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Growth and development of cotton cultivated after *Urochloa* spp.

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ABSTRACT

No-tillage systems (NTSs) are generally known for their beneficial effects, whether on soil attributes or the yield of the target crop. For instance, research has explored the benefits of growing target crops, such as soybean or cotton, on soil previously occupied by a cover crop. However, fewer studies have investigated the potential negative implications of NTSs. Since, certain cover crops can release exudates harmful to other plants, there is a need to fill this knowledge gap. To this end, this study used four experiments to investigate the effects of two species of *Urochloa* on cotton germination, plant emergence, and biomass production. In the first two experiments, cotton germination was evaluated by placing seeds on paper rolls moistened with different concentrations of root washings of *Urochloa* plants cultivated for 45 days in tubes kept in a greenhouse, and desiccated with or without glyphosate. In the other two experiments, the emergence and biomass production of cotton were evaluated, which was sown in pots where two species of *Urochloa* were previously grown and subsequently desiccated or not with glyphosate, and managed in three ways: a) the entire plant of *Urochloa* spp. was kept in the pot (shoots and roots in the soil), b) only the aerial parts of *Urochloa* spp. were kept on the soil surface, and c) only the roots of *Urochloa* spp. were kept in the soil. Cotton seed germination was negatively affected by *Urochloa* spp. root washings. Both the emergence percentage and emergence speed index of the cotton plants were negatively affected when only the leaves of *Urochloa* spp. were kept in the soil with and without glyphosate desiccation. No adverse effect of the treatments (pre-cultivation and management of *Urochloa* spp.) on the production of cotton shoot and root biomass was observed.

Keywords: No-tillage, *Gossypium hirsutum, Brachiaria*

Crescimento e desenvolvimento de algodoeiro cultivado após *Urochloa* spp.

RESUMO

Os sistemas de plantio direto (SPDs) são geralmente conhecidos por seus efeitos benéficos, seja nos atributos do solo ou no rendimento da cultura alvo. A pesquisa tem explorado os benefícios do cultivo de culturas-alvo, como soja ou algodão, em solo previamente ocupado por uma cultura de cobertura. No entanto, poucos estudos investigaram as potenciais implicações negativas dos SPDs. Uma vez que certas plantas de cobertura podem liberar exsudatos nocivos a outras plantas, surge a necessidade de preencher esta lacuna de conhecimento. Para tanto, este estudo utilizou quatro experimentos para investigar os efeitos de duas espécies de *Urochloa* na germinação, emergência de plantas e produção de biomassa do algodoeiro. Nos dois primeiros experimentos, a germinação do algodão foi avaliada colocando-se sementes em rolos de papel umedecidos com diferentes concentrações de lavados de raízes de plantas de *Urochloa* cultivadas por 45 dias em tubetes mantidos em casa de vegetação e dessecadas ou não dessecadas com glifosato. Nos outros dois experimentos foram avaliadas a emergência e a produção de biomassa do algodão, que foi semeado em vasos onde foram previamente cultivadas duas espécies de *Urochloa* e posteriormente dessecadas ou não com glifosato, e manejadas de três maneiras: a) toda a planta de Urochloa spp. foi mantida no vaso (partes aéreas e raízes no solo), b) apenas as partes aéreas de *Urochloa* spp. foram mantidas na superfície do solo, e c) apenas as raízes de *Urochloa* spp. foram mantidos no solo. A germinação de sementes de algodão foi afetada negativamente por lavados de raízes de *Urochloa* spp. Tanto a porcentagem quanto o índice de velocidade de emergência dos algodoeiros foram afetados negativamente quando apenas as folhas de *Urochloa* spp. foram mantidas no solo com e sem dessecação com glifosato. Não foi observado efeito adverso dos tratamentos (pré-cultivo e manejo de *Urochloa* spp.) na produção de biomassa da parte aérea e da raiz do algodoeiro.

Palavras-chave: Plantio direto, *Gossypium hirsutum*, *Brachiaria*.

1. Introduction

Among the cover crops commonly used in the main cotton-growing regions of Brazil, forage grasses of the genus *Urochloa* (Syn.: *Brachiaria*) are the most important crops, with *U. brizantha* and *U. ruziziensis* being the most widely used species. These species can be cultivated either individually or in combination with maize (Ferreira et al., 2020).

