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Interference of glyphosate-resistant sourgrass regrowth density on soybean development and yield

Interferência da densidade de rebrota de capim-amargoso resistente ao glifosato no desenvolvimento e na produtividade da soja

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A B S T R A C T

Sourgrass is a prevalent weed species in various agricultural systems and poses a persistent challenge in soybean crops due to its glyphosate resistance, high aggressiveness, and strong establishment capacity in no-tillage systems. However, studies investigating the interference of sourgrass regrowth in soybean cultivation remain limited. Thus, the objective of this study was to assess the impact of increasing densities of glyphosate-resistant sourgrass regrowth on the development and yield of 'TMG-7067' soybean. The experiment was conducted in a randomized complete block design with seven treatments and four replications. Treatments were arranged in a factorial arrangement, with factors being the duration of coexistence (49, 61, 90, and 117 days) and sourgrass densities (0, 1, 2, 3, 4, 5, and 6 plants m^{-2}). The evaluated parameters included plant height, stem diameter, leaf area, and first pod insertion height, number of pods, dry matter, and grain yield. Soybean exhibited significant yield losses in all treatments with sourgrass presence, exceeding 40% compared to the control. Densities of one or more sourgrass regrowth plants m^{-2} resulted in maximum interference in soybean development and yield.

Keywords: *Digitaria insularis* (L.) Fedde, *Glycine max* (L.) Merrill, weed competition, glyphosate resistance

R E S U M O

O capim-amargoso é uma espécie daninha prevalente em diversos sistemas agrícolas e representa um desafio persistente para a cultura da soja devido à sua resistência ao glifosato, alta agressividade e forte capacidade de estabelecimento em sistemas de plantio direto. No entanto, estudos que investigam a interferência do rebrote do capim-amargoso no cultivo da soja ainda são limitados. Assim, o objetivo deste estudo foi avaliar o impacto do aumento da densidade de rebrote de capim-amargoso resistente ao glifosato no desenvolvimento e na produtividade da soja 'TMG-7067'. O experimento foi conduzido em delineamento de blocos casualizados com sete tratamentos e quatro repetições. Os tratamentos foram dispostos em arranjo fatorial, sendo os fatores a duração da coexistência (49, 61, 90 e 117 dias) e a densidade de capim-amargoso (0, 1, 2, 3, 4, 5 e 6 plantas m^{-2}). Os parâmetros avaliados incluíram altura da planta, diâmetro do colmo, área foliar, altura de inserção da primeira vagem, número de vagens, matéria seca e produtividade de grãos. A soja apresentou perdas significativas de produtividade em todos os tratamentos com presença de capim-amargoso, superiores a 40% em comparação com o controle. Densidades de uma ou mais plantas de capim-amargoso por metro quadrado resultaram em interferência máxima no desenvolvimento e na produtividade da soja.

Palavras-chave: *Digitaria insularis* (L.) Fedde, *Glycine max* (L.) Merrill, competição, resistência a glifosato

INTRODUCTION

Soybean (*Glycine max*) crops are highly economically significant in Brazil and globally. Soybean grains are a primary component of animal feed, particularly for poultry and swine and have significant importance in human nutrition as one of the main protein sources in the world (Tetteh *et al*., 2022). Soybean oil is also relevant, accounting for 56% of the total global vegetable oil supply (Silva *et al*., 2015).

Brazil is one of the world's leading producers and exporters of soybean. During the 2023–2024 growing season, the cultivated area reached 44.03 million hectares, with a production of 155.7 million Mg and a mean yield of 3,537 kg ha^{-1}. Domestic consumption was estimated at 56.221 million Mg, while export totaled 95.640 million Mg, resulting in a total grain demand of 151.861 million Mg (CONAB, 2024).

Soybean yield is affected by various factors, including interference by weeds, primarily through resource competition. Competition is defined as a situation in which the resources or environmental conditions required by one or more organisms within a community are insufficient to meet the needs of all individuals (Rizzardi *et al*., 2022). Weed interference in cultivated plants depends on factors related to the specific composition, density, and distribution of the weed community, the crop species or cultivar, spacing, and seeding density, edaphoclimatic characteristics, and the duration and timing of coexistence (Rizzardi *et al*., 2022).

Weed species commonly found in soybean crops adversely affect trifoliate leaf formation, dry matter, number of pods, number of grains per pod, and grain weight, resulting in yield reductions of up to 94% when no control measures are implemented (Braz *et al*., 2021). The greater the rusticity of weed species, the higher their competitive advantage over soybean, as they exhibit lower physiological requirements, high growth rates, and greater tolerance to environmental variability (Ibanhes Neto *et al*., 2020). The relative density of weeds and the crop defines the degree and intensity of competition in agricultural fields.

