THE EVOLUTION OF THE NUTRITION INDEX IN RELATION TO WATER REGIME

EVOLUȚIA INDICILOR DE NUTRIȚIE ÎN RELAȚIE CU REGIMUL HIDRIC

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Abstract: *The studies where carried out on two permanent grasslands located in France, in the Central Pyrenees (Ercé) and in the Massif-Central (Gramond). Our results show that there is an inverse relationship between the total biomass and a synthetic indicator of the water regime, namely, the number of decades with a reserve RFU=0 on the horizon 0-5 cm. easy to use. The results also revealed a marked reduction of the nitrogen nutrition index (IN) when the mineral balance becomes negative. This result suggests that the IN is able to account for the depletion of the level of reserves in nitrogen as a result of changing balances accumulated over time. However, the question arises to what extent this development does not depend on water conditions that have prevailed over the last 2 years (2003 and 2004)?*

Rezumat: *Studiile au fost realizate pe două dispozitive de pajişti permanente, situate în Franța în Pirineii Centrali (Ercé) şi respectiv în Masivul Central (Gramond). Rezultatele arată că există o relație inversă între producția totală de biomasă şi un indicator sintetic al regimului hidric adică numărul de decade cu rezerva uşor utilizabilă RFU=0 pe adâncimea de 0–5 cm. Printre altele, rezultatele au pus în evidență o diminuare accentuată al indicilor de nutriție azot (INN) când bilanțul mineral devine negativ. Acest rezultat demonstrează că INN sunt capabili să dea o informație asupra rezevelor de azot din sol în urma evoluției bilanțurilor minerale cumulate în timp. Totuşi, întrebarea care se pune este de a şti în ce măsură această evoluție nu depinde de condițiile hidrice care s-au prevalat pe perioada ultimilor două campanii (2003 şi 2004)?*

Key words: *grassland, nitrogen nutrition index (INN), water deficit*
Cuvinte cheie: *pajişte, indice de nutriție azot (INN), deficit hidric*

INTRODUCTION

There are a few studies, which use the nutrition index to analyse the influence of the water regime on the growth of the forage species such as pure culture (LEMAIRE AND DENOIX, 1987) or grassland communities (STROIA, 2007). Our aim is to verify how the nitrogen nutrition index (IN) evolves in relationship with the water regime during the study, and to determine, which are the effects on the evolution of indices over successive years on the level of depletion of water reserves and of water stress that are observed in particular in 2003 and 2004.

MATERIALS AND METHODS

Since 1999 one grassland experiment has been located in the village of Ercé in the French Pyrenees (0° East, 43° North; elevation 660 asl). The other one, initiated in 1998, has been located in the village of Gramond in the Massif Central, France (2° East, 44° North; elevation 607 asl). The mean annual rainfall is 1200 and 960 mm and the mean annual air temperature lies at 12.7 and 11° C at the Ercé and Gramond sites, respectively. In Ercé, the soil is a Luvisol developed on alluvium and in Gramond a Brunisol developed on mica schist. Both sites were placed by the Orphée team (INRA Toulouse).

The experiments were intended to study the over time effects of N and P fertilisation and frequent defoliation of soil fertility and the changes in the vegetation. It had a 2*2 factorial design with two rates of N and P, resulting in four treatments denoted N0P0, N0P1, N1P0 and N1P1, where N0 = 0 kg N ha^{-1}; P0 = 0 kg ha^{-1}; N1 = 160 kg N ha^{-1}; P1 = 50 kg P ha^{-1}. Nitrogen was spread every year as ammonium nitrate (NH_4NO_3): 100 kg ha^{-1} in the first cycle and 60 kg ha^{-1} in the second cycle for the Gramond site and 60 kg N ha^{-1} in the first cycle and 100 kg N ha^{-1} in the second cycle for the Ercé site. Phosphorus was spread every year as commercial triple super phosphate (45% P_2O_5).

Reserve easily usable (RFU), which corresponds to the amount of water that a plant can extract from a soil without production being affected significantly and without subjecting the plant to water stress, is calculated with a formula by MERMOUD (2005). The calculation of the RFU for both devices was made at the depth of 0–5 cm.

Nitrogen nutrition index, which are able to diagnose the nutritional status of grasslands and to assess the bioavailability of soil nutrients for plants, were calculated using the method developed by LEMAIRE and SALETTE (1981). This method is based on the principle of dilution of nutrients during the growth. At each cycle of prairie regrowth, the nitrogen content of the grass (%N) decreases as the quantity of biomass (DM) produced increases, which determines a dilution of N. At a normal nitrogen supply, the critical nitrogen content is determined as it follows:

$$N\% = 4.8\ (DM)^{-0.32}$$

The nutrition index is the ratio, expressed as a percentage of the content measured on the content given by the critical dilution curve:

$$IN = (N\%_{mesured}/4.8\ (DM)^{-0.32})*100$$ (LEMAIRE *ET AL.*, 1989)

In this paper we use only the N content ($N\%_{nonleg.}$) and the biomass (DM_{nonleg}) measured only for the fraction without leguminous.

RESULTS AND DISCUSSION

Figure 1 shows the relation between the nitrogen nutrition index IN_{nonleg} (treatments N0 and N1, cut I) and the number of decades with water deficit (RFU = 0) on the layer 0–5 cm for both sites; the treatment N0 is the average of the index measured for the N0P0 and N0P1 treatments; the N1 treatment is the average of the index measured for the N1P0 and N1P1 treatments. The arrows represent the chronology of the various measurements. The first cycle is presented as the preferred one, because it allows us to have the widest range of water regimes.

For both sites the number of decades with water deficit counted between March 10 and the date of the first cut vary between 0 and 6 in Ercé and between 1 and 7 in Gramond from a maximum of 7. For both sites we observe a decrease of INN_{nonleg} when the number of decades with water deficit increases, this being the situation both for the N1 treatment as well as for the N0 treatment. The minimum index value reached for the maximum deficit is less than 50.

For the N1 treatment at the Ercé site, i.e. for years with little water deficit (0 or 1st decade), the index measured remained above 80; at the Gramond site they are more variable, for one decade with water deficit, it was between 70 in 2001 and 90 in 2000. In 2003 at both sites, for the period with maximum deficit the index had minimum values (IN_{nonleg} = 64 to Ercé and 74 to Gramond); in 2004, the year for which deficits are low for both sites, the IN values corresponding to the N nutrition levels were up to 80; the system presents a certain reversibility, the return of favourable weather allows plots receiving nitrogen to find again the levels of non-limiting nitrogen nutrition.

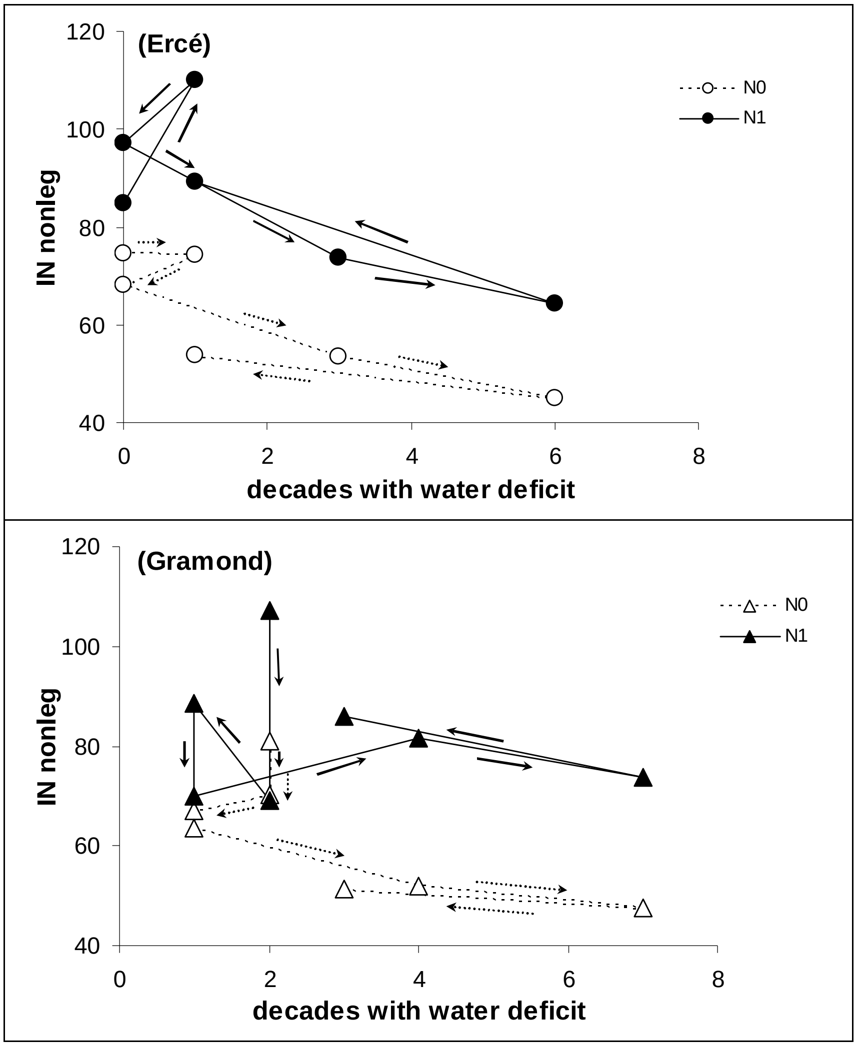

Figure 1. IN_{nonleg} evolution in relation to the number of decades of water deficit during the first cycle of growth for Ercé and Gramond

Regarding the treatment N0, the indices are always below 80, whatever the site or the number of decades with water deficit. The index decreases with the deficit to reach very low values in 2003 (IN=48 for Ercé and 45 for Gramond). When in 2004 the levels of water supply became favourable, a slight increase of the index above 50 (54 to Ercé, 52 to Gramond) is noticed but these values do not reach previous levels, the difference being approximately of 15 index points for Ercé and 10 points for Gramond.

CONCLUSIONS

The smallest reversal of the index N0, compared with what is observed for N1, leads us to consider that the evolution of IN in time is the result of two additive effects: the continuous depletion of the N level in soil in time is in relation to the balance of N on one side, and the aleatory and instant effect of the climate (precipitations) in addition to the previous effect on the other one.

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