Carbon and Nutrient Inputs by Litterfall into Three Chestnut High Forest Stands in North Portugal

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INTRODUCTION

Annual return of bioelements to the soil through litterfall is one of the most important renewal factors of forest ecosystem sustainability. Organic residue, accumulated in the soil surface, is returned to the ecosystem continuously, which represents a provisional accumulation of nutrients that are gradually released into the soil. Although sweet chestnut (Castanea sativa Mill.) grows on a wide variety of soils, optimal conditions for this species are deep, moderately fertile and acid soils (pH 4.0 – 4.5) (Kerr e Evans, 1993). In Portugal, chestnut stands grow in soil types as regosols, cambisols and leptosols. In poor nutrient soils the ecosystem productivity is highly influenced by the efficiency of nutrient cycling (Davinqueud, 1984). In this context, litter is an important reservoir of nutrients to the site productivity and sustainability. In agreement with Kavadias et al. (2001), growth and productivity of forest ecosystems depend mainly on the amount, nature and decomposition rate of litter.

OBJECTIVES

In this particular study we quantify litterfall, litter accumulation on soil and also nutrients and carbon sequestration both in two fractions of litter and in the first ten centimeters of soil in three old high forest chestnut stands located in North Portugal. The objective of this study was to quantify and compare the litter biomass produced in the three sites and to evaluate its richness in nutrients and carbon contents that were progressively restored to the soil.

Site conditions

This study is based on litter ground information collected in the three old chestnut high forest stands located in North Portugal: Bornes (41º 29' 42'' N, 7º 44' 08'' W and 900 m above the sea level), Marão (41º 14' 48'' N, 7º 46' 07'' W and 900 m above the sea level) and Padrela (41º 31' 47'' N, 7º 31' 22'' W and 800 m above the sea level) with 45, 65 and 90 years old, respectively. The total annual rainfall in Bornes, 2055 mm in Marão and 1112 mm in Padrela. The mean annual temperature is 11.9 ºC, 13.4 ºC and 12.5 ºC, following the same order and maximum and minimum temperatures are 37.2 and -4.1 ºC in Bornes, 39.7 and 4.8 ºC in Marão and 37.5 and -7.4 ºC in Padrela. Tree densities are 1227 trees ha-1 in Bornes, 405 trees ha-1 in Marão and 250 trees ha-1 in Padrela, respectively. As far as nutrient composition in these stands are concerned, Bornes is fertile in Marão and poor in Padrela. An ANOVA was performed to compare the total litterfall among the three study sites. A Tukey test was used to compare the differences at p<0.05.

RESULTS AND DISCUSSION

Total litterfall was 12.44 Mg ha-1 year-1 in Padrela, 7.73 Mg ha-1 year-1 in Marão and 8.28 Mg ha-1 year-1 in Bornes (Fig.1). There were significant differences (p<0.05) among localities. Padrela stand produced significantly more biomass than the other sites and, consequently, nutrients return to the forest floor was higher than in the other sites. The maximum values of carbon sequestration was observed also in Padrela.

The higher Ca-concentration in total litterfall in Bornes can be explained by the observed high concentrations of exchangeable Ca in soil. Chatelus (1987) and Leonardi et al. (1996) made similar observations in chestnut copice. The Mg-concentration in total litterfall in Padrela was lower compared to Ca and K and the highest Mg-concentration was found in leaves. According to Manucher (1995), physiologically active parts of plants tend to have higher Mg-concentrations which can explain the highest concentration in leaves.

Concentrations of P, K and B cannot be considered as diagnostic values for chestnut litterfall (Chatelus, 1987; Zimmermann et al., 2002; Table 2). The concentration of N presents significant differences among the three chestnut stands. The highest N-concentration is found in Padrela (5.70 g kg-1) which is 4.6 times higher than Marão (1.24 g kg-1). The highest Ca-concentration in total litterfall in Bornes can be explained by the observed high concentrations of exchangeable Ca in soil. Chatelus (1987) and Leonardi et al. (1996) made similar observations in chestnut copice. The Mg-concentration in total litterfall in Padrela was lower compared to Ca and K and the highest Mg-concentration was found in leaves. According to Manucher (1995), physiologically active parts of plants tend to have higher Mg-concentrations which can explain the highest concentration in leaves.

In Padrela, litter fraction is composed by orchards, ceps and young stumps, while the high chestnut crown of old stands is reduced. In the study area, where the chestnut has got its largest distribution, the stands occupy an area just about 6 hectares.