Sourgrass (*Digitaria insularis*), a widespread weed species in soybean fields, causes significant yield losses (Ibanhes Neto *et al*., 2020). According to Gazziero *et al*. (2012), sourgrass initially grown from seeds significantly reduced soybean yield at densities exceeding 4 plants m^{-2}, reaching the highest interference level at 8 plants m^{-2}. In another study, to determine the coexistence period of the 'TMG7063 IPRO' soybean with a weed community predominated by *D. insularis*, Piazentine *et al*. (2024) concluded that this weed community reduces soybean yield by up to 59.3%, and the soybean can coexist with this weed community for up to nine days after sowing, considering a yield loss of up to 5%; for 10%, the PPI increases to 37 days.

Studies have shown that sourgrass not only competes directly for essential resources, such as light, water, and nutrients but also significantly reduces crop yields (Da Silva *et al*., 2024; Piazentine *et al*., 2024). Despite its intense competitiveness and high aggressiveness, sourgrass exhibits slow initial growth during the first 45 days after emergence (Machado *et al*., 2006), which may favor its suppression by soybean plants (Gazziero *et al*., 2019). However, in regrowth scenarios, initial growth is not slow due to the plant's well-formed root system, which confers highly competitive ability with cultivated species (Guidugli *et al*., 2024).

Sourgrass regrowth in cultivation areas represents one of the main challenges in managing this species (Gritti *et al*., 2024). Moreover, these plants can develop rhizomes, which enable regrowth and hindering their control due to increased starch accumulation and tissue differentiation (Machado *et al*., 2008; Amaral *et al*., 2023). These differentiated tissues act as a barrier to herbicide translocation, facilitating rapid regrowth and suppression of cultivated plants (Silveira *et al*., 2018). Consequently, the excessive use of herbicides with a single mechanism of action has directly contributed to an increase in cases of species resistant to specific molecules.

The resistance of sourgrass to glyphosate is widely documented both in South America and globally. In Brazil, glyphosate-resistant sourgrass was first identified in 2008 in the state of Paraná (Correia, 2023), and in 2009 in the state of São Paulo (Carvalho *et al*., 2011; Amaral *et al*., 2023). This resistance had significant impacts on both annual and perennial crop systems (Cesarin *et al*., 2019; Guidugli *et al*., 2024).

Glyphosate-resistant sourgrass populations identified in Brazil are characterized by the absence of mutations in the gene encoding the herbicide's target enzyme (Moisinho *et al*., 2024). However, these populations can inhibit systemic translocation of herbicide within the plant (Suzukawa *et al*., 2020). Differences in translocation between biotypes have also been observed and appear to be a major factor contributing to glyphosate insensitivity (Martins *et al*., 2016). In addition, individuals remaining in the field due to this resistance perpetuate the species' presence, especially in the no-tillage system, where the soil is not disturbed.

Studies investigating the interference of sourgrass regrowth remain limited. Research on the effects of sourgrass populations originating from regrowth in coexistence with soybean crops can provide insights into their quantitative and qualitative impacts on the crop, as well as guidance for optimizing management strategies. In this context, the objective of this study was to assess the impact of increasing densities of glyphosate-resistant sourgrass regrowth on the development and yield of 'TMG-7067' soybean.

MATERIAL AND METHODS

Experiment location and implementation

The experiment was conducted at the Teaching, Research, and Extension Farm (FEPE) of the School of Agricultural and Veterinary Sciences, São Paulo State University (UNESP), in Jaboticabal, SP, Brazil (21°15′22″S, 48°18′58″W and 595 m altitude).

The experimental area had a confirmed history of predominant infestation by glyphosate-resistant sourgrass (*Digitaria insularis*) (Carvalho *et al*., 2011; Martins *et al*., 2016; Cesarin *et al*., 2019; Guidugli *et al.,* 2024). Chemical analysis of composite soil samples from the 0–20 cm layer showed a pH of 5.7; 13 g dm^{-3} of organic matter; 41 mg dm^{-3} of P; and 2.3, 24, and 8 mmolc dm^{-3} of K, Ca, and Mg, respectively, resulting in a base saturation of 61%.

