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Research Article

Straw interference in the emergence of talquezal seeds from different origins

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INFORMATION ARTICLE

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The authors declare that there is no conflict of interest regarding the publication of this manuscript.

HIGHLIGHTS

- Seeds from Rondonópolis-MT have lower weight and higher viability.
- *Urochloa brizantha* straw influences the emergence pattern of *Paspalum virgatum* seedlings.
- Amounts of straw higher than 4.0 ton ha^{-1} negatively affect the emergence of *P. virgatum* seedlings.

ABSTRACT

Background: Talquezal (*Paspalum virgatum* L.) has become one of the main pasture weeds due to its association with the *Urochloa brizantha* death syndrome, a disease that causes the progressive death of clumps of susceptible grasses in patches, which leads to weed colonization and pasture degradation. Understanding the weed emergence pattern is essential in decision making for management strategies.
Objective: Thus, this study aimed to evaluate the emergence pattern of talquezal seedlings according to its origin and the amount of straw covering the soil.
Methods: The experiment was carried out in a greenhouse in a completely randomized design, with six replications and treatments arranged in an 8 × 3 factorial scheme with eight amounts of *Urochloa brizantha* straw covering the seeds (0, 0.5, 1.0, 2.0, 4.0, 6.0, 8.0, and 10.0 ton ha^{-1}) and three collection sites (Rondonópolis, Redenção, and Cacoal). The effect of the origin and amount of straw was evaluated by the percentage of emergence, relative emergence frequency, mean emergence time, emergence synchrony, and emergence speed index of seedlings obtained over 35 days after sowing.
Results: Talquezal seeds showed high seedling emergence vigor regardless of their origin under amounts of straw lower than 4.0 ton ha^{-1}.
Conclusions: The result suggests that the amounts of *U. brizantha* straw higher than 4.0 ton ha^{-1} on the soil surface, the lower is the percentage of Talquezal seedling emergence.

1 INTRODUCTION

Weed grasses are the most complex weeds for effective control in cultivated pastures due to the morphological, physiological, and biochemical similarity with forage species. For example, talquezal or razor grass (*Paspalum virgatum* L.) is considered one of the main pasture weeds for having a high capacity for multiplication and competition with forage grasses (Silva et al., 2017).

The vigorous competition exercised by *P. virgatum* occurs due to its acceptability and palatability being lower compared to other forages, increasing its presence in the botanical composition of pasture areas. In addition, this species has low nutritional value and can cause blood diseases in cattle, such as methemoglobinemia (Diaz, 2011; Mosquera-Figueroa et al., 2012). Another concern caused by *P. virgatum* infestations in pastures is due to its association with the *Urochloa brizantha* (A. Rich.) R.D. Webster cv. Marandú death syndrome (Herrera, 2015).

The mechanical method is commonly used in pasture areas for weed control, in which the viable alternative is the use of rotary cutters coupled to tractors (Souza et al., 2015). This method, although considered non-selective for forage grasses (Victória Filho et al., 2014), provides the advantage of recovering the pasture structure by renewing the tiller population (Fontoura Júnior et al., 2007; Pellegrini et al., 2010; Souza et al., 2015), in addition to producing large amounts of straw that would eventually constitute a physical barrier to the emergence of weed seedlings.

Soil cover using straw is an agricultural practice that, among numerous benefits, can be effective in suppressing weeds (Cerqueira et al., 2018). This practice interferes with the infestation and establishment of weeds by physical, chemical, and biological means (Teixeira et al., 2014).

Straw on the soil surface reduces the germination of positive photoblastic seeds, besides affects seeds that need high thermal amplitude to start the germination process. In addition, the emergence of seeds with a small amount of reserve may be impaired, as the plant may not be able to go through the straw (Gomes et al., 2014).

The site of origin of weeds may change the process of seed formation, thus influencing its germination and vigor (Bognounou et al., 2010; Mendonça et al., 2014). Some researchers have stated that ecotypes can be selected from variations in the environment in which they survive, resulting in genetic changes that guarantee evolutionary and ecological success to individuals and, consequently, higher capacity to invade and establish in an area (Gemelli et al., 2012; Melo et al., 2012).

