0.00	0.00	0.00	0.00	0.00	15.89	3.47
ARGME	6.13	0.00	0.00	0.00	0.00	14.32	0.00	3.30
RICBR	9.44	13.29	0.00	0.00	0.00	5.56	0.00	4.13
AGECO	8.50	9.81	0.00	0.00	0.00	8.85	8.91	5.38
DIGHO	5.15	0.00	0.00	0.00	4.58	3.51	0.00	2.16
PENSE	8.23	9.19	0.00	0.00	14.88	5.31	3.51	5.97
EMIFO	4.76	0.00	0.00	0.00	15.57	0.00	4.41	3.80

MC - Monocrop maize; calicoplant: *Alternanthera tenella* (ALTTE); morning glory: *Ipomoea* spp. (IPOMO); Benghal dayflower: *Commelina benghalensis* (COMBE); Beggar's tick: *Bidens pilosa* (BIDPI); goosegrass: *Eleusine indica* (ELEIN); castor: *Ricinus communis* (RINCO); southern sandbur: *Cenchrus echinatus* (CENEC); apple of Peru: *Nicandra physaloides* (NICPH); tropical Mexican clover: *Richardia brasiliensis* (RICBR); Jamaican crabgrass: *Digitaria horizontalis* (DIGHO); stonebreaker: *Phyllanthus niruri* (PHYNI); bristly starbur: *Acanthospermum hispidum* (ACAHI); fleabane: *Conyza* sp. (CONBO); Mexican Pricklepoppy: *Argemone mexicana* (ARGME); goatweed: *Ageratum conyzoides* (AGECO); mission grass: *Pennisetum setosum* (PENSE); Florida tassel-flower: *Emilia fosbergii* (EMIFO)

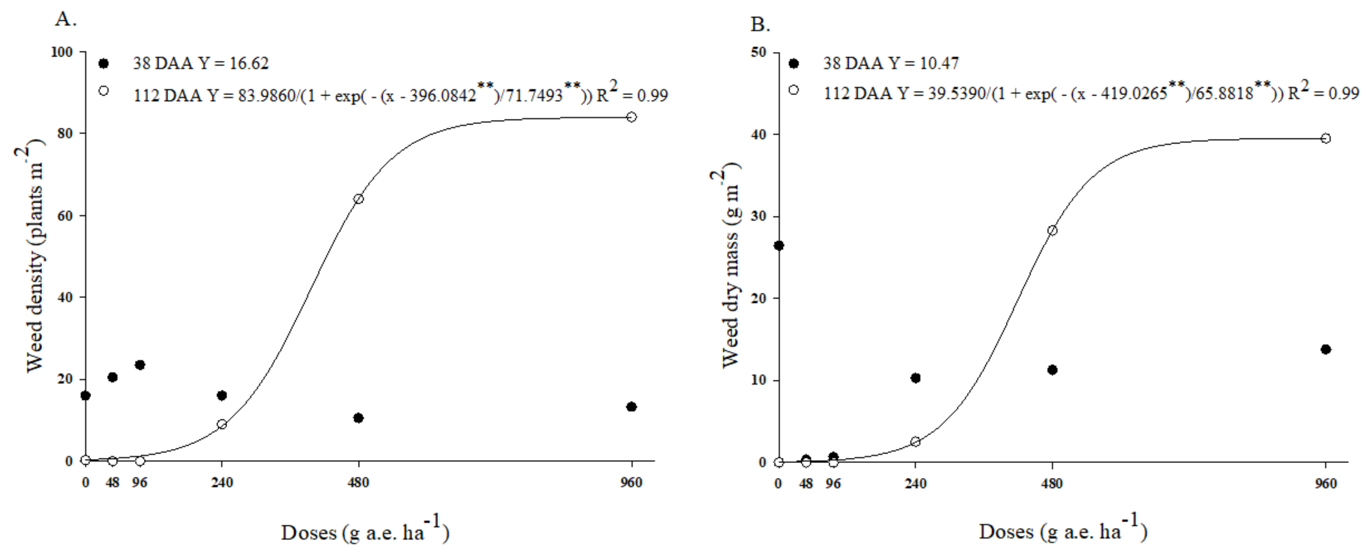
Table 3. Summary of analysis of variance for weed density (WD38) and weed dry mass (WDM38) at 38 days after application of treatments and weed density (WD112) and weed dry mass (WDM112) at 112 after application of treatments

