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Scientific paper

Production, decomposition and half-life of the straw of grass under different levels of manure for no-tillage system in cerrado

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Abstract

In the conditions of cerrado (savannah), the climate is favorable in the increase and acceleration of the straw decomposition, thus, hindering the permanence and the maintenance of the residue in the surface of the soil. This work aimed at evaluating the production, decomposition and half-life of straw mixture with grass about the anticipation of levels of the culture successor's manure in no-tillage system, in the savannah, in the Southwest area of Tocantins. The production of dry mass and the decomposition rate were appraised in an experiment with fifteen types of vegetable covering: millet (*Pennisetum americanum*), brachiaria (*Brachiaria brizantha*), forage sorghum (*Sorghum vugares pers*), bluestem (*Gayanus kunth*), in single and in mixed plantation, and with 0% and 40% of chemical manure recommended for the culture successor (soy), in savannah soil, in Alvorada, south area of Tocantins. In a Latossolo Vermelho Distrófico, submitted to 13 years of cultivation, which were: 8 years under conventional system with the use of harrow disc and disking; 2 years under minimum cultivation with the use of disking and later subsolador and 3 years under no-tillage system. The obtained results demonstrate that the consortium use of grass increases the straw production in no-tillage system. The increase of the amount of chemical fertilizer promotes increment in the fitomass production, being the most significant effect in the mixed plantation that involved grass. The throwing seeding of the bluestem grass in the soil surface promotes a better exploration of the area which produces straw. However, that grass did not contribute to the increase of the productivity in the mixed plantation to which it was involved. The presence of millet, brachiaria and sorghum grass in mixed plantation increases the production and volume of remaining straw for the system of no-tillage system in both levels of chemical manure.

Key words: covering of the soil, matter dries, fitomass, plantation mixed.

Introduction

Since its introduction in Brazil, in the beginning of the decade of 70, the no-tillage system (NT) had an evaluation by the pioneer farmers for the importance of maintaining the crop residues in the soil protection. Thus, it was named by the innovator farmers as "seeding direct in the straw". The comprehension of the real value of the straw in the no-tillage system was one of the factors which determined the success of the new system in tropical and subtropical conditions.

Among the main advantages of this straw layer there are: reduction of the soil temperature; higher infiltration and water retention; increase in the biological activity; increase in the aggregation and preservation of the superficial structure; increase in the supply of carbon (VAN BREEMER, 1993; VEZZANI, 2001); improve in the cycling and increase in the providence of nutrients to plants by the reduction of losses by leaching and erosion; possibility of reduction of the use of inputs from outside of the property; control of the erosion, and reduction of the superficial compaction of the soil trough animal trading (AMADO, 1999).

However, the amount of straw produced under the no-tillage system in subtropical conditions has been indicated as inferior to the amount needed so that the system may express completely its potential. DENARDIN and KOCHHANN (1993);

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RUEDELL (1998) suggest an annual addition of 6.0 t ha^{-1}, while for BAYER (1996) and FIORIN (1999) the input should be from 10 to 12 t ha^{-1}. Taking soybean as an example, in which the production of straw after the harvest is estimated in 2,5 t ha^{-1} (RUEDELL, 1998), the annual deficit of the volume of straw for the promotion of the no-tillage system would be between 2 and 4 times the volume produced. Thus, this small contribution needs to be compensated by the cultivation of crops with high potential of straw input.

In the conditions of savannah, taking as example Tocantins, in which the climate conditions are more favorable to the increase of the decomposition of the residues, and the short rainy period seasonal makes the production of straw more difficult, the problems for the production and maintaining the straw in the surface have a larger complexity.

Thus, to obtain high amounts of residues it is necessary the inclusion in the cover crop production system in succession, rotation or preceding the main crop with high potential of production of straw, as well as with improve in the techniques of cultivation of them with example in the anticipation of part of the fertilization of the succeeding crop.

