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Cientific Paper

Floristic and phytosociology of weed in response to winter pasture sward height at Integrated Crop-Livestock in Southern Brazil

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Abstract

The knowledge of weed floristic composition and phytosociology are key factors for their management. Informations about weed species that occur in pastures in Southern Brazil is very limited in an Integrated Crop-Livestock Systems (ICLS). It is, important, therefore, to search for information to help integrated weed control strategy. This paper describes the weed flora diversity and community structure due to modification on sward height in ICLS. The data survey was set within a 250 km radius around the Guarapuava's town, being selected 26 areas in order to embrace a sward height management with winter pasture compounded by black oat and mixed ryegrass. The weed flora was represented by 813 individuals, from 18 families and 55 species. The weed density in the winter pasture compounded by black oat and mixed ryegrass ICLS was of 29,5 plants $m^{-2.}$ The most important infesting specie based on a relative dominance was Stachys arvensis L. The high reduction of pasture management increase of weed density. These results could lead to an improved weed management in winter pasture in ICLS.
Key words: Ecological filters; weed ecology; biological invasion; integrated weed management.

Florística e fitossociologia das plantas daninhas em resposta a altura de manejo do pasto de inverno na Integração Lavoura-Pecuária no sul do Brasil

Resumo

O conhecimento da composição florística e da fitossociologia das plantas daninhas são fatores-chave para o manejo destas. Informações sobre as espécies de plantas daninhas que ocorrem em pastagens de inverno no Sul do Brasil ainda para os Sistemas Integração de Produção Agropecuária (SIPA). É, portanto, importante, a busca de informações para ajudar a planejar estratégias de manejo integrado de plantas daninhas. Este artigo descreve a flora, a diversidade e estrutura da comunidade de plantas daninhas em SIPA. O levantamento das plantas daninhas foi realizado dentro de um raio de 250 km em torno da cidade de Guarapuava, sendo selecionadas 26 áreas, a fim de abranger um gradiente de altura de manejo de pastagens, com pastagem de inverno composta por aveia preta e azevém em mistura. A flora de plantas daninhas foi representada por 813 indivíduos, de 18 famílias e 55 espécies. A densidade das plantas daninhas nas pastagens de inverno no SIPA foi de 29,5 plantas m^{-2}. A espécie infestante mais importante com base na dominância relativa foi Stachys arvensis L. A redução da altura de manejo da pastagem ocasionou o aumento da densidade de plantas daninhas. Os resultados permitem melhor entendimento para o manejo das plantas invasoras nas pastagens de inverno no SIPA.
Palavras chave: Filtros ecológicos, ecologia de plantas daninhas, invasão biologia, manejo integrado de plantas daninhas.

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Florística y fitosociología de malezas en respuesta a altura de manejo del pasto de invierno en la integración Agricultura-Ganaderia en el Sur de Brasil

Resumen

El conocimiento de la composición florística y de la fitosociología de las malezas son factores claves para el manejo de estas. Informaciones sobre las especies de malezas que se presentan en pastos de invierno en el sur de Brasil todavía para los Sistemas Integración de Producción Agropecuaria (SIPA). Es por lo tanto, importante, la busca de informaciones para ayudar a diseñar estrategias de manejo integrado de malezas. Este trabajo describe la flora, la diversidad y estructura de la comunidad de malezas en SIPA. El levantamiento de las malezas fue realizado dentro de un radio de 250 km en torno de la ciudad de Guarapuava, siendo seleccionadas 26 áreas, a fin de incluir un gradiente de altura de manejo de pastos, con pastos de invierno compuesto por avena negra y azavem en mixtura. A flora de malezas fue representada por 813 individuos, 18 familias y 55 especies. La densidad de malezas en los pastos de invierno en el SIPA fue de 29,5 plantas mt2. La especie infectante más importante con base en la dominancia relativa fue Stachys arvensis L. La reducción de la altura de manejo de los pastos ocasiono el aumento de la densidad de malezas. Los resultados permiten un mejor entendimiento para el manejo de plantas invasoras en los pastos de invierno en el SIPA.

Palabras clave: Filtros ecológicos, ecología de malezas, invasión biológica, manejo integrado de malezas.

