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Impact of above-ground dry matter residue from cover crops on fall-winter corn and spring-summer soybean yield under no-tillage system

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Abstract

Due to the high temperature and moisture in the region of Brazilian "Cerrado", the greatest challenge in no-till system is the maintenance of above-ground dry matter. The aim of this research was to assess the above-ground dry matter production from cover crops and its effects on soybean and corn yield in Brazilian "Cerrado". The experiment was carried out from 2012 to 2014 growing seasons. The experimental design was randomized blocks with four repetitions. The treatments (T) adopted were formed by different cover crops [fall-winter corn crop (T1); intercropping fall-winter corn with *Brachiaria ruziziensis* (T2); intercropping fall-winter corn with *Brachiaria brizantha* cv. Marandu (T3); intercropping fall-winter corn with *Crotalaria spectabilis* (T4); *B. ruziziensis* (T5); *B. brizantha* cv. Marandu (T6); *Penisetum glaucum* L. (T7) and reference area (T8)]. The above-ground dry matter productions were influenced by the treatments assessed through two growing seasons (2012/2013 and 2013/2014). There was interaction between the cover crops and growing seasons for above-ground dry matter of the cover crops. In relation to fall-winter corn yield, the cover crops and growing seasons showed significant effect on corn yield. The cover crops effect on soybean yield. The cultivation of intercropping fall-winter corn crop with *B. brizantha* cv. Marandu or this forage grass single showed higher production of above-ground dry matter, these values reached quantities over than 6 Mg ha^{-1}. The soybean crop yield decreased because of the above-ground dry matter production of the cover crop of *B. brizantha* cv. Marandu and the intercropping fall-winter corn with *B. brizantha* cv. Marandu.

Keywords: Crop trash; *Brachiaria brizantha* cv.Marandu; sustainability; conservation tillage.
Abbreviations: Mg ha^{-1}_ton ha^{-1}.

Introduction

In 2013/2014 growing season, the area cultivated with soybean in Brazil was approximately 30.1 million of hectares with average yield of 86.2 millions of tons. In respect to fall-winter corn, the area cultivated was 9 million of hectares with yield of 46.2 million of tons (Conab, 2014). Among these production areas, Brazilian "Cerrado" located in the state of Mato Grosso do Sul, shows satisfactory weather conditions for vegetable production, like spring-summer soybean and fall-winter corn crop. These areas are considered an important agriculture frontier in Brazil. The areas cultivated in no-till system in Brazil correspond to 25.5 million of hectares. To have a sustainable no-till system it is essential to have above-ground dry matter of cover crops, and the correct crop rotation. The definition of the cover crop is quite important to remain the above-ground dry matter, because the C:N ratio in some cover crops is low and the process of mineralization is intensified (Gomes et al., 2009), majority in weather condition of Brazilian "Cerrado".

Among the vegetable species used as cover crop, the *Brachiaria* spp., millet (*Pennisetum glaucum*L.) and *Crotalaria spectabilis* have shown to be adaptable to Brazilian "Cerrado" weather conditions. The advantage of the forage (*Brachiaria* spp.) is the highest resistance to drought stress, high dry matter production (over than 15 Mg ha^{-1}) and slow mineralization process through the growing season (Nascente et al., 2013). The cover crop millet (*Pennisetum glaucum* L.) is cultivated as a cover crop and has been shown relevant efficient in no-till system, especially in dry winter region, because of the fast growth, even in drought region, and the benefit of the root system that may reach 1.0 to 2.0 m depth (Wilcke et al., 2004; Paciullo et al., 2010). As reported by Habib et al. (2007), the dry matter production of millet may reach over than 28.72 Mg ha^{-1}. In relation to the C:N ratio, this cover crop showed range value from 50.4 to 65.9 (Kushwah et al. 2014). These features contribute to have a slow process of dry matter decomposition for this cover crop.

In a crop rotation system, it is essential to introduce crops from the Fabaceae family, as *Crotalaria spectabilis*, which may produce over than 8 Mg ha^{-1} of dry matter (Ambrosano et al., 2003). Besides, *Crotalaria spectabilis* has the capability to input nitrogen for the next crop (Jeranyama et al., 2000). Nevertheless, the low C:N ratio equal to 23:4 promotes fast decomposition of the crop trash (Balota and Chaves et al., 2011), the half-life of *Crotalaria spectabilis* residues surround 66 to 98 days (Torres et al., 2014), on the other hand, this fast process of decomposition releases nutrients in the soil for the next crop or the intercropping.

