CHANGES IN SOIL MICROBIAL BIOMASS-N UNDER RYEGRASS/WHITE CLOVER GRAZED PASTURES BASED ON SYMBIOTIC N FIXATION AND FERTILIZER N

E. Ruz[1] , H. Troncoso[2], L. Longeri [2], E. Jahn[1] and I. Vidal[2]
[1] Instituto de Investigaciones Agropecuarias. CRI Quilamapu, Casilla 426 Chillán, Chile
[2] Dpto. Suelos, Fac. Agronomía, Universidad de Concepción, Casilla 537 Chillán, Chile

ABSTRACT

Soil microbial biomass nitrogen (B_N) was periodically measured in two pastures a) grazed pastures without N fertilizer and b) grazed pastures receiving 200 kg of fertilizer N per year, respectively, during July 1993 to July 1994. Soil type was a volcanic soil Medial, thermic, Typic Distrandept. B_N was highly variable and the two type of pastures showed a similar pattern of distribution, with statistical differences in only three sampling. Values of B_N were lower than that found in other studies of temperate regions, but also the B_N was significantly higher than the available pool of mineral N, indicating the importance of the B_N as a component of N cycle, and as a mediator in the transformation of N between the mineral and organic pools.

INTRODUCTION

In grazed grassland soils, nitrogen (N) follows several cyclic transformations and movements from one pool to another (Gandar and Ball, 1982, Ruz-Jerez, 1991). The amount of N cycling in grazed pastures based on symbiotic N fixation can be of the order of 365 kg N/ha annually (Parson et al 1991), and 490 kg N/ha in N fertilized pastures (Ruz-Jerez, 1991). The size and activity of B_N play an important role as a mediator of the transformations, and as the reservoir of mobile N, especially in grassland soils with large amount of organic C where mineral N may be rapidly incorporated into biomass (Bristow and Jarvis, 1991). The objective of this study was to examine the changes in biomass N during one complete year in grassland soil with pastures based on symbiotic N fixation (as the only source of N input) and pastures fertilized with N.

MATERIAL AND METHODS

The experiment was carried out from July 1993 to July 1994 on permanent, irrigated white clover/ryegrass pastures established in 1988 in a volcanic soil (Medial, thermic, Typic Distrandept) at the Santa Rosa Experiment Station (INIA, Quilamapu), Chillán (36° 26´S Latitude), Chile. The average annual rainfall of the experimental area is 1264 mm (13 year period) and average annual evaporation (class A pan) is 1023 mm. The pasture was a mixture of perennial ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.) with two treatments a) without fertilizer N, based in symbiotic N fixation, and b) with fertilizer N, receiving 200 kg N/ha per year as urea in four split dressings. The pastures were replicated four times and arranged in a randomized block. The area of each pasture plot was 0.10 ha and the plot were periodically grazed with dry cows. The frequency of defoliations varied with seasonal changes in pasture growth rates. Herbage yield was measured by standard cutting techniques before each grazing. Post grazing herbage residue was also measured. B_N was determined periodically 10 days after each grazing in soil samples at 10 cm depth by the fumigation/incubation procedure proposed by Shen *et al*., (1984). Biomass N was calculated by the relationship $B_N = F'N/0.68$ where F´N is (N in fumigated soil incubated by 10 days)-(N in unfumigated soil incubated by 10 days). Soil mineral N (NH_4-N + NO_3-N) was also determined at sampling time in an extraction with 2 M KCl,

RESULTS AND DISCUSSION

Seasonal variation of B_N in grazed pastures is shown in Fig. 1. There was a similar pattern of biomass N distributions throughout the study period, statistical differences were only found in sampling 5, 6 and 7, (corresponding to spring time), where B_N was higher in pastures fertilized with N. Also both pastures during the year of the study showed large cyclic variations of B_N with a range of 25 - 64 mg N/ kg dry soil. This pattern of variation could be due to a complex interaction of climatic factors and the effect of grazing (defoliation, feces return, treading) as well as the plant uptake during regrowth periods. The temporal declining of B_N has been reported to be influenced by treading of animals by Scholefield and Hall (1985). The amount of B_N measured in this study is comparably less than that recorded for other grassland soils of temperate regions, where B_N fluctuate around 90 - 132 mg N/kg soil (Bristow and Jarvis, 1991). Herbage production was high in both types of pastures for the average of the region, and significantly increased from 12.63 ton/ha/year to 16.48 ton /ha/yr in pastures fertilizer with N. Plant N uptake from this large amount of herbage production can compete for soil N and limits the microbial uptake. Moreover, soil organic carbon of volcanic soil of the region is very stable, therefore a limitation of carbon as energy source for the biomass growth, could be another factor that influences the amount and pattern of biomass N.

A comparison of B_N and soil mineral N is shown in Fig. 2. In pastures without N fertilizer (a), it is apparent that in certain periods of the year, B_N and mineral N are inversely related especially at the beginning of summer, when mineral N increases and B_N decline, reflecting a possible increment of mineralisation of soil biomass, by alternated changes in soil moisture due to irrigation. In pasture receiving fertilizer N (b), tendency of both curves are similar especially at the beginning of the study, probably due to the effect of N fertilizer application which encourage the growth of biomass as well as the residual soil mineral N. In spring, because of vigorous plant growth, the uptake of N increases, depleting both soil N and biomass N pools. The results of this study shows that the amount of B_N is an important component of the N cycle, not only because of its amount (which is higher than the available mineral pool in both pastures), but also, because of its dynamics during the year. It is also apparent that there is a need to understand the complex relationships that occurs among these large and mobile pools of N in grassland soils.

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Figure 1
Seasonal variation of soil microbial biomass N in grazed pastures with and without fertilizer N

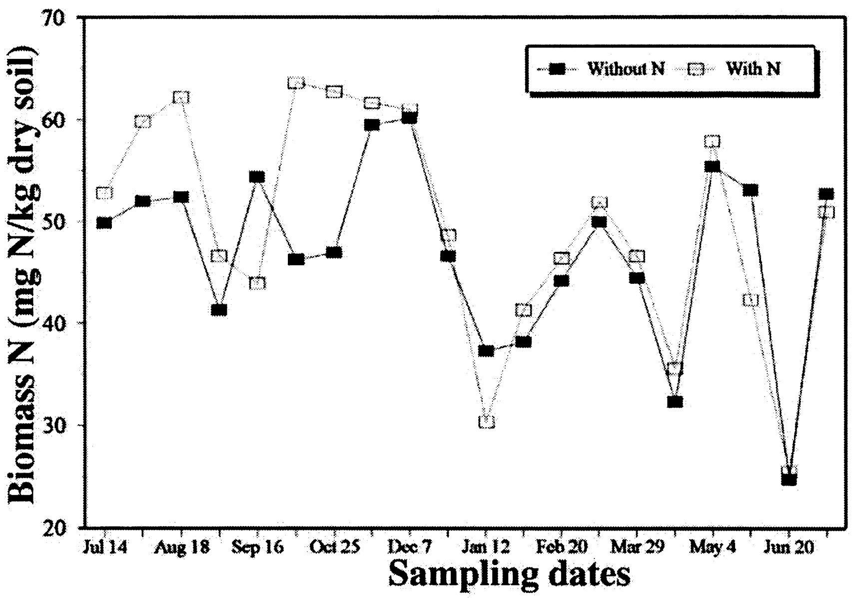

Figure 2
Comparison of soil biomass N and soil mineral N in

a) pastures without fertilizer N and
b) pastures receiving 200 kg N/ha as urea.