One of the main benefits of establishing cover crops prior to cotton sowing, a culture with slow initial growth, is the management of difficult-to-control weeds (Ferreira and Lamas, 2010). However, several species of the Poaceae family, including *Urochloa* spp., produce substances with allelopathic effects, which, in some situations, can affect the germination and initial development of successive crops (Sanches-Moreiras et al., 2004). Senarathne et al. (2010) observed that root washings of *U. brizantha* and *U. milliformis* significantly reduced the seed germination of *Raphanus sativus*, *Capsicum annum*, *Lycopersicom esculentum*, *Crotalaria junica*, and *Chromoleana odorata*. The allelochemical compounds identified in grasses can be divided into four chemical groups: phenolic acids, hydroxaminic acids, alkaloids, and quinones. Sorgoleone is one of the main allelochemicals produced by sorghum plants (*Sorghum bicolor*). The mode of release of allelochemicals and the plant organs where they are located are not specific and may include grains, pollen, root exudates, decomposing straw, and extracts from various plant parts (Sanches-Moreiras et al., 2004).

In experiments carried out by Silva et al. (2018), allelopathic extracts of *U. brizantha* cv. Xaraés and cv. BRS RB331 Ipyporã reduced the vigor and germination of soybean seeds. According to Echer et al. (2012), cotton grown in soils that were previously occupied by *U. ruziziensis* exhibited a reduction in initial root growth and shoot biomass. According to the authors, the lower growth of cotton plants cultivated after foraging could be attributed to the absorption of N by the roots of *U. ruziziensis*, which reduces its availability for cotton plants.

However, Ferreira and Lamas (2010) did not find any adverse effects No-tillage systems (NTSs) are based on direct seeding without soil disturbances, continuous cover cropping, and crop rotation (Hernani and Salton, 1998). There are many benefits of NTS including an evident improvement in the chemical, physical, and biological attributes of the soil and a consequent increase in the sustainability indices of agricultural activity (Escosteguy, 2022). Recently, the use of perennial forage grasses as cover crops has allowed the wide-spread of NTS to the northern regions of Brazil. Specifically for the cotton crop, which exhibits slow initial growth, NTS is greatly beneficial; this is especially true for the management of difficult-to-control weeds, as the soil is occupied by a cover crop prior to cotton cultivation, thus preventing weed emergence (Ferreira and Lamas, 2010).

of prior cultivation with grasses—including *U. ruziziensis*—on cotton productivity. When *U. ruziziensis* or *U. brizntha* cv BRS Piatã were cultivated during the winter season, there was an increase in the yield of soybean sown in succession to the grasses, as compared to fallow. Furthermore, the effect of *Urochloa* roots on productivity was greater than that of straw while the combined presence of roots and straw conferred better performance to soybeans than did the individual presence of roots or straw (Balbinot Junior et al., 2017).

Under this light, the objectives of this work were: to evaluate a) the effect of *U. ruziensis* and *U. brizantha* cv BRS Piatã root washings on cotton seed germination, and b) the distinct effects of roots, leaves, and whole plants of the above grasses on plant emergence, growth, and root- and aerial biomass of cotton cultivar BRS 430 B2RF cultivated in sequence to the grasses.

2. Material and Methods

The effects of *U. ruziziensis* and *U. brizantha* cv. BRS Piatã root washing on cotton seed germination were evaluated in two experiments carried out in a completely randomized design, in a 2 × 5 factorial arrangement (two species of *Urochloa* x five concentrations of root washings) with four replications. On October 16, 2020, three untreated seeds per tube of *U. ruziziensis* and *U. brizantha* cv. BRS Piatã were sown in 280-cm^3 tubes containing 250 cm^3 of a 1:1 (v:v) mixture of soil and sand. Three days after emergence, thinning was performed leaving one plant per tube. A total of 30 tubes per species of *Urochloa* was utilized. The tubes were kept in a greenhouse under temperatures ranging from 18–33.5 ºC, and the plants were irrigated twice a day.

Forty-four days after emergence, irrigation was interrupted and 24 h later, the tubes were transferred to the laboratory to obtain root-wash treatments. In the laboratory, the shoots of the *Urochloa* plants were cut off at the substrate level and discarded. The tubes containing the substrate and *Urochloa* roots were individually attached to a 1-L Kitasato flask. Then, 50 mL of distilled water was added to each tube, which was drained after percolation through the substrate and *Urochloa* roots under a vacuum of 400 mm Hg for 10 s. The root washings of each *Urochloa* species collected in the Kitasato flask were appropriately diluted in distilled water to obtain concentrations of 100%, 75%, 50%, 25%, and 0% of the original flow-through washings.

