Postburning legume seeding in the Flooding Pampas, Argentina

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Abstract

In Argentina, *Paspalum quadrifarium* Lam. (paja colorada) forms tall dense grassland communities in the flooding pampas. Referred to locally as “pajonales”, these grasslands generally have very low nutritional value for cattle, except at the post-burn regrowth stage. To improve forage quality and consumption by breeding cattle, *Lotus tenuis* Walst et Kit. is over seeded immediately after burning of paja colorada pajonales. The objectives of this experiment were to follow the after seeding cover of lotus, evaluate weed control, and assess disease incidence and severity. The experiment was carried out in Azul, Buenos Aires province of Argentina, between September 1993 to September 1996. The postburn seedbed was very favorable for lotus germination and establishment. The most effective chemical weed control was obtained with 2,4-DB used alone or in combination with dicamba. *Lotus* increased markedly the quality of the pasture forage due to its high crude protein content. Four fungus diseases were found: *Botrytis cinerea* Pers., *Stemphylium* sp. Wallroth, *Uromyces loti* Blytt. and *Fusarium* spp. Link ex Fr. However, these caused only light foliar damage and did not impair lotus germination or establishment. The overseeding of lotus after burning of *P. quadrifarium* pajonales, is a very effective technique to improve carrying capacity and animal performance.

Key Words: *Paspalum quadrifarium*, *Lotus tenuis*, fire, weed control, diseases, species diversity

Paspalum quadrifarium Lam. (paja colorada) forms dense tall (1-1.5 m) grassland communities referred to locally “pajonales”. Some researchers believe that it was the predominant vegetation of the Flooding Pampas at the end of the 19th Century (Vervoorst 1967). Because of the low carrying capacity of the “pajonales”, ranchers tend to replace them with seeded pastures. There is concern about the impact that this replacement process has on the biodiversity of the region by decreasing the native fauna that is strongly attached to the pajonales communities.

Paja colorada has very low nutritional value for cattle except at the postburn regrowth stage. *In vitro* digestibility varies around 50%, crude fiber exceeds 70% and crude protein rarely reaches 12% on a dry matter basis. Consequently, it does not provide suit-

Resumen

En las pampas inundables de la Argentina el *Paspalum quadrifarium* Lamb. (Paja colorada) forma densas matas de pastizal. Estas comunidades son conocidas localmente como “pajonales” y generalmente tienen muy bajo valor nutritivo para los bovinos domésticos, excepto en los rebrotes postquemados. Para mejorar la calidad de forraje y el consumo de los pajonales de paja colorada, se sobresembró *Lotus tenuis* al voleo postquemado de dichos pajonales. Los objetivos de este experimento fueron monitorear las variaciones en la cobertura de *Lotus* y los demás componentes del pastizal luego de la siembra, evaluar el control de las malezas y la incidencia y severidad de enfermedades en *Lotus*. El experimento se condujo entre setiembre de 1993 y setiembre de 1996, en Azul, Provincia de Buenos Aires, Argentina. La cama de siembra postquemada favoreció la germinación y establecimiento del *Lotus*. El control químico de malezas más efectivo se obtuvo con 2,4-DB utilizado solo o en combinación con dicamba. El *Lotus* incrementó marcadamente la calidad del forraje del lote debido a su alto contenido de proteína cruda. Fueron determinadas 4 enfermedades fúngicas en *Lotus*: *Botrytis cinerea* Pers., *Stemphylium* sp. Wallroth, *Uromyces loti* Blytt. y *Fusarium* spp. Link ex Fr. las que solo causaron un ligero daño foliar y no impidieron la germinación y establecimiento de esta especie. La siembra en cobertura de *Lotus* inmediatamente luego de la quema de los pajonales de *Paspalum quadrifarium* es una técnica muy efectiva para mejorar la capacidad de carga y la respuesta animal.

able forage for young cattle or breeding females with high levels of nutrient requirements. The over seeding of lotus (*Lotus tenuis* Walst et Kit. is a naturalized forage legume in the region) immediately after burning of paja colorada pajonales, appears to have potential to improve forage quality and consumption by breeding cattle. However, a range of diseases caused by pathogens in Argentina (Wolcan and Dall Bello 1988, Dall Bello and Wolcan 1992) could affect the lotus survival.

The adequacy of postburned “seedbed” (formed by ashes and bare ground) for lotus germination, the competition with perennial weeds and the effect of diseases, could affect the establishment of the lotus plants. The objective of this experiment were to follow the after seeding cover development of lotus, evaluate the efficiency by weed control and to describe the diseases affecting its aerial plant parts.

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Materials and Methods

The experiment was carried out in a "pajonal" situated 70 km north of Azul in the center of Buenos Aires province of Argentina, between September 1993 to September 1996. The climate is sub humid and temperate (Thornthwaite and Mather 1957) with an annual rainfall of 900 mm and mean temperatures of 16°C. The pajonal was covered with 70% paja colorada growing over hydromorphic soil with pH varying between 7.5 and 8.0 and 4% organic matter. The soil belongs to the edaphic dominion 23 group (INTA-CIRN 1989).