Introduction

In the Southern Brazil was 19,3 million hectares with arable lands under no-till for summer crops (mostly corn and soybean). Although this region in the winter the season reaches below of 25% of the area is cultivated with grain crops during the winter (CONAB, 2016). It results a large area containing cover crops (mostly black oat and ryegrass) with high forage potential. Using cover crops is an important method of integrated weed management and rise the reduction cost for weed control to farms (BORGES et al., 2014).

The introduction of animals into such areas forming Integrated Crop-Livestock System (ICLS) it is a widespread land used on Southern Brazil (MORAES et al., 2014) for economic goals (OLIVEIRA et al., 2013), environmental quality and increment production (LEMAIRE et al., 2014). Although, among questions for an animal to be introduced on cover crop with forage potential is a weed occurrence, mainly the glyphosate-resistance weeds (SCHUSTER et al., 2015; TRACY and DAVIS, 2009) and the effects of different grazing intensities on weed community (SHUSTER et al., 2016).

Weed community assembly in pastures was determined by forage disturbance intensity (RENNE and TRACY, 2013) and sward height management is mostly important disturbance factor imposed by grazing on forage, changing their morphology and physiology (HODGSON and ILLIUS, 1996). Information on weed species that occur in pastures on Southern Brazil is very limited in an ICLS (MORAES et al., 2014) and knowledge of floristic composition of weeds is a key factor for improving weed management (COSTA and MESQUITA, 2016).

The goal of this study was to undertake a weed survey and to study floristic composition, phytosociology and diversity of the weed community in winter pasture with different height of management in an ICLS in southern Brazil. The hypothesis with pasture management height can change the community assembly.

Material and Methods

Study site

The study area was set within a 250 km around Guarapuava's town. The area is dominated by clayey Oxisol soils and major local crop rotation is soybean-maize and black oat-wheat. In this study area, a network of farmers started to implement ICLS long-term years. Within this network, 26 winter-black oat ICLS fields were selected in order to hold a sward height management. The average area of the surveyed field was 600 ha with field size ranging from 2000 to 50 ha. The grazing period was around 3 months (between May and August).

The locations had distinct agronomic history (i.e. soil fertility, agrochemical use). Despite these differences, during the winter season, black oat (*Avena strigosa*) and Italian ryegrass (*Lolium multiflorum* "common") to form a mixed winter pasture system, using a continuous grazing system with steers for meat production under no-tillage management.

Weed data collection

In each field, weed communities were surveyed and pasture management height were measured in 2014 within a plot of 50 x 40 m located 100-m away from a field boundary to avoid the field edge effects. As the ICLS is relative new cropping system and the associated weed flora is no well documented. Weed data were collected in mid-June 2014 (grazing period). The sampling protocol was consisted of recording species occurring within the 2000 m^{-2} area by walking according a "W" in the plot.

The density of each species was estimated using the Barralis'scale, described in FRIED et al. (2009): "+": found once in the 2000 m^{-2} area; "1" less than 1; "2" 1–2; "3" 3–20; "4" 21–50 and "5" more than 50 individuals m^{-2}. Abundance classes were altered into weed density by using the median value of the abundance classes following methodology proposed by TRICHARD et al. (2013). Weeds were identified following LORENZI (2006).

Data analysis

The relative dominance was de number of individuals of species divided by total number of individuals of all species found. The frequency was calculated with a percentage of number of sites that had occurrence. In order to quantify the association between pasture management height with species was used the Pearson correlation and its significance was tested.

Shannon's diversity index was estimated for each treatment as follows (KENT and COKER, 1992):

$$H = \sum_{i=1}^{S} \left(\frac{ni}{N}\right)\left(\log_2 \frac{ni}{N}\right)$$

where N represents the total number of individuals per plot, ni refers the number of individuals per species and plot and S describes the total number of species.

The evenness of species in each treatment was also calculated using the Shannon's diversity index as follows (KENT and COKER, 1992):

$$J = \frac{H}{\ln(s)}$$

Where *H is the Shannon's diversity and s describe total number of species.*

For density, species richness and evenness was used linear regression analysis function pasture management height and significance were tested by one-way ANOVA.

