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Cientific Paper

Production, chemical composition and nutrient accumulation of winter cereal managed under integrated crop livestock

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Abstract

The aim of this study was to evaluate the production, chemical composition, as well as the accumulation of residues of three different winter cereals, managed under integration of crop and livestock. The study was conducted in the autumn/winter of 2012 in experimental area of the Universidade Estadual do Oeste do Paraná – Campus Marechal Cândido Rondon in Dystrophic Oxisol (LVdf) with a randomized block design in slot scheme, with four repetitions. The treatments consisted of three different winter cereals (oat IPR 126, triticale IPR 111 and wheat BRS Tarumã) with three different managements: no grazing, one grazing and two grazing. It was performed until achieving a residual height of 15 cm of each one of the forages, using Holstein cows with an average weight of 663 kg. It was determined the production of biomass, the content and accumulation of C, N, P, K, Ca, Mg and the relation C: N in the residues of the winter cereals after harvest. The biomass production was higher in the management which grazing was not performed, associated with oat and triticale. The different used winter cereals influenced the C and K contents, in the C: N relation and in the amount of C accumulated in the area. The managements affected the accumulated amount of Ca, P and N. The studied characteristics were not influenced. The results suggest that the management used, as well as the used crop, directly interfere in the quantity and quality of plant residues.

Keywords: Oat; triticale; wheat; cereals of dual purpose; nitrogen

Producción, composición química y acumulación de nutrientes de residuos de cereales de invierno manejados bajo sistema de integración agricultura y pecuaria

Resumen

El objetivo del estudio fue evaluar la producción, composición química y la acumulación de nutrientes de los residuos de tres diferentes cereales de invierno manejados mediante el sistema de integración agricultura y pecuaria. El estudio se llevó a cabo en el otoño invierno de 2012, en un área de la Universidade do Oeste do Paraná - Campus Marechal Cândido Rondon (Brasil), con diseño en bloques al azar en bandas, con cuatro repeticiones. Los tratamientos consistieron en tres diferentes cereales de invierno (avena IPR 126, triticale IPR 111 y trigo 111 BRS Tarumã), con tres distintos manejos: Sin pastoreo, uno pastoreo y dos pastoreos. El pastoreo se llevó a cabo hasta que se alcanzar la altura residual de 15 cm de cada forraje, utilizando vacas de raza Holstein (holandés) con un peso promedio de 663 kg. Se determinaron la producción de paja, los niveles de acumulación de C, N, P, K, Ca, Mg y la relación C:N en los residuos de cereales de invierno después de la cosecha. La producción de paja fue superior en el manejo en lo cual no se realizó el pastoreo, asociado con los cultivos de la avena y del triticale. Los diferentes cereales de invierno utilizados influenciaran en los niveles de C y K, relación C:N y cantidad de C acumulada en la zona. Los manejos afectaran en la cantidad acumulada Ca, P y N. Las otras características estudiadas no se vieron afectados. Los resultados sugieren que el manejo, así como el cultivo utilizado, interfieren directamente en la cantidad y calidad de los residuos vegetales.

Palabras clave: avena; triticale; trigo; cereales de doble propósito; de nitrógeno

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Produção, composição química e acúmulos de nutrientes de resíduos de cereais de inverno manejados sob sistema de integração lavoura pecuária

Resumo

Objetivou-se com o trabalho avaliar a produção, a composição química, bem como, o acumulo de nutrientes, dos resíduos de três diferentes cereais de inverno, manejados sob sistema de integração lavoura pecuária. O trabalho foi desenvolvido, no outono inverno de 2012, em área experimental da Universidade Estadual do Oeste do Paraná - Campus Marechal Cândido Rondon, em LATOSSOLO VERMELHO Distroférrico (LVdf), com delineamento de blocos casualizados em esquema de faixas, com quatro repetições. Os tratamentos foram constituídos de três diferentes cereais de inverno (aveia IPR 126, triticale IPR 111 e trigo BRS Tarumã), com três diferentes manejos: sem pastejo, um pastejo e dois pastejos. O pastejo foi realizado até atingir a altura residual de 15 cm de cada forrageira, utilizando-se vacas da raça holandesa com peso médio de 663 kg. Foram determinados a produção de palhada, os teores e o acumulo de C, N, P, K, Ca, Mg e a relação C:N nos resíduos dos cereais de inverno, após a colheita dos mesmos. A produção de palhada foi superior no manejo em que não foi realizado o pastejo, associado com a cultura da aveia e do triticale. Os diferentes cereais de inverno utilizados influenciaram nos teores de C e K, relação C:N e na quantidade de C acumulado na área. Os manejos afetaram na quantidade acumulada de Ca, P e N. As demais características estudadas não foram influenciadas. Os resultados sugerem que o manejo empregado, bem como a cultura utilizada, interferem diretamente na quantidade e na qualidade dos resíduos vegetais.

