EFFECT OF IRRIGATION AND NITROGEN FERTILIZATION ON RYEGRASS AND RYEGRASS/WHITE CLOVER SWARDS

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ABSTRACT

An experiment to determine nitrogen and water effect on dry matter yield of perennial ryegrass (*Lolium perenne* L) in mixtures with white clover (*Trifolium repens* L) and pure ryegrass pastures was carried out during two years at Balcarce, the Buenos Aires province, Argentina. Two levels of irrigation, natural rainfall and 20 mm irrigation when needed, and four levels of nitrogen fertilization 0; 150; 300; and 450 kg N.ha^{-1}.yr were applied. During the first year it was necessary to apply 250 mm of supplementary water to the irrigated plots, while 530 mm were needed the second year. Nitrogen responses of irrigated pure ryegrass pastures varied between 14.2 and 17.6 kg DM per kg applied N in the first and second year respectively. Nitrogen fertilization of ryegrass/clover pastures depressed clover content and had negligible effects on DM production. In both years, the irrigation of mixed pastures had a response of about 22 kg DM per mm of supplementary water.

KEYWORDS

Dry matter accumulation, irrigation, nitrogen fertilization

INTRODUCTION

Although the lack of persistence of perennial ryegrass and white clover in the Southeast region of the Buenos Aires province, Argentina is well recognized, recent economic changes in the country allows consideration of the application of new technologies, such as irrigation and nitrogen fertilization, to intensify pasture production. Because utilization of nitrogen is greatly affected by water supply (Garwood, 1988) a study to determine the relative importance of both factors on production and persistence of a perennial ryegrass/ white clover sward, in comparison to a pure ryegrass sward during the first two years after implantation, was carried out.

METHODS

In April, 1994, an experiment was established at Balcarce Experimental Station, (37½45'Lat.S; 58½18'Long.W.;97 m over sea level) on a Typic Natraquoll soil with 5.0 % O.M., 8 ppm P, pH 5,9. The climate is humid-temperate with annual mean of 937 mm rainfall evenly distributed and mean month temperatures between 7.6½C (July) and 19.7 ½C (January).

6 x 3 m plots were laid out in a split-plot design with (I) and without irrigation (NI) as main treatment in completed blocks replicated 3 times and combinations of pastures (pure ryegrass (R) or ryegrass/ white clover (R/WC) and four levels of nitrogen fertilization as subtreatments. Pastures used were a mixture of perennial ryegrass (cv. Nui) sown at 20 kg.ha^{-1} and 4 kg white clover (El Lucero) or a pure perennial ryegrass sward sown at 25 kg.ha^{-1}. Fertilization with 140 kg.ha^{-1} of superphosphate (20% P) was applied before sowing. Irrigation with 20 mm was done when the soil water deficit reached 50% of the difference between field capacity and wilting point. Soil water content was determined by the gravimetric method. It was planned to obtain 3 cuts in spring and 2 in the other seasons. Four nitrogen levels 0 (N0); 150 (N1); 300 (N2) and 450 (N3) kg N.ha^{-1}.yr as urea (46%) were applied after each cut, split 1/3 in spring and 2/3 in the rest of the year. No cuts were possible in mid-winter because pastures were too short, but fertilization was as planned. Dry matter yields were estimated cutting at 6 cm stubble height 4 m^2 in each plot and a subsample dried at 80½C for dry matter content. From the mixture pasture another subsample was taken for botanical separation. The effects of treatment on total dry matter yield (TDM), and clover percent were subjected to analysis of variance and Duncan's test was used as test of significance. Percentage data were analyzed after observation of normality (Shapiro-Wilks) and residuals with leaf-stem and box graphics. (SAS Int.1988).

RESULTS AND DISCUSSION

From April, 1994 to March, 1995 total rainfall was 820 mm, meanwhile from April, 1995 to April, 1996 only 661 mm were recorded. Accordingly, 250 mm of supplementary irrigation were applied the first year and 530 mm the second one. TDM yield for R and R/WC in 1994-95 and 1995-96 are shown in Fig.1. Second order interaction were not significant in the first year but pasture x irrigation and pasture x N were highly significant. Applying irrigation in R/WC increased yield from 7663 to 11900 kg DM.ha^{-1} while the increment in pure ryegrass pasture was much less, from 6170 to 6785 kg DM.ha^{-1}. In addition, increasing nitrogen level resulted in linear increments in pure ryegrass yields from 3528 to 9036 kg DM.ha^{-1} while the TDM yield of R/WC increased only by 13 %, from 9288 to 10523 Kg DM.ha^{-1}. These interactions can be explained by the positive response to irrigation (Garwood, 1988) and the detrimental effect of increasing levels of nitrogen on clover yield (Chestnutt and Lowe, 1970) (Table 1).

Nitrogen response varied between 10.2 kg DM per Kg of applied N in NIR pastures (N3 vs N0) and 14.2 in the irrigated ones. Irrigated treatment produced an additional 5735 kg.ha^{-1} at N1 in R/WC, or 22.9 kg DM.ha^{-1} per mm supplementary applied water. TDM results in 1995-6 showed a significant second order interaction, indicating that the three significant first order interactions irrigation x pasture, pasture x N and irrigation x N, differed with the level of the other factor. These results, as those of the first year, can be explained by the detrimental effect of nitrogen on clover content and by a positive response of clover to irrigation. Increasing N levels on NIR pastures without irrigation resulted in an increment of only 3834 kg DM.ha^{-1} (N2 vs. N0) or 12.8 kg DM per kg of nitrogen applied, but when irrigation was applied an increment of 7220 kg DM.ha^{-1} (N3 vs. N0) could be harvested. This means a response of 17.6 kg DM per kg of nitrogen applied. The effect of an increment of nitrogen fertilization on ryegrass/clover pasture was of -304 (N3 vs. N0) and 1075 (N3 vs. N0) kg DM.ha^{-1} with and without irrigation respectively. In R/WC pasture at N1 level of fertilization a response of 22 kg DM per mm of supplementary water applied was obtained.

The present study gives some insight into the comparative productivity and persistence of clover and fertilized pure ryegrass pastures in the region. In both years DM production from irrigated and fertilized (N3) pure ryegrass swards was not higher than that from irrigated clover dominant (N0) plots. The high temperature during spring-summer could explain the limited ryegrass yield (Wilson and Ford, 1981). From December to February there were a total of 58 and 68 days with maximum temperatures higher than 25½C, in 1994-95 and 1995-96, respectively. A substantial impact on DM production resulted by irrigation in both types of pastures, but nitrogen fertilization on ryegrass/clover pastures had negligible effects.

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Table 1
Clover percentage in irrigated and non irrigates mixed pastures with four levels of nitrogen fertilization.

	1994-95		1995-96	
	I	NI	I	NI
N_0	57.7	49.0	61.3	25.5
N_1	38.9	25.1	53.8	13.4
N_2	27.2	22.6	35.5	11.7
N_3	15.3	9.9	44.0	11.0
	Sd (irri)= 3.5		Sd (irri)= 15.6	
	Sd (N-P)= 6.0		Sd (N-P)= 6.4	

Figure 1
Herbage yield of irrigated and nonirrigated swards of ryegrass and ryegrass/white clover with four levels of nitrogen.