Due to the great competition exerted by weeds, several studies have been developed with the objective of better understanding the behavior of these ecotypes and, consequently, managing them efficiently (Marchi et al., 2017). The knowledge on the propagating capacity of weeds such as talquezal can provide subsidies to develop practices to control and/or manage the species, keeping it at levels lower than those of economic damage (Silva et al., 2017).

In this sense, knowing the influence of straw on the emergence of seedlings, especially grasses that invade pastures, is essential for effective management. Thus, this research aimed to study the emergence pattern of talquezal (*Paspalum virgatum* L.) seedlings according to its origin and different amounts of *U. brizantha* straw covering the soil.

2 Material and Methods

The experimental phase of this research was represented by a study conducted in a greenhouse whose geographical coordinates are 15º52′25″ S and 52º18′51″ WGr.

Panicles of *P. virgatum* containing physiologically mature spikelets were manually collected from pasture areas located in Rondonópolis-MT (RO) (16º44′53.5″ S and 54º28′19.3″ WGr), Redenção-PA (RE) (7º47′23.5″ S and 49º15′18.7″ WGr), and Cacoal-RO (CA) (11º05′53.8″ S and 61º26′05.1″ WGr), forming three lots. The climate conditions of the sites of origin are shown in Table 1. The point of physiological maturity was considered the moment when there was natural threshing of spikelets from the inflorescences (Lopes and Franke, 2011). Approximately 1.5 kg of seeds were collected and stored in paper bags.

The seeds from the different origins were cleaned using a set of soil sieves with dimensions 8″ × 2″ to obtain only the dispersal units of the species. Each lot of clean seed was then subjected to a uniform

Table 1 - Climate data(1) of the sites of origin of *Paspalum virgatum* seeds

Origin	Climate(2)	Annual mean temperature (ºC)			Solar radiation(3)	Annual precipitation (mm)
		Minimum	Mean	Maximum		
Rondonópolis-MT	AW	20.4	26.8	33.2	16.49	1313
Redenção-PA	AW	21.5	27.4	33.7	17.65	1165
Cacoal-RO	AW	22.4	27.6	32.9	18.92	1982

(1) Average for the last 10 = years. (2) Köppen classification. (3) Solar radiation in W m^{-2} day^{-1}. Source: Agritempo: Agrometeorological Monitoring System.

ventilation blower previously regulated with an adequate opening to separate empty seeds from those considered pure.

Subsequently, the thousand-seed weight (TSW) was determined and the viability analysis of pure seeds was carried out using a 0.75% 2,3,5-triphenyl-tetrazolium chloride aqueous solution, adopting a completely randomized design with eight replications (Brasil, 2009). The results of viability and TSW were subjected to analysis of variance by the F-test and means compared by the Scott-Knott test at 5% probability.

The experimental plots consisted of 2.0 L plastic pots filled with a dry sandy loam textured Oxisol collected from the arable layer and sieved to remove plant remains. The soil chemical and physical characteristics were as follows: pH in $CaCl_2$ of 4.8; organic matter of 22.0 g dm^{-3}; P resin of 4.0 mg dm^{-3}; V of 44.6%; K, Ca, Mg, and H+Al contents of 3.1, 18.0, 6.0, and 34.0 $mmol_c$ dm^{-3}, respectively; and sand, silt, and clay contents of 706, 85, and 209 g kg^{-3}, respectively. No correction was carried out regarding soil fertility and acidity.

The soil in the pots remained moist during the experimental period using an automatic irrigation system set to apply an amount of water close to that of the field capacity. The minimum and maximum daily average temperatures inside the greenhouse during the experimental period were 18 and 35 ^oC, respectively.

The experimental design was completely randomized with six replications and the treatments were arranged in an 8 × 3 factorial scheme, with eight amounts of *U. brizantha* straw covering the soil (0.0, 0.5, 1.0, 2.0, 4.0, 6.0, 8.0, and 10.0 ton ha^{-1}) associated with three seed origins (Rondonópolis, Redenção, and Cacoal). The sowing process was carried out by placing 50 seeds on the soil surface, followed by the mentioned amounts of straw.

Straw samples were obtained by cutting *U. brizantha* plants at 10.0 cm high from the soil surface. The collected plants were cut into fractions of approximately 2.0 cm, packed in paper bags, and maintained in a forced-air circulation oven at a temperature of 65 ^oC until reaching constant weight.