PENÃ (1991) emphasizes that the use of grass as: millet, sorghum and brachiaria cropped alone has increased the production of straw. The same authors emphasize also that the production of straw of these species is optimized with the use in consortium with green fertilizers, looking at its potential to fix nitrogen and the possibility of recycling other nutrients. However, this practice still presents difficulties of mechanized operation.

For MELO FILHO (1997), results similar to these, or even increase in the production of straw may be reached with the improve in the soil fertility for the development of the cover crop, which will optimize the production of straw even in short rainy period which precedes the soybean crop.

This management may be reached in an economically viable way with the anticipation of levels of fertilization recommended for the soybean crop, since this culture presents potential of recovery of the fertilization in the previous crop of up to 60% of its recommendation.

Concerning the maintenance of straw in the soil surface, this can be increased trough the cultivation in mixed cultivation of several species which present different resistances to decomposition, using as an example the grasses with characteristics of high production of mass and large relation C/N.

The objective of the work was to evaluate the production, decomposition and half-life of straw in consortium of grass over the anticipation of levels of fertilization of the succeeding crop in no-tillage system in the cerrado, in the South region of the state of Tocantis.

Material and methods

The work was conducted in the Fazenda São Jorge in the municipality of Alvorada, South region of Tocantins, located at 12º28'30" S and 49º07'30" W, in a humid climate with moderate water deficiency, according to KÖPPEN (1948), with mean annual temperatures of 29.5 ºC. The annual mean rainfall is 1.804 mm, with rainy period concentrated and high water deficit between the months of May to September according to what is shown in figure 1.

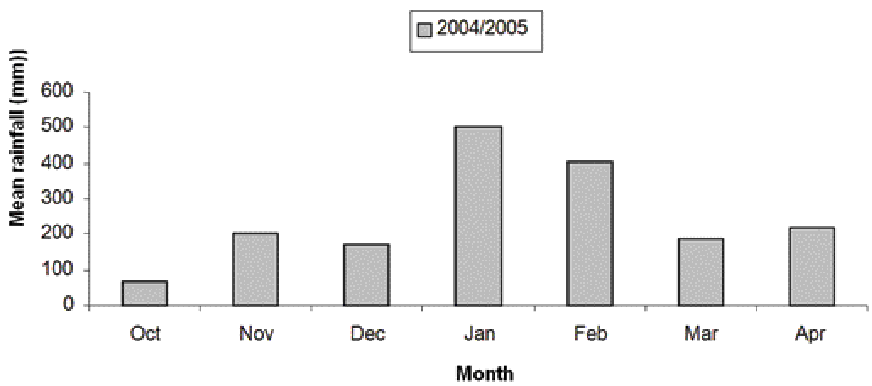

Figure 1. Mean rainfall of the agricultural year 2004/2005 in the Fazenda São Jorge in the municipality of Alvorada, South region of the State of Tocantins

The experiment was installed in a Latossolo Vermelho distrófico, submitted to 13 years of cultivation, which were: 8 years under conventional system with use of harrow disc and disking; 2 years under minimum cultivation with the use of disking and later subsolador and, 3 years under no-tillage system, with the following characteristics: pH $CaCl_2$: 5.0; Ca: 2.5 $cmol_c\ dm^{-3}$; Mg: 0.7 $cmol_c\ dm^{-3}$; Al: 0.0 $cmol_c\ dm^{-3}$; Al+H: 3.3 $cmol_c\ dm^{-3}$; P (*mehlich*): 32.5 mg dm^{-3}; P (resin): 41.0 mg dm^{-3}; K: 85.0 mg dm^{-3}; Cu: 0.7 mg dm^{-3}; Zn: 5.8 mg dm^{-3}; Fe: 490.0 mg dm^{-3}; Mn: 44.6 mg dm^{-3}; CEC: 6.72 $cmol_c\ dm^{-3}$; V: 50.96 %; O. M: 1.5 %.

The experiment design used was completely randomized blocks with 3 replications. Each block was composed by 30 treatments obtained by the factorial combination 15 x 2, and the factors were 15 grasses (alone or mixed) and 2 levels of fertilization.