Four randomized 20 x 34 m blocks with a factorial arrangement were divided into 2 equal sized plots, 1 of which was seeded and the other remained as a control. Burning was done in early spring (12 September 1993) with prescript fire. Immediately after burning, 2 kg/ha of scarified, inoculated and pelleted *Lotus tenuis* seed was hand broadcast.

Two month after sowing plots were divided into 6 subplots: control, dicamba (3,6-dichloro-2-methoxybenzoic acid) 57.5 g ai ha⁻¹, 2,4 DB (4-(2,4-dichlorophenoxy) butanoic acid) 800 g ae ha⁻¹, MCPA (4-chloro-2-methylphenoxyacetic acid) 280 g ae ha⁻¹, 2,4DB 800 g ae ha⁻¹ + dicamba 57.5 g ai ha⁻¹, MCPA 280 g ae ha⁻¹ + dicamba 57.5 g ai ha⁻¹. All treatments included a 0.2% rate of non-ionic detergent in the aspersion volume that was equivalent to 170 liter/ha. Overall, the main treatments were: seeded or control and sub-factors were 5 herbicide treatments and control. The effects were evaluated with ANOVA and means tested with the SNK test at P 0.05.

The Braun-Blanquet (1979) method was used to determine the establishment and growing of lotus, weeds, paja colorada and bare ground 2, 8, 12, 14, and 29 months after sowing. Biomass was harvested in the 12, 20, and 29 month after sowing and dry matter and crude protein determined on subsamples by standard procedures. Seedling emergence of lotus was measured by presence and abundance parameters. The effectiveness of herbicide treatments was evaluated using a visual percent scale method in which zero represents the control treatment and 100%, the treatment with a total control of weeds.

Plant pathogens were studied in lotus plants. Ten, 0.5 m² quadrats were sampled in each of the sites for 2 situations: lotus plants in associate growth with paja colorada and lotus growing in the area between paja colorada plants. The inci-

◊, Paja Colorada □ Weed = Lotus tenuis ◻ Bare Ground - Other Grasses

Fig. 1. Cover changes occurred throughout the experimental time.

dence and severity of plant pathogens were appraised from emergence until the 24th month by estimating the percentage of leaf and shoot area affected by disease on a visual 0–6 scale (modified from James 1971), where 0 = no disease and 6 = leaf/shoot very severely affected.

Results and Discussion

Vegetation cover changes after burning and lotus seeding

Figure 1 shows the changes in ground cover observed throughout the experiment. Prior to burning in September 1993, cover was made up of 70% dead paja colorada, 10% broad-leaved weeds (*Plantago lanceolata* L., *Rumex crispus* L., *Hydrocotyle bonariensis* Lam., *Mentha pulegium* L., *Eryngium echinatum* Urban.) and 20% bare ground. A number of other weeds

(*Anagallis arvensis* L., *Carduus acanthoides* L., *Stellaria media* (L.) Vill., *Leontodon taraxacoides* (Vill.) Merat, *Sonchus oleraceus* L.) germinated after the burning treatment.

After 45 days from sowing, lotus accounted for 33% of ground cover. Weeds cover increased to 23% and paja colorada and bare ground diminished to 40% and 4%, respectively. After 8 months (Fig. 1), the cover of paja colorada and bare ground were unchanged, but lotus increased to 43% and weeds decreased to 8%. A new component, other grasses, emerged with values close to 5%. The decreased weed cover is associated with the chemical controls, although cover data is an average of a range of control effects given by the different herbicides used. The relationship between decreased weed cover and increased lotus cover, suggest the importance of weed suppression on lotus establishment. Once established,

Table 1. Weed cover 2 months after burning.

Species	Cover		Phenological Stages
	Without Lotus	With Lotus	
	(%)	(%)	
<i>Anagallis arvensis</i> L.	8.0	4.0	Seedlings
<i>Carduus acanthoides</i> L.	11.0	5.0	Seedlings
<i>Eryngium echinatum</i> Urban.	5.0	5.0	Adults
<i>Hydrocotyle bonariensis</i> Lam.	11.0	18.0	Adults
<i>Leontodon taraxacoides</i> (Vill.) Merat	3.0	3.0	Seedlings
<i>Mentha pulegium</i> L.	22.0	27.0	Adults
<i>Rumex crispus</i> L.	22.0	24.0	Adults
<i>Sonchus oleraceus</i> L.	8.0	5.0	Seedlings
<i>Stellaria media</i> (L.) Vill.	8.0	5.0	Seedlings

Table 2. Efficacy of chemical control.

Treatment	Efficacy
	(%)
Dicamba	21 d
2,4-DB	69 ab
MCPA	54 bc
2,4-DB + Dicamba	79 a
MCPA + Dicamba	47 c

lotus is highly competitive with weeds (Ortega and Laterra 1995).

After 12 months, the cover percentage of paja colorada and lotus stabilized at 37 and 40%, respectively. However, during the second year, a very severe winter drought occurred which killed plants thereby increasing the proportion of bare ground. After the spring rains, lotus cover recovered and in the 29th month occupied most of the vegetable cover. Paja colorada cover and bare ground decreased markedly. It was observed that cattle consumed a larger proportion of the paja colorada plants when lotus grew together with them. This probably explains the decrease in paja colorada cover when lotus is present.