The intercropping system has shown a promise as a method to increase the above-ground dry matter in no-till system. The most common regime used is the intercropping winter corn with *Brachiaria* spp. or *Crotalaria spectabilis*, this combination of crop configures the intercropping system (Anil et al., 1998). According to (Ceccon et al., 2013), the intercropping fall-winter corn crop with *Brachiaria* spp. promotes the maintainace of grain corn yield and above-ground dry matter. The intercropping winter corn crop with *Crotalaria spectabilis* shows physiological advantage for winter corn crop because of the efficiency of carbon fixation and the input of nitrogen by *Crotalaria spectabilis* (Heinrichs et al., 2005), and this combination of factors promote the increase of fall-winter crop yield. However, the negative influence of the cover crop dry matter on the soybean yield ought to be investigated, because in many occasions it is observed this negative influence. In preview studies, Correia and Durigan (2008) observed negative results in soybean yield cultivated under different cover crops above-ground dry matter in no-till system. Based on the above consideration, studies about the identification of cover crops that have the capacity to promote high dry matter production in intercropping or crop rotation and its effects in the fall-winter corn and spring-summer soybean crop ought to be incentivized to obtain more information about the cover crop species to introduce in no-till system. The purpose of this research was to assess the above-ground dry matter production from cover crops and its effects on soybean and winter corn crop yield in Brazilian "Cerrado".

Results and Discussion

Above-ground dry matter production of cover crops for no-till system

There was interaction ($p \leq 0.01$) between the cover crops and growing seasons for above-ground dry matter of the cover crops (Table 1). In comparison to the growing seasons it was observed significant difference just for the T5 and T6. Higher amount of above-ground dry matter production was obtained in the T5 (7.85 Mg ha^{-1}) and T6 (8.22 Mg ha^{-1}) in 2012/2013 growing season (Fig 1). In 2012/2013 growing season, the cover crops (T5 and T6) produced higher amount of above-ground dry matter in comparison to the other cover crops. The cover crops (T1, T2, T4, T7 and T8) showed less production of above-ground dry matter (Fig 1). On the other hand, in 2013/2014 growing season the cover crops (T2, T3, T5 and T6) showed higher production of above-ground dry matter and the less production was observed in the cover crops (T1, T2, T4, T5, T7 and T8). In both growing seasons, it was observed that the higher production of above-ground dry matter was associated with the forage grass in intercropping or single crop. The amount of above-ground dry matter in the T5 and T6 reached values over than 6 Mg ha^{-1}, which is important to remain the soil surface covered (Fig. 1). As reported by Costa et al. (2012), the *Brachiaria* sp produced above-ground dry matter over than 8.99 Mg ha^{-1} in an integrated crop-livestock system in no-till system, which indicated this species promises to make part of a crop rotation system to sustainable system of conservative tillage.