The grasses were: 1) millet (*Pennisentum americanum*) 12 kg of seeds ha^{-1}; 2) Sorghum (*Sorghum vugare* Pers) 10 kg of seeds ha^{-1}; 3) Bluestem (*Gayanus kunth*) 15 kg of seeds ha^{-1} and 4) Brachiaria (*Brachiaria brizantha*) 10 kg of seeds ha^{-1} and mixed 5) Millet + Brachiaria; 6) Millet + Bluestem; 7) Millet + Sorghum; 8) Sorghum + Brachiaria; 9) Sorghum + Bluestem; 10) Brachiaria + Bluestem; 11) Millet + Brachiaria + Sorghum; 12) Millet + Sorghum + Bluestem; 13) Millet + Brachiaria + Bluestem; 14) Brachiaria + Sorghum + Bluestem; 15) Millet + Brachiaria + Bluestem + Sorghum. The two levels of fertilization were: 1) 0%) 0% (0 kg ha^{-1}) and 2) 40% (160 kg ha^{-1}) from the recommendation of the chemical fertilization for the soybean crop, according to the soil analysis in the moment of planting (400 kg ha^{-1} from 0-20-20 NPK).

Each treatment was installed in plots of 60 m^2 (6 x 10 m). The sowing fertilization was performed broadcast according to the level of fertilization for each treatment on November 23 2004. In the same day it was performed the sowing of all the grasses, and the bluestem in all the treatments involved was broadcast seeded.

The seeding of the other grasses was performed with specific sowing for no-tillage system (model *SEMEATO - SHM 11/13*). The seeding in the single treatments was: millet – sowed trough boxes with small seedlings, brachiaria – trough fertilizer box, being necessary the use of rice husk with vehicle of distribution; sorghum – seeded trough drums with rollers and replaceable perforated horizontal disks.

For the sowing of the treatments mixed with 2 and 3 species of grass, it was performed changes in the seed distribution trough the sealing of the distribution compartments so that the planting is performed in alternated lines according to the combinations between millet, sorghum and brachiaria. In the treatments which involved 4 species of grass it was used the same combinations used in the treatments with 2 and 3 species, and they were different in the broadcast distribution of the bluestem seed.

For the evaluation of the produced straw, it was collected the biomass of an area of 0.0625 m^2 with 12 replications in each plot.

As phytosanitary control along the grass development, it was applied insecticide (Cipemetrina) for the control of caterpillars. For the control of weeds (broad leaf), it was used the herbicide 2.4 D applied on January 8. The dissection of the green matter of each treatment was performed on January 12, 44 days after the emergence for brachiaria with application of the herbicide Goal + Glister + mineral herbicide in the area previous to the soybean planting.

The soybean planting, cultivar conquista (cycle of 90 days), was performed on January 12 with spacing of 45 cm between lines and 4 cm of depth, and with stand of 14 pants m^{-2}. The evaluations of production of straw were performed after the grass dissection, and it was collected the green matter (GM) of each treatment and after drying in an oven for 72 hours in a temperature of 72 ºC, it was determined the dry matter in kg ha^{-1} (straw itself).

For the evaluation of the decomposition of straw in the soil surface, it was collected and weighted the straw contained in an area of 0.0625 m^2 and placed in screened bags of nylon (*litterbags*) with dimensions of 0.25 x 0.25 m with black color with screen of 1 mm, which were returned to their respective places of origin in the experiment, where the decompositions occurred.

The subsequent evaluations of decomposition were made with intervals of 30 days, during a total period of 120 days, and were performed with three replications in each collection interval, with a total of 12 collections per treatment. Thus, it was installed and evaluated 1350 litterbags, avoiding, thus, the return of the evaluated bags to the experiment, since it was already changed the activity of the microbial biomass in the collection place.