The soil was prepared under a no-tillage system. A seeder-fertilizer machine with five rows (Jumil Exacta® PD) was used for planting, distributing fourteen seeds per meter at a depth of 3–4 cm, with a spacing of 0.45 m between rows. Soil fertilization at planting consisted of the application of 300 kg ha^{-1} of a 04-28-08 N-P-K formulation.

The soybean cultivar used was 'TMG-7067', which has a semi-determinate growth habit, a cycle of 110–115 days, and a maturity group 7.2. Seeds were treated with Carbendazim fungicide (100 mL per 100 kg of seeds) and inoculated with *Bradyrhizobium japonicum* prior to planting.

Experimental design and treatments

The field experiment was conducted using a randomized complete block design with seven treatments and four replications. Treatments were arranged in a factorial arrangement, with factors being the duration of coexistence (49, 61, 90, and 117 days after soybean emergence) and sourgrass densities (0, 1, 2, 3, 4, 5, and 6 plants m^{-2}). Each plot consisted of five 6-meter soybean rows, with a total area of 13.5 m^2. Sampling and evaluations were conducted in the three central rows, excluding 0.5 m from each end, resulting in a sampling area of 6.75 m^2.

All weeds were removed by manual weeding before soybean sowing, leaving only the required number of sourgrass clumps in each plot. The specific sourgrass density levels were maintained through manual weeding.

Evaluated variables

Plant height was measured on two soybean plants per plot at 49, 61, 90, and 117 days after crop emergence (DAE). Stem diameter, leaf area (LI 3000A, LI-COR), and dry matter in leaves and stems were assessed at 49, 61, and 90 DAE. First pod insertion height and number of pods were determined at 61, 90, and 117 DAE. Pod dry matter was measured at 61 and 90 DAE. Dry matter was assessed by drying the plant material in a forced-air oven at 70°C until constant weight.

Soybean plants from all plots were harvested when grain moisture content was approximately 13%. Pods were mechanically threshed using a grain thresher (Nogueira®), and the harvested grains were weighed on a precision scale (0.01 g resolution) to estimate grain yield (kg ha^{-1}).

Statistical analysis

Data was analyzed using analysis of variance (ANOVA) with the F-test, and significant means were compared using Tukey's test at a 5% significance level. Regression analyses were conducted to evaluate relationship between variables.

RESULTS

Increasing sourgrass (*Digitaria insularis*) density adversely affected soybean growth, reducing plant height, stem diameter, leaf area, and dry matter over time following crop emergence (Figure 1). Plant height increased throughout crop development (Figure 1a) but varied with sourgrass density. Soybean plants grown with sourgrass at 1 to 3 plants m^{-2} showed no significant difference in height compared to those grown without weeds