In comparison to the reference area with the T5 and T6 in 2012/2013 growing season, the increase of above-ground dry matter was 102.3% (T5) and 111.86% (T6) (Fig. 1A), and for 2013/2014 growing season the T2, T3, T5 and T6 promoted average above-ground dry matter increase of 55% (Fig. 1). These results indicated the efficiency of these cover crops to promote the input of above-ground dry matter, which is indispensable for the maintenance and sustainability of the no-till crop system, because of the high amount of above-ground dry matter produced. The highest amount of above-ground dry matter was promoted by *Brachiaria* sp. in comparison to the other cover crops, it is probably because of the vigorous and deep root system, besides the drought tolerance showed by *Brachiaria* sp. (Mutimura and Everson et al., 2012). Another reason may be the perennial vegetation, which shows high capacity of tillering (Araujo et al., 2011), these issues combined can promote high capacity of below-ground and above-ground dry matter production. According to Sage and Kubien (2007), species like *Brachiaria* spp with C4 photosynthetic metabolism show quite low photorespiratory activity and this feature promoted higher CO_2 assimilation even in drought stress. The intercropping winter corn with *B. ruziziensis* promoted increase in the above-ground dry matter production (Ceccon et al., 2013). According to Borghi et al. (2013), the implementation of intercropping fall-winter corn with *B. brizantha* cv. Marandu guarantee high production of above-ground dry matter (9.2 Mg ha^{-1}), nevertheless, it is possible when there is no drought stress or nutrient restriction. In weather conditions of Brazilian "Cerrado", it is quite difficult to maintain the above-ground dry matter, because of high temperature and moisture. According to Sá et al. (2001), it is necessary to have above-ground dry matter amount over than 6 Mg ha^{-1}. In the results obtained in this investigation, the amount of above-ground dry matter rich values over than 6 Mg ha^{-1} in the T3, T5 and T6 in 2012/2013 growing season, and T3 and T6 in 2013/2014 growing season (Fig. 1). These results point to the adoption of forages grass species (*B. brizantha* cv. Marandu or *B. ruziziensis*) allowed to achieve enough amount of above-ground dry matter to remain the no-till system sustainable, it is in part due to the capacity of these forages in produce below-ground and above-ground dry matter higher than the other cover crops in comparison in this research.

Cover crops effects on fall-winter corn yield

In relation to winter corn yield, there was not interaction effect ($p > 0.05$) between cover crops and growing seasons. Despite the interaction, the cover crops and growing seasons showed significant ($p \leq 0.01$) effect on winter corn yield (Table 1). The above-ground dry matter production by the cover crops influenced significantly ($p \leq 0.01$) the winter corn crop yield in both growing seasons (Fig 2). The average corn yield in 2012/2013 growing season was 6.518 Mg ha^{-1}, this result of corn yield is over than the Brazilian average (5.188 Mg ha^{-1}), according to Conab (2014). In relation to 2013/2014 growing season, the winter corn crop yield was 4.638 Mg ha^{-1} (Fig 2), whereas the average Brazilian yield for this growing season was 5.094 Mg ha^{-1} (Conab, 2014). The difference between growing seasons was 28.8 % less in the corn yield (Fig 2). The decrease in fall-winter corn yield was due to the frost occurred in the region of Brazilian "Cerrado". The effects of frost promote alteration in plant

Table 1. Summary of analysis of variance (ANOVA).

		Above-ground dry matter	Soybean yield		Corn yield
Source of variation	*Df*	------------------*F*-value	----------------------	*Df*	*F*-value
Block	3	0.2362^{NS}	3.513^{NS}	3	0.229^{NS}
CC[†]	7	16.4028**	3.525**	3	3.68**
GS[††]	1	2.4265^{NS}	3.708^{NS}	1	291.85**
CRxGS	7	3.2855 **	1.676^{NS}	3	2.1526^{ns}
CV		15.91	8.12		5.58

DF_degree of freedom. **significant at 0.01 probability level by *F*-value. ^{NS} no significant at 0.05 probability level by *F*-value. [†]CC=Crop rotation; [††]GS=Growing season.

