Fertilizer Nitrogen and Morphogenetic Response in Avena Sativa and Lolium Multiflorum

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FERTILIZER NITROGEN AND MORPHOGENETIC RESPONSES IN AVENA SATIVA AND LOLIUM MULTIFLORUM

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ABSTRACT

A field experiment was carried out at the EEA Balcarce, INTA, Argentina (37° 45'LS, 58° 18'LW) to determine whether Leaf Appearance Rate (LAR) was affected by N fertilization in Italian ryegrass (*Lolium multiflorum Lam*.) and forage oats (*Avena sativa*). N treatments (0, 50, 100, 150, 200 and 250 kg N ha^{-1}) were applied in winter 1995, after a defoliation. Subsequently, number of leaves per tiller was determined on 45 labelled tillers in each treatment twice a week. LAR was calculated as the slope of the linear regression of number of leaves on thermal time (air temperature, base 0 °C). Leaf appearance was more rapid with N fertilization in ryegrass, but was not in oats. In situations in which N applied did not affect LAR similar phyllochrons of 112 (± 4,6) and 113 (± 3,6) GDD $leaf^{1}$ were found for Italian ryegrass and oats, respectively.

KEYWORDS

Phyllochron, nitrogen fertilization, *Lolium multiflorum*, *Avena sativa*, morphogenesis

INTRODUCTION

In the absence of water and P or K deficiency, a large part of the difference in aerial biomass accumulation between swards with different nitrogen (N) availability can be explained by the higher quantity of intercepted photosynthetically active radiation (PAR) by the treatments with higher doses of N (Bélanger *et al*., 1992). The amount of incident PAR captured by the crops depends on a programme of morphogenesis which is regulated by both genetic and environmental factors. Leaf and Tiller Appearance Rate (LAR and TAR) and Leaf Extension Rate (LER) determine the leaf area expansion rate (Chapman and Lemaire, 1993).

In temperate grasses, several authors have found that N nutrition systematically stimulated TAR and LER (Langer, 1963; Mazzanti et al, 1994) and delayed the onset of senescence (Thomas and Stoddart, 1980). However, there are conflicting reports about the response of LAR to N availability (Longnecker *et al*, 1993).

The purpose of this work was to analyse the effect of N fertilization upon LAR in two annual crops: Italian ryegrass and forage oats. Both of them are used in the Argentinian Pampa Region as winter forages to stabilize the seasonality of herbage supply due to their capability of growing at low temperatures.

MATERIALS AND METHODS

A field experiment was carried out on a Typic Argiudol soil, at the Estación Experimental Agropecuaria of the Instituto Nacional de Tecnologia Agropecuaria (INTA) located in Balcarce, Argentina (37° 45'LS, 58° 18'LW). Plots (1,5 m x 6 m) without P nor K deficiency and well irrigated were arranged in a split-plot design with three replications. Factors were species (*Lolium multiflorum* cv Grassland Tama and *Avena sativa* cv Bonaerense Payé) in the principal plot and N fertilization rate (0, 50, 100, 150, 200 and 250 kg N ha^{-1}) in the subplot.

The experiment was sown in autumn 1995 and N was applied as urea on August 9, after a defoliation to a height of 5 cm. In 45 labelled tillers in each treatment number of leaves was recorded twice a week between August 11 and September 20, 1995. A leaf was considered to have appeared when its tip was visible in the sheath of the nearest fully expanded leaf.

LAR was estimated as the slope of the linear regression of number of leaves on thermal time (Growing Degree Days, GDD, base 0 °C, air temperature). Phyllochron was calculated as the inverse of LAR. On two occasions total N concentration and Leaf Area Index (LAI) were obtained from a hand clipped sample (20 cm x 50 cm area).

RESULTS AND DISCUSSION

During the measurement period oats were not growing actively and reached relatively low LAI and high N concentration in plants (Table 1). There was an interaction N * Species (p<0,0001). Leaf appearance was more rapid with N fertilization in ryegrass (p<0,0001). This effect was not significant in oats (p>0,25), although LAR in treatment N0 tended to be lower than LAR in the other N treatments (p<0,10) (Figure 1).