Daily counts of the number of seedlings emerged were carried out until the date when there was no variation between evaluations for a minimum of five consecutive days, which was observed at 35 days after sowing. A seedling was considered emerged when the first leaf was already emerged and expanded through its coleoptile.

The effect of treatments was evaluated by the percentage of emergence (PE), emergence speed index (ESI), relative emergence frequency (Fr), mean emergence time (Te), and emergence synchrony of seedlings (Z). The percentage of emergence was calculated by the equation established by Labouriau and Valadares (1976). The emergence speed index was calculated using the formula described by Maguire (1962), while the mean emergence time, emergence synchrony, and relative emergence frequency were obtained using the formulas described by Santana and Ranal (2004). The variation in the relative emergence frequency was evaluated by observing the unimodality or polymodality of graphic polygons obtained as a function of the different amounts of straw in the substrate over time.

The results of seedling emergence (%), ESI, mean emergence time, and emergence synchrony of seedlings were adjusted to linear or polynomial regression models by the software Origin 8.5.1 SR1. The regression model was chosen considering the highest value of the coefficient of determination (R^2) at $p \leq 0.05$, according to the F-test and respecting the biological response.

3 Results and Discussion

The highest thousand-seed weight (TSW) was observed in Cacoal. On the other hand, Redenção presented an intermediate TSW and Rondonópolis provided the lightest seeds (Table 2).

Table 2 - Thousand-seed weight (TSW) and viability (%) of *Paspalum virgatum* seeds from Rondonópolis, Redenção, and Cacoal

Origin	TSW (g)	Viability (%)[1]
Rondonópolis-MT	1.268 c	77.9 a
Redenção-PA	1.460 b	49.5 b
Cacoal-RO	1.617 a	25.4 c
F Origin	175.48**	455.63**
CV (%)	2.58	6.8

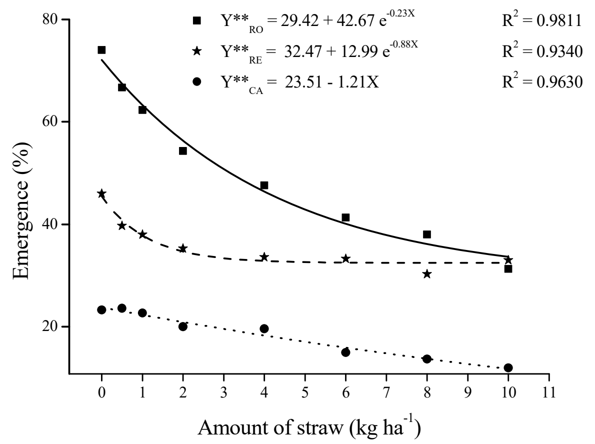
[1] Tetrazolium test. ** Significant at 1% probability. Means followed by the same letter do not differ statistically from each other by the Scott-Knott test at 5% probability.

The differences between TSW values in the seed lots can be attributed to the possible genetic variability between populations and the climate conditions that occur during seed formation (Barros et al., 2017). The highest PMS observed in seeds from Cacoal is probably related to the climate conditions of the region, especially the association between higher water availability, temperatures, and incidence of solar radiation than the other two regions (Table 1). These environmental conditions favor the process of photosynthesis, plant metabolism, and, consequently, the synthesis of reserve substances accumulated during seed formation (Lamarca et al., 2013).

The tetrazolium test showed that full seeds from Rondonópolis had higher viability than those from Redenção and Cacoal (Table 2). Germination levels are in line with those mentioned by Silva et al. (2017), who obtained values between 30 and 73% of germination of *P. virgatum* seeds submitted to different methods of overcoming dormancy.

The discrepancy regarding the seed viability found in Rondonópolis, Redenção, and Cacoal due to differences in the regional climate conditions may be related to the occurrence of pathogens. Mallmann et al. (2013) stated that the environmental conditions may also favor the development of certain phytopathogenic organisms responsible for decreasing seed viability besides being favorable for seed formation.

A proportional decrease in the emergence (%) of *P. virgatum* seedlings was observed regardless of the seed origin even when the seed was under only 0.5 ton ha^{-1} of straw coverage (Figure 1). An exponential and descending behavior was found for seeds from Rondonópolis and Redenção, while a linear and descending behavior was observed for seeds from Cacoal. Moreover, the highest percentages of emergence were obtained in Rondonópolis, followed by Redenção and Cacoal when considering only the origin factor and regardless of the amount of straw coverage.