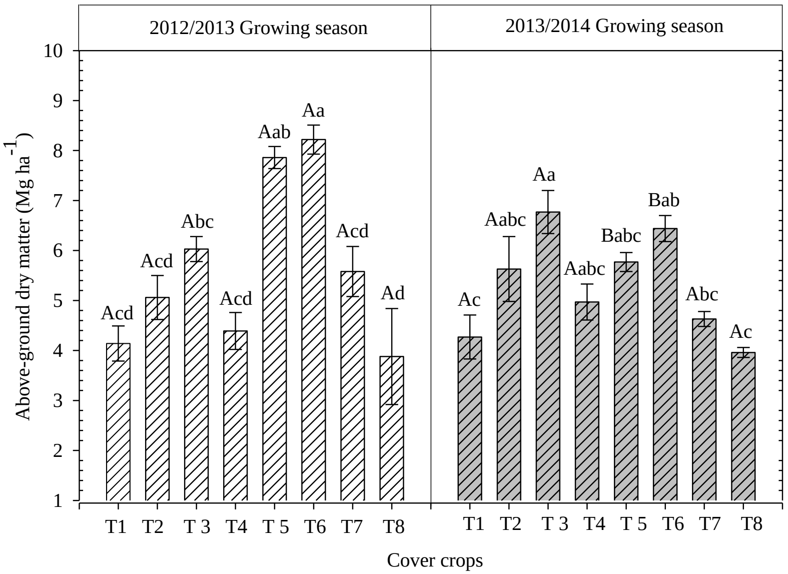

Fig 1. Above-ground dry matter production (Mg ha^{-1}) in response to the cover crops evaluated and two growing seasons (2010/2011 and 2011/2012). Means followed by the same low case letter in the column do not differ by Tukey at 5% of probability level. [winter corn crop (T1); intercropping winter corn with *Brachiaria ruziziensis* (T2); intercropping winter corn with *Brachiariabrizantha* cv. Marandu (T3); intercropping winter corn with *Crotalaria spectabilis* (T4); *B. ruziziensis* (T5); *B. brizantha* cv. Marandu (T6); *Penisetumglaucum* (T7) and reference area (T8)].

metabolism and resulted in physiological damage in plant tissue due to the solidification of dew under the aerial part of the plants (Ometto, 1981; Streck et al., 2010). The fall-winter corn cultivated after the spring-summer soybean in Brazilian “Cerrado” is a risk, because in winter season in this region, the occurrence of frost and drought stress is high, this is one of the reasons that the average yield is below the other countries or even the spring-summer corn cultivated in Brazilian “Cerrado”. However, even the risk, the farmers obtain economic funds in cultivate fall-winter corn after the soybean harvest. The results obtained in this investigation showed that the intercropping winter corn with *B. ruziziensis* (T2) did not decrease the winter corn yield, as follows; it is feasible to introduce this intercropping as an alternative to produce above-ground dry matter in no-till system without the decrease of winter corn yield. However, the adoption of intercropping winter corn with *B. brizantha* cv. Marandu (T3) or *Crotalaria spectabilis* (T4) decreased the fall-winter corn yield, this negative influence may occur because of the competition for production factors (water, light, nutrients, etc.). There is the possibility of allelopathy inhibit of *B. brizantha* cv. Marandu (T3) or *Crotalaria spectabilis* (T4) in fall-winter corn, but it is not easy to distinguish whether the adverse effect of one species on another is due to environment competition or allelopathy factors. It is possible to observe in literature that the results for intercropping fall-winter corn with *Brachiaria* spp are still undefined, on the one hand the *B. ruziziensis* in intercropping with corn did not decrease the grain yield (Baldé et al., 2011) and on the other hand it is observed. The fact is that, probably the capacity of *B. brizantha* cv. Marandu in biomass production due to C4 photosynthetic metabolism (Sage and Kubien, 2007) associated with the shade tolerance of *B. brizantha* cv. Marandu (Dias-Filho, 2002) may decrease the corn grain yield (Fig 2). The smallest fall-winter corn yield when in intercropping with *Crotalaria spectabilis* was obtained by Ceccon et al. (2013), as well as the results observed in this investigation. To avoid decrease of fall-winter corn yield in intercropping with *Crotalaria spectabilis*, it is necessary to input source of nitrogen fertilizer to supply the winter corn crop need. As reported by Fischler et al (1999), the intercropping fall-winter corn with *Crotalaria spectabilis* decreased the corn crop yield in 40% when the *Crotalaria spectabilis* was sowed at the same moment that corn crop, and decreased in 22% when *Crotalaria spectabilis* was sowed three days after corn crop. It was observed in this experiment that after corn senescence it is important to harvest without delay, because the *Crotalaria spectabilis* above-ground biomass grows faster due to the absence of light limitation and this fact can decrease the harvest process with the decrease of grain yield.

Cover crops effects on soybean yield

The soybean yield did not differ ($p>0.05$) between the growing seasons and no interaction was observed between growing season and cover crops. However, the cover crops effects on soybean yield ($p\leq0.01$) (Table 1).

The smallest soybean yield (3.593 Mg ha^{-1}) was showed when the soybean was cultivated under above-ground dry

Table 2. Some physical and chemical soil properties of the experimental site.