It was considered that the decomposition of the residues and the release of nutrients follow the simple exponential model, used by REZENDE et al. (1999):

$$X = X_0\ e^{-kt} \quad (1)$$

In which X is the amount of dry matter or nutrient remaining after a period of time t, in days; X_0 is the amount of dry matter or initial nutrient; and k is the constant of decomposition. Reorganizing the terms of this equation, it is possible to calculate the constant of decomposition, or value k:

$$k = \ln (X/X_0)/t \quad (2)$$

Another characteristic considered in the evaluation of the decomposition of vegetable material was the half-life time, which expresses the period of time needed so that half of the nutrients contained in these residues are released. For the same author, it is possible to calculate the times of half-life trough the equation:

$$t_{1/2} = \ln (2)/k \quad (3)$$

in which $t_{1/2}$ is the time of half-live of dry matter or nutrient, In (2) is a constant value; and k is the constant of decomposition described previously.

The data about production and decomposition of dry matter were submitted to analysis of variance, evaluating the differences between the averages by the Skott_Knott test at 5% with the use of the statistic program SISVAR (FERREIRA, 2003).

Results and discussion

In relation to the production of dry matter (X_0), considering the different mixed grasses and single grass (Table 1), in the absence of fertilization, it was observed higher values in the mixture Brachiaria + Bluestem and in Millet + Brachiaria + Sorghum, being superior to the ones verified in single millet, sorghum, brachiaria and bluestem grass. However, it can be verified that the increase in the production of straw was limited in function of the optimization in the exploitation of the planted area and of the diversity of the planted species, involving the mixture between two or more species of grass.

The lower productivity of straw was found in the mixtures Millet + Brachiaria + Bluestem and in Millet + Brachiaria + Bluestem + Sorghum, respectively, with exception to the mixture Millet + Brachiaria + Sorghum.

The highest production of straw (X_0) in the mixture with two grasses is related, besides the higher exploitation of the area, to the high potential of brachiaria in the exploitation of residues in soil.

Tabele 1. Parameters of the equation $X=X_0e^{-kt}$ adjusted to the values of dry matter and time of half-life for the material incubated in the soil surface for 120 days under different levels of fertilization.

GRASS	Levels of fertilization (%)					
	0			40		
	X_0 t ha^{-1}	K day^{-1}	$t_{1/2}$ day	X_0 t ha^{-1}	K day^{-1}	$t_{1/2}$ day
Millet+Sorghum	10.19 aA	0.01231	56	10.94 aA	0.01108	63
Millet+Brachiaria+Sorghum	10.89 aA	0.01040	67	14.36 aA	0.01169	59
Millet+Brachiaria	9.63 aA	0.01189	58	10.55 aA	0.01267	55
Sorghum	8.56 aA	0.01299	53	10.47 aA	0.00958	72
Sorghum+Bluestem	8.57 aA	0.00887	78	9.01 aB	0.01201	58
Sorghum+Brachiaria	8.96 aA	0.00887	78	12.22 aA	0.01244	56
Millet	10.22 aA	0.01163	60	10.95 aA	0.01447	48
Millet+Bluestem	7.60 aB	0.01019	68	10.59 aA	0.01289	54
Brachiaria+Bluestem	10.89 aA	0.00830	84	8.95 aB	0.01312	53
Brachiaria	10.64 aA	0.01049	66	10.72 aA	0.01412	49
Millet+Sorghum+Bluestem	6.62 aB	0.00994	70	8.44 aB	0.00803	86
Bluestem	6.03 aB	0.01145	61	6.94 aB	0.01310	53
Sorghum+Brachiaria+Bluestem	6.62 aB	0.01069	65	6.38 aB	0.00730	95
Millet+Brachiaria+Bluestem	4.45 bB	0.00819	85	9.10 aB	0.01037	67
Millet+Brachiaria+Bluestem+Sorghum	4.67 aB	0.00678	102	7.63 aB	0.00920	75

**Averages followed by the same lowercase letter in column and uppercase in line do not differ, by the Skott_Knott test, at the level of 5% of probability. (CV=42%)*

According to BAYER and MIELNICZUK (1997) and SILVA et al (2005), this grass presents aggressive root system in the soil exploitation.