The same methodology was used in the second experiment, except that the *Urochloa* plants were desiccated with glyphosate 48 days after emergence (14 g a.i./L of water, applied with a backpack manual sprayer until runoff). After 7 days, the tubes containing the dried plants were taken to the laboratory to obtain the root washings according to the procedures described in the first experiment. To evaluate the effect of root washing on seed germination, standard germination tests were conducted on paper rolls according to the Rules for Seed Analysis of the Ministry of Agriculture, Livestock, and Supply (BRASIL/MAPA, 2009), using different dilutions of root washes to moisten the germ test paper where seeds were placed. Four replicates of 50 cotton seeds from the cultivar BRS 430 B2RF were used. The germination chamber was set at a temperature of 25 ºC and a photoperiod of 8 h light/16 h dark for 12 days.

To evaluate the effect of shoots, roots, or whole plants of the two *Urochloa* species on the emergence and biomass production of cotton grown after foraging, two experiments were carried out in a greenhouse using a completely randomized design with four replications, in a 2 × 3 + 1 factorial scheme (*Urochloa* species × management schemes + additional treatment of bare soil). On July 20, 2021, 10 untreated seeds per pot (equivalent to approximately 6.0 kg ha^{-1}) of *U. ruziziensis* and *U. brizantha* cv. BRS Piatã were sown in 0.3-m diameter polyethylene pots, containing 10 L of a highly clayey dystroferric oxisol soil (Santos et al., 2018). *Urochloa* plants were kept in a greenhouse and irrigated daily with 200 mL of water per pot.

On September 27, 2021, the plants from Experiment 1 were cut at ground level and the aerial parts were chopped into segments of approximately 0.1 m, and the following treatments were subsequently applied by: a) spreading only the aerial part on the surface of soil that had not been cultivated with *Urochloa* (Fo); b) spreading the aerial parts over the surface of the soil cultivated with *Urochloa*, retaining the roots (To); and c) using soil with *Urochloa* roots only, without adding the aerial parts on the surface (Ra). Additional treatments were also included with pots containing only soil. In Experiment 2, on September 27, 2021, the aerial parts of the *Urochloa* plants were desiccated with glyphosate (14 g a.i./L of water, applied with a manual knapsack sprayer until run-off). All other procedures were similar to those in Experiment 1.

On October 18, 2021, delinted and untreated seeds of cotton cv. BRS 430 B2RF were sown at a rate of 10 seeds per pot. From October 22–29, daily records of the number of emerged plants per pot were collected; based on the data obtained, the emergence speed index was calculated. Two thinning steps were conducted on October 29 and November 3, 2021, resulting in three/ and one plants/pot, respectively. The cotton crop was cultivated for 64 days by applying appropriate daily irrigation, phytosanitary control, and topdressing fertilization. At 64 days after sowing, the plants were cut at ground level, and the remaining cotton and *Urochloa* roots were carefully collected from the soil and separated. Both shoots and roots were dried in a forced air oven at 55 ºC for 5 days, until dry mass values stabilized.

The germination percentage data were subjected to analysis of variance; the effects of washing concentrations on germination were subjected to polynomial regression analysis when significant values were obtained. The model with the highest significant coefficient of determination (R^2) was used to explain the effects of root-washing concentrations on cotton germination. When the treatment effect was significant on cotton plants emergence and biomass production, Tukey’s test (5%) was used to compare the means. The AgroEstat program (Barbosa and Maldonado Júnior, 2015) was used for the statistical analysis.

3. Results and Discussion

About germination of cotton seeds subjected to *Urochloa* spp. root washings No significant differences ($p > 0.05$) were observed in the percentage of cotton seed germination between the two *Urochloa* species (Table 1). However, the effects of root-washing treatments and their interaction with *Urochloa* species were both significant ($p < 0.01$).

Analysis of the interactions between *Urochloa* species and the concentrations of root washing revealed that the response of concentrations on the percentage of germination was better fitted by a quadratic model (F = 22.91; p<0.01) in *U. ruziziensis* (Figure 1). For *U. brizantha* cv. Piatã, the best fit (F = 6.83; p<0.05) was obtained with the linear model (Figure 2).

Table 1. Percentage of germination of cotton seeds in a standard germination test using a paper roll moistened with different concentrations of washings from roots of *Urochloa ruziziensis* (Ur) and *U. brizantha* (Ub) cv BRS Piatã.