** Significant (p≤0.01).

Figure 1 - Emergence (%) of *Paspalum virgatum* seedlings obtained as a function of the origin (RO-Rondonópolis, RE-Redenção, and CA-Cacoal) and amount of *Urochloa brizantha* straw.

The reduction in the percentage of emergence of *P. virgatum* seedlings is probably related to the non-direct incidence of solar radiation on the seeds under high amounts of straw. The presence of straw exerts physical effects that affect weed germination, hindering or preventing seedling emergence when germination occurs (Borges et al., 2014). It occurs because the seed biomass is insufficient to break the physical barrier imposed by the straw coverage (Li et al., 2018).

The emergence frequency of *P. virgatum* seedlings showed that the highest uniformity was obtained when seeds from Rondonópolis, Redenção, and Cacoal received 0.0, 0.5, and 1.0 ton ha^{-1} of straw coverage, respectively. Moreover, the polygons of distribution of the relative emergence frequency tended to unimodality, with emergence peaks between the sixth and fifteenth days after sowing (Figures 2A, 2B, and 2C). However, seeds that received 2.0, 4.0, 6.0, 8.0, and 10.0 ton ha^{-1} of straw showed a polymodality in the polygons of relative emergence frequency, characterized by several emergence peaks located mainly from the eighth day, indicating less homogeneity in the emergence behavior of seeds from the three studied origins (Figures 2C, 2D, 2E, 2F, 2G, and 2H).

The emergence behavior of the seedlings as a function of the different amounts of straw showed that the different frequency peaks can also be related to the low amount of solar radiation on the seeds and the availability of reserve substances in them (insufficient to break the physical barrier imposed by the straw). Bortolin (2016) observed that the peak frequency of seed germination of *Paspalum regnellii* Mez. occurred during the first five days in which the experiment was carried out and that seeds collected in different years presented a different germination frequency.

Seeds from Rondonópolis showed the lowest values of mean emergence time (Te), followed by those from Cacoal, with an exponential and increasing behavior for seeds from Rondonópolis and Redenção and a quadratic and increasing behavior for those from Cacoal as the amount of straw increased. Seeds collected in Redenção showed the highest Te values, with a quadratic and increasing behavior up to 6.0 ton ha^{-1} of straw, when it tended to be inversely proportional to the increase in the amount of straw (Figure 3).