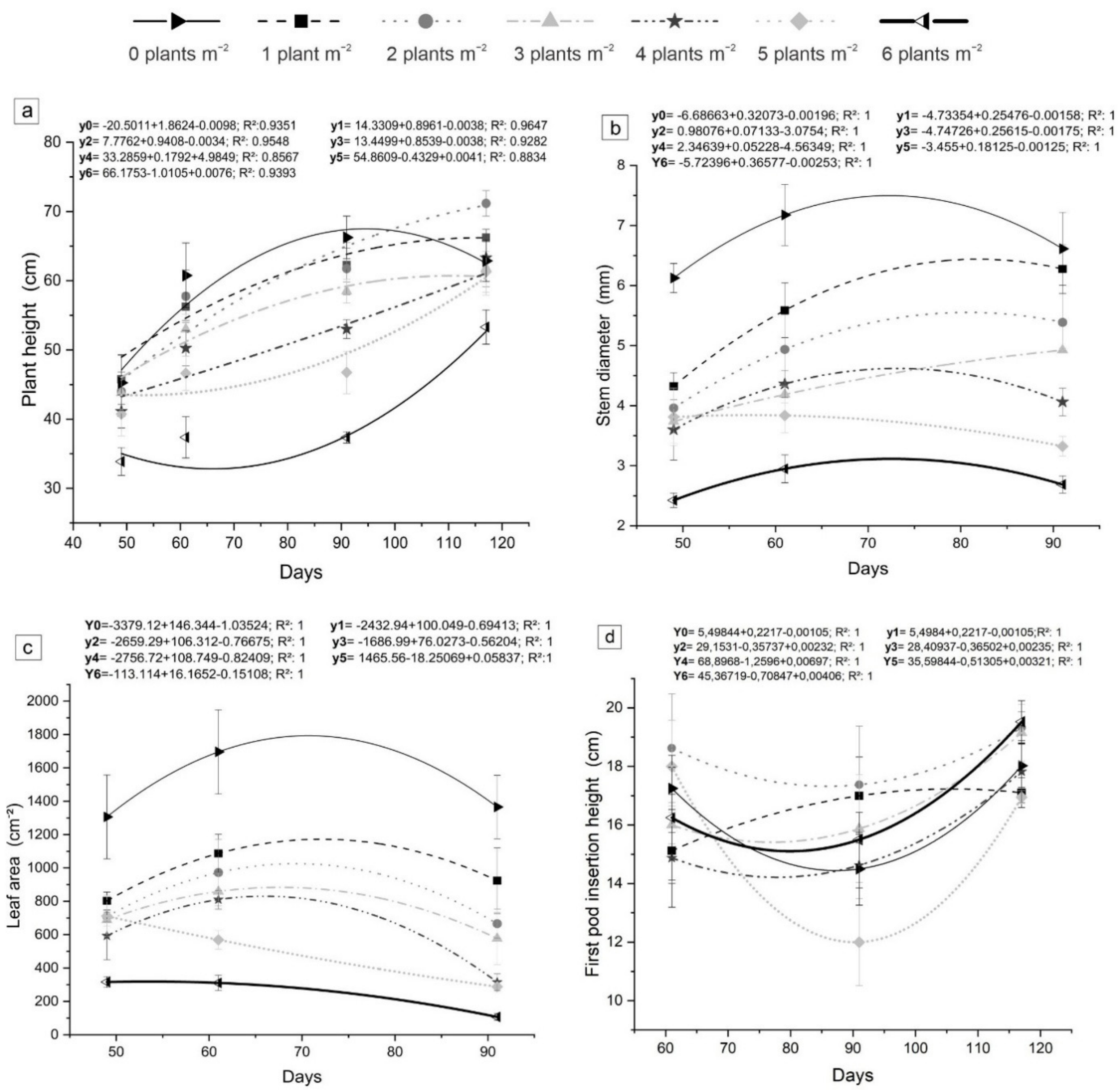

Figure 1 - Plant height (a), stem diameter (b), leaf area (c), and first pod insertion height (d) of soybean plants under increasing densities of sourgrass (*Digitaria insularis*) up to 117 days after crop emergence.

(Table 1), with mean heights of 57.61, 58.66, and 54.29 cm, respectively. Plant height decreased with increasing sourgrass density, with a pronounced reduction of approximately 31% at 6 plants m^{-2} compared to the control (Figure 1a).

Increasing sourgrass density adversely affected soybean stem diameter (Figure 1b). The control treatment (no weeds) had a mean stem diameter of approximately 6.63 mm, with a significant and consistent reduction with increasing sourgrass density. Mean stem diameter was reduced to 3.44 mm at sourgrass densities of 4, 5, and 6 plants m^{-2} (approximately 50% reduction compared to the control) and by approximately 27% at lower densities (Table 1).

The control treatment had a mean leaf area was 1,455.81 cm^2, which decreased to 937.89 cm^2 at a sourgrass density of 1 plant m^{-2}, representing a reduction of approximately 35% (Figure 1c). Leaf area continued to decrease with increasing density, reaching 244.64 cm^2 at 6 plants m^{-2}, an 83.20% reduction compared to the control (Table 1).

Mean first pod insertion height (Figure 1d) was consistent across treatments, with no statistical differences (Table 1), averaging approximately 16.67 cm at 117 days after crop emergence (DAE).

The control treatment had a mean leaf dry matter of 7.9 g at 90 DAE (Figure 2a), which decreased to 3.6 g at a density of 1 plant m^{-2}, a reduction of approximately 50% compared to the control. The percentage reduction increased progressively up to a density of 6 plants m^{-2}, with soybean plants exhibiting a mean of 0.5 g, representing a reduction of 93.67%. A general increase in leaf dry matter was observed for all densities up to 61 DAE (Table 2a), followed by a significant decrease by 90 DAE for densities of 2, 3, 4, and 5 plants m^{-2}.

Stem and branch dry matter differed significantly between the control and sourgrass treatments (Table 1). Stem dry matter at sourgrass density of 1 plant m^{-2} was similar to the control, with a mean of 7.40 g, but decreased progressively with increasing sourgrass density, reaching 1.57 g at 6 plants m^{-2}, an 86.50% reduction compared to the control (Table 1).