Palavras chave: Aveia; triticale; trigo; cereais de duplo propósito; nitrogênio

Introduction

In the south of Brazil, the areas under the production system with integration crop and livestock (SILP) designed to grazing, are generally restrict to the period winter/ spring (ALBUQUERQUE et al. 2001), being that there is great reduction of the availability of fresh forage in this time of the year. The using of SILP is a way to partially or totally supply the deficit of forage during this period, with the cultivation of annual forages, such as oat, sowed in succession to summer crops (MACHADO and ASSIS 2010).

The use of management systems with lesser revolving of the soil and that provides accumulation of plant residues on the surface (MARCOLAN and ANGHINONI, 2006) enables increase in the crops yield (COSTA et al., 2003). Besides the use of no tillage under the straw provide lesser impact to the environment, the dead coverage also protects the soil from solar radiation, dissipates the energy of impact of the rain drops, reduces water evaporation and increases efficiency of nutrients cycling (MATEUS et al., 2004).

The availability of forage in the system is directly associated to the growth of biomass in the grazing, this being determined by the quantity of carbon fixated every day, depending on the intercepted energy, which in turn depends of the incident solar radiation and of the existing foliar area (MARASCHIN, 2001). Therefore, the grazing, depending of its intensity, affects the foliar area and the luminous interception by the plants, which in turn interferes in the ability of producing new leaves, altering the growth of the grazing and of the available forage (SILVA et al., 2011).

In the SILP occurs differentiated input of vegetal residues in relation to the systems of pure production of grains, both on the surface and in the profile of the soil by the roots (SOUZA et al., 2010). There is possibility of occurring increase of concentrations of organic carbon in the soil over time, incrementing the mass produced through time due to the grazing and greater cycling of nutrients (TRACY and ZHANG 2008).

The management of grazing is the key point in the process of adoption of integration crop livestock, and it is necessary to understand the functioning of plant growth and how the management practices affect this process (SILVA et al., 2011). In integrated systems it is important to find an intermediate level of biomass, which benefits both summer crops and the animal production in the grazing cycle, in order to ensure high yield and sustainability to the system (MORAES et al., 2003). For this reason, to the consolidation and success of this system, it is of fundamental importance the establishment of crops for the straw production, in adequate amount for the soil coverage (ANDREOTTI et al., 2008), and that will not undermine the agropastoral system (SILVA et al., 2011).

In this context, the current study had

as objective to study the production, chemical composition and the deposited amount of residues nutrients of three different winter cereals, managed in system of integration crop livestock.

Material and Methods

The study was developed in the experimental farm "Professor Antonio Carlos dos Santos Pessoa" (latitude 24º 31' 58'' S and longitude 54º 01' 10'' W, with approximate altitude of 400 m), property of the Universidade Estadual do Oeste Paraná - *Campus* Marechal Cândido Rondon, in Dystrophic Oxisol (LVdf) (SANTOS et al., 2013). The place was being managed with no tillage system, being that before the experiment implementation the area presented the chemical characteristics described in Table 1. Due to saturation through bases (V%) presenting value below 50%, it was performed liming on the surface 30 days before the sowing, with the objective of elevating the saturation of bases to 70% (Table 1).

The region weather according to the Köppen classification, is Cfa mesothermal humid subtropical with dry winter, with well distributed rains during the year and with warm summers. The climatologic data referent to the experimental period was obtained from the automatic meteorological station, with 50 m of distance from the area (Figure 1).