SV	DF	Mean squares			
		WD38	WDM38	WD112	WDM112
Treatment	6	1.4142^{ns}	8.0986**	65.5454**	24.9119**
Block	3	0.4628^{ns}	2.6321^{ns}	3.1522^{ns}	1.8799^{ns}
Error	18	1.4174	1.7786	1.9002	1.9147
C.V. (%)		29.26	52.16	31.39	48.21

** and ^{ns} - Significant at p ≤ 0.01 and non-significant by the F-test, respectively

a.e. ha^{-1}. The dry mass of weeds found in maize monocropping was 31.1 g m^{-2}.

The lower density and dry mass of weeds at the lower doses may be associated with the response in height and yield of the forage to glyphosate applications (Figures 2A and B), exerting crop control in the weed community, similar to those reported by Ceccon et al. (2010), who found that the crop control caused by the forage can assist in the suppression caused by underdosing in weeds, mainly due to the reduction of luminosity for the weeds, as well as the competition exerted by space, water, and nutrients.



** - Significant at p ≤ 0.01 by F-test; Density and dry mass of weeds in maize monocropping (112 DAA): 84 plants m^{-2} and 31.1 g m^{-2}, respectively

Figure 4. Weed density (A) and weed dry mass (B) according to the glyphosate doses at 38 and 112 days after application of treatments (DAA)

Table 4. Summary of analysis of variance for the number of ears (NEP), percentage of lodged plants (PLP), plant height (PH), stem diameter (SD), first ear insertion height (EIH), ear length (EL), number of rows per ear (NRE), number of grains per row (NGR), thousand grain weight (TGW), and yield (YIEL) of maize intercropped with *M. maximus* BRS Quênia

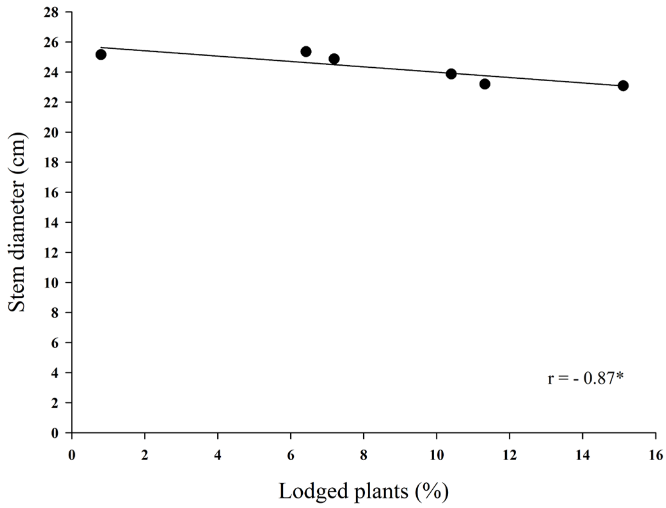
SV	DF	Mean squares									
		NEP	PLP	PH	SD	EIH	EL	NRE	NGR	TGW	YIEL
Treatment	6	10.7261^{ns}	141.9136**	0.0002^{ns}	4.3161**	0.0020^{ns}	2.2815^{ns}	0.0101^{ns}	12.5810^{ns}	2954.0801**	3174875.2965**
Block	3	7.8452^{ns}	6.7435^{ns}	0.0032^{ns}	2.3637*	0.0073^{ns}	0.8160^{ns}	0.0009^{ns}	32.6081^{ns}	1516.3616*	333761.2403^{ns}
Error	13	12.1230	6.6286	0.0038	0.7756	0.61	0.9569	0.0094	16.1720	452.2524	507466.0949
C.V. (%)		9.59	34.48	5.31	3.60	3.80	5.10	2.33	12.99	7.83	9.30

**, *, and ns - Significant at $p \leq 0.01$ and $p \leq 0.05$ and non-significant by the F-test, respectively

For the variables analyzed in maize plants intercropped with *M. maximus* BRS Quênia (Table 4), the treatments did not influence the number of ears per plant (NEP), plant height (PH), ear insertion height (EIH), ear length (EL), number of rows per ear (NRE), and number of grains per row (NGR). The treatments significantly influenced the percentage of lodged plants (PLP), stem diameter (SD), thousand grain weight (TGW), and yield (YIEL).