The control treatment had a mean of 48.25 of pods per plant at 117 DAE, while plots with a sourgrass density of 1 plant m^{-2} had a mean of 31.27 pods, a

Table 1 - Plant height (PH), stem diameter (SD), leaf area (LA), leaf dry matter (LDM), stem dry matter (SDM), pod dry matter (PDM), number of pods per plant (NPP), and first pod insertion height (FPH) of soybean plants under increasing densities of sourgrass (*Digitaria insularis*) up to 117 days after crop emergence (DAE)

Factor	PH (cm)	SD (mm)	LA (cm^2)	FPH (cm)	NPP	LDM (g)	SDM (g)	PDM (g)
DAE (a)								
49	42.08 c	3.99 b	732.57 b	------	------	3.17 b	4.22 b	------
61	51.17 b	4.71 a	900.84 a	16.58 b	20.75 b	4.06 a	5.81 a	1.56 b
91	55.12 b	4.75 a	606.01 b	15.26 b	26.50 a	2.87 b	6.60 a	11.92 a
117	62.86 a	------	------	18.26 a	28.16 a	------	------	------
Density (b)								
0	58.78 a	6.63 a	1455.81 a	16.40 a	48.41 a	7.54 a	11.63 a	14.32 a
1	57.61 ab	5.39 b	937.89 b	18.44 a	31.09 b	3.83 b	7.40 b	8.79 b
2	58.66 a	4.76 bc	782.51 bc	17.00 a	27.44bc	3.57 b	5.79 bc	7.68 b
3	54.29 abc	4.28 cd	708.48 bc	15.77 a	23.71cd	2.58 c	4.85 bc	6.77 bc
4	51.91 bc	4.00 cd	573.00 c	15.65 a	18.33de	2.49 c	4.11 cd	4.57 cd
5	48.85 c	3.65 d	522.99 cd	17.09 a	16.56 e	2.49 c	3.46 cd	3.48 de
6	40.48 d	2.68 e	244.64 d	16.4 a	10.4 f	1.08 d	1.57 d	1.58 e
F (a)	61.10**	10.17**	9.01**	9.74**	18.84**	23.02**	9.26**	417.46**
F (b)	20.67**	38.80**	25.72**	1.64^{NS}	81.96**	108.32**	28.52**	38.71**
F (a×b)	0.94 ^{NS}	1.56 ^{NS}	0.80 ^{NS}	0.86 ^{NS}	3.44**	3.9**	1.75 ^{NS}	26.91**
C.V. (%)	**11.01**	**15.76**	**34.92**	**15.27**	**18.46**	**20.16**	**37.96**	**28.11**

Means followed by different letters in the columns differ from each other by Tukey's test at 5% probability. ** = significant at 1% probability by the F test. NS = not significant at 5% probability by the F test. C.V. = coefficient of variation.