Urochloa species	Concentration					
	0%	25%	50%	75%	100%	Mean
Ur	81.5*	65.0	71.5	66.0	81.5	73.1^{ns}
Ub	81.5	83.0	70.5	73.0	74.0	76.4

*Mean values of four replicates.
^{ns} = differences between means of the two species not significant according to the F-test (p>0.05).

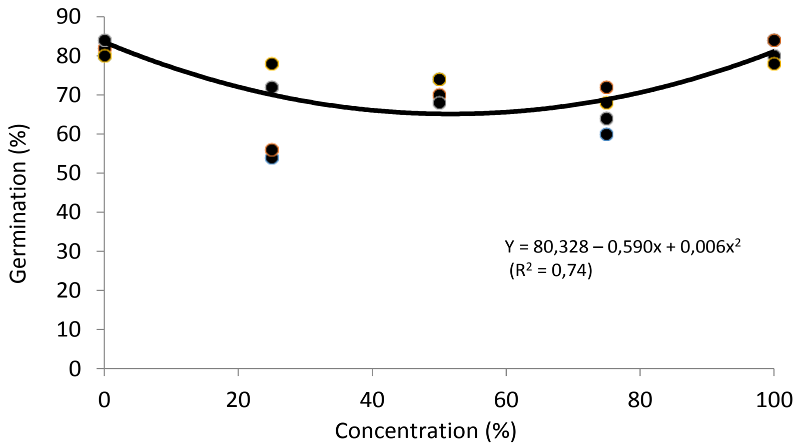

Figure 1. Percentage of germination of cotton seeds as a function of concentrations of washings from the roots of *Urochloa ruzuziensis*.

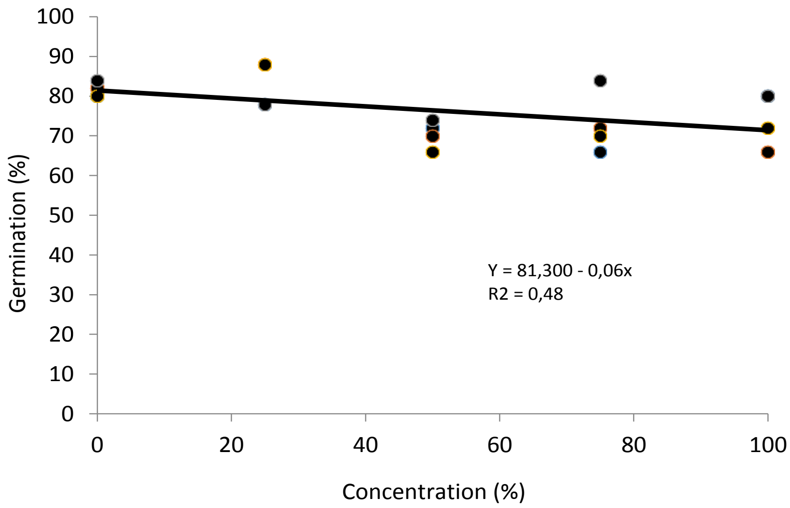

Figure 2. Percentage of germination of cotton seeds as a function of concentrations of washings from roots of *Urochloa brizantha* cv. BRS Piatã.

In Experiment 2, data analysis revealed significant differences in seed germination between the two *Urochloa* species (F = 41.33; p<0.01), root-washing concentrations (F = 13.23; p<0.01), and the interaction between them (F = 4.08; p<0.01). Cotton seed germination was significantly lower on filter paper moistened with root washes of *U. brizantha* cv. BRS Piatã (Table 2). The effect of *U. ruziziensis* root washing concentration on cotton seed germination was not significant. In contrast, washing the roots of *U. brizantha* cv. BRS Piatã had a significant effect on cotton seed germination. Regression analysis showed a better fit of the data (F = 44.95; p<0.01) to the linear model (Figure 3).

The results obtained in the present study show that washings from the roots of the species of *Urochloa* negatively affected germination of cotton seeds, especially in the case of *U. brizantha* cv. BRS Piatã root washings. It can be proposed that the roots of *Urochola* plants exude substances with allelopathic properties that can interfere with the germination of cotton plants, as demonstrated in other grass species that produce allelopathic substances, thus inhibiting seed germination of several cultivated plants (Sanches-Moreiras et al., 2004). In the experiment where *Urochloa* spp. plants were desiccated with the herbicide glyphosate, which is the common practice in the cultivation of cotton in NTS (Christoffoleti et al., 2015), the adverse effects of *U. brizantha* cv. BRS Piatã washings on cotton seed germination were more profound (25% average reduction in germination).

