MICROORGANISMS ABUNDANCE IN GRAZED AND NON-GRAZED SOIL

Alexandre Dinnys ROESE [1]; Louise Larissa May de MIO [2]

[1] Agronomist. Research Support Analist. Embrapa Agropecuária Oeste; [2] Agronomist. Professor. Universidade Federal do Paraná

ABSTRACT
Cattle grazing confers several benefits when present in production systems, but careful handling is needed to maintain the soil quality. We evaluated the total fungal propagules in soil from two integrated crop-livestock systems (ICLS) compared to a non-integrated control. The method consisted of a twice soil sampling submitted to dilutions and culture media evaluation for total fungi growth. Results showed greater colony-forming units per plate in the soil from the non-grazed control, independently of the sampling time. We conclude that grazing influences the soil microbial attributes, probably by changing the quantity and quality of residues in the soil.
Key words: microbial biomass carbon; soil quality; suppressiveness

INTRODUCTION

Cattle grazing is long and fairly incorporated in grain production systems, with or without the inclusion of trees, aiming to better explore the natural and economical resources, diversify incomes, reduce risks, etc. (RYSCHAWY et al., 2012). It is expected that intensified production systems return several benefits to farmers, but the management of production factors is more complex as more diversified the system is. An example is the management of cattle grazing, its requisites (e.g.: grass quantity and quality), and its consequences in the soil quality, as measured by microbiological attributes.

The crop-livestock system with cattle grazing on oats and ryegrass in the winter and soybean and corn as grain crops in the summer is very common in the South Brazil (MORAES et al., 2014) and the soil quality in pasturelands is a great issue for the agricultural development in the recent years (GIL et al., 2015). With this concern, the present work evaluated the abundance of cultivable fungi in three different production systems in a long-term experiment of integrated crop-livestock systems (ICLS) in the Region of Campos Gerais, Brazil: agropastoral, agrosilvopastoral, and a non-integrated control system.

MATERIAL AND METHODS

Soil samples (eight per plot) were collected for microorganism's quantification in a long-term ICLS experiment in the Ponta Grossa County, Paraná State, Brazil in August (winter) and November (spring) 2014. The experiment was put in place in 2006, and had three production systems: agropastoral (AP) system, agrosilvopastoral (ASP) system, and a control (CO) with a non-integrated crop treatment, arranged in randomized blocks with 3 replications. All production systems had summer crops of soybean and corn on alternated crop seasons. The winter grazing in all production systems consisted of black oat and annual ryegrass intercropped. Cattle grazing occurred for an uninterrupted period of 90 to 120 days every winter in AP and ASP systems, and the stocking rate was managed to maintain the pasture with 20 cm height.

Summer crops and winter pastures were established by direct seeding (no-tillage). The tree component of the ASP system was composed of eucalyptus (*Eucalyptus dunnii*) and silver oak (*Grevillea robusta*) alternated in single rows, with 4.5 m between trees and 14 m between rows. Each plot had an area of about one hectare, except CO plots, which were established within the AP plots in 2010 and sized at 100 m².

Soil samples from zero to 15 cm depth were collected randomly from each plot. The soil was stored at 4 ºC in capped acrylic pots, until use. An aliquot of 10 g of soil was diluted in 90 mL of sterile distilled water and stirred for 90 minutes at 170 rpm on an orbital flask shaker. Suspensions were diluted to a concentration of 10^{-3} and 0.5 mL was then spread on Petri dishes containing potato dextrose agar (PDA) medium added with 0.8 ml L^{-1} of lactic acid to avoid bacterial growth, with four plates per sample. The plates were incubated in the dark at 22 to 26 °C and evaluated after 5 days by visual quantification of colony-forming units per plate.

A generalized linear mixed model structure was used for data analysis, with a Poisson distribution for the response variable and adding a random effect to account for measurements (Petri dishes) taken at the same experimental unit (soil sample). Statistical analyses were performed using R software (R Core Team, 2017) with models fitted by the function glmer from the add-on package *lme4* (BATES et al., 2014), and glht from the package *multcomp* (HOTHORN et al., 2008).

