NITROGEN FERTILIZATION IN WINTER FORAGE CROPS IN THE SOUTHEAST OF BUENOS AIRES PROVINCE (ARGENTINA)

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ABSTRACT

The potential growth in the winter annual forage crops in the Southeast of Buenos Aires Province (Argentina), is limited by the availability of nitrogen during the winter period. The effect of nitrogen fertilization on growth of the two main winter forage crops: oat (*Avena sativa*) and annual ryegrass (*Lolium multiflorum Lam*) was analyzed. Under winter-spring temperatures a higher growth potential was shown by annual ryegrass. The critical N doses were 150 and 100 kg.ha^{-1} of N for oat and annual ryegrass, respectively. The nitrogen dilution curves and the critical N concentration in the forage were determined. The initial concentration of N should not be less than 4.01 gr.100gr-1, a condition that, in the absence of water limitations or other nutrients, would permit expression of growth levels of forage in winter-spring close to the potential.

KEYWORDS

Nitrogen fertilizer, *Avena sativa*, *Lolium multiflorum*, potential growth, nitrogen dilution

INTRODUCTION

In the Southeast of Buenos Aires province (Argentina) potential winter-spring growth of winter forage crops is limited by N deficiency. Correction of this defficiency in non-limiting conditions of water and other nutrients would allow expression of winter forage crops growth potential.

In this study the effect of nitrogen fertilization on winter-spring growth of *Avena sativa* var. Bonaerense Payé (AS) and *Lolium multiflorum lam* cv Grassland Tama (LM) was analyzed. The evolution of N concentration in the forage along the growing period for the critical N dosage is also determined.

MATERIALS AND METHODS

The experiment was established on a tipic Argiudol soil at the Balcarce Experimental Station (INTA-FCA)(37° 45'LS, 58° 18'LW). In a split split-plot block design with 3 replications, 6 levels of N applied as urea (Ni) (Table) were evaluated. Phosphorus (50 kg.ha^{-1}) was applied and frequent irrigation was used. To determine forage accumulation, six forage harvests at 2.5cm from ground level were performed on 5.5 m^2 plots at different times between 9/8/95 and 17/10/95. Daily air temperature and incident global radiation were registered at the Experimental Station Agrometeorological Unit. Monthly mean temperatures ranged from 8.7 to 13.4°C during the period studied. Photosynthetically active radiation intercepted by the canopy (PARint) was measured every 15 days with a radiometer (AT DELTA). Radiation use efficiency (EUR) and growth rate by thermal time unit (basis temperature=0°) for each N_i were calculated as the linear regression slopes between forage accumulation and accumulated PAR and temperature, respectively. Leaf area index (LAI) was measured by means of an electronic planimeter (Li-COR 3100) and its morphological and structural components were evaluated.

The concentration of total organic N (gr.100 gr-1) was determined using the Kjeldahl method. Variance analysis to a 5% of significance were performed (GLM, SAS,1988). The curves of N dilution for each Ni were adjusted by regression (NLIN, SAS,1988), its parameters were compared using the Dummy variable method (Berenson *et al*.,1983).

RESULTS AND DISCUSSION

LM showed a higher forage accumulation and growth rate than AS. Differences in this variables between Ni were found in both crops. The highest values were found with N250, but N150 for AS and N100 for LM (critical dosage) did not differ from the highest doses (Table). The highest growth rate values were similar to those found for other perennial forage grasses in non-limiting conditions (Lemaire and Salette, 1982).

The values obtained for RUE in non-limited conditions was coincident with those found for temperate grasses by Gosse, *et al*., (1986) and Belanger *et al*. (1992). Although RUE was affected by Ni (Table), the principal effect of the applied N was found on LAI development (Table), which increased PARint. The values of cumulative PARint for the critical doses were 236.87 and 303.7 Mj.m^2 for AS and LM, respectively. Foliar elongation rate was more affected by N than were tiller density and leaf appearance rate (data not presented).

Average N concentration (gr.100gr^{-1}) was affected by Ni. Evolution of nitrogen content as a function of forage accumulation for each Ni was described by Lemaire and Salette's exponential equation (1984):

$$N = a * (DM)^{-b}$$

where:N= total nitrogen concentration in forage (gr.100 gr^{-1}), a= nitrogen concentration for a 1 Mg.ha^{-1} DM aerial biomass, b= nitrogen dilution coefficient as a function of forage increase, DM= accumulated forage (kg.ha^{-1}).

Functions did not differ between crops and differences between Ni were found. Nitrogen concentrations for the critical doses were expressed by the following equation:

$$N150(AS)\ (gr.100\ gr-1) = 4.01 * (MS)^{-0.42} \qquad r^2 = 0{,}96$$

$$N100(RA)\ (gr.100\ gr-1) = 4.006 * (MS)^{-0.50} \qquad r^2 = 0{,}93$$

The a values were lower for the model than those described for other C3 grasses (Lemaire and Salette, 1984; Greenwood *et al.*,1990) but the dilution coefficient was similar to that adjusted by Greenwood *et al*. (1990) for C3 species.

CONCLUSIONS

LM showed a higher forage growth potential than AS. The application of N in crops with no other agronomical limitations accelerated LAI development and thus forage growth and accumulation on *Avena sativa* and *Lolium multiflorum lam* when compared with crops with limited N availability. The critical N doses were 150 and 100 kg.ha^{-1} for AS and LM respectively which correspond to the 4.01 gr.100 gr^{-1} for the initial nitrogen concentrations. This concentration, in the absence of water limitations or other nutrients, would permit expression of growth levels of forage in winter-spring close to the potential.

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Table 1

Effect of nitrogen fertilization on forage accumulation (FA) (09/08 -17/10/1995), growth rate by thermal time unit (growth rate) (base temperature= 0_C), leaf area index (LAI) and radiation use efficiency (RUE) of winter forage crops.

	Oats			
	FA	GR	LAI	RUE
	(MS kg.ha^{-1})	(MS kg.ha^{-1}.°C^{-1})	(MS gr.Mj^{-1})	
Nitrogen doses				
N0	1628.7a	2.45±0.47a	1.14a	1.16±0.078a
N50	3000.8 b	5.69±0.42 b	2.68ab	1.55±0.049 b
N100	3402.6 b	6.20±0.83 b	3.49 bc	1.73±0.088 bc
N150	4607.4 c	8.69±1.01 c	4.63 cd	1.90±0.093 c
N200	4822.9 c	8.83±1.05 c	4.38 bcd	1.83±0.091 c
N250	5117.7 c	9.48±1.34 c	5.37 d	1.90±0.110 c
Prob.	(0.0004)	(0.0001)	(0.002)	(0.0012)

	Annual ryegrass			
	FA	GR	LAI	RUE
	(MS kg.ha^{-1})	(MS kg.ha^{-1}.°C^{-1})	(MS gr.Mj^{-1})	
Nitrogen doses				
N0	2442.4a	3.47±0.70a	1.61a	1.40±0.096a
N50	5053.0 b	7.83±1.29 b	4.89ab	1.76±0.089 b
N100	6306.6 c	9.36±1.29 bc	6.11ab	1.95±0.083 bc
N150	6901.4 c	10.55±1.20 c	7.80 b	2.12±0.074 cd
N200	6742.8 c	10.46±0.57 c	5.53ab	2.21±0.060 cd
N250	7121.9 c	10.63±0.96 c	8.27 b	2.28±0.079 d
Prob.	(0.0001)	(0.0003)	(0.022)	(0.0003)

For each species figures followed by the same letter in vertical sense do not differ statistically (Duncan's Test, p.0.05).