In the mixture with three grasses Millet + Brachiaria + Sorghum, the increase of the production is also related to the potential of the components millet and brachiaria in exploit in soil the residues of fertilizers from previous crops, according to what was verified by KLUTHCOUSKI et al. (2003). However, since in this mixture they are all grasses, and there were all sown in line and, still, since there is no specific crop to exploit the free spaces between lines, it is not possible to suggest that the increase in the production of straw in relation to the single crops is due to an optimization in the exploitation of the planted area.

Comparing the mixture Millet + Brachiaria + Bluestem, it was observed reductions in relation to the single cultivation of the Millet, Brachiaria and Bluestem grass, respectively (Table 1).

In relation to the mixture Millet + Brachiaria + Bluestem + Sorghum, it was verified reduction in relation to the single cultivation of millet, brachiaria, bluestem and sorghum (Table 1). This shows a higher demand in fertility, mainly from the grass millet and brachiaria, which ends up reducing its contribution in function of the increase of the competition per area and, manly by nutrients in the crops in mixture involving the millet and brachiaria grass in the absence of fertilization, according to what is emphasized by LARCHER (2000) and RUGGIERI et al. (1995).

Another factor that contributed for the reduction in the production of straw in mixture with more grass was the way of seeding of the bluestem grass, which was broadcast performed between lines, without incorporation of the seed. This favored a fast emergence of the seed of bluestem in the surface, in relation to the other grass which were seeded in depth, in which moment of emergence the bluestem was already established and with higher competitive potential due to its stage of development.

In this case, possibly bluestem may have inhibited the other grass, establishing its dominance. However, since bluestem presents low production of biomass in the initial stages (VANTINI et al., 2001), it reduced the total production of straw in the area, presenting production lower that the one observed in single cultivation of each grass.

According to LARCHER (2000), the fertilization contributes with the increase in the production rate, and may be expressed in increase of dry matter trough products of assimilation. Thus, analyzing the production of straw from different mixtures of grass, cultivated under the anticipation of 40% of the fertilization of 400 kg ha^{-1}, recommended for the succeeding crop (soybean) (Table 1), it was observed the highest productivity of straw in the mixture Millet + Brachiaria + Sorghum, in the order of 14.36 t ha^{-1}.

With this input in the initial fertility, it is possible to have gains in the productivity of straw (Table 2) in the order of 23.74, 25.34 and 27.08%, when compared to the yield of the grass millet, brachiaria and sorghum, respectively, in single crop.

The higher productivity of straw observed in the mixture millet + brachiaria + sorghum corresponds to approximately twice the demands of the remaining straw for the cover of 100% of the soil surface, recommended by LOPES et al. (1987) and by SARAIVA and TORRES (1993), who point to a necessity of 7.0 t ha^{-1}. Conversely to this mixture, the productivity of straw of 6.37 t ha^{-1} was observed in the mixture Brachiaria + Sorghum + Bluestem.

When analyzing the effect of the level of fertilization in the production of straw (X_0) in different mixture of grass (Table 1), it was observed increase in the mixtures Sorghum + Brachiaria, in Millet + Brachiaria + Sorghum and in Millet + Brachiaria + Bluestem, where the additions verified in function of the type of fertilization were 36.38%, 31.98% and 104.26%, respectively.

In the mixture Sorghum + Brachiaria, the increase in the production of straw is related to higher capacity of response of brachiaria in initial development, when there is improvement of the soil fertility (RUGGIERI et al., 1995), mainly in function of the addition of 40 kg ha^{-1} of phosphorus in the sowing.

The results for the mixture with three grasses Millet + Brachiaria + Sorghum and in Millet + Brachiaria + Bluestem, which also presented significant increase in the production of straw, may be explained for the high response of brachiaria to the increase of the level of fertilization, besides the presence of millet. These two mixtures also presented the same behavior of response to the level of fertilization described to the case of Brachiaria (Table 1).

The mixture Brachiaria + Sorghum + Bluestem in the presence of fertilization, and Millet + Brachiaria + Bluestem + Sorghum in the absence of fertilization presented the lowest values of decomposed straw

Table 2. Decomposition of straw, rate of decomposition and remaining straw of the mixture of grass and grass alone over the antecipation of levels of fertilization of the succeeding crop in no-tillage system, in the period of 120 days, in the south region of the State of Tocantins.