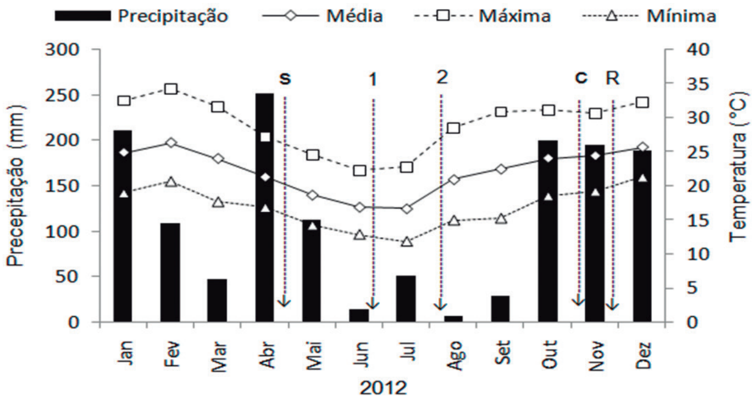
The used experimental design was composed by randomized blocks in rows scheme, with four repetitions. In the A rows (10 x 18 m) were allocated three annual winter crops: white oat (IPR 126), triticale (IPR 111) and dual-purpose wheat (BRS Tarumã). In the B rows (5 x 30 m), transversal to the A rows, were allocated the managements of winter cereals: without grazing, a grazing with residues height of 15 cm and two grazing also with 15 cm of residues height, with grains harvest by the end of the cycle. The plots were formed by the A and B rows combination (5 x 10 m), each block had an area of 540 m² (18 x 30 m).

The experiment started in the autumn/ winter of 2012, being that the area was desiccated 30 days

Table 1. chemical and texture characteristics of the soil in the layer of 0 to 30 cm of depth, before the implementation of winter crops.

Dep	P	MO	pH	H+Al	Al^{3+}	K^{+}	Ca^{2+}	Mg^{2+}	CTC	V	Sand	Silt	Clay
cm	mg dm^{-3}	g dm^{-3}	$CaCl_2$	----------	----------	----------	---------- $cmol_c$ dm^{-3}	----------	----------	----------	%	----------g kg^{-1}	----------
0-10	24,49	32.64	4.55	9.40	0.46	0.53	4.56	1.54	16.02	41.66	681.00	266.48	52.52
10-20	25,86	32.64	4.65	8.62	0.34	0.44	5.32	1.67	16.04	46.32	751.50	199.11	49.39
20-30	12,11	32.47	4.77	7.47	0.19	0.25	5.49	1.75	14.95	50.13	706.50	238.93	54.57

Dep.: Depth. P and K – Extractor MEHLICH-1; Al, Ca and Mg = KCl 1 mol L-1;H+Al = pH SMP (7.5).



Source: Automatic Climatological Station of the Center of Experimental Stations of the Unioeste, Marechal Cândido Rondon-PR.

Figure 1. Month averages of the maximum, minimum and medium temperature and rainfall accumulated during the months of the experimental period. S: sowing of winter cereals. C: harvest of winter cereals. R: collect of crop residues. 1 and 2: grazing of winter cereal.

before the sowing, using the Glyphosate-salt of Isopropylamine with dose of 3.0 L ha^{-1}, of commercial product, with spraying volume of 250 L ha^{-1}.

The winter cereals were sowed on 04/19/12, with seeder fertilizer machine coupled to a tractor, in the no tillage system over maize straw. It was used 60 kg ha^{-1} of oat seeds, 50 kg ha^{-1} of triticale seeds and 90 kg ha^{-1} of wheat seeds, with 0.17 m between rows. The base fertilization for the oat, triticale and wheat crop was performed according to the chemical analysis of the soil. For the base fertilization it was used 200 kg ha^{-1} of a formulated 8-20-20 (N, P_2O_5 and K_2O) and for the coverage fertilization 120 kg ha^{-1} of N in the form of urea. The coverage fertilization was divided in three times, at the beginning of the cereal tillering and right after each grazing, in the treatments which was used two grazing. However, for the treatment which was used only one grazing and/ or the one that was not used grazing, the coverage fertilization was divided in two times, in the tillering and after the realization of grazing. It was not necessary to perform the application of herbicides and insecticides during the development cycle of the winter cereals. Nevertheless, it was performed an application of the fungicide Triazole in the dose of 650 ml ha^{-1}, of commercial product with spray volume of 250 L ha^{-1}.

The managements of winter cereals, B rows started when the plants achieved 25 to 35 cm of height. For the grazing were used nine Holstein cows with average weight of 663 ± 50 kg. The animals stood on the rows four hours daily (two in the morning and two in the afternoon) or until the halm achieved 15-20 cm, so there would be no damage to the apical meristem.