Smaller values for stem diameter occurred for glyphosate doses below 113.8 g a.e. ha^{-1} because, according to the adjusted model, it was the dose to reach 50% in the response variable (Figure 5A). The reduction in stem diameter was due to the competition exerted by the grass with maize plants since there was no suppression of forage growth in the respective doses. This also influenced the percentage of lodged plants (Figure 5B), which was fitted to a decreasing linear model. Therefore, in the treatments in which the forage did not have its growth suppressed by the treatments, there was a reduction in stem diameter and an increase in the percentage of lodged plants.

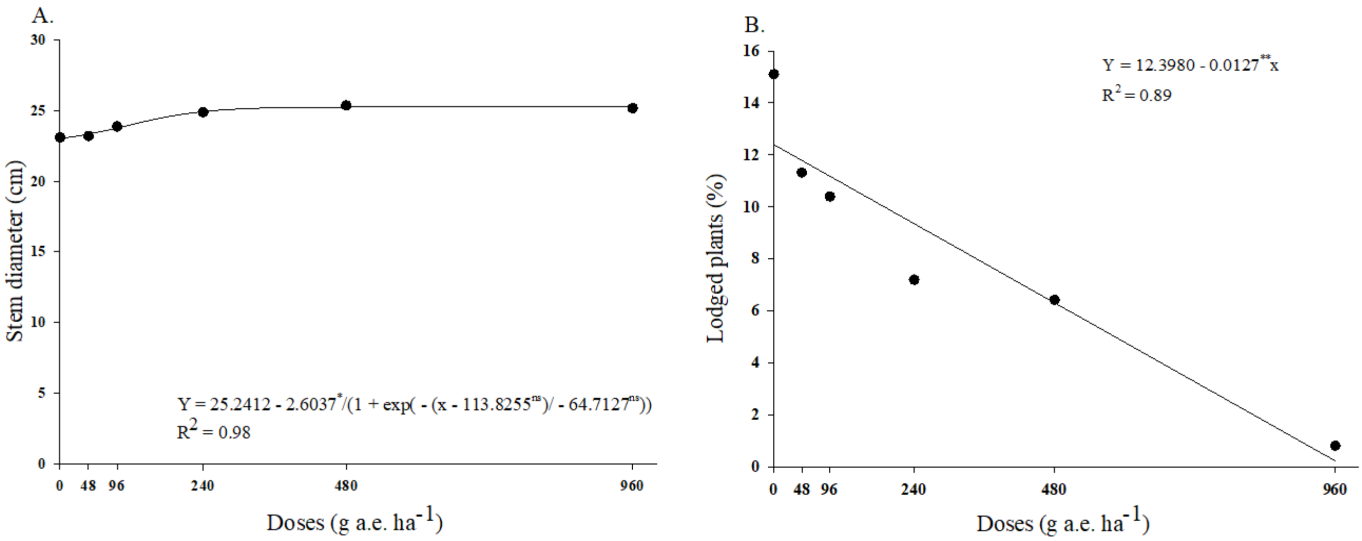
Maize intercropped with *Urochloa* spp. may not have reduced grain yield (Almeida et al., 2017); however, forages of the *Megathyrsus* genus, due to their vigorous growth habit and yield potential, have a great capacity to compete with cereal (Jakelaitis et al., 2010). This was observed in this study since the competition exerted by the forage reduced the stem diameter of the plants, and consequently, there was a higher percentage of lodged plants (Figure 6). This highlights the need to adequately suppress the forage growth so that the intercropping can be made viable.