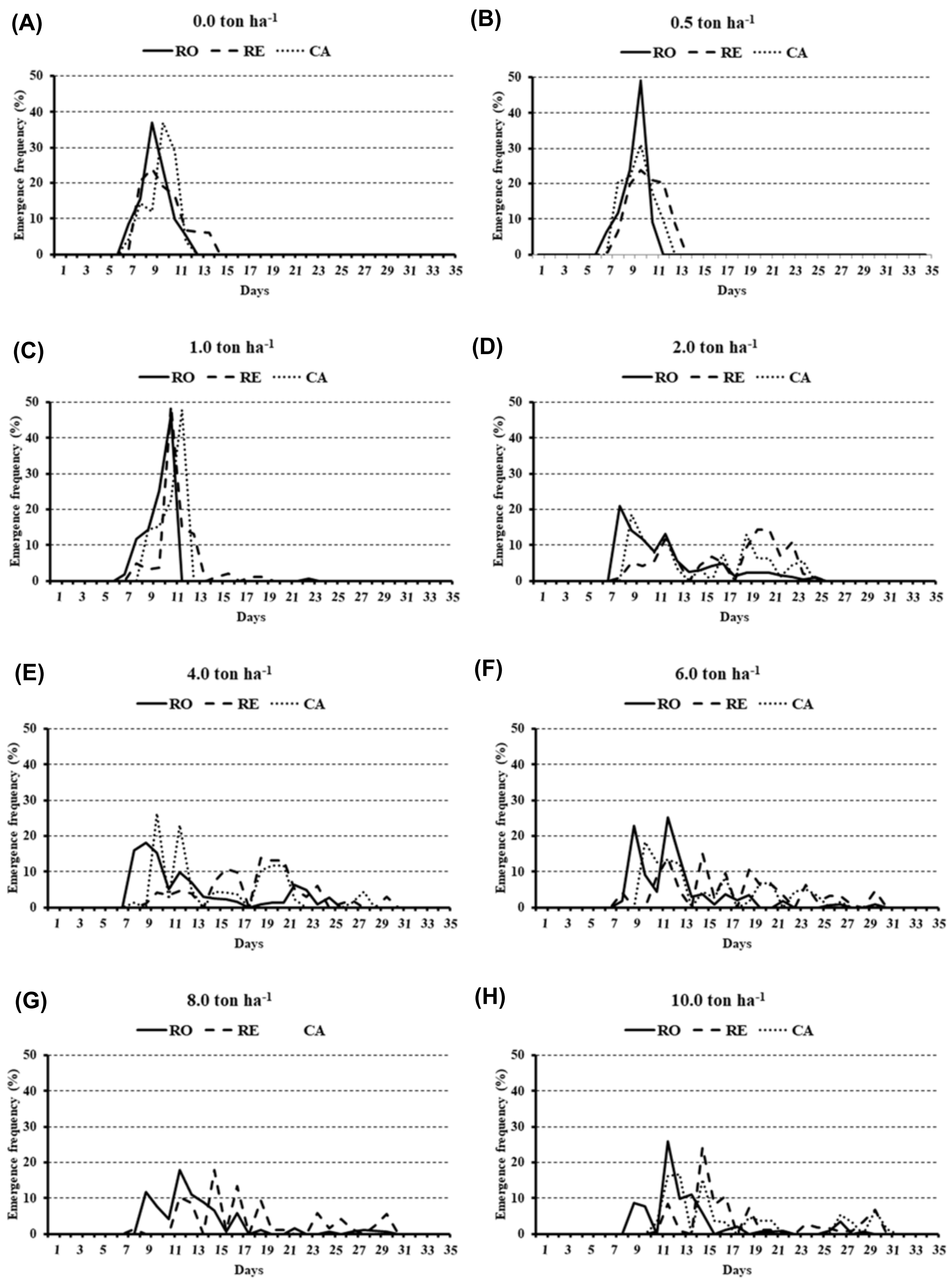
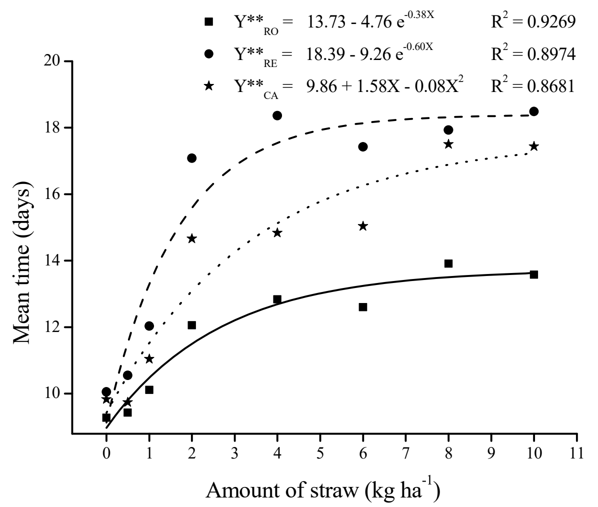


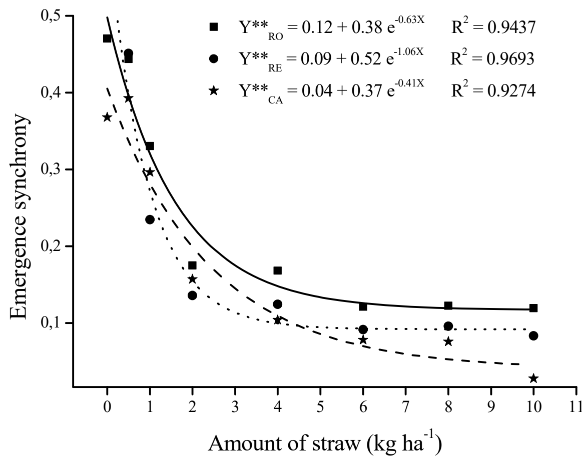
Figure 2 - Relative emergence frequency of *Paspalum virgatum* seedlings obtained as a function of the origin (RO-Rondonópolis, RE-Redenção, and CA-Cacoal) and amount of *Urochloa brizantha* straw.