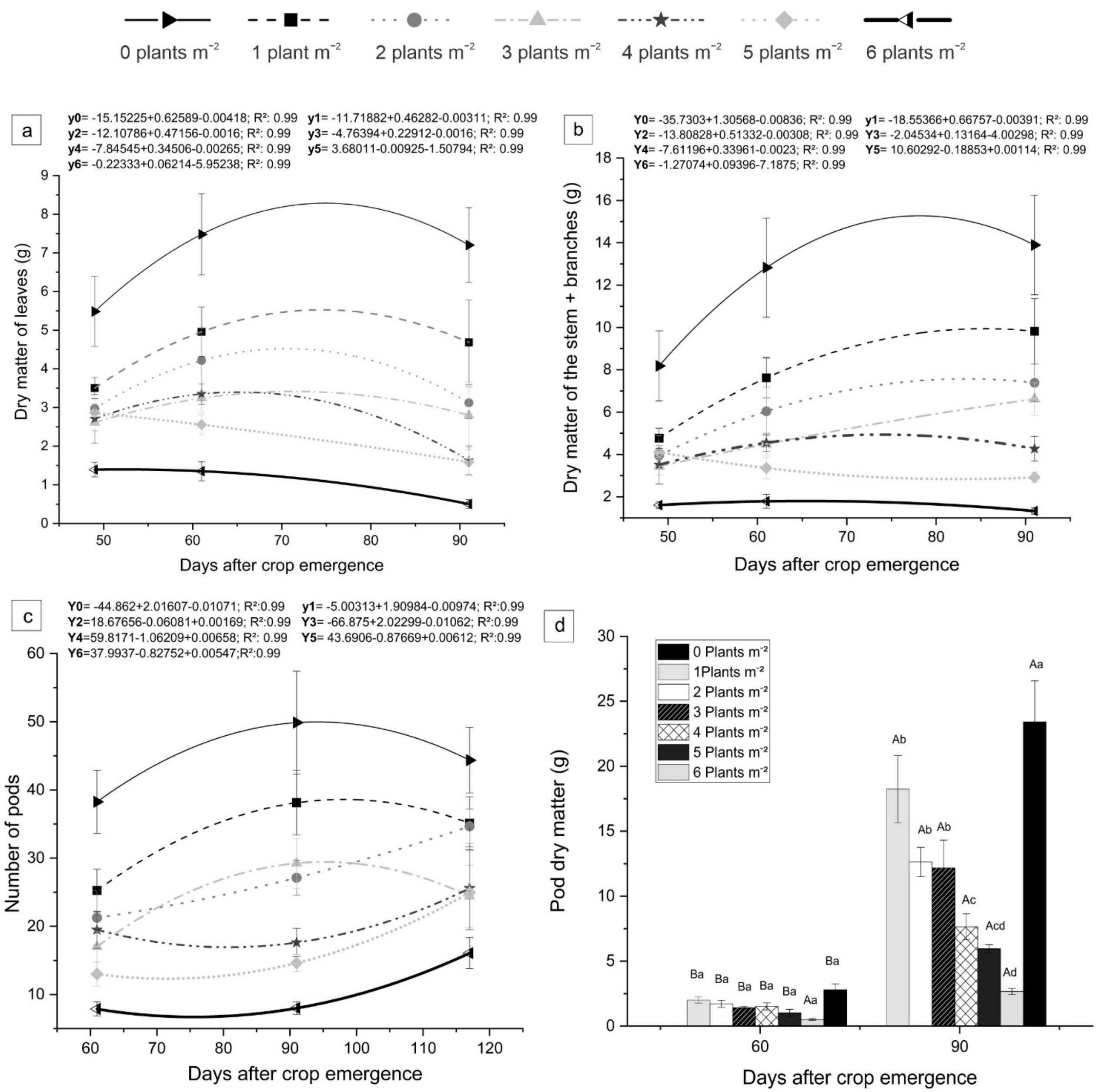

Figure 2 - Leaf dry matter (a), stem and branch dry matter (b), number of pods (c), pod dry matter (d) of soybean plants under increasing densities of sourgrass (*Digitaria insularis*) up to 117 days after crop emergence. In Figure 2D, bars with the same uppercase letters within plant densities, or the same lowercase letters within days after emergence, are not significantly different by Tukey's test at 5% probability.

35.19% reduction. The mean number of pods per plant at sourgrass density of 6 plants m^{-2} was 16.07, a 66.7% reduction.

Soybean stems were still branching and developing at 60 DAE, with no significant differences in pod dry matter across sourgrass densities (Table 2c). However, pod dry matter was significantly reduced at 91 DAE, with control plants averaging 11.6 g and plants at the highest sourgrass density (6 plants m^{-2}) averaging 1.57 g, an 86.5% reduction (Figure 2d).

Table 2 - Effects of days after crop emergence and sourgrass (*Digitaria insularis*) density on leaf dry matter (a), pod dry matter (b), and number of pods (c) of soybean plants under increasing densities of sourgrass up to 117 days after crop emergence (DAE)

a) Leaf dry matter (g)								
Density (plants m^{-2})								
DAE	0	1	2	3	4	5	6	$F_{(DAE)}$
49	6.16 Aa	3.50 Ab	2.97 Ab	2.61 Abbc	2.24 ABbc	3.34 Ab	1.39 Ac	19.46**
61	8.55 Ba	4.36 Abc	5.015 Bb	3.24 Acd	3.35 Acd	2.55 ABde	1.35 Ae	46.09**
90	7.90 Ba	3.62 Ab	2.73 Abc	1.90 Bcd	1.88 Bcd	1.59 Bcd	0.50 Ad	50.57**
$F_{(Dens)}$	13.17**	1.90^{NS}	13.57**	3.87*	5.08**	6.65**	2.19^{NS}	
b) Number of pods per plant								
Density (plants m^{-2})								
DAE	0	1	2	3	4	5	6	$F_{(DAE)}$
61	42.25 Ba	28.00 Ab	24.62 Abc	14.62 Bcd	17.25 Acd	11.37 Bd	7.12 Bd	25.29**
90	54.75 Aa	34.00 Ab	25.65 Abc	32.12 Ab	17.62 Acd	13.37 Bd	8.00 Bd	43.87**
117	48.25 Aa	31.27 Ab	32.07 Ab	24.40 Abc	20.12 Ac	24.95 Abc	16.07 Ac	19.67**
$F_{(Dens)}$	6.95**	1.61^{NS}	2.91^{NS}	13.68**	0.43^{NS}	9.55**	4.33*	
c) Pod dry matter (g)								
Density (plants m^{-2})								
DAE	0	1	2	3	4	5	6	$F_{(DAE)}$
61	2.80 Ba	2.0 Ba	1.71 Ba	1.41 Ba	1.51 Ba	1.022 Ba	0.50 Aa	0.59^{NS}
90	25.84 Aa	15.58 Ab	11.84 Ab	13.94 Ab	7.64 Ac	5.95 Acd	2.66 Ad	65.02**
$F_{(Dens)}$	295.08**	102.62**	56.99**	87.22**	20.88**	13.53**	2.60^{NS}	

