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Germination and development of Brachiaria seedling in textures of soil and sowing depth

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Abstract: The agriculture expansion at Brazil is turning to lower clay index soils and consequently, less organic matter content and cation exchange capacity. To overcome those deficiencies, an intense organic matter addition in these soils may be a solution, and this solution is positive when using a crop-livestock integration with corn-pasture dual crop planted on winter. However, to establish this dual-crop system, there is a need to study the behavior of seeds and seedlings of *Brachiaria ruziziensis* sown in greater depths than normally recommended. Thus, this work aimed to determine the best depth of sowing *B. ruziziensis* in sandy and loamy soils of Umuarama region, studying the germination and early development of seedlings. The work was held in pots of 12 cm diameter x 12 cm deep, filled with 2 types of soil, a sandy and clay ones with 30 *B. ruziziensis* seeds sown each pot in five sowing depths: 0, 2, 4, 6 and 8 cm. After 16 days, the number of emerged seedlings was evaluated to set up the germination rate of each treatment, after that, the plants where leveled to 4 each pot, those were cultivated for another 45 days to evaluate the fresh and dried masses of plants and roots, the height of the plants and average length of roots. The sowing depth with higher percentage of germination estimated was 2.65 cm to sandy and 3.02 cm to clay soil. At seedlings development, there was a standard, with better development seedling at lower sowing depths on clay soil and better developments at higher sowing depths in sandy soil.
Keywords: Sandy soil; *Brachiaria ruziziensis*; dual-crop; crop-livestock integration.

Introduction

With the increase in grain production in areas previously marginal, either by drought or low fertility soils, crops tended to expand to regions with good rainfall and sandy soils, which generally have low natural fertility (FRANCHINI et al., 2011; YASSU, 2012; BORGHI et al., 2014). These soils have low cation exchange capacity, water storage and organic matter (BISSANI et al., 2008; LANDAU, 2009; DICK et al., 2009), which results in lower production capacity. In an attempt to minimize these factors and improve soil fertility, use of conservation practices and intensive accumulation of organic matter is an alternative. Organic matter comes from the decomposition of dry matter deposited in the soil that has high electrical charges in its composition, and provides nutrients to the soil gradually (NASCIMENTO et al., 2010; CUNHA et al., 2012).

To assist the deposition of dry matter, the crop-livestock integration system should be assessed. In this system, grain cultivation occurs in summer and winter, in the latter, can be intercropped with Brachiaria, in order to reduce the final cost of reform and promote intensification of grassland and to maintain green ground cover providing intense deposition of matter dry, which will serve as a soil conditioner, keeping higher humidity, lower temperature variation in the soil and is the organic matter through its deposition. (COSTA et al., 2013).

Thus, intercropping maize cultivation with Brachiaria, especially *Brachiaria ruziziensis* during the winter period has been shown as a practice that promotes these specificities. For the association of grain and pasture in winter, the use of grain seeders adapted to deposit the same time corn seeds and Brachiaria has been frequently used. However, this practice sow deeper Brachiaria seeds than recommended. (CECCON et al., 2008).

Paulino et al. (2004), described as determining the depth of sowing Brachiaria, and the next water availability to seeds. Vilela (2007) recommended the sowing depth of 2 cm for *Brachiaria ruziziensis*, however, Rezende et al. (2007) reported better germination of *B. brizantha* and *B. decumbens* in deeper sowing using a substrate composed of sand and steep bank. Thus, in the literature there is a difference for the best depth of *Brachiaria ruziziensis* sowing intercropped with corn (CECCON et al., 2008). The lack of information is greater in the case of sandstone Caiuá, which has low fertility, has high temperatures at the time of sowing Brachiaria and can influence the crop-livestock integration to increase their production rates (CASTALDO et al., 2015).

This study aimed to evaluate the percentage of germination and development of *Brachiaria ruziziensis* at different depths of sowing and in soils with different textures.

Methods

The experiment was conducted at the State University of Maringa - Campus Umuarama, located in Umuarama, Paraná, with geographic coordinates $27^{0}47'28''$ S, $53^{0}15'24''$ O, Altitude: 406 m., in the period March-April 2015.

It was used pots of 12 cm diameter x 12 cm depth, with a volume of 1.35 cm^3 (PACHECO et al., 2010) filled with two different types of soil, one originated from the Campus, characterized as sandy soil and another coming from the region of Assis Chateaubriand, Paraná, characterized as clay soil, the physical and chemical analysis of soils are shown in Table 1.