Adults plants of *Eryngium*, *Rumex*, *Mentha* and *Hydrocotyle* spp. which were present prior to burning, sprouted after burning and did not suffered the effect of lotus presence. The annual weeds (*Anagallis arvensis*, *Carduus acanthoides*, *Sonchus oleraceus* and *Stellaria media*) germinated after burning and showed a significant lower plant cover on plots

where lotus were present, as compared to plots not sown with lotus (Table 1).

The chemical control of weeds (Table 2) was equally effective for 2,4-DB when used alone or when combined with dicamba with values close to 80%. The least effective treatment was with dicamba. Intermediate control was obtained with the MCPA's formulas. Due to the low presence of annual weeds, significant differences were not detected on the chemical control between lotus seeded or unseeded plots. Consequently, chemical control data was analyzed independently from the lotus seeding treatment.

Fig. 2. Dry biomass (kg m⁻²) of treatments with or without lotus.

Fig. 3. Pathogens on *Lotus tenuis* in a 24-month period.

Mixtures of 2,4-DB with dicamba, as well as dicamba used alone, were effective only with the postburn regrowth of adult plants of *Rumex crispus*. This species, as all the *poligonacea* are not satisfactorily controlled by the herbicides 2,4-D, 2,4-DB and MCPA.

Biomass accumulation

Lotus dry biomass accumulated 86 g/m² 12 months after burning and seeding which accounted for 16 % of total dry biomass. The lotus biomass contribution to total biomass increased to 18 % and 28 % after 20 and 29 months, respectively. There was no difference in total biomass between the unseeded and seeded treatments. This indicates that the lotus growth occurred at the expense of paja colorada growth. Also it seems to show that once established, lotus has the ability to maintain or even increase pasture biomass (Fig. 2).

The crude protein content of accumulated biomass increased from 7 % for paja colorada to 21% for lotus. The protein content in paja colorada is lower than the nutritional requirements for beef cattle. The lotus plots offered about 30g/m² of crude protein compared to only 10 g/m² in unseeded plots. In earlier studies, paja colorada postburn regrowth reached a crude protein content of 12% for the first regrowth after burning, but decreased thereafter (Sacido et al. 1995). An increase in available soil nitrogen availability from N fixed by legumes and liberation of N of microbial biomass facilitated by the early heating of soil have been suggested as possible explanations for this increase in

Fig. 4. Incidence and severity of *Uromyces loti* in leaflets of *Lotus tenuis* a) in associate growth with *P. quadrifarium* plants, b) growing in the area between *P. quadrifarium* plants.

the quality of paja colorada (Ojima et al. 1990, García 1992). The replacement of broad leaves weeds by forage legumes also improves the primary productivity and forage quality of native grasslands (Quinos, et al. 1994, De Battista and Miller 1995, Colabelli and Miñón 1993, Teglia et al. 1992, Montes and Cauhépe 1985).

Diseases in *Lotus tenuis*

Four fungal diseases were found on lotus plants throughout the experiment: leaf spot (*Botrytis cinerea* Pers.) in leaflets and stems, the disease did not injure more than 20% of plants and the severity never reached grades above 1 in leaflets and stems. Cold and moist weather was coincident with these symptoms (Fig 3). Rust

(*Uromyces loti* Blytt.) was found also on lotus leaflets and stems. Lotus plants growing in close proximity to paja colorada exhibited high rust incidence (100% with and severity grade 2) whereas for plants growing in the area between paja colorada the incidence was reduced (70% and severity grade 1). During February and May 1995, another rust attack was registered (Figs. 3 and 4).

Fusarium spp. Link ex Fr., (predominantly *F. oxysporum* Schlecht.), affected 20-30% of roots and stems during November 1995 (14 months after burning) with a grade 3 severity. In April 1996, the incidence was 90% and the severity was also grade 3. Although the incidence was high, the disease did not cause plant death.

The leaf spot caused by *Stemphylium* sp. Wallroth, affected 30% of leaflets with the more severe attacks in the summer months. The location of lotus plants affected the severity of attack with grades 2 to 3 found in lotus plants growing in associated growth with paja colorada, but only grade 1 in the lotus growing between paja colorada plants.

Conclusions

(1) The postburn seedbed was very favorable for lotus germination and establishment. After 29 months of treatments of burning and seeding, lotus reached a cover of 20%; paja colorada and bare ground cover decreased significantly during the same period.

(2) Lotus showed a high competitive ability with the annual broad-leaved weeds. The most effective chemical control was obtained with 2,4-DB formulated pure or mixed with dicamba.

(3) Lotus increased markedly the forage quality of the pasture due to its high crude protein content.

(4) Four fungus diseases were found: *Botrytis* and *Stemphylium* leaf spots, leaf and shoot rust and *Fusarium* wilt. However, they caused only light damage and did not impair lotus germination or establishment.

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