Although not proven in the current study, it is possible that glyphosate affects the production (quantity and/or quality) of allelochemicals produced by the roots of *Urochloa* plants. No references in the literature are available for the effects of glyphosate on the quantity or quality of allelochemicals produced by plants (Yamada and Camargo-Castro, 2007). However, the work carried out by Iqbal et al. (2009), who studied the possibility of reducing the dose of glyphosate used to control weeds in cotton by the addition of allelochemicals, indicates that herbicides can be combined with allelochemicals to control weeds.

Table 2. Percentage of germination of cotton seeds in a standard germination test on a paper roll moistened with different concentrations of washings from roots of *Urochloa ruziziensis* (Ur) and *U. brizantha* (Ub) cv. BRS Piatã, desiccated with the herbicide glyphosate.

Urochloa species	Concentration					
	0%	25%	50%	75%	100%	Mean
Ur	69.5*	67.0	69.0	66.0	59.0	66.1a**
Ub	69.5	50.0	56.0	53.5	31.5	52.1 b

*Mean values of four replicates.
** = Values followed by the same letter do not differ significantly according to the F test (p>0.05).

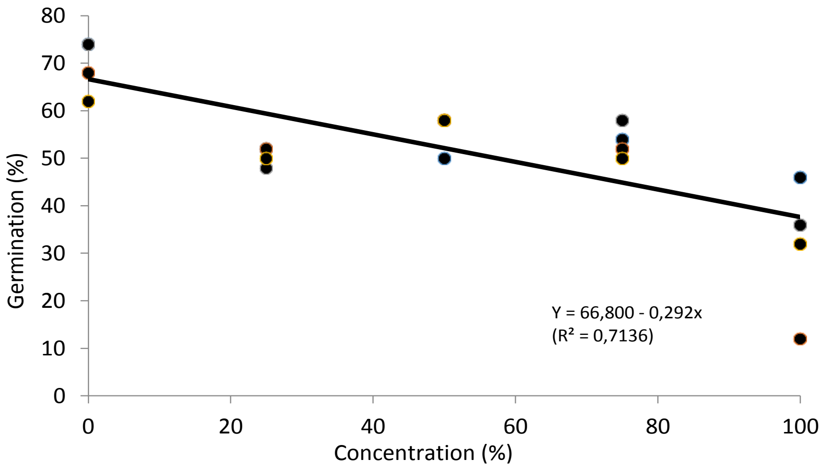

Figure 3. Percentage of germination of cotton seeds as a function of concentrations of washings from roots of *Urochloa brizantha* cv. BRS Piatã desiccated with glyphosate.

In the experiment 1, the percentage of cotton plants emergence was significantly affected by the management system of the *U. ruziziensis* and *U. brizantha* cv BRS Piatã cover crops studied. In glyphosate-free management system 3 (Ra), the germination percentage was significantly higher than that of the Pa management system that contained only straw on the soil surface. The emergence speed index did not differ significantly between species, management systems, their interaction, or additional treatments (Table 3). Studies carried out by Sonego et al. (2012) using a *Panicum maximum* cv. Tanzânia extract revealed that the extract significantly affected only the speed index in maize seed emergence.

The dry biomass of the aerial parts and root systems of the cotton plants was not affected by the previous cultivation of either of the two species of *Urochloa*, regardless of the management system. These results are contrary to those reported by Echer et al. (2012), who found a reduction in root and aerial growth in cotton cultivated in succession to *U. ruziziensis.* In a study conducted by Souza et al. (2006), cotton growth was negatively affected when 3% (w/w) of dried *B. decumbens* was incorporated into the soil. In the present study, no significant differences were observed between the *Urochloa* species, type of management, interaction between the *Urochloa* species and the management system, or the additional treatment with bare soil without previous cultivation of *Urochloa* (Table 4).

In the experiment 2, when cover crops were desiccated with the herbicide glyphosate, no significant effect of management systems, *Urochloa* species, interaction between management systems and *Urochloa* species, or additional treatments was found on the emergence percentage. The emergence speed index differed among the species and management systems studied with *B. brizantha* cv. BRS Piatã, exhibiting the highest value ($p > 0.05$). When only the roots (Ra) of *Urochloa* were maintained, the emergence speed was higher than that of the treatment in which only the aerial part was spread on the soil surface (Pa).