In situations in which N applied did not affect LAR (N_{150} to N_{250} in ryegrass and N_{50} to N_{250} in oats) similar phyllochrons of 112 (± 4,6) and 113 (± 3,6) GDD leaf -1 were found for Italian ryegrass and oats respectively. Both of them are close to the 110 GDD leaf -1 found by Davies and Thomas (1983) for perennial ryegrass.

Some crop growth models, which incorporate morphogenetic variables as determinants of LAI, have minimised the effect of N deficiency upon LAR. However, our results show that important differences on LAR can be due to interactions between N nutrition and species. On the other hand, number of leaves can be useful plant-related indicators of optimal time to defoliation (Fulkerson and Slack, 1994). The large variations in phyllochron observed between N treatments, in Italian ryegrass, should not be neglected in the definition of cut or rotational harvest programs.

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Figure 1
Leaf Appearance Rate (LAR) in Italian ryegrass and forage oats with different N fertilization rates. Each point is the average of three replications. Errors bars represent standard error of the means. Means with equal letter do not differ (Duncan's test 5%).

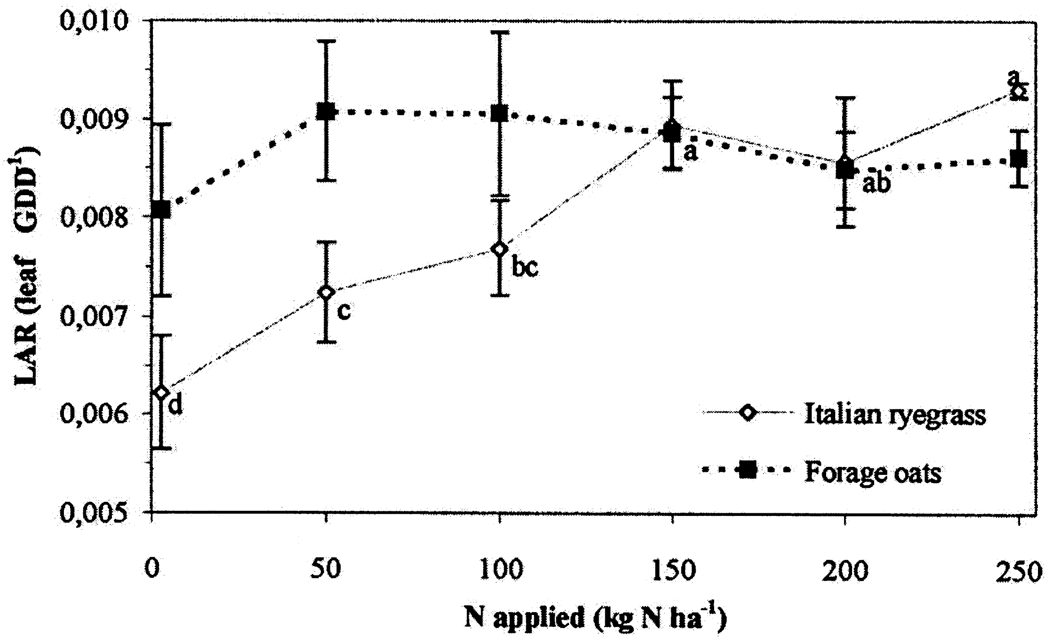

Table 1
N concentration, Leaf Area Index (LAI) and phyllochron in Italian ryegrass and forage oats receiving six N fertilization rates. Means with equal letter do not differ (Duncan's test 5%).

	N Applied kg N ha-1	N in plant %	Leaf Area Index $m^2\ m^{-2}$	Phyllochron GDD leaf-1
ITALIAN RYEGRASS	0	1.49	2,2	161 d
	50	2.18	3,5	138 c
	100	3.12	4,5	130 bc
	150	3.32	4,5	112 a
	200	3.92	5,3	117 ab
	250	3.85	5,9	107 a
			s.e. 0,43	
FORAGE OATS	0	1.91	0,4	124
	50	2.77	0,8	110
	100	2.78	0,8	111
	150	3.39	1,2	113
	200	3.05	0,9	118
	250	3.44	1,7	116
			s.e. 0,24	