	Depths	
	0-20 cm	20-40 cm
pH ($CaCl_2$)	5.10	4.66
SOM (g dm^{-3})	28.0	19.0
P (mg dm^{-3})	16.30	1.08
K^+ ($cmol_c$ dm^{-3})	0.41	0.10
Ca^{2+} ($cmol_c$ dm^{-3})	4.15	1.90
Mg^{2+} ($cmol_c$ dm^{-3})	1.30	0.75
H+Al ($cmol_c$ dm^{-3})	4.98	4.83
Al^{3+} ($cmol_c$ dm^{-3})	0	0.34
SB ($cmol_c$ dm^{-3})	5.86	2.75
CEC ($cmol_c$ dm^{-3})	10.84	7.58
BS (%)	54.06	36.28
Clay (g kg^{-1})	390	
Sand (g kg^{-1})	310	
Silt (g kg^{-1})	300	

CEC: Cation Exchange Capacity; total acidity pH 7.0 (H^+ +Al^{3+}); Exchangeable (KCl 1 mol L^{-1}) Ca, Mg and Al; SB: Sum of Base=∑cations; BS: Base Saturation=(∑cations/CEC)x100.

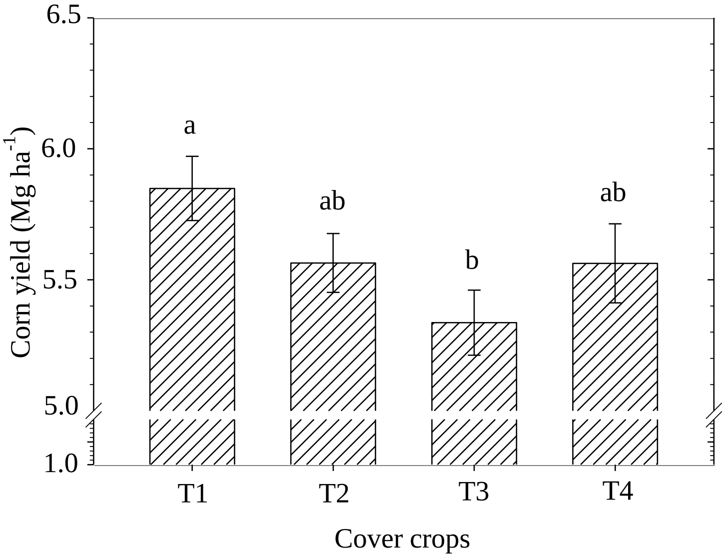

Fig 2. Corn yield (Mg ha^{-1}) in no-till system in Brazilian "Cerrado", each bar represents the mean value in two growing season (2012/2013 and 2013/2014). Means in each bar followed by the same low case letter do not differ at 0.05 probability level by Tukey test. [winter corn crop (T1); intercropping winter corn with *Brachiaria ruziziensis* (T2); intercropping winter corn with *Brachiaria brizantha* cv. Marandu (T3); intercropping winter corn with *Crotalaria spectabilis* (T4)].

matter of *B. brizantha* cv. Marandu (T6) or intercropping fall-winter corn with *B. brizantha* cv Marandu (T3), which obtained the soybean yield of 3.836 Mg ha^{-1} (Fig. 4). The depletion in soybean yield observed in this research may be because of higher above-ground dry matter production *B. brizantha* cv. Marandu, which promoted slow development of soybean in the beginning of soybean establishment and growth. Another possible explanation for the depletion of soybean yield, can be due to the growth habit of *B. brizantha* cv. Marandu, this forage grass has caespitosus growing with high possibility to develop clump with 1 meter of diameter and tillers with 1.5 m of height. These features combined may influence the soybean sowing, which decreases the stand and development of soybean plant. The biggest challenge is to find the adequate level of above-ground dry matter production of the cover crops, which may reach acceptable soybean grain yield (above 2.842 Mg ha^{-1}). Even if the decrease of soybean yield among the treatments, the soybean yield obtained in this research reached values above the average of the United States of American (2.880 Mg ha^{-1}) and the highest soybean producer State of Brazil (Mato Grosso) that has the average yield of 3.069 Mg ha^{-1} (USDA, 2015), this indicated that the cover crops used in this experiment can achieve higher production even if with the decrease in some case (Fig. 4).