The sampling for the determination of quantity of residual straw was performed after the harvest of the winter cereals, with assist of a hollowed metallic square with known area (0.25 m^2), which was released randomly in each plot and all the straw of the soil surface contained in its interior was collected. After the harvest the material was submitted to drying in greenhouse with forced air ventilation with a temperature of 55°C for 72 hours, with posterior weighing for the determination of dry mass. For the weighing it was estimated the quantity of residual straw deposited per hectare. The material was grounded in a Willey mill for the determination of the concentrations and then was determined the deposited quantity of C, N, P, K, Ca and Mg. The C was obtained from the determination of the organic matter in muffle furnace as described by Silva and Queiroz (2006). For the estimation of the C concentration in the samples, the organic matter concentration was divided by 1.72, as recommended by Peixoto et al. (2007). The N was determined by sulfuric digestion and distillation in semi-micro Kjeldal system, while that for the determination of macro and micronutrients it was performed the nitropercloric digestion, with afterward reading in atomic absorption spectrophotometer (EMBRAPA, 2009).

The data were submitted to the Lilliefors test, in order to verify the normality, being that the ones which presented $p>0.05$ without normal distribution were transformed (1/x: carbon, nitrogen and relation carbon: nitrogen). It was performed variance analysis and for the treatments whose F test was significant, it were compared the averages through the Tukey test, at the level of 5% of significance. The used program for the statistical analysis was the GENES (CRUZ, 2006).

Results and Discussions

According to the obtained results, the amount of residual straw was influenced by the interaction of the studied factors (crop x management). However, the chemical composition of the crop residues suffered influence of the studied crops for the carbon contents (C), relation C: N and potassium (K). The values of nitrogen (N), phosphorus (P), calcium (Ca) and magnesium (MG), were not influenced ($p>0.05$), by the studied factors.

For the quantity of accumulated nutrients after the winter cereals harvest, the interaction of the studied factors influenced in the amount of N deposited per area. In relation to the C, this suffered influence of the studied crops. The management affected the amount of Ca and P. Meanwhile for the other nutrients (K and Mg), deposited in the area, did not experience influence of the studied factors.

The production of residual straw of the winter crops, when submitted to grazing was inferior if compared to the management in which the crops of triticale and oat were not grazed (Table 2). This result was expected, because due to the grazing the sprouting capacity of the plants is reduced, impairing the restoration of the foliar area and consequently the accumulation of dry mass by the crop. Nevertheless, the low volumes of rainfall registered during the grazing (Figure 1), can have contributed for this result.

Flores et al. (2007), working under the same experimental conditions of this study, obtained straw quantities on the surface varying from 1.850 to 5.400 kg ha^{-1} of DM, from the higher to the lesser intensity of grazing, respectively, being observed 6.050 kg ha^{-1} of DM in the area without grazing. LOPES et al. (2009), found values which vary from 1.860 to 5.170 kg ha^{-1} of DM, working with different heights of grazing. Yet, it can be observed low production of wheat straw, even where no grazing occurred.

The addition of vegetal residues to the soil in areas under SILP, with no tillage, is of utmost importance for the maintenance and increase of organic matter contents of the soil (OMS), which has a fundamental role in the sustainability maintenance of the production over the time (LOPES et al., 2009). To Nicoloso et al. (2006), the annual addition of straw to the soil in the no tillage system must be superior to 8.000 kg ha^{-1} of DM of vegetal residues, yet, none of the treatments reached these values in this study. Moreover, the levels of residual straw close to 2000 kg ha^{-1} may not compromise the grains production in the subsequent cultivation (FLORES et al., 2007).

Nevertheless, excessive amounts of grass straws during its decomposition may compromise the N availability (AITA et al., 2003), due to its high relation carbon/ nitrogen (C: N) (SILVA et al. 2006) and to occurrence of microbial immobilization of N (AMADO et al., 2003), besides this, due to the high relation C: N, the decomposition of the material will be slower.

The oat crop, when compared to the other crops, provided deposition of the straw with higher concentration of C (Table 2), as well as in the total amount of C deposited per area (Table 3), consequently influencing the C: N relation. The grazing enable an increment in the carbon contents in function of the high vegetal development, both in the aerial part and roots, this can be observed in the systems of SILP with no tillage (FRANZLUEBBERS and STUEDEMANN, 2008). With the increasing age of crop development, there is elevation of concentration of structural components in the dry mass, which are rich in C withal occurs the decreasing of cellular content (ZANINE and MACEDO, 2006).

There is also in SILP, the pasture management and animal stocking, due to resulting in different quantities of produced mass and recycled nutrients, which can contribute with different amounts of C (SOUZA et al., 2008). However, this variation is due, in part, to the fact of the materials come from different species (ALVES et al., 2011), which despite belonging to the same family, accumulate different amounts of nutrients.