Table 1. Chemical attributes and soil clay content used in the experiment, analyzes in depth 0-20 cm.

Soil	pH	Ca^{+2}	Mg^{+2}	K^{+}	Al^{+3}	H+Al	SB^{1}	CTC^{2}	P	V^{3}	Clay
	$CaCl_2$	-------------------------cmol$_c$dm^{-3}----------------------							mg kg^{-1}	%	**%**
Sandy	4,40	1,03	0,30	0,16	0,26	3,42	1,49	4,91	2,48	30,35	7,50
Clayed	5,00	5,38	1,50	0,46	0,00	4,28	7,34	11,62	7,87	63,17	69,44

Extractors: P e K^+ = Melich I (HCl 0,05 mol + H_2SO_4 0,0125 mol); Ca^{+2}, Mg^{+} e Al^{+3} = KCl 1 mol; granulometric composition determined by Bouyoucos method (1926). [1] Base sum, [2] Cation exchange capacity, [3] Base saturation of CTC.

The experimental design was a randomized block in factorial arrangement 2x4 (two soil types) x (four sowing depths) with four replications, totaling 32 vessels positioned on bench to 1.30 m tall. The evaluated sowing depths of 0, 2, 4, 6 and 8 cm. In each pot were planted 30 seeds of *Brachiaria ruziziensis*, followed by filling the pot with soil, setting a sowing depth in each pot.

Brachiaria ruziziensis seeds cv. Ruziziensis were commercial, the SOESP brand, batch 00631/2014, harvested in the 2013/2014 crop, with pure seeds of 90% guarantee and minimum viability of 60%. During the evaluation period, irrigation was necessary for adequate maintenance of moisture in pots, totaling 5 irrigations with volume of 200 ml in each pot (simulating a rainfall of 4.42 mm), spaced 3 in 3 days (PAULINO et al., 2008).

The evaluation of germination and emergence of seed was carried out 16 days after sowing (GASPAR-OLIVEIRA et al., 2008) to count fully emerged seedlings and determination of germination percentage. After evaluating the percentage of germination, it performed the thinning of plants, leaving only 4 plants per pot. Thus, the plants were grown for 45 days to evaluate the effects of treatments on plant development. After the cultivation, withdrew the ground the pot, washed the roots with water, separating the soil and evaluated the fresh pasta (MFP) and dry (MSP) of the aerial part, the plant height (AP) and fresh (MFR) and dried (MSR) of the roots, beyond the average length (CR) of the roots.

To evaluate the fresh weight of aerial part was used to precision balance, all of which were weighed after the plants from the roots. The plant height was evaluated using ruler and the average value as the plot. Finally, the plants were placed in paper bags and dried at 65^{0} C with air circulation for 48 hours. The fresh weight of the aerial part was determined by weighing the dry material in an oven.

Likewise it was given fresh weight, dry weight and the average root length, separating the part area of the roots and weighing these in precision balance then measures with the ruler of aid and the average values used as value of the plot. After packed in paper bags and dried in an oven, the samples were weighed to obtain the dry weight of roots. To determine the average root length was measured fresh roots using a ruler, considering the average value interpolation more visible roots.

The data were analyzed by ANOVA and the means compared by Tukey test at 5% significance to the ground levels and linear quadratic polynomial regression and to depth levels, when there was a significant interaction between the sources of variation.

Results and discussion

The interaction between soil x depth was significant, with 18.8% in coefficient of variation in germination rate (Figure 1).

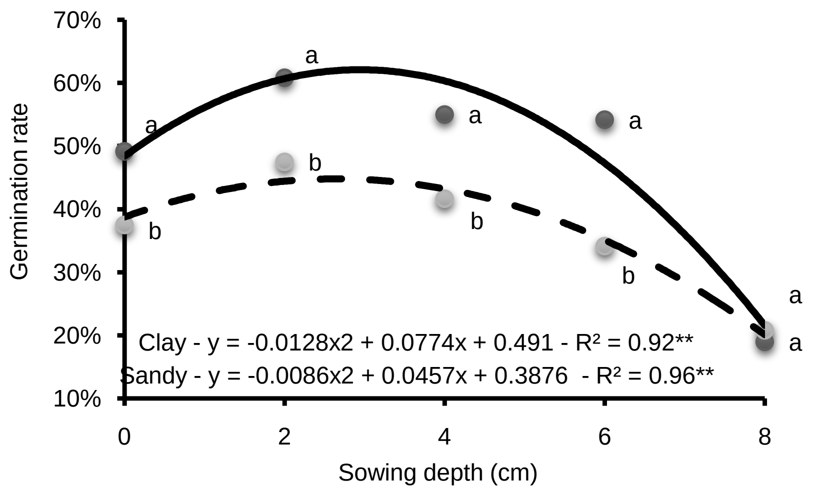

Figure 1. Germination rate of *Brachiaria ruziziensis* according to seeding depth and soil type. Means followed by the same letter at the same depth do not differ.

