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EFFECT OF CLIMATIC FACTORS ON THE PLANT POPULATION DYNAMICS IN TEMPERATE PASTURE IMPLANTATION

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Abstract

The objective of this experiment was to determine the environmental influence on seedling emergence of alfalfa and fescue in mixture. We hypothesized that the temperature and precipitation data could be used to estimate field emergence of alfalfa and fescue. A field trial was carried out at Zavalla, Argentina and consisted of sowing a tall fescue – alfalfa mixture at different seeding date (March, April and June). Relationships between the range of temperature, rainfalls and alfalfa and fescue seedling emergence were described by linear regression models. Patterns of emergence and death of alfalfa and fescue seedling were found in the different sowing dates. The measurements performed in other mixed pastures on the area were used to adjust the models. Historical series (1973-1999) of temperature and rainfall data were used to verify the obtained models. The r^2 of the correlation between predicted and observed demographic curves of the species was 64 to 97%. The species studied presented varied situations in the phase of emergency and death. When they were sowed in different dates, the April sowing generated an appropriate composition of the mixture. The application of models based on meteorological factors that explain the demographic variations of a forage mixture will allow to plan sowing strategies and to predict the structure of the resulting pastures.

Keywords: seedling emergence, alfalfa, tall fescue.

Introduction

Perennial pastures constitute the most important forage resources for the bovine production in the dairy or fattening of cattle farms of Argentina. Alfalfa is the dominating species in mixture and is frequently associated to tall fescue. The efficiency of a mix pasture implantation depends on the interaction of several factors that operate throughout the establishment period, affecting to different degrees the component species. Among these factors, soil fertility, water availability and sowing date are worth mentioning (Romero *et al*, 1995). The main sowing time is autumn, which may span from the beginning of March to mid-June in the Rolling Pampa, a stage during which, important variations on thermic and hydric conditions are registered, which determine the seed number that actually germinates and emerges.

The emergence phase and seedling establishment is sensitive to a complex amount of genetic, climatic and positional influences, which determine the composition of the pastures. In relation to the meteorological requirements, works performed in controlled environments (Fick *et al*, 1988) and on field (Martín *et al*, 2000) have highlighted temperature and moisture action as a conditioning factor in the seed number that actually germinates and emerges.

All the techniques used for the implantation of pastures partially consider the action of the climatic environment in the development of seedling, which remain small and weak during the first months of life. We hypothesise that the emergence and survival of alfalfa and fescue plants is strongly conditioned by the autumn sowing date, which in this way defines the mixture configuration.

The purpose of this study was: 1) to determine the effect of the sowing and fescue plants before the first grazing and 2) to examine the climatic potential of the region according to the prediction of different demographic curves.

Material and Methods

The experiment was carried out in the Villarino Experimental Field (33º Lat. S, 67º Long. W), Zavalla district, Argentine, on an Argiudol vertic soil. The treatments consisted of three sowing date (FS): early (FS1, March), regular (FS2, April) and late (FS3, June). The design used was time divided plots with three repetitions. The size of the main plot was 4,5 x 5,5 m, subplots were the sowing dates. A mixture of alfalfa (*Medicago sativa* L.) cv. "Monarca" (latency group 9) and fescue (*Festuca arundinacea* Schreb) cv. "El Palenque INTA", with a density of 500 viable seeds per m^2 for each species was sown. Daily maximum, mean and minimum air temperatures were registered at 1,50 m height, and the daily temperature range, thermic additions and rainfall accumulation, were calculate. Density per specie in plants per m^2 was measured in the vegetation (through fixed stations placed at random). Sowing date comparison was made with ANOVA and the Tukey test ($p<0.05$). The degree of association between the climatic variables and the number of individuals was analysed (SAS, 1998); mean mobile patterns were estimated from lineal equations for each sowing date and for each species. Average values from 4 to 6 measurements from the alfalfa and fescue stand in mix pastures of the area of influence and from several years were used to tested the selected rights.

Results and Discussion

Weather conditions between March and July, during 1997 were extreme, generating a warm and dry year; 1998 was cool and wet, while 1999 presented average temperatures and rainfall similar to those of the historical values.