Means followed by the same lowercase letter in the rows, or uppercase letters in the columns, do not differ from each other by Tukey's test at 5% probability. * and ** = significant at 5% and 1% probability, respectively, by the F test. NS = not significant at 5% probability by the F test.

Soybean yield was significantly higher in the absence of sourgrass, averaging approximately 1,700 kg ha^{-1} (Figure 3). Soybean yield was reduced by approximately 50% at sourgrass densities of 1, 2, and 3 plants m^{-2} compared to the control, and by approximately 80% at the highest sourgrass density (6 plants m^{-2}).

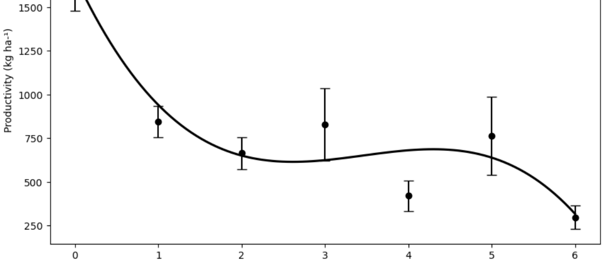

Figure 3 - Soybean grain yield (kg per hectare) under increasing sourgrass (*Digitaria insularis*) densities (plant m^{-2}) square meter.

DISCUSSION

Sourgrass regrowth significantly reduced soybean growth and yield parameters, even at the lowest density (1 plant m^{-2}) (Table 1; Figures 1 and 3). This reduction may be attributed to, among other factors, the high compensatory capacity of sourgrass after regrowth, enabling recovery from aboveground biomass loss and resulting in plants with greater vigor and adaptability, thus increasing their interference with the crop (Gritti *et al.*, 2024). Glyphosate resistance is also a critical factor, as susceptible sourgrass biotypes cause yield losses of up to 37% at a density of 6 plants m^{-2} (Gazziero *et al.*, 2019), whereas resistant biotypes can cause losses of up to 57% at only 2 plants m^{-2} (Braz *et al.*, 2021). Resistant sourgrass biotypes exhibit an enhanced ability to exploit nutrient-rich soil zones, establishing dominance to the detriment of cultivated crops (Pereira *et al.*, 2017).

Interspecific competition significantly impacts soybean crops, particularly by reducing chlorophyll a and b concentrations. Freitas Souza *et al.* (2024) reported that the presence of sourgrass caused an imbalance in chlorophyll production in maize plants, reducing light energy capture and, consequently, the photosynthetic rate. Tomazzini *et al*. (2022) observed a reduction in total chlorophyll content in common bean plants prior to flowering with increasing sourgrass density. This phenomenon may reflect the mobilization of essential nutrients, such as nitrogen (N) (Tomazzini *et al*., 2022) and magnesium (Mg^{2+}) (Freitas Souza *et al*., 2024).

Increases in density of glyphosate-resistant sourgrass significantly affected soybean growth, as evidenced by reductions in plant height, stem diameter, leaf area, and dry matter (Table 1). These findings align with prior studies by Machado *et al*. (2008) and Pereira *et al*. (2017), which reported the competitive capacity of glyphosate-resistant sourgrass for growth resources, particularly 35 days after emergence, when the plant develops a system of rhizomes, which it uses for propagation and nutrition under conditions of resource scarcity (Correia *et al*., 2015).

Soybean plants competing with sourgrass regrowth did not exhibit branch etiolation. In contrast, Braz *et al*. (2021) reported a linear increase in soybean plant height at 14 and 35 days after crop emergence (DAE), with plants reaching 45 to 50 cm at sourgrass densities of 4, 6, and 8 plants m^{-2}. The absence of etiolation in soybean plants in the present study may be attributed to stress from intense competition with sourgrass regrowth, whose well-developed root system enhanced nutrient uptake, thereby limiting the soybean plant ability to rapid develop morphological adaptations and reducing plant height and stem diameter (Figures 1a and 2b).