Results and Discussion

The weeds had several competition with forages, were as change morphological characteristics resulting to reduce forage production (SZYMCZAK et al., 2016). The knowledge of floristic composition of weeds is important to understand weed interference and design strategies for weed management (COSTA and MESQUITA, 2016). The weed flora assessed in the whole study was represented by 813 individuals from 18 families and 55 species. The total weed density in pastures was 29,5 plants m^{-2} (Tables 1 and 2).

The most important 31 weed were show on table 1 and 2, another species found few taxa (with density less than 0,01 plants m^{-2} and found on only one field) were: *Bowlesia incana Ruiz* e Pav., *Rumex obtusifolius* L., *Plantago major* L., *Chamaesyce hyssopifolia* (L.) Small, *Cyperus esculentus* L., *Spergula arvensis* L., *Vernonia polysphaera* L., *Taraxacum officinale* (L.) *Webe*r, *Brachiaria brizantha* (Hochst.) Stapf., *Cyperu*s *rotundus* L., *Commelina benghalensis* L., *Solanum viarum* L., *Dichondra repens* L., *Silene gallica* L., *Amaranthus viridis* L., *Ipomeia sp*., *Cuphea carthagenensis* (Jacq.) J.F. Macbr, *Sida cordifolia* L., *Paspalum paniculatum* L., *Chenopodium album* L., *Pennisetum clandestinum* L., *Solanum pseudocapsicum* L., *Polygonum convolvulu*s L. The number of species found in this study was higher than usually observed on pastures and crops (INOUE et al., 2012).

The families with the highest species richness were Asteraceae (n=16) and these family contributed with 28% of the total species number. On the other hand, eight families had only two species each. The five most important weed species (by relative dominance) in decreasing order were *Stachys arvensis* L., *Raphanus raphanistrum* L., *Conyza canadensis* (L.) Cronquist., *Stellaria media* (L.) Vill and *Veronica peregrina* (Kunth) Pennell.

Table 1. List of 14 mostly important weeds recorded in winter pasture in an Integrated Crop-Livestock in Southern Brazil and there individuals (m^{-2}), relative dominance (%), relative frequency (%) and correlation with increase height sward management pasture.

Species	Family	N	RD(%)	RF(%)	r
Stachys arvensis L.	Lamiaceae	7.45	23.81	76.9	-0.39**
Stellaria media (L.) Vill	Caryophyllaceae	4.81	15.36	38.4	-0.27^{ns}
Raphanus raphanistrum L.	Brassicaceae	4.78	15.27	80.7	-0.33**
Conyza canadensis (L.) Cronquist.	Asteraceae	3.50	11.17	69.2	-0.27**
Veronica peregrina (Kunth) Pennell	Asteraceae	2.57	8.22	76.9	-0.29^{ns}
Oxalis corniculata L.	Oxalidaceae	1.93	6.17	11.5	-0.23 ^{ns}
Gnaphalium spicatum Lam.	Asteraceae	0.81	2.58	84.6	-0.22 ^{ns}
Facelis apiculata L.	Asteraceae	0.67	2.14	30.8	0.09 ^{ns}
Richardia brasiliensis Gomes	Rubiaceae	0.50	1.61	30.7	-0.19 ^{ns}
Hypochoeris brasiliensis (Less.) Griseb.	Asteraceae	0.46	1.46	34.6	-0.08 ^{ns}
Sida rhombifolia L.	Malvaceae	0.29	0.93	38.4	-0.35*
Senecio brasiliensis L.	Asteraceae	0.23	0.75	57.7	-0.40**
Sonchus oleraceus L.	Asteraceae	0.15	0.49	50.0	-0.42**
Spergula arvensis L.	Caryophyllaceae	0.15	0.47	23.0	-0.01^{ns}

Table 2. List of 17 mostly important weeds recorded in winter pasture in an Integrated Crop-Livestock in Southern Brazil and there individuals (m^{-2}), relative dominance (%), relative frequency (%) and correlation with increase height sward management pasture.