GRASS	Decomposed Straw (t ha^{-1})		Rate of decomposition (%)		Remaining Straw (t ha^{-1})	
	Level of Fertilization %					
	0	40	0	40	0	40
Millet	7.68 aB	8.88 aA	75.00 aA	82.00 aA	2.53 aA	1.93 aA
Sorghum	7.32 aA	7.42 aA	80.33 aA	69.33 aB	1.80 bB	3.32 aA
Brachiaria	7.60 aA	6.91 aA	71.67 aA	77.67 aA	3.02 aA	1.97 aA
Bluestem	4.51 aA	5.40 aA	74.67 aA	79.00 aA	1.53 cA	1.44 cA
Millet+Sorghum	8.21 aA	8.08 aA	78.00 aA	73.67 aA	2.33 aA	2.89 aA
Millet+Brachiaria	7.41 aA	8.35 aA	76.33 aA	78.00 aA	2.31 aA	2.30 aA
Millet+Bluestem	6.38 aB	8.48 aA	78.33 aA	79.00 aA	1.78 bA	2.25 aA
Sorghum + Brachiaria	5.95 aB	9.73 aA	65.67 aB	78.00 aA	3.09 aA	2.75 aA
Sorghum + Bluestem	5.22 aB	6.89 aA	59.00 aB	76.33 aA	3.62 aA	2.13 aB
Brachiaria + Bluestem	7.86 aA	7.50 aA	70.33 aA	80.33 aA	3.32 aA	1.85 bB
Millet+Brachiaria+Sorghum	7.96 aB	10.71 aA	72.00 aA	75.00 aA	3.13 aA	3.53 aA
Millet+Sorghum+Bluestem	5.18 aA	5.17 aA	76.67 aA	61.67 aB	1.57 cB	3.22 aA
Millet+Brachiaria+Bluestem	2.90 aB	6.51 aA	63.33 aA	71.33 aA	1.67 bA	2.62 aA
Sorghum+Brachiaria+Bluestem	5.06 aA	3.91 bB	73.33 aA	59.67 aB	1.84 bA	2.66 aA
Millet+Brachiaria+Bluestem+Sorghum	2.73 bB	5.57 aA	56.67 aB	68.67 aA	2.07 aA	2.53 aA
CV =	28%		39%		34%	

in relation to the other mixtures and grass in single culture (Table 2). In these mixtures it was observed values 3.91 and 2.73 t ha^{-1}, respectively. These mixtures, in these conditions of cultivation, could not be recommended, since the volume of straw produced, of 6.38 and 4.67 t ha^{-1} (Table 1), is considered low to maintain the minimum value of 6.0 t ha^{-1}, according to recommendations of DAROLT (1998), DENARDIN and KOCHHANN (1993) and RUEDELL (1998).

When analyzing the data from Table 2, it is verified that after the period of 120 days of decomposition, during the cultivation of soybean in the absence of fertilization, the mixture Millet + Sorghum + Bluestem presents the lowest volume of remaining straw, being observed only 23% of the initial volume (5.18 t ha^{-1}), which corresponds to 1.57 t ha^{-1}. In the comparison with the same grass in single cultivation, it is observed that only bluestem presented inferior value of remaining straw.

In the presence of fertilization, the mixture Brachiaria + Bluestem, presented the lowest value of remaining straw, and only bluestem was superior. In the presence of fertilization, the mixture of Brachiaria + Bluestem, presented the lowest volume of remaining straw, only bluestem was superior to that. Among the concepts studied, the highest values of remaining straw were observed in the mixture Sorghum + Bluestem in the absence of fertilization, and Millet + Brachiaria + Sorghum in the presence of fertilization.

When it is added the volumes of straw superior to 3,5 t ha^{-1} to the volume left by soybean in the soil surface, which is approximately 3,0 t ha^{-1}, it is verified a remaining volume of approximately 7,0 t ha^{-1}. This volume presents cover of the soil surface of approximately 100% according to LOPES et al. (1987) and SARAIVA and TORRES (1993).

