

Carbon storage of Mediterranean grasslands

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Abstract

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Secondary grasslands are one of the most common vegetation types worldwide. In Europe, and in the Mediterranean basin, human activities have transformed many woodlands into secondary grasslands. Despite their recognized role in the global carbon cycle, very few data are available for estimating the biomass of Mediterranean grasslands. We developed linear regression models in order to predict the biomass of two native Mediterranean grasses (*Ampelodesmos mauritanicus* and *Hyparrhenia hirta*) and an invasive alien grass (*Pennisetum setaceum*). *Ampelodesmos mauritanicus* is very common throughout the Mediterranean basin, mostly on north-facing slopes, *H. hirta* characterizes thermo-xeric grasslands, while *P. setaceum* is an alien species that is rapidly spreading along coastal areas. The measured morphometric attributes of individual plants as potential predictors were considered. The