The effect of the additional treatment (cotton sown on bare soil) was not significant (Table 5). Balbinot et al. (2017) demonstrated that the impact of *U. ruziziensis* roots on soybean productivity was greater than that of straw. The combination of roots and straw resulted in a greater soybean yield than did the individual presence of roots and leaves. The dry biomass of the aerial parts and root systems of the *Urochloa* species studied was not significantly affected by the management systems (Table 6).

Table 3. Emergence percentage (EP) and emergence speed index (IVE) of cotton grown after *Urochloa ruziziensis* (Ur) and *U. brizantha* (Ub) cv. BRS Piatã under different management systems, without desiccation. To = maintenance of every *Urochloa* plant; Pa = shoot maintenance only; Ra = maintenance of roots only; So = additional treatment (soil only, no *Urochloa*).

Management system (MS)	EP		Mean	IVE		Mean
	Species			Species		
	Ur	Ub		Ur	Ub	
Management 1– To	72.5	67.5	70.0 ab	5.40	6.09	5.74 a*
Management 2 – Pa	45.0	72.5	58.75 b	4.30	5.86	5.08 a
Management 3 – Ra	77.5	85.0	81.25a	6.53	6.16	6.34 a
Mean	65.0A	75.0A		5.41A	6.03A	
Additional treatment (soil) – So	77.5			6.54		
F (SM)	3.34*			1.91^{ns**}		
F (Species)	5.63^{ns}			2.61^{ns}		
F (MS x Species)	2.99^{ns}			1.51^{ns}		
F (Additional treat. – soil)	1.07^{ns}			1.85^{ns}		
C.V. (%)	18.86			18.96		

*Means followed by the same lowercase letters in columns and uppercase letters in rows did not differ significantly according to Tukey's test (5%). ** ns: not significant

Table 4. Dry biomass of the aerial part (MSPA) and the root system (MSSR) of cotton cultivated after *U. ruziziensis* (Ur) and *U. brizantha* (Ub) cv. BRS Piatã in different management systems, without desiccation. To = maintenance of every *Urochloa* plant; Pa = shoot maintenance only; Ra = maintenance of roots only; So = additional treatment (soil only, no *Urochloa*).

Management system	MSPA		Mean	MSSR		Mean
	Species			Species		
	Ur	Ub		Ur	Ub	
Management 1- To	43.74	37.58	40.66a*	6.12	4.21	5.16a
Management 2 – Pa	49.71	41.32	48.01a	10.05	7.43	8.72a
Management 3 – Ra	38.86	38.29	38.57a	4.59	8.43	6.51a
Mean	44.10A	40.73A		6.91A	6.69A	
Additional treatment (soil) - So	49.35			23.94		
F (MS)	0.95^{ns}			0.02^{ns}		
F (Species)	2.75^{ns}			1.97^{ns}		
F (MS x Species)	0.22^{ns}			1.90^{ns}		
F (Additional treat.-soil)	2.30^{ns}			77.05		
C.V. (%)	19.47			39.08		

*Means followed by the same lowercase letters in columns and uppercase letters in rows did not significantly differ according to Tukey's test (5%). ns Not significant.

The results obtained in the present study indicate that the maintenance of *Urochloa* aerial straw on the soil surface can negatively affect the emergence percentage (experiment without desiccation with glyphosate) and the emergence speed index of cotton (experiment with desiccation with glyphosate). However, such effects were not reflected in the biomass production of shoots or cotton roots, which were not affected by the management systems. Few studies have been conducted on the effects of exudates or grass extracts on the emergence of cultivated plants. A study conducted by Sonego et al. (2012) reported a significant effect of *P. maximum* cv. Tanzania extract on the emergence speed index in maize seeds.

Our results indicating that the dry aerial part and root system biomass of cotton was not affected by the previous cultivation of either of the two *Urochloa* species, regardless of the management system, are not in accordance with the results of Echer et al. (2012), who reported a reduction in root and aerial growth in cotton when cultivated after *U. ruziziensis*. According to the authors, the reduced development of cotton plants cultivated after foraging is related to nitrogen immobilization by the roots of *B. ruziziensis*. This difference could be explained by the fact that the study by Echer et al. (2012) was conducted up to 15 days after cotton emergence.

