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INTEGRATING THE PASTORAL COMPONENT IN AGRICULTURAL SYSTEMS COULD CHANGE THE FLUXES OF NITROGEN?

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Abstract: Integrated systems can foster opportunities to capture ecological interactions, increasing efficiency in nutrient cycling and soil quality and preserving natural resources. Thus, the present study aims to investigate the effects of the introduction of animals within in an integrated crop-livestock system (ICLS), evaluating the effect of different grazing intensities on the nitrogen balance. The study site is located at Espinilho Farm, in São Miguel das Missões district, Rio Grande do Sul State, Southern Brazil. Since 2001, soybean [*Glycine max* (L.) Merr.] was grown in the summer and a mixture of black-oat (*Avena strigosa* Schreb.) and Italian ryegrass (*Lolium multiflorum* Lam.) pastures in the winter, in a soybean-beef cattle integrated system focusing on fattening and slaughter of the grazing animals.
The N balances estimated in the different treatments, in his different intensities of grazing showed that there are marked differences in the quantity of N in circulation and in the amount of N lost from the system.

Key Words: grazing management, integrated crop livestock system, sustainable intensification

Introduction

The benefits of integrating crops and livestock are supported by many recent published papers (Trayce and Zang, 2008; Bell et al., 2014; Bonaudo et al., 2014; Deiss et al., 2016), reviews (Carvalho et al., 2010; Ryschawy et al., 2014; Gastal and Lemaire, 2015; Lemaire et al., 2015), and special issues (Franzluebbers et al., 2014). The majority of these manuscripts suggests that integrated crop-livestock systems (ICLS) are capable of reconciling food production with environmental preservation.

The balance between compartments depends critically on grazing intensity (Carvalho et al., 2010; Soussana and Lemaire, 2014). Moderate grazing intensities favor the coupling between C and N by cycling N via urine, stimulating leaf area renewal and favoring rhizodeposition by grazing, often related to increases in soil C stocks (Balesdent and Balabane, 1996). However, at high grazing intensities, decoupling is greater than coupling and the system balance is negative. Therefore, the management of nutrient flows between compartments by controlling the coupling and decoupling processes is essential to obtain positive results in ICLS.

Thus, given the new complexity levels achieved from the introduction of grazing, the probability of arising emergent properties (Anghinoni et al., 2013) is theoretically much higher. Due to the fact of accepting several synergistic processes, the soil is considered as the main component of these compartments. Therefore, the nutrient cycling that occurs in ICLS is important for the efficient use of soil nutrients, residues and fertilizers.

The present study works with the hypothesis that the introduction of the animal component in the compartment soil-plant will generate new fluxes of nitrogen within the system and this magnitude will be influenced by different grazing management targets. Thus, the present study aimed to investigate the effect of different forage management heights on nitrogen fluxes in an Integrated Crop-Livestock System.

Material and methods

The study site is located at Espinilho Farm, in São Miguel das Missões district, Rio Grande do Sul State, Southern Brazil. Since 2001, soybean [*Glycine max* (L.) Merr.] was grown in the summer and a mixture of black-oat (*Avena strigosa* Schreb.) and Italian ryegrass (*Lolium multiflorum* Lam.) pastures in the winter, in a soybean-beef cattle integrated system focusing on fattening and slaughter of the grazing animals.

Treatments consisted of different grazing intensities, defined by target sward heights under continuous stocking: intense grazing, 10 cm (G10); moderate grazing, 20 cm (G20); moderate-light grazing, 30 cm (G30); and light grazing, 40 cm (G40).and an additional ungrazed treatment (UG). (10, 20, 30 and 40 cm). Treatments were arranged in a randomised complete block design with three replicates, resulting in 12 grazed paddocks varying from 0.8 to 3.6 ha.

The field evaluations were carried out from April to November in two stocking periods (2013 and 2014). The nitrogen fertilization was applied as urea (130 kg N ha^{-1}). Experimental animals were crossbred Angus x Hereford x Nelore steers initially weighting 249.5 ± 4.9 kg and ageing 14 months.

The daily dry matter intake was estimated according to double n-alkane technique proposed by Dove & Mayes (2006). Forage samples were collected by hand- plucking (Halls, 1954), (500g for animal tester evaluated) on the second and third day of n-alkane campaign, according to Johnson (1978) to make the evaluation of nitrogen available in the pasture grazed by animals. Excretion (dung and urine) of nitrogen was calculated accord to Whitehead (2000) assuming the nitrogen intake measured in the experiment.

Residual herbage biomass (RB, kg DM ha^{-1}) was evaluated after removing the animals from the experimental area at the end of the stocking period, collecting all the aboveground residual biomass in five randomly located 0.25 m^{2-} quadrats.

Results and discussion

Nitrogen balances is demonstrated in the table 1. To evaluate the nitrogen amount cycling in the system it was necessary to access different compartments. In the plant component, part of the nitrogen left to soybean crop is reminiscent from the previous pasture cycle. For this, we analyze the herbage residual biomass.

Table 1. Estimated N balances (Kg ha^{-1} $year^{-1}$) for different grazing intensities and no-grazing under ICLS.

Biomass/ Nutrient	Residue/output /ciclagem	Treatment					P value
		NG	10 cm	20 cm	30 cm	40 cm	
	Input						
	Fertilizer (urea)	130	130	130	130	130	
	Recycling	127	300,9	301,7	275,8	236,7	
	Herbage (aerial residue)	127 a	41 c	98 b	115 a	136 a	<0,0001
Nitrogen, Kg/ha	N herbage in-take by animals	-	137 a	107 b	84 c	53 d	<0,0001
	Dung	-	24,6 a	19,3 b	15,2 c	9,6 d	<0,0001
	Urine	-	98,4 a	77,3 b	60,8 c	38,3 d	<0,0001
	Output						
	Animal carcass	-	13,6 a	10,7 b	8,44 c	5,32 d	<0,0001
	Emissions (output of N-N_2O)	1,28 c	2,20 a	1,66 b	2,04 a	2,08 a	<0,0001

The higher the grazing intensity, the lower the residual biomass at the time of crop sowing and the higher the compaction transferred to the crop phase (Carvalho et al., 2011). This value converted into nitrogen/ha showed the difference between treatments (P<0,0001) related to the level of grazing intensity. Moreover, under high grazing intensities, nutrient decoupling is higher than coupling, as previously mentioned. This entire context finally determines the soil chemical, physical, and biological environment that receives the crop.

Due to different stock rate for maintain the different treatments (*in* grazing), the excretion was higher when increase the stock rate (P<0,0001). This behavior accompanied the output of nitrogen by animal intake and increase the process of C:N decoupling and increasing the risk of leaching/runoff. Although the presence of large numbers of animals accelerates the recycling of N, the excreted N is distributed unevenly and this increases the extent of loss as gaseous emissions and the utilization of recycled N become less efficient, in terms of percentage.

Conclusion

The N balances estimated in the different treatments, in his different intensities of grazing showed that there are marked differences in the quantity of N in circulation provides by the insertion of the animal component and the amount of N lost from the system.

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