Species	Family	N	RD(%)	RF(%)	r
Solanum americanum **L.**	Solanaceae	0.12	0.39	30.7	-0.35*
Leonurus sibiricus L.	Lamiaceae	0.09	0.28	19.2	-0.29 ^{ns}
Solanum sisymbriifolium L.	Solanaceae	0.08	0.26	3.8	-0.29 ^{ns}
Xanthium strumarium L.	Asteraceae	0.08	0.26	11.53	-0.20^{ns}
Soliva pterosperma (Juss.) Less.	Asteraceae	0.07	0.23	19.2	-0.19 ^{ns}
Facelis retrusa (Lam.) Schultz-Bip.	Asteraceae	0.07	0.21	7.7	-0.10*
Spermacoce latifolia Aubl.	Rubiaceae	0.07	0.21	11.5	-0.19 ^{ns}
Brachiaria plantaginea L.	Poaceae	0.05	0.16	7.7	0.04 ^{ns}
Ambrosia tenuifolia L.	Asteraceae	0.05	0.15	3.8	-0.16 ^{ns}
Malvastrum coromandelianum (L.) Garcke	Malvaceae	0.04	0.12	7.7	-0.21 ^{ns}
Raphanus sativus L.	Brassicaceae	0.04	0.12	3.8	-0.16 ^{ns}
Conyza bonariensis (L.) cronquist	Asteraceae	0.04	0.12	3.8	-0.17 ^{ns}
Eleusine indica (L.) Gaertn	Poaceae	0.02	0.07	23.1	-0.33 ^{ns}
Bidens pilosa L	Asteraceae	0.02	0.06	19.2	0.56 ^{ns}
Euphorbia heterophylla L.	Euphorbiaceae	0.02	0.06	19.2	-0.16 ^{ns}
Murdaia nudiflora (L.) Brenan	Commelinaceae	0.02	0.05	3.8	-0.29 ^{ns}
Coroopus didymus (L.) Sm.	Brassicaceae	0.02	0.05	15.3	-0.35*

*N = number of individuals m^{-2}; RD = Relative dominance; RF = Frequency; r = Correlation with increase height of pasture management. NS = no significant; * = significant at p<0,05; ** = significant at p<0,01.*

The high sward management was significantly modified by the weed density (p<0.01) in winter pasture (figure 1). It may be increased competition for resources by taller swards (i.e. light and space) reduced weed density due to germination and growth are inhibited by forage interference (PELISSARI et al., 2013).

Factors linked to disturbance by cattle grazing modifies weed abundance at pasture scales (TRACY et al., 2004). *R. raphanistrum* and *G. spicatum* were found in more than 80% of fields evaluated (table 1 and 2) indicating great plasticity with adaptability to grazing intensity within stress tolerance or rejection to imposed by animals. The possibility *R. raphanistrum*