As the present study was carried out for up to 64 days after emergence, it is possible that the initial suppressive effect on growth, as observed by Echer et al. (2012), could be reversed with the resumption of normal growth of the cotton plant post the termination of the effect of the limiting factor on growth, that is, the nitrogen immobilized by the *Urochloa* roots has been released and thus made available to the cotton plants (Torres et al., 2005).

Table 5. Emergence percentage (EP) and emergence speed index (IVE) of cotton grown after *Urochloa ruziziensis* (Ur) and *U. brizantha* (Ub) cv. BRS Piatã, desiccated with glyphosate, in different management systems. To = maintenance of every *Urochloa* plant; Pa = shoot maintenance only; Ra = maintenance of roots only; So = additional treatment (soil only, no *Urochloa*).

Management System	EP		Mean	IVE		Mean
	Species			Species		
	Ur	Ub		Ur	Ub	
Management 1- To	72.5	80.0	76.25a**	5.43	6.23	5.83ab
Management 2 – Pa	85.0	90.0	87.50a	3.50	5.78	4.64b
Management 3 – Ra	67.5	77.5	72.50a	6.44	6.62	6.53a
Mean	75.0A	82.5A		5.12B	6.21A	
(Additional treat.-soil)	77.5			6.04		
F (MS)	1.77^{ns}			4.80*		
F (Species)	2.56^{ns}			5.01*		
F (MS x Species)	0.07^{ns}			1.58^{ns}		
F (Additional treat.-soil)	0.03^{ns}			0.32^{ns}		
C.V. (%)	17.56			21.17		

**Means followed by the same lowercase letters in columns and uppercase letters in rows did not significantly differ according to Tukey's test (5%). * Denotes significant differences. ^{ns} Not significant.

Table 6. Dry biomass of the aerial part (MSPA) and the root system (MSSR) of cotton cultivated after *Urochloa ruziziensis* (Ur) and *U. brizantha* (Ub) cv. BRS Piatã desiccated with glyphosate under different management systems. To = maintenance of every *Urochloa* plant; Pa = shoot maintenance only; Ra = maintenance of roots only; So = additional treatment (soil only, no *Urochloa*).

Management System	MSPA		Mean	MSSR		Mean
	Species			Species		
	Ur	Ub		Ur	Ub	
Management 1- To	38.91	40.65	39.78a*	6.12	4.21	5.16a
Management 2 – Pa	50.51	46.14	48.32a	10.00	7.43	8.72a
Management 3 – Ra	37.35	42.52	39.93a	4.59	8.43	6.51a
Mean	42.25A	43.10A		6.90A	6.69A	
(Additional treat.-soil)	50.34			6.80		
F (MS)	0.06^{ns}			0.62^{ns}		
F (Species)	2.62^{ns}			1.97^{ns}		
F (MS x Species)	0.64^{ns}			1.90^{ns}		
F (Additional treat.-soil)	2.76^{ns}			77.05**		
C.V. (%)	19.51			39.08		

*Means followed by the same lowercase letters in columns and uppercase letters in rows did not differ according to Tukey's test (5%). ^{ns} Not significant. ** Statistically significant.

Bogiani et al. (2020) who worked with sandy soils in Western Bahia, found no deleterious effects of *U. ruziziensis* on cotton growth or development. In contrast, another study reported that when dry matter of *U. decumbens* (3%, w/w) was incorporated into the soil, cotton plant growth was reduced 30 days after emergence (Souza et al., 2006). Similar to the results of the present study, Balbinot Junior et al. (2017) observed that the effect of *U. ruziziensis* roots on soybean productivity was greater than that of straw. The combination of roots and straw resulted in a greater soybean yield than the individual treatment with roots or leaves.

4. Conclusions

Overall, the cultivation of *Urochloa* spp. as a cover crop can negatively affect seed germination and cotton emergence. The aerial parts (straw) of *Urochloa* spp. caused greater suppression of cotton emergence than did the roots, while cotton shoot and root biomass production were not adversely affected by *Urochloa* spp. This study provides crucial insights on the role of *Urochloa* as cover crops in cotton emergence and development and a basis for future studies to elucidate the specific mechanisms involved at the biochemical or molecular levels.

Authors' Contribution

Fernando Mendes Lamas and Guilherme Lafourcade Asmus have contributed equally to the planning and implementation of the experiments, evaluation, data collection and analysis, and manuscript writing.

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