RESULTS AND DISCUSSIONS

Total fungi capable of cultivation in PDA, a rich culture medium, were more abundant in the non-grazed CO treatment than in the grazed ones: AP and ASP (Figure 1). This is in accordance with Vargas Gil et al. (2009), who observed also a prevalence of Actinomycetes, *Trichoderma* spp., and *Gliocladium* spp. in non-grazed treatments, while Salton et al. (2014) found little or no differences in soil microbial-biomass carbon and basal respiration between grazed and non-grazed treatments. The soil samples were collected at the beginning (August) and just after (November) grazing when vegetal residues were abundant in the soil. A probable reason for the greater microorganism density in non-grazed plots is the abundance and quality of available residues in the soil, as the grazing process reduces the abundance of residues and returns it to the soil after processed by animals. This is in accordance with previous observations (VARGAS GIL et al., 2009; XUN et al., 2018).

The number of colony-forming units was also lower in the ASP treatment, where the tree component intercepts light and competes with the grasses and grain crops for other growth factors. Previous work in the same experimental area found a greater abundance of *Fusarium* spp. propagules in non-grazed treatments, while *Trichoderma* spp. were more abundant in CO and ASP treatments (ROESE et al., 2018), but the authors discuss that the greater diversity of vegetal species increased the *Trichoderma* spp. in ASP plots.

Cattle grazing play an important role in soil microbial ecology, and incorporating grazing in the grain production system requires careful planning and monitoring of the soil quality. It is important to mention that the soil samples were collected during and just after the grazing phase when the abundance of residues in non-grazed plots influenced the results. The temporal effect is also shown by the greater abundance of microorganisms in August than in November. Certainly, the correct (equilibrated) management of trees, grasses, cattle stock, and fertilization is the key to maintain the soil quality in intensified production systems, as pointed by Carvalho et al. (2010) and Pontes et al. (2017).

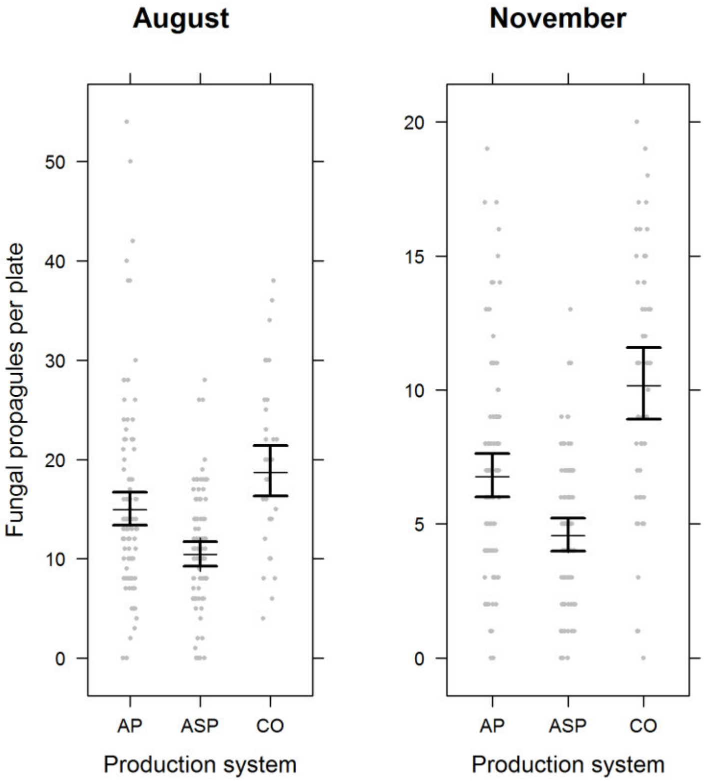

Figure 1. Total colony-forming units in Potato Dextrose Agar medium from soil samples collected twice (August and November) in three production systems: agropastoral (AP), agrosilvopastoral (ASP), and a non-integrated control (CO) in 2014 in the Region of Campos Gerais, Paraná State, Brazil. Bars shown the 95% confidence interval, the line crossing the bar is the estimated average and the points are the raw data.

CONCLUSIONS

Cattle grazing significantly influences the soil microbiota.