The evolution in the number of plants per m^2 in the different sowing dates showed emergence and loss patterns similar between years for each species (Table 1)

Until the first 35-45 days after sowing, the alfalfa and fescue stand of plants exceeded the average effective value -for each specie- before the first exploitation (alfalfa 122,7 ± 32,1 plants per m^2 and fescue 87 ± 28,7 before the first trim with grazing or mechanic clipping). Afterwards, each species showed in different densities.

The effect of the suboptimun environment (temperature and soil humidity), reduced the emergence of alfalfa and fescue seedlings and extended the average time for that event to happen (Hill *et al*, 1985). This situation provoked a low efficiency of implementation, lower than 15% (Table 1).

Late sowings achieved a greater emergence of fescue seedling in the first 30-40 days (Deregibus *et al*, 1992). Later on, mortality was pronounced due to their weak development and to their shallow radicular system which could not support the seedlings during the high temperature and low soil humidity conditions in the winter-spring transition (Pearson *et al*, 1987).

The velocity with which the alfalfa and fescue seedling emerged was described with mathematics equations. Correlations between the accumulative percentages of emergence and the climatic variables affected the most, were adjusted (equations 1 and 2 for alfalfa and fescue, respectively). The accumulative percentage of emergence show one plateau which we denominated fullness of emergence phase. The later decrease in the number of plants found per species and per sowing date did not respond to any climatic variable considered,

depending more on a complex interaction between the position, size, genotype, microenvironment and competition of the seedlings (Pearson *et al*, 1987).

- Equation 1= 230,71 – 6,014 x(mean Tº) + 2,596 x(accumulated rainfall), n=27, R^2=41
- Equation 2=332,35 – 8,998 x(maximum Tº) n=27, R^2 =38

To make the predictive model for the demographic curves of each specie and for each sowing date, the fullness of the emergence phase was calculated. The meteorological regressive variables were replaced for the climatic values of the area (1975-1999 period) in the equations 1 and 2 and the decreasing phase was adjusted according to the estimations of the decreasing percentages found in the counting (Figure 1).

The measurements performed in other mixed pastures on the area were used to adjust the model. They were characterised by having alfalfa as dominating species sowed in a proportion of 45-50% of the mixture and fescue as a perennial grass sowed in a range of 20% to 30%. The contribution of the genetic factor to explain the variation of the level of emergence in alfalfa was not considered important because observations of short winter latency cultivars were the only ones used.

Even though the proportion of fescue used by the producers was not 50%, the predictive number of plants that emerged and established were well adjusted to observed values. This fact demonstrate that the number of plants that emerges and establishes is independent of sowing density.

The reduction after the maximum number of emerged seedlings, both of alfalfa and fescue coincide with their active growth stage in which a high intra and interspecific competition is generated. This did not happen in the second sowing date, when the stand was reduced more slowly, suggesting that in this case the competition begins later because the species express moderate growth rates or because the soil-climatic environment is more favourable so that there would be a low interference between them.

We conclude that 1) the climatic environment affects the demographic curves of alfalfa and fescue generating different temporal patterns of emergence and establishment according to the sowing time, and 2) the application of models based on meteorological factors that explain the demographic variations of a forage mixture, will allow to plan sowing strategies and to predict the structure of the resulting pastures.

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Table 1 - Number of plants of alfalfa and fescue for each sowing dates (FS) and implantation efficiency to the 180 days concerning the density of sowing (EF,%).

	----------1997----------			----------1998----------			----------1999----------		
Alfalfa	FS 1	FS 2	FS 3	FS 1	FS 2	FS 3	FS 1	FS 2	FS 3
Days from sowing									
30	54b	407a	395a	135b	194a	128b	436a	256b	318b
180	40b	320a	270a	120a	45b	99b	137a	200a	110a
EF (%)	8	64	54	24	9	20	27	40	22
Fescue									
30	11b	84a	98.5a	197a	135a	188.5a	125.5a	189a	56b
180	17c	61b	157a	120b	61c	243a	108a	130a	98a
EF (%)	3.4	12	31	24	12	49	22	26	20

The different letters in line, for each year, differentiated means by Tukey test ($P<0.05$)