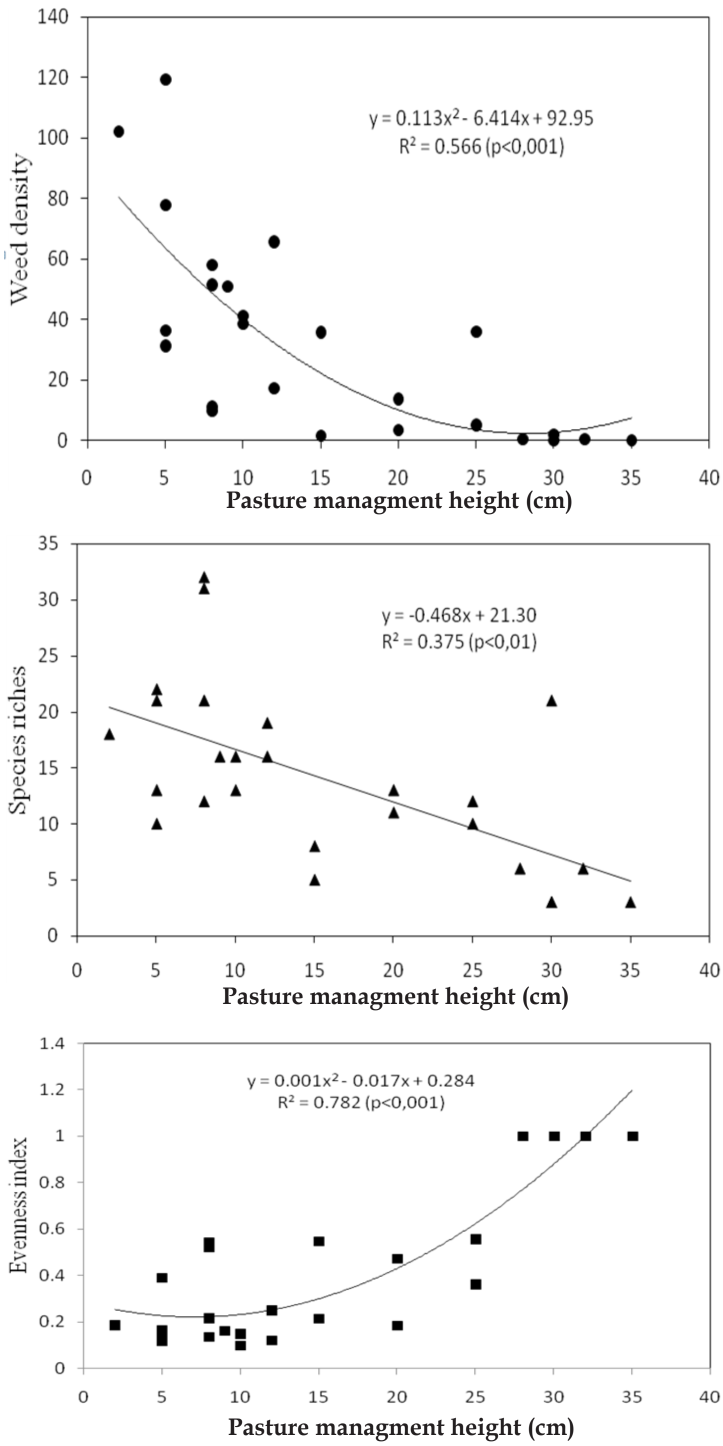

Figure 1. Relationship of sward height (cm) with weed density (seedling m^{-2}), species richness (number of individuals) and evenness index in winter pasture in an Integrated Crop-Livestock in Southern Brazil.

had the rejection mechanisms that reduce probability to grazing because had biochemical compounds like glucosinolates which reduce tissue accessibility and acceptance (VIG et al., 2009) and *G. spicatum* had meristem availability and these mechanisms of tolerance enabling plants to survive along grazing intensities (KISSMANN and GROTH, 1997).

The species evenness was calculated using Shannon's index which varies from 0 to 1, being that near zero indicates that the species community is dominated by one specie (BOOTH et al., 2003), the results presents that species evenness with sward height management had directly linked with weed community structure and suggest with decrease sward height management is dominated by a community of common weeds (figure 1), mainly *S. arvensis*, *R. raphanistrum, C. canadensis*, S. *brasiliensis* and *S. oleraceus* that had significantly ($p<0,01$) a negative correlation with increased pasture management sward height (table 1 and 2). Possibly lower pasture sward height management may promote intensely weed defoliation by grazing animals and increased possibly animals trampling, resulting on selection some weeds with resistance for these factors.

Special attention for *C. canadensis* due to this specie is an increasing problem in no-tillage agriculture and is a common specie distributed globally in fields. In order to complement the glyphosate was used herbicides with alternative modes of action and with soil-residual activity is frequently reported as strategies for *C. canadensis* control in no-tillage systems (NORSWORTHY et al., 2009). Although the results of this work suggests and that increase pasture management height reduce density of *C. canadensis* (table 1) and it may be used as a way of integrated weed management (SHUSTER et al., 2016).

In addition, species richness increase with the reduction of sward height (figure 1) indicate that many species present in high intensities increase the complexity and difficulty for planning integrated weed management and chemical weed control in winter pasture in an ICLS (SHUSTER et al., 2015).

Conclusions

The results could lead to improved weed management strategies in winter pasture in an ICLS regarding weed density and community complex can be reduced by increased sward height of winter pasture management in Southern Brazil.

The most important weed species in winter pastures in ICLS, in the Southern Brazil decreasing order is are *Stachys arvensis* L., *Raphanus raphanistrum* L., *Conyza canadensis* (L.) Cronquist., *Stellaria media* (L.) Vill and *Veronica peregrina* (Kunth) Pennell. These species must deserve better attention in weed management programs in winter pastures in ICLS.

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