Materials and Methods

Site description

This research was carried out from October 2012 to February 2014 in a dystroferric Red Latosol, classified according to Santos et al. (2013), located in the municipality of Maracaju, State of Mato Grosso do Sul, Brazil (approximately 21°36'52''S. 55°10'06''W, average altitude 384 m above sea level). According to Köppen (1948), the region is classified as tropical climate of type Am, with rainy summer and dry winter. The rainfall and temperature in the region of the experimental site is showed in Fig. 5.

Implementation of the experiment

During 10 years, the experimental site was cropped with soybean and corn crops in no-till system. Before the implementation of the experiment, it was collected soil samples in 0-20 cm and 20-40 cm depths to determine the

Table 3. Treatments description.

Treatments (T)	Cover crops	Spring-summer season
T1	Fall-winter corn	Soybean
T2	Intercropping fall-winter corn with *B. ruziziensis*	Soybean
T3	Intercropping fall-winter corn with *B. brizantha* cv. Marandu	Soybean
T4	Intercropping fall-winter corn with *Crotalaria spectabilis*	Soybean
T5	*Brachiaria ruziziensis*	Soybean
T6	*Brachiaria brizantha* cv. Marandu	Soybean
T7	*Pennisetum glaucum* L.	Soybean
T8	Set-aside area	Soybean

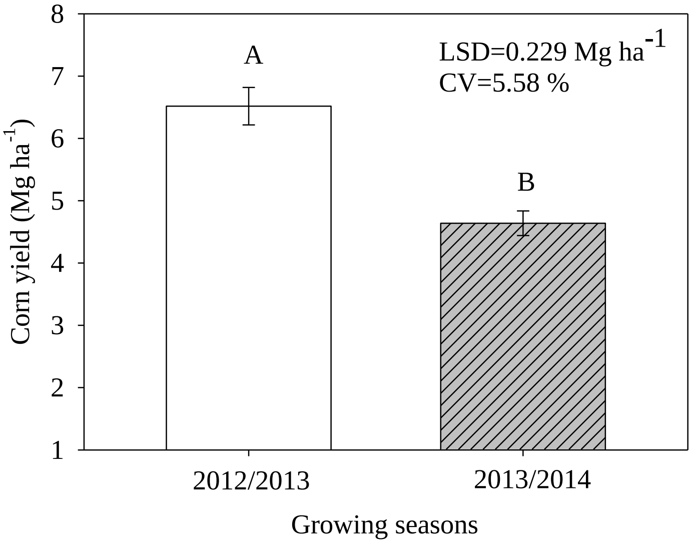

Fig 3. Corn yield (Mg ha^{-1}) in no-till system in Brazilian "Cerrado" in 2012/2013 and 2013/2014 growing seasons. Mean in each bar followed by the same capital letter do not differ by at 0.01 probability level by LSD (Least significant difference).

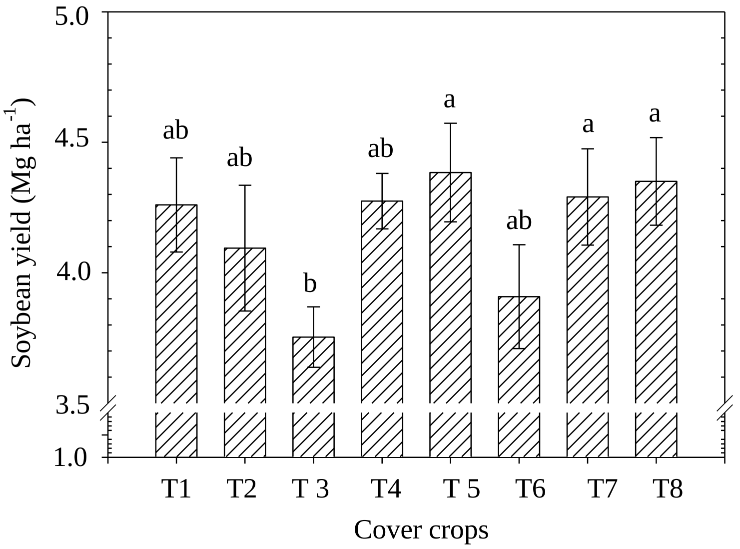

Fig 4. Soybean crop yield (Mg ha^{-1}) in no-till system in Brazilian "Cerrado". Each bar represents the mean value in two growing seasons (2012/2013 and 2013/2014). Means followed by the same letter in the column do not differ at 0.05 of probability by Tukey test. [winter corn crop (T1); intercropping winter corn with *Brachiaria ruziziensis* (T2); intercropping winter corn with *Brachiaria brizantha* cv. Marandu (T3); intercropping winter corn with *Crotalaria spectabilis* (T4); *B. ruziziensis* (T5); *B. brizantha* cv. Marandu (T6); *Penisetum americanum* (T7) and reference area (T8)].