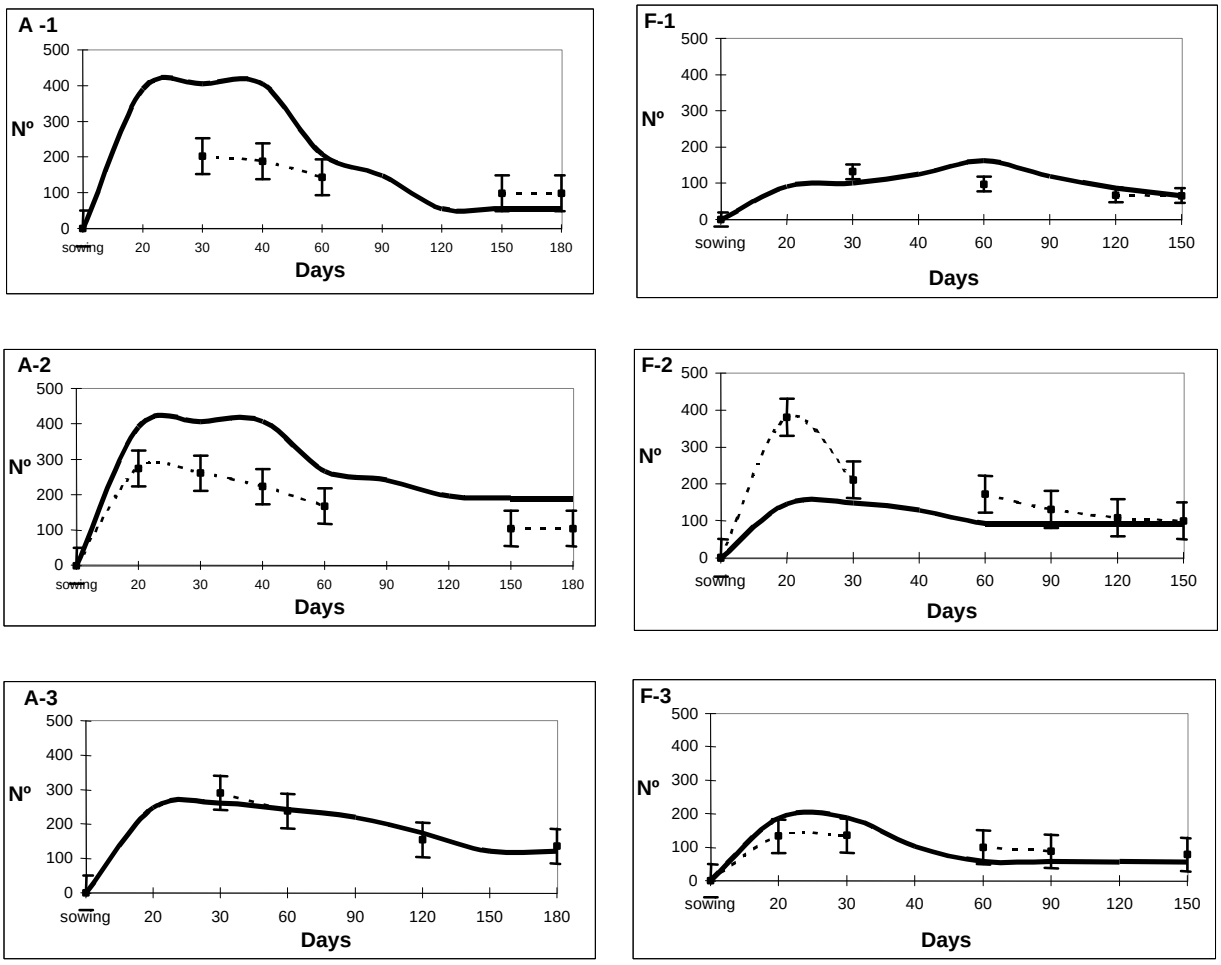

Figure 1 - Demographic curves of alfalfa (A) and fescue (F) observed (dotted line) and predicted (continuous line) for pasture in Zavalla district and for different years (1987-1999). The r^2 of the correlation between predicted and observed curves was 64 to 97%.