* - Significant at $p \leq 0.05$ by Pearson correlation

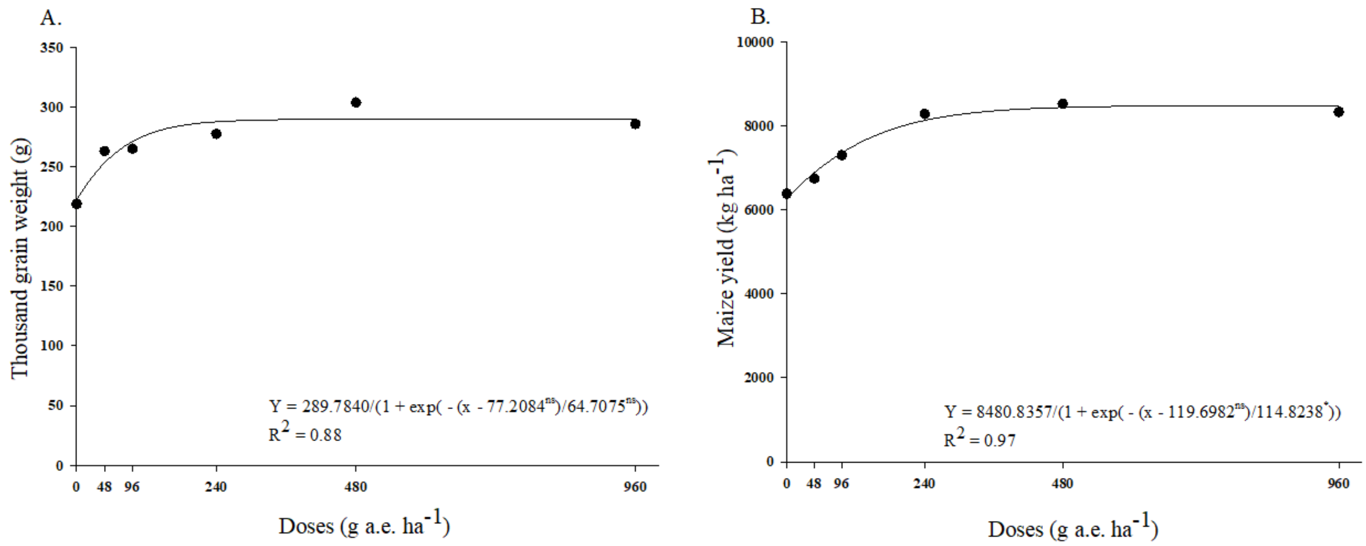
Figure 6. Correlation between stem diameter and percentage of lodged plants of maize intercropped with *M. maximus* BRS Quênia

For the thousand grain weight (Figure 7A) and grain yield (Figure 7B) of maize, there was a similar influence of glyphosate doses on these two variables, as the smaller values were observed when low doses were used, 77.20 and 119.69 g a.e. ha^{-1}, respectively. Intercropped forages can interfere with maize yield, making this cropping system economically unfeasible, as reported by Adegas et al. (2011), where they found a 45% reduction in maize yield in intercropping with *Urochloa ruziziensis*.



**, *, and ns - Significant at $p \leq 0.01$and $p \leq 0.05$ and non-significant, respectively, by the F-test; Stem diameter and lodged plants in maize monocropping: 25.62 cm and 0 %, respectively

Figure 5. Stem diameter (A) and percentage of lodged plants (B) of maize plants intercropped with *M. maximus* BRS Quênia according to the glyphosate doses



*; ns - Significant at $p \leq 0.05$ and non-significant, respectively, by F-test; Thousand grain weight and yield of the maize monocropping: 287.50 g and 8,734.29 kg ha^{-1}, respectively

Figure 7. Thousand grain weight (A) and yield (B) of maize intercropped with M. maximus BRS Quênia according to the glyphosate doses

In this study, comparing the yield of maize intercropped with *M. maximus* BRS Quênia without glyphosate application with the yield obtained from the maize monocropping, there was a reduction of 37.58% in this variable. Considering the dose of 260.87 g a.e. ha^{-1} glyphosate, which obtained 50% of the response variable for forage yield, the reduction in maize yield was 25%.

Cruvinel et al. (2021) investigated the suppression of different *Megathyrsus maximus* cultivars and found that the BRS Quênia was the least sensitive to glyphosate application. This fact, combined with the reduction in maize yield obtained in this experiment after the application of low doses of glyphosate, evidence once again the need to apply an assertive dose of herbicide to suppress the growth of this forage to enable intercropping.

Conclusions

1. The glyphosate dose of 260.87 g a.e. ha^{-1} can be used to suppress the initial competition of *Megathyrsus maximus* cv. BRS Quênia in intercropping with transgenic maize.
2. The presence of *Megathyrsus maximus* cv. BRS Quênia, after application of 260.87 g a.e. ha^{-1}, assists in weed control by exerting crop control.

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