When observing Table 1, it is possible to observe that the dry matter, trough the decomposition in the period of 120 days, decreased for all the materials. Thus, those materials which have lower rate of decomposition and higher initial production of dry matter and, consequently, a higher half life, will be the most desirable for the soil cover, since they decompose half of its production of dry matter in a long period. For LUPWAYI and HAQUE (1998), this depends on the loss of labile soluble compounds and on the easiness of decomposition of each material.

In the South region of Tocantins, there were high temperatures and season periods along the year, accelerating the material decomposition, it was possible to verify that the fertilization acts directly in the decomposition of most of the materials.

However, the more recalcitrant, considering the half life in the process of decomposition with 0% of fertilization, were a) Millet + Brachiaria + Bluestem + Sorghum, b) Millet + Brachiaria + Bluestem, c) Brachiaria + Bluestem, d) Sorghum + Brachiaria, and f) Sorghum + Bluestem and with 40% of the fertilization were a) Sorghum + Brachiaria + Bluestem, b) Millet + Sorghum + Bluestem, c) Sorghum and d) Millet + Brachiaria + Bluestem + Sorghum.

It was estimated for Sorghum, Millet + Sorghum with 0% of fertilization, in millet and Brachiaria + Bluestem, in bluestem, in Millet + Bluestem, in Millet + Brachiaria, in Sorghum + Brachiaria and in brachiaria with 40% of the fertilization, presenting higher easiness to biodegrade carbon (Table 1)

According to LARCHER (2000), the fertilization may leave the cellular wall with lower resistance, provided that there is competition and, consequently, etiolating of the branches and leaves (development stage), thus facilitating the break of carbon bond and accelerating the material decomposition.

Millet with fertilization and Sorghum without fertilization presented the highest constants of decomposition, while an opposed behavior was observed for Millet + Brachiaria + Bluestem + Sorghum and in Sorghum + Brachiaria + Bluestem with 0% and 40% of fertilization, respectively. In Table 1 it can be verified that the other vegetal covers presented intermediate behavior.

The decomposition of the residues was slowest for most of the vegetal covers under management with level of 0% of fertilization, probably as a consequence of the higher rigidity of the mass to be decomposed.

Conclusions

The use of mixture of grass increases the production of straw in no-tillage system.

The increase in the level of chemical fertilization provides increase in the production of straw, and the most significant effect is in the mixtures which involve higher number of grass species.

The broadcast seeding of bluestem grass in the soil surface provides a better exploitation of the area which produces straw. However, this grass does not contribute to improve the productivity in the mixtures in which it is present.

The presence of the millet, brachiaria and sorghum grass as mixture provides higher productivity and volume of remaining straw for the no-tillage system in both levels of chemical fertilization (0 and 40% of the total recommended).

Millet + Brachiaria + Bluestem + Sorghum with 0% of fertilization and Sorghum + Brachiaria + Bluestem with 40% of fertilization present more recalcitrant materials, making the decomposition and release of nutrients more difficult.

Referencias

AMADO, T.J.C. Seqüestro de carbono em plantio direto e a melhoria da qualidade ambiental. **In: Anais** da Conferência Anual da Revista Plantio Direto, IV., Uberlândia, Aldeia Norte Editora Ltda, 1999. p.44-51.

BAYER, C. **Dinâmica da matéria orgânica em sistema de manejo do solo**. Tese (doutorado em Ciências do solo) - UFRGS, Porto Alegre. 1996. 240f.

BAYER, C.; MIELNICZUK, J. Características químicas do solo afetadas por métodos de preparo e sistemas de cultura. **Revista Brasileira de Ciência do Solo**, v.21, n.2, p.105-112, 1997.

DAROLT, M.R. Princípios para implantação e manutenção de sistemas. **In:** Plantio direto: Pequena propriedade sustentável. Londrina, Iapar, 1998. p.16-45 (**Circular, 101**).