The values obtained for N in the crop residues do not show significant differences between the used managements and, neither between the three studied crops, among which the wheat crop presents a higher tendency to accumulation of N. However, the management with no grazing provided a greater quantity of accumulated N. The results obtained for N concentration in the straw were not expected, because the grazing of the plants eliminates the possibility of lignifications of the plants structures and stimulates the regrowth and emergence of new shoots and leaves. To Campos et al. (2002), oat plants which were kept under free growth lignificated the cell wall of the cells, with consequent reduction in the concentration of N (HENRIQUES et al., 2007). Although the cereals studied being other than leguminous plants, they also accumulate and recycle N. Different results to this research were found by Borkert et al. (2003), which found that N is the second nutrient of higher quantity in the mass after K.

For the relation C: N the significant difference was only found for the oat crop in relation to the other crops, mainly due to the high contents of carbon found in the residual straw (Table 4). Moreover, this characteristic is the most used in models to predict the N availability in the soil during the decomposition of organic materials (NICOLARDOT et al., 2001), because as higher the relation is, slower will be the process of decomposition. The addition of crop residues with high relation C: N in the soil can also provide a depletion of N, in function of the great demand of N by the microbiota, causing immobilization of the soil N, now when the relation C: N is lower, occurs liberation of the mineralized element (MOREIRA and SIQUEIRA, 2006).

The contents of K found in the crop residues were higher for the triticale crop if compared to the other winter cereals, however, in the accumulation of this nutrient, there was no difference between the crops in the area. Yet, the deadline for implantation of crops in succession must be minimized, aiming the decrease of losses, due to its quick liberation. As the ion (K) is the most abundant in plant cells, not being associated to any structural component of the plant (TAIZ; ZEIGER, 2004), it is also due to the fact that the cation K^+ is not metabolized in the plant, forming links with organic complexes of easy reversibility (ROSOLEM et al., 2003).

Table 2. Quantity and chemical composition of the residual biomass of different winter cereals, managed in integration system between crop and livestock.

Crop	Residual biomass (Kg ha^{-1}) Management 1P	2P	SP	Average	Carbon (g kg^{-1}) Management 1P	2P	SP	Average
Oat	1990aB	1675aB	4440aA	2701.45	107.11	134.90	55.72	99.24a
Wheat	1540aA	650aA	1840bA	1343.12	40.91	48.10	40.26	43.09b
Triticale	1965aB	975aB	4540aA	2493.12	39.77	41.12	44.21	41.70b
Average	1831	1100	3606		62,60	74,71	46,73	
CV 1 (%)		47.60				19.57		
CV 2 (%)		35.57				41.64		
CV 3 (%)		29.31				25.55		
		Nitrogen (g kg^{-1})				**Relation C:N**		
Oat	19.89	20.71	24.04	21.55	5.44	6.51	2.34	4.76a
Wheat	38.42	30.31	39.17	35.97	1.07	2.18	1.03	1.42b
Triticale	29.91	31.86	27.76	29.84	1.33	1.29	1.59	1.40b
Average	29.40	27.63	30.33		2.61	3.32	1.65	
CV 1 (%)		35.44				15.59		
CV 2 (%)		41.90				24.88		
CV 3 (%)		40.16				27.58		
		Phosphorus (g kg^{-1})				**Potassium (g kg^{-1})**		
Oat	1.03	0.90	0.96	0.97	2.72	4.28	1.97	2.99b
Wheat	0.90	1.05	1.10	1.01	1.81	1.72	2.13	1.89b
Triticale	0.73	0.78	0.66	0.72	9.56	6.84	7.09	7.83a
Average	0.89	0.91	0.91		4.70	4.28	3.73	
CV 1 (%)		30.05				85.14		
CV 2 (%)		19.42				67.29		
CV 3 (%)		22.89				61.78		
		Calcium (g kg^{-1})				**Magnesium (g kg^{-1})**		
Oat	1.94	1.97	1.53	1.81	0.75	0.78	0.59	0.71
Wheat	2.31	2.22	1.63	2.05	2.47	0.84	0.66	1.32
Triticale	1.84	2.28	1.59	1.91	0.75	0.81	0.56	0.71
Average	2.03	2.16	1.58		1.32	0.81	0.60	
CV 1 (%)		35.35				102.66		
CV 2 (%)		41.36				129.27		
CV 3 (%)		34.18				131.59		

Averages followed by the same lowercase letter in the column and uppercase in the line do not statistically differ by the Tukey test (5%) 1: Untrasformed averages 1P: 1 grazing; 2P: 2 grazing; SP: without grazing. CV 1: Coefficient of variation for the crops; CV 2: Coefficient of variation for the managements; CV 3: Coefficient of variation for interaction between crops with the managements.

