Carbon accumulation in fine roots of soils of a Mediterranean oak forest growing under different levels of thinning and drought conditions after fire disturbance.

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ABSTRACT

International reports like IPCC predict an increase in drought of at least 20% in the Mediterranean basin. In this scenario, which will be the contribution to the carbon balance of the soil plus root system as CO_2 sequestration agents?
In a Mediterranean oak forest under regeneration after a fire (1998) located at Castelltallat range, Barcelona (Spain), two treatments were applied in 2003: forest management with two levels (thinning and no thinning) and rainfall inputs with two levels (natural and artificially decreased). In 2007, a dry year, no effect of managing was seen either in root density or total root carbon. In 2008, a rainy year, there was an increment in root density; however, this increment only resulted in higher root carbon concentration in the soil in the artificially decreased rainfall treatment, managing having no effect in this parameter.

INTRODUCTION

The rise of atmospheric CO_2 concentrations has increased the interest in the last years of scientific and political communities in the global carbon cycle (Janssens et al., 2002), rising the need for a better understanding and quantification of the carbon cycle of forest ecosystems and a discussion on the potential of woody ecosystems to store carbon and its contribution to mitigation strategies to offset carbon emissions. The aboveground components of forest ecosystems have been intensively studied but comparatively little is known about the belowground compartment (Vogt et al. 1996). In this scenario, which will be the contribution to the carbon balance of the soil plus root system as CO_2 sequestration agents?

MATERIAL AND METHODS

The experiment was conducted in a forested Mediterranean area in Catalonia, NE Spain (41º 44'N, 1º39'E) from June of 2007 to September of 2008, with a factorial experimental design applied over 12 randomly distributed plots (15m x 20m): two levels of water stress (natural drought and increased drought) and two levels of management (thinning and no thinning) were combined in four treatments, with 3 replicates (plots) each. Core samples were collected on 20 June and 20 July 2007 and on 5 June and 9 September 2008. Core depth was very heterogeneous (25-90cm) due to the rocky soil. The soil columns were separated into 15 cm fractions. Root dry weight, root density in the core volume, and carbon and nitrogen concentrations were estimated in each fraction. Nutrients and minerals from fine roots were analyzed in the Laboratory Agroambiental Applus (Lleida, Spain). For statistical analysis, (SAS Mixed Models procedure, v. 9.1, SAS Institute Inc., Cary, NC, USA), root density data were log-transformed.

RESULTS

In June 2007 there was no difference in root density due to treatments, but the lowest root density was found at 30 cm (Figure 1). Root density was not affected by treatments or depth in July 2007. In June 2008 results were similar to June 2007, but log-transformed data pointed to a significant decrease with depth. Finally, in September 2008, no differences were found in root density, as in

July 2007. July 2007 showed the lowest root density, (difference statistically significant with June 2007 and June 2008). A tendency of a higher root density in 2008 was found (Figure 1).

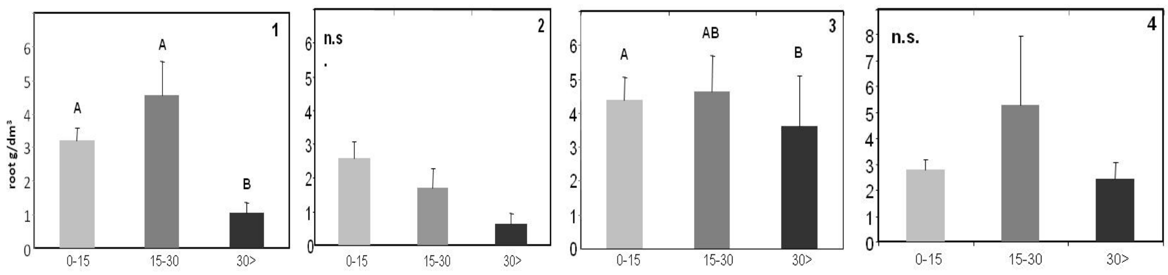

Figure 1: Root density (g/dm^3) in 0-15 cm; 15-30 cm and >30 cm at four times: 1= June 2007; 2= July 2007; 3= June 2008 and 4= September 2008

C concentration in roots was 46.8% ±0.82 in June 2007 (no differences between treatments). However, C:N ratio (Figure 2) increased with thinning and depth (15-30 cm, >30 cm). In the next sampling date, July 2007, the only statistically significant differences were in C:N which increased with depth. C concentration in July 2007 was 42.70%±1.28. In June 2008, after intense rains, thinning treatment affected C concentrations and C:N ratio: C concentration increased in no thinning treatment while C:N ratio was higher in thinning treatment. In September 2008, we did not found a general effect of treatment or depth in root nutrients: C concentration was higher in the topsoil of increased drought treatment only, suggesting more lignified roots. The C:N ratio was affected by thinning treatment resulting in a higher proportion at 15-30 cm. C:N ratio was higher in thinning treatment after growth period in 2007 and during 2008 suggesting removal of N from roots to supply the demand in the photosynthetic period (Mooney 1983). In 2007, no effect of managing was seen either in root dry density or root carbon concentration. In the rainy year 2008, there was an increment in root density; however, this increment only resulted in higher root carbon concentration in the soil in the artificially decreased rainfall treatment, managing having no effect in this parameter.

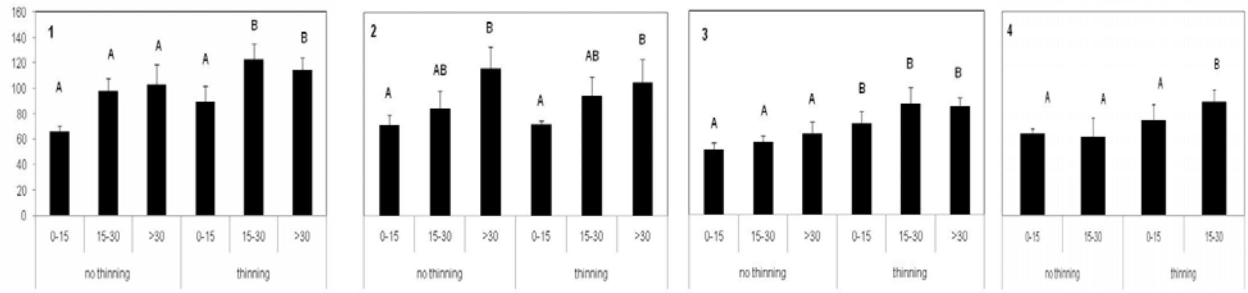

Figure 2: C:N ratio at four times: 1= June 2007; 2= July 2007; 3= June 2008 and 4= September 2008

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