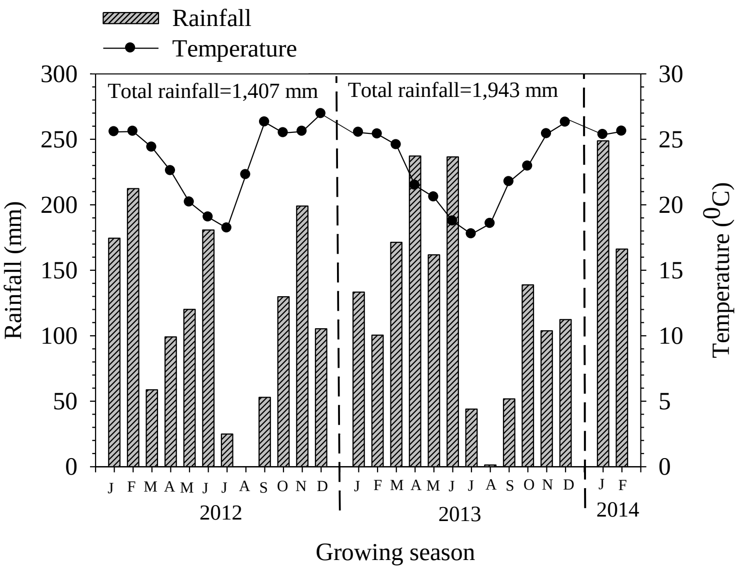

Fig 5. Monthly rainfall and temperature in 2012/2013 and 2013/2014 cropping seasons in the region of the experiment. J=January, F=February, M=March, A=April, M=May, J=June, J=July, A=August, S=September, O=October, N=November, D=December.

physical and chemical properties of the soil (Table 2). The dolomitic lime (2.4 Mg ha^{-1}) and gypsum ($CaSO_4.2H_2O$) (0.6 Mg ha^{-1}) were applied in 2010, 30 days before soybeans sowed. The lime showed calcium carbonate equivalent (CCE) to 64%, it was applied the dolomitic lime enough to increase the base saturation to 60%. The lime and gypsum were accomplished by spreading on the soil without incorporation. At the end of October 2010, it was sowed the soybean and after the soybean harvest, the fall-winter crops that comprise the treatments were sowed.

Experimental design and treatments

The assessments of the experiment were performed in 2012/2013 and in 2013/2014 growing seasons. The experimental was set up in completely randomized blocks designed in a factorial with eight cover crops and two growing seasons, with four repetitions making a total of 32 units per growing season. The experimental unit was set in a dimension of 12 m x 2.5 m. The treatments adopted were different cover crops sowed in the fall-winter season before soybean cultivate in the spring-summer season under no-till system (Table 3).

The vegetation of the reference area (RA) was performed basically for *Bidens pilosa*, *Eleusine indica*, *Euphorbia heterophylla*, *Brachiaria* spp. and *Ipomoea grandifolia*. The sowing of the fall-winter corn in the growing seasons (2012/2013 and 2013/2014) was accomplished in no-till system right after the soybean harvest. It was used the fall-winter corn hybrid DKB 390 VTPRO. The sowing of fall-winter corn was executed depositing 3 seeds per meter in the spacing between rows of 50 cm. At the moment of sowing, the fertilizer was accomplished with 256 kg ha^{-1}of the formulation 12-15-15 (N-P_2O_5-K_2O). The seeds were treated with insecticide using 1,750 mL of Imidacloprid + Tiodicarbe for each 100 kg of seeds.