Leaf area was significantly reduced at higher sourgrass densities, consistent with trends observed in other growth parameters (Figure 1c and Table 1). The reduced leaf area limited solar energy interception and photosynthetic CO_2 assimilation, thereby reducing dry matter accumulation (Raza *et al*., 2022). In this study, a sourgrass density of 1 plant m^{-2} reduced leaf area by 35%, affecting all soybean dry matter parameters (Figure 1 and Table 1).

Sourgrass interference significantly reduced soybean dry matter accumulation at the lowest sourgrass density (1 plant m^{-2}), with reductions of 37.5%, 30.9%, and 26% in leaf dry matter, stem and branch dry matter, and pod dry matter, respectively, at 91 DAE (Figures 2a, 2b, and 2d). Braz *et al*. (2021) reported progressive reductions in soybean shoot dry matter with increasing density of non-regrowth sourgrass plants, reaching a 55% reduction at 8 plants m^{-2}. Similar effects were reported in cowpea seedlings (Tomazzini *et al*., 2022), maize hybrids (Galon *et al*., 2025) and eucalyptus seedlings (Guidugli *et al*., 2024). This effect is particularly detrimental for soybean and other cereals, as reduced leaf area limits light interception and photosynthesis, resulting in insufficient assimilates for grain formation (Rambo *et al.,* 2003).

Reductions in soybean dry matter accumulation directly affect yield parameters, adversely impacting grain yield and quality (Correia, 2023). Similar reductions in grain yield associated with decreased dry matter accumulation have been reported in other legumes, including cowpea (Tomazzini *et al*., 2022) and chickpea (Amaral *et al*., 2013). Raza *et al*. (2022) noted that the number of pods and seeds in soybean depends on the balance between the dry matter allocation in vegetative and reproductive structures, which can be compromised by reduced production of photoassimilates.

Although increasing sourgrass density at 90 DAE progressively reduced pod dry matter (Figure 2d), these reductions did not significantly affect soybean yield, as no significant variation in grain yield was observed across the sourgrass densities at 117 DAE (Figure 3). Thus, pod dry matter may not be directly correlated with soybean grain yield, as it reflects structural modifications rather than grain quantity.

Sourgrass significantly reduced soybean yield even at the lowest density (1 plant m^{-2}) (Figure 3), consistent with Gazziero *et al.* (2019), who reported the low competitive ability of soybean in the presence of sourgrass regrowth. The erect growth habit of sourgrass, which enhances light interception, likely contributes to the reduced ability of soybean plants to establish and compete effectively with this weed (Amaral *et al*., 2023).

The competitive advantage of sourgrass regrowth in this study is attributed to its rhizomatous origin, which confers enhanced competitive traits, including greater shade tolerance, higher stomatal density, and thicker cuticles (Bukovac *et al*., 1990; Machado *et al*., 2008). These traits highlight the importance of controlling sourgrass before rhizome formation, which typically occurs around 45 days after emergence (Machado *et al*., 2006).

CONCLUSIONS

The glyphosate-resistant sourgrass (*Digitaria insularis*) at densities of 1 to 6 plants m^{-2} significantly reduces the growth and yield of the soybean cultivar TMG-7067. Increasing sourgrass density adversely affects soybean growth parameters, including plant height, stem diameter, leaf area, and dry matter, with significant reductions observed even at densities of 1 plant m^{-2}. Competition from glyphosate-resistant sourgrass regrowth significantly reduces soybean grain yield, with losses of up to 50% at densities of 1 to 3 plants m^{-2}.

AUTHOR CONTRIBUTION

Conceptualization: P.L.C.A.A. Methodology: P.L.C.A.A., A.L.B. Software: V.M.D.P. Validation: P.L.C.A.A. Formal analysis: V.M.D.P., F.R.C.S. Investigation: V.Y.T.S. Resources: A.L.B. Data curation: V.Y.T.S. Writing-original draft: V.Y.T.S., F.R.C.S. Writing-review & editing: P.L.C.A.A, A.L.B., V.M.D.P. Supervision: P.L.C.A.A. Project administration: P.L.C.A.A. Funding acquisition: P.L.C.A.A. All co-authors reviewed the final version and approved the manuscript before submission.

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