ACKNOWLEDGMENTS

This work was supported by the SERVIAMBI project (Scientific Cooperation Term 21500.10/ 0008-2, signed between Instituto Agronômico do Paraná and Embrapa Florestas) and also by grants of the Conselho Nacional de Desenvolvimento Científico e Tecnológico: project CNPq PROCAD number 552334/2011-1, and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - CAPES.

REFERENCES

BATES, D.; MAECHLER, M.; BOLKER, B.; WALKER, S. **lme4:** linear mixed-effects models using Eigen and S4. R package version 1.1-5**.** Available at: <http://cran.r-project.org/package=lme4>. Accessed on: Aug. 2015.

CARVALHO, P. C. de F.; ANGHINONI, I.; MORAES, A. de; SOUZA, E. D. de; SULC, R. M.; LANG, C. R.; FLORES, J. P. C.; LOPES, M. L. T.; SILVA, J. L. S. da; CONTE, O.; WESP, C. de L.; LEVIEN, R.; FONTANELI, R. S.; BAYER, C. Managing grazing animals to achieve nutrient cycling and soil improvement in no-till integrated systems. **Nutrient Cycling in Agroecosystems**, v.88, n.2, p.259–273, 2010.

GIL, J.; SIEBOLD, M.; BERGER, T. Adoption and development of integrated crop–livestock–forestry systems in Mato Grosso, Brazil. **Agriculture, Ecosystems & Environment**, v.199, p.394–406, 2015.

HOTHORN, T.; BRETZ, F.; WESTFALL, P. Simultaneous inference in general parametric models. **Biometrical Journal**, v.50, p.346–363, 2008.

MORAES, A. DE; CARVALHO, P. C. F.; ANGHINONI, I.; LUSTOSA, S. B. C.; COSTA, S. E. V. G. A.; KUNRATH, T. R. Integrated crop-livestock systems in the Brazilian subtropics. **European Journal of Agronomy**, v.57, p.4-9, Jul. 2014.

PONTES, L. DA S.; CARPINELLI, S.; STAFIN, G.; PORFÍRIO-DA-SILVA, V.; SANTOS, B. R. C. DOS. Relationship between sward height and herbage mass for integrated crop-livestock systems with trees. **Grassland Science**, v.63, n.1, p.29–35, Jan.2017.

R CORE TEAM. **R:** A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. 2017. Available at: <https://www.r-project.org/>

ROESE, A. D.; RIBEIRO JUNIOR, P.J.; PORFÍRIO-DA-SILVA, V.; MAY DE MIO, L.L. Agrosilvopastoral system enhances suppressiveness to soybean damping-off caused by Rhizoctonia solani and alters *Fusarium* and *Trichoderma* population density. **Acta Scientiarum. Agronomy**, v.40, n.1, p.35075, Fev 9, 2018.

RYSCHAWY, J.; CHOISIS, N.; CHOISIS, J.P.; JOANNON, A.; GIBON, A. Mixed crop-livestock systems: an economic and environmental-friendly way of farming? **Animal**, v.6, n.10, p.1722–1730, 2012.

SALTON, J. C.; MERCANTE, F.M.; TOMAZI, M.; ZANATTA, J.A.; CONCENÇO, G.; SILVA, W.M.; RETORE, M. Integrated crop-livestock system in tropical Brazil: Toward a sustainable production system. **Agriculture, Ecosystems and Environment**, v.190, p.70–79, 2014.

VARGAS GIL, S.; BECKER, A.; ODDINO, C.; ZUZA, M.; MARINELLI, A.; MARCH, G. Field Trial Assessment of Biological, Chemical, and Physical Responses of Soil to Tillage Intensity, Fertilization, and Grazing. **Environmental Management**, v.44, n.2, p.378–386, Aug. 16, 2009.

XUN, W.; YAN, R.; REN, Y.; JIN, D.; XIONG, W.; ZHANG, G.; CUI, Z.; XIN, X.; ZHANG, R. Grazing-induced microbiome alterations drive soil organic carbon turnover and productivity in meadow steppe. **Microbiome**, v.6, n.1, p.170, Dec. 20, 2018.