The clay soil resulted in improved germination at depths of 0, 2, 4 and 6 cm compared with sandy soil. Probably the clay soil retains more moisture and undergoes less temperature variation during the day, providing a better environment for seed germination (LANDAU et al., 2009). Germination rate lower sowing depth in clay soil was similar to minimum guarantee described by the manufacturer (60%).

Greater depth of planting resulted in a lower germination rate in both soil, however, the resilience in reducing the percentage was higher in clayey soil (Figure 1). With maximum points observed at 2.65 and 3.02 cm for sandy soil and clay, respectively.

The decrease in seed germination in sandy soil as greater seeding depth may be explained by water and nutrient retention capacity available for the plants, since the intensive leaching results in loss of water by evaporation (LANDAU et al., 2009).

The results suggested a range of 2 to 6 cm seeding depth for the clayey soil and 2 to 4 cm for sandy soil, according to Pauline et al. (2008). These authors reported that Brachiaria brizantha sowing depths around 4 cm would be recommended due to germination and water stress sandy soils or with possibility of dry spells. Ceccon et al. (2008) concluded that seeding depth between 4 and 6 cm would be ideal for germination of *Brachiaria ruziziensis* in clayey soils

Pacheco et al. (2010) also found no difference to the emergence rate of *Brachiaria ruziziensis* at depths up to 4 cm in clay soils

There was a difference in the development of plants according to the treatment. There was a significant interaction for MFP, MSP, CR, MFR and MSR (Table 2).

Table 2. F values calculated according to test F and average values for the variables plant height (AP), fresh (MFP) and shoot dry (MSP), root length (CR), fresh (MFR) and dry root (MSR) of the analyzed plants.

Variables	AP	MFP	MSP	CR	MFR	MSR
Soil (S)	0,539^{ns1}	4,454**^{2}	9,637**	23,281**	0,059^{ns}	2,31^{ns}
Depth (P)	0,276^{ns}	2,043^{ns}	1,262^{ns}	0,569^{ns}	2,992 *^{3}	3,82 *
Block	2,919^{ns}	2,565^{ns}	1,83^{ns}	2,762^{ns}	2,858^{ns}	1,41^{ns}
S x P	0,623^{ns}	6,75**	4,696**	4,503**	7,645**	4,33**
Average	8,17	0,56	0,12	25,42	2,02	0,37
C.V.[4] (%)	23,7	26,71	28,99	10,96	34,35	37,1

[1] not significant at the 5% probability, [2] significant at the 1% probability, [3] significant at the 5% probability, [4] Coefficient of variation.

In regression analysis of the variables in the interaction between the factors was significant, there was a linear adjustment for both soils for MFP, MSP and CR, however, the adjustment was significant only for the clayey soil for MFR and MSR (Figure 2).

In clay soil the better development of the plants was lower depths and sandy soil in depths of sowing, corroborating Pacheco et al. (2010).

With the increase of sowing depth, root length and fresh and dry weight of the aerial part and roots were reduced in clay soil. Sandy soils showed contrary, increasing depth resulted in increased root length and fresh and dry mass of the plants.

In the analysis, except for the variable plant height, the behavior of the two types of soil was similar in all variables, with higher production for the clay soil in the lower depths and higher yields for the sandy soil at greater depths. This response suggests lower water holding capacity and higher thermal amplitude observed in sandy soils, reducing both the germination and the production of these soils (LANDAU et al., 2009). But the decrease in production in clay soil can be explained by the difficulty of seedling to break a soil with higher density and resistance to penetration (SÁ E SANTOS JUNIOR, 2005)

In general, both soils had dry matter production (aerial and underground) similar depths where it obtained the best results in the percentage of germination.

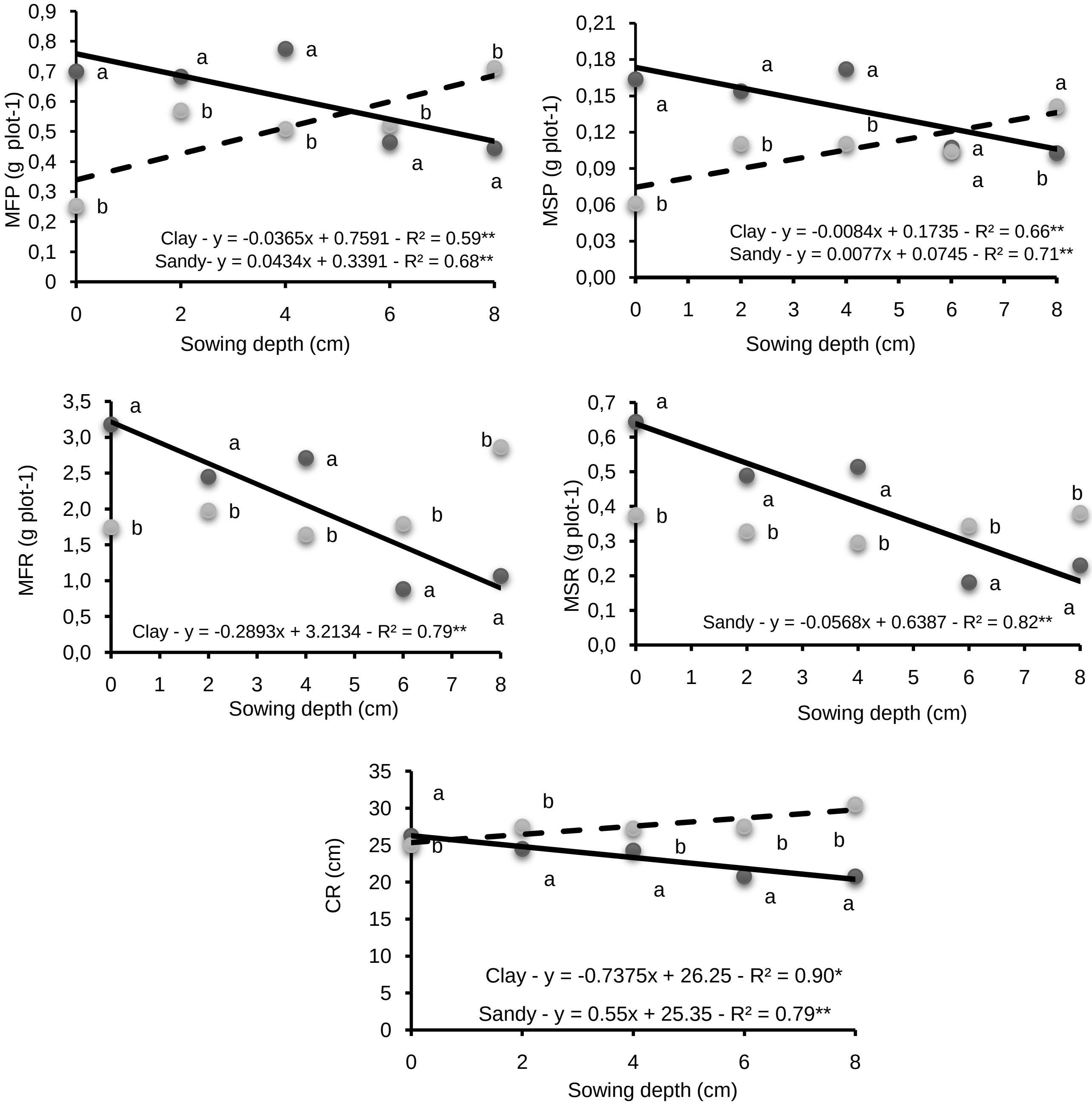

Figure 2. Fresh mass and dry of aerial part, root length, fresh and dry *Brachiaria ruziziensis* roots depending on the sowing depth in soils with different textures. Continuous lines are clay soils and separated lines are sandy soils. Means followed by the same letter at the same depth do not differ by Tukey test at 5% probability.

Conclusions

The *Brachiaria ruziziensis* seeding range should be slightly smaller (around 2 cm) in sandy soils than in clay soils (around 3 cm), ensuring the highest percentage of germination and similar mass production plants.

In general, mass production plants showed a pattern with higher yields at lower sowing depth in loamy soils and the reverse occurring in sandy soils.

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