These results show possible genotypic differences between *P. virgatum* populations, which is probably related to the high competitive capacity of this species. These genotypic differences may be the result of environmental factors that can significantly interfere with the germinative process of weeds and may favor their ability to dominate a certain area (Luz et al., 2014).



** Significant (p≤0.01).

Figure 3 - Mean emergence time of *Paspalum virgatum* seedlings obtained as a function of the origin (RO-Rondonópolis, RE-Redenção, and CA-Cacoal) and amount of *Urochloa brizantha* straw.



** Significant (p≤0.01).

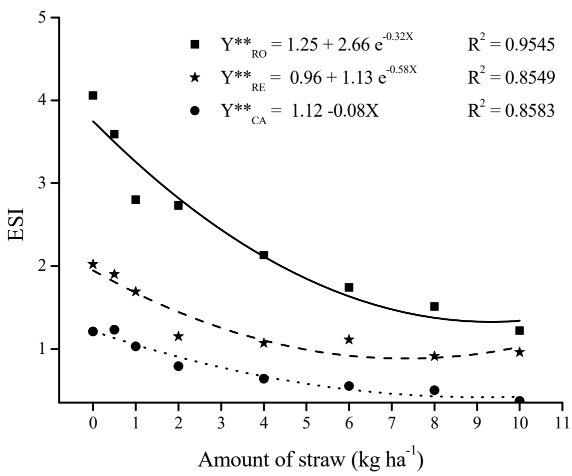
Figure 4 - Emergence synchrony of *Paspalum virgatum* seedlings obtained as a function of the origin (RO-Rondonópolis, RE-Redenção, and CA-Cacoal) and amount of *Urochloa brizantha* straw.

The interference of weeds such as *P. virgatum* in a production system that promotes the production of straw to cover the soil surface may be low compared to systems that use no straw, as there is an intense increase in Te due to the physical barrier provided by these plant residues (Yamashita and Guimarães, 2016).

The emergence synchrony of seedlings presented an exponential and decreasing behavior as the amount of straw increased up to 4.0 ton ha^{-1}, regardless of the seed origin. Besides having this same behavior, the seeds from the different sites also showed no difference relative to the emergence synchrony values, with the highest discrepancy between values occurring when 10.0 ton ha^{-1} of straw was added, leading to values of 0.14, 0.12, and 0.03 for Rondonópolis, Redenção, and Cacoal, respectively (Figure 4).

Higher amounts of straw directly influence the effectiveness of the species to be established in a certain area because this behavior was inversely proportional to the increased amount of straw. According to Conserva et al. (2013), the germination synchrony pattern is a very effective parameter to establish how species that colonize the same physical space can explore different opportunities, differentially distributing their germination over time.

The ESI values were also inversely proportional to the increased amount of straw, with an exponential behavior for seeds from Rondonópolis and Redenção and a linear behavior for seeds from Cacoal. Seeds from Rondonópolis showed the highest ESI values compared to the other sites, with also a more intense decrease in this parameter (Figure 5).



** Significant (p≤0.01).

Figure 5 - Emergence speed index of *Paspalum virgatum* seedlings obtained as a function of the origin (RO-Rondonópolis, RE-Redenção, and CA-Cacoal) and amount of *Urochloa brizantha* straw.

The highest ESI values were obtained when no straw was added (0 ton ha^{-1}), and a marked decrease was observed when the seeds were subjected to only 2.0 ton ha^{-1} of straw, regardless of their origin (Figure 5). As previously mentioned, soil cover creates a physical barrier that filters solar radiation, changing the germinative flow of species and decreasing the emergence speed index due to their sensitivity to light (Ferreira et al., 2017).

4 Conclusions

This study showed that *P. virgatum* seeds have high seedling emergence vigor, regardless of their collection site, under amounts of straw lower than

4.0 ton ha^{-1}, suggesting that the higher the amount of *U. brizantha* straw covering the soil, the lower the percentage of seedling emergence.

5 Contributions

SRM, RFM, RMS, and CFJ: seed collect, morphologic analisys, writing. CFJ, and CCM: seed analisys, writing.

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