The average values for the concentration of N, P and K, are below the values found by Calegari (1990), in relation to the oat crop, which found the concentration of N, P and K of 16.5 g kg^{-1}; 1.0 g kg^{-1} and 16 g kg^{-1}, respectively. However, to Floss (2002), the vegetal remains of the grasses are nutrients providers, at medium and long term, to succeeding crops with accumulation on the superficial layer. This process, according to the author, favors the increase in the contents of P and K of the soil under no tillage system.

The fact that the poaceae have close physiological characteristics, were submitted to the same techniques, periods of grazing and weather conditions, as well as similar conditions of soil fertility, can explain why there was no difference in the contents of K, Ca and Mg, as well as in the accumulation of K and Mg. Moreover, differences in

Table 3. Quantity and chemical composition of the residual biomass of different winter cereals, managed under integration system between crop and livestock.

Crop	Carbon ($kg\ ha^{-1}$)				Nitrogen ($kg\ ha^{-1}$)			
	Management			Average	Management			Average
	1P	2P	SP		1P	2P	SP	
Oat	211.51	224.39	245.31	227.07a	39.41B	34.93B	107.12abA	60.49
Wheat	62.66	31.94	74.02	56.20b	59.27B	20.90B	71.41bA	50.53
Triticale	79.89	41.89	189.80	103.86b	58.59B	32.07B	126.02aA	72.22
Average	118.02	99.41	169.71		52.42	29.30	101.52	
CV 1 (%)		46.85				49.46		
CV 2 (%)		50.95				32.37		
CV 3 (%)		38.54				28.65		
	Potassium ($kg\ ha^{-1}$)				Calcium ($kg\ ha^{-1}$)			
Oat	5.35	5.65	9.17	6.73	3.78	3.22	6.83	4.61
Wheat	2.79	0.97	3.93	2.56	3.43	1.38	2.83	2.55
Triticale	22.16	7.16	35.92	21.75	3.97	2.28	6.87	4.37
Average	10.10	4.59	16.34		3.73AB	2.29B	5.51A	
CV 1 (%)		192.90				61.59		
CV 2 (%)		106.50				59.66		
CV 3 (%)		92.50				42.74		
	Magnesium ($kg\ ha^{-1}$)				Phosphorus ($kg\ ha^{-1}$)			
Oat	1.49	1.22	2.63	1.78	1.96	1.60	4.17	2.57
Wheat	3.29	0.51	1.16	1.65	1.38	0.63	2.00	1.34
Triticale	1.63	0.80	2.34	1.59	1.55	0.77	2.96	1.76
Average	2.14	0.84	2.05		1.63B	1.00B	3.04A	
CV 1 (%)		55.67				64.07		
CV 2 (%)		100.68				39.11		
CV 3 (%)		79.00				26.71		

Averages followed by the same lowercase letter in the column and uppercase in the line do not statistically differ by the Tukey test (5%). 1P: 1 grazing; 2P: 2 grazing; SP: without grazing. CV 1: Coefficient of variation for the crops; CV 2: Coefficient of variation for the managements; CV 3: Coefficient of variation for interaction between crops with the managements.

the accumulated quantity of P and Ca are due to the higher accumulation in the not grazed management.

The intense use of the soil in systems of production directed to high production promotes elevated retrieval of nutrients and, or, decomposition of straw. The nutrients may be reposed through fertilization, while the straw, which is the main source of organic matter, has not being adequately reposed in these systems (SPERA et al., 2009). The management of forage mass has great importance, mainly because it can determine the success or failure of the SILP. In theory, the maintenance of low residual biomass can compromise the no tillage system, once small quantities of mass or lower heights of management caused degradation and losses to the soil (LOPES et al., 2009).

Conclusions

The amount of crop residues, which remains on the soil surface suffers direct influence of the management which is used in the crop, being that the production of residual biomass was superior in the management which was performed the grazing, associated to the oat and triticale crop. The quantity of nutrients present in the crop residues was influenced by the crop type, in the contents of C, K in the relation C: N and in the amount of C accumulated in the area. The managements studied affected in the accumulated quantity of Ca, P and N. The results suggest that the used managements, as well as the used crop, directly interfere in the amount and quality of vegetal residues.

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