DENARDIN, J.E.; KOCHHANN, R.A. Requisito para a implantação e a manutenção do sistema de plantio direto. **In: Anais** Encontro Plantio Direto no Brasil, Uberlândia. CNPT-Embrapa, Fundacep-Fecotrigo, Fundação ABC. Aldeia Norte Editora Ltda, 1993. P.19-27.

FERREIRA, D.F. **Programa de análises estatísticas (Statistical Analysis Software) e planejamento de experimentos**. Universidade Federal de Lavras, 2003. 176p.

FIORIN, J.E. Plantas recuperadoras da fertilidade do solo. In: Anais Fertilidade do Solo em Plantio Direto. Uberlândia: Aldeia Norte Editora Ltda, 1999. P.92.

KLUTHCOUSKI, J.; STONE, L.F.; AIDAR, H. **Integração lavoura-pecuária.** Santo Antônio de Goiás: Embrapa Arroz e Feijão, 2003. 570p.

KÖPPEN, W. **Climatologia: con un estudio de los climas de la tierra. Fundo de Cultura Econômica.** México, 1948. 479p.

LARCHER, W. **Ecofisiologia Vegetal**: São Carlos, RIMA, 2000. 531p.

LOPES, L.M.X.; BOLZANI, V.S.; TREVISAN, L.M.V. Clerodane diterpenes from *Aristolochia* species. **Phytochemistry**, v.26, p.2781-2784, 1987.

LUPWAYI, N. Z.; HAQUE, I. Mineralization of N, P, K, Ca and Mg from Sesbania and Leucaena leaves varying in chemical composition. **Soil Biology Biochemistri**, v.30, p.337-343, 1998.

MELO FILHO, J.F. Avaliação de leguminosas em associação com milheto para utilização como adubo verde no ambiente dos tabuleiros costeiros. **In: Resumos** da XIII Reunião Brasileira de Manejo e Conservação do Solo e da Água, Ilhéus: Sociedade Brasileira de Ciência do Solo, 2000. P.1036.

PENÃ, R.P. **Contribuição ao desenvolvimento de novos métodos para adubação verde**. Instituto Biodinâmico de Desenvolvimento Rural, Botucatu, 1991. P.5.

RUEDELL, J.A. Soja numa agricultura sustentável. **In: Resumos** A Soja em Rotação de Culturas no Plantio Direto, Cruz Alta: Fundacep-Fecotrigo, 1998. p.234.

RUGGIERI, A.C., FAVORETTO, V.; MALHEIROS, E.B. Efeito de níveis de nitrogênio e regime de corte na distribuição, na composição bromatológica e na digestibilidade "*in vitro*" da matéria seca da Brachiaria brizantha (Hochst) Staft cv. Marandu. **Revista da Sociedade Brasileira de Zootecnia**, v.24, n.1, p.20-30, 1995.

SARAIVA, O.F.; TORRES, E. **Estimação da cobertura do solo por resíduos culturais**. Londrina: EMBRAPA–CNPSo, 1993. 4p. (EMBR5APA–CNPSo, 14).

SILVA, E.F.; PREMAZZI, L.M.; MENEGUELLI, N.A.; MACEDO, J.R.; ARAÚJO, F.O. Propriedades químicas do solo e produção de forragem em áreas de pastagens recuperadas em relevo forte ondulado na região noroeste do Estado do Rio de Janeiro. **In: Anais** do 30º Congresso brasileiro de ciência do solo, Recife-PE, 2005, *CD Rom.*

VAN BREEMER, N. Soils as biotic cronstruct favouring net primary productivity. **Geoderma**, v.57. p.183-211, 1993.

VANTINI, P.P.; RODRIGUES, T.J.D.; RODRIGUES, L.R.A. Morfofisiologia de *Andropogon gayanus* Kunth sob adubação mineral e orgânica em três estratos verticais. **Acta Scientiarum - Animal Sciences**. v.23, n.4. p.769-774, 2001.

VEZZANI, F.M. **Qualidade do sistema do solo na produção agrícola**. Porto Alegre, Universidade Federal do Rio Grande do Sul, 2001. 184 p.