The intercropping fall-winter corn with forages grass (*Brachiaria* ruzizienses and *Brachiaria brizantha* cv. Marandu) was sowed at the same moment through the use of automatized machine. The space between rows for forages grass was 21 cm. The seed cultural value for *B. ruzizienses* and *B. brizantha* cv. Marandu were 50% and 80%, respectively. Both species of forages grass showed seeds with 80% of germination and 62.5% of purity. To stablish the intercropping fall-winter corn with *B. ruzizienses* and *B. brizantha* cv.Marandu, it was used 5 and 7 kg ha^{-1} of seeds, respectively. The plots sowed with only *B. ruziziensis* and *B. brizantha* cv. Marandu were established with 7 and 8 kg ha^{-1} of seeds, respectively.

The *Pennisetum glaucum* L. sowing was accomplished in the space between rows of 50 cm. The *P. glaucum* L. cultivar sowed was BRS 1501, which was used 11 kg ha^{-1} of seeds. The intercropping fall-winter corn with *Crotalaria spectabilis* was accomplished with 6 kg ha^{-1} of seeds in the space between rows of 45 cm. The sowing of *C. spectabilis* was done manually 15 days after the winter corn sowed.

In the soybean sowing in the growing seasons studied (2012/2013 and 2013/2014), it was used an automatized machine. In the occasion of sowing, it was accomplished the fertilizer with 380 kg ha^{-1} of the formulation 02-20-20 (N-P_2O_5-K_2O) in sowing furrow. The soybean cultivar sowed was BMX Potência Roundup Ready (99% of purity and 90% of germination). It was sowed 14 seeds per meter of row in the space between rows of 45 cm.

The soybean seeds were treated with fungicide [Carboxin + Thiran (48 g L^{-1})], insecticide [Fipronil (40 g L^{-1})], micronutrients [cobalt (2.32 g L^{-1}) and Molybdenum (40.6 g L^{-1})], and these doses were in gram of active ingredient per 80 kg of seeds. Besides, the seeds were inoculated before the sowing with inoculate in turf, which contented the bacteria *Bradyrhizobium elkani* (Race Semia 5019) and *Bradyrhizobium japonicum* (Race Semia 5079) in the concentration of $5x10^9$ viable cells per gram of inoculate. It was used 100 ml of inoculate in which 80 kg of soybean seed. The desiccation of cover crops was accomplished in 20 days before the soybean sowing, through the use of glyphosate-salt-isopropylamine (1,440 g ha^{-1} of active ingredient) plus 1,209 g ha^{-1} of active ingredient of 2.4-D, dimethylamine salt.

Assessment of the experiment and plant material

The assessments were taken in 2012/2013 and 2013/2014 growing seasons. The measurement of the cover crops above-ground dry matter was taken after the desiccation of cover crops in 2012 and 2013, in 10 days before the soybean sowing. It was collected all the dry matter above-ground in an area of 1 m^2 (it was made an iron square with dimension of 1 meter in each side), following the recommendation in the methodology of Stott et al. (1990). The iron square of $1m^2$ was thrown randomly in each plot to be assessed the above-ground dry matter. The material collected was placed to dry in stove with forced air circulation at temperature of 65^0C until reach the constant weight to determine the dry matter (DM). The fall-winter corn and soybean crop yield were determined through the sample of two central rows in three meters in four points inside the plot. After harvesting and threshing, the grains were weighted and the moisture was adjusted to 13% of the moisture in wet bases. The 1000-grains weight was determined according to the Rules for Analysis of Seeds (Brasil, 1992).

Statistical analysis

The variables assessed in this experiment were submitted to the analysis of variance (ANOVA) by the *F*-test, which was through in a joint analysis between the cover crops and growing seasons. The means were compared through the Tukey test ($p \leq 0.05$) for multiple means and in the case of two means comparison, it was applied the L.S.D. test (Least Significant Difference) at 0.05 of probability level. These tests were carried out with the use of SISVAR software (Ferrreira, 2010).

Conclusions

The cultivation of intercropping fall-winter corn crop with *B. brizantha* cv. Marandu or this forage grass single showed higher production of above-ground dry matter, these values reached quantities over than 6 Mg ha^{-1}. The soybean crop yield suffered decreasing in yield because of the dry matter production of the cover crop of *B. brizantha* cv. Marandu and the intercropping winter corn crop with *B. brizantha* cv. Marandu.

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