Ecological Questions 21/2015: 65 – 66 http://dx.doi.org/10.12775/EQ.2015.010

Short-term effects of nitrogen deposition on soil microbial biomass in *Calluna* heathlands NW Spain: critical loads

Javier Calvo-Fernández, Elena Marcos, Leonor Calvo

Area of Ecology, University of León, 24071 León, Spain,
e-mail: jcalf@unileon.es

Abstract. We evaluate the short-term effects of different N deposition loads on nutrient dynamic of soil microbial biomass in Cantabrian heathlands. A surplus of 10 kg N ha^{-1} yr^{-1} above N background deposition was required to increase soil microbial biomass N content in old *Calluna* heathlands, while a surplus of 20 kg N ha^{-1} yr^{-1} was required in young ones. The increase of atmospheric N deposition showed no change in soil microbial biomass C content. This caused a decrease in C:N ratio with the highest N deposition loads, being linked to a bacterial biomass dominance against fungal dominance.

Key words: *Calluna vulgaris*, Cantabrian heathlands, N critical loads, soil microbial biomass, C:N ratio.

1. Introduction

Empirical critical load for N in dry heaths is established between 10–20 kg N ha^{-1} yr^{-1}(Bobbink et al., 2010). Cantabrian heathlands are currently receiving a great N background deposition higher than 15 kg N ha^{-1} yr^{-1}(García-Gómez et al., 2014), exceeding its empirical critical load. The increase of N inputs may affect the structure and dynamic of soil microbial communities and may have consequences for the functioning of heathlands. Therefore, the aim was to evaluate the short-term effects of different N deposition loads on nutrient content of soil microbial biomass in heathlands of different ages, in order to establish empirical critical loads for soil microbial biomass of *Calluna* heathlands.

2. Study site

Three *Calluna* heathland sites were selected in the Cantabrian Mountains: Riopinos I (1.653 m.a.s.l.), Riopinos II (1.567 m.a.s.l.) and San Isidro (1.636 m.a.s.l.). In the first week of July 2013 nine replicate plots (2x2 m) per treatment were established (three per study site) for each age of *Calluna*: (i) young (8 years) and (ii) mature (> 40 years). In order to evaluate the effects of different N deposition loads, the plots received: 0 (natural N deposition), 10 (low load), 20 (medium load) and 50 (high load) kg N ha^{-1} yr^{-1} as granules of NH_4NO_3 spread over 6 doses during the growing season. In each plot, one (0–10 cm) soil sample was taken in October 2013.

3. Materials and Methods

Soil microbial biomass C and N were determined by Fumigation-Extraction method (Brookes et al., 1985). Estimation of soil microbial biomass N was performed by titration of total extracted N according to Brookes et al. (1985). Estimation of soil microbial biomass C was performed by wet digestion according to Vance et al. (1987). Statistical analyses were performed using SPSS 20.0 for Windows. Treatment effects were tested by one-way Anova. Differences between mean values of C, N and C:N ratio of soil microbial biomass were tested using the Tukey multiple comparison test.

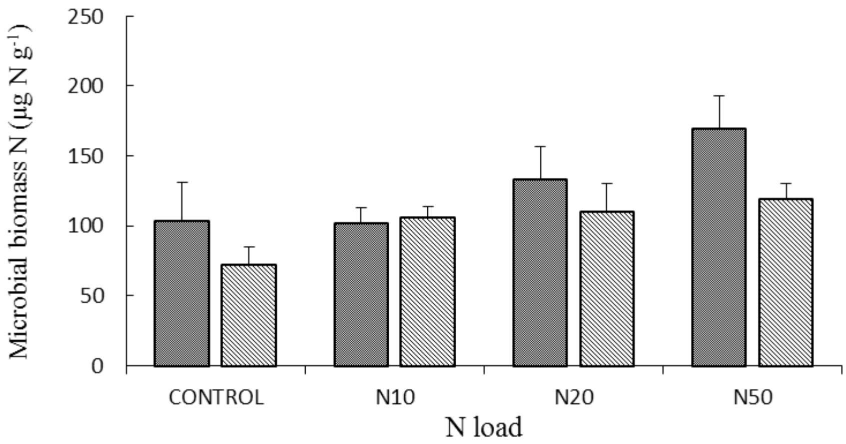

Figure 1. Mean values and standard error of soil microbial biomass N (µg N g^{-1} dry soil) for each N load (Control, 10, 20 and 50 kg N ha^{-1} yr^{-1}). Filled bars represent young *Calluna* and hatched bars represent mature *Calluna*

4. Results

An increase of N content of soil microbial biomass in the short-term was observed with the highest N load (Fig. 1). This increase was higher in young *Calluna*, although without any significant differences with the mature ones (P=0.055). There were no significant changes in C content of soil microbial biomass in relation to the nitrogen loads or *Calluna* age (P=0.813) (data not shown).

The C:N ratio in the soil microbial biomass decreased with the highest N deposition load (Table 1). Mature *Calluna* plots showed higher ratio C:N ratio, although no significant differences were found depending on the age (P=0.118).

Table 1. Mean C:N ratio [n=9] and standard error of soil microbial biomass (µg $µg^{-1}$) at the end of the growing season (October 2013)

N load (kg N ha^{-1} yr^{-1})	Young *Calluna*		Mature *Calluna*	
0	9.75	(1.01)	14.74	(3.56)
10	6.75	(1.33)	8.34	(1.86)
20	8.05	(2.81)	9.24	(3.00)
50	5.79	(0.73)	7.97	(1.38)

5. Discussion

Soil microbial biomass showed changes in its N content with low N load (10 kg N ha^{-1} yr^{-1}) in old *Calluna*, while these changes were observed with medium N load (20 kg N ha^{-1} yr^{-1}) for young *Calluna*. An increase in soil microbial biomass N occurred without a concomitant increase in soil microbial biomass C, suggesting that higher microbial N content was a result of luxury consumption. High values of soil microbial biomass C:N ratio found in control plots were an indication of fungal biomass dominance over total soil microbial biomass at the end of the growing season (Nielsen et al., 2009). For this reason, low N load (10 kg N ha^{-1} yr^{-1}) may have been enough to change fungal biomass dominance to bacterial biomass dominance due to its lower C:N ratio compared to control plots.

References

Bobbink R., Hicks K. & Galloway J., 2010, Global assessment of nitrogen deposition effects on terrestrial plant diversity: a synthesis, Ecological Applications, 20(1): 30–59.

Brookes P.C., Landman A., Pruden G. & Jenkinson D.S., 1985, Chloroform fumigation and the release of soil nitrogen: a rapid direct extraction method to measure microbial biomass nitrogen in soil, Soil Biology & Biochemistry, 17: 837–842.

García-Gómez H., Garrido J.L., Vivanco M.G., 2014, Nitrogen deposition in Spain: Modeled patterns and threatened habitats within the Natura 2000 network, Sci Total Env., 485–486: 450–460.

Nielsen P.L., Andresen L.C., Michelsen A., Schmidt I.K. & Kongstad J., 2009, Seasonal variations and effects of nutrient applications on N and P and microbial biomass under two temperate heathland plants, Applied Soil Ecology, 42: 279–287.

Vance E.D., Brookes P.C., Jenkinson D.S., 1987, An extraction method for measuring soil microbial biomass C, Soil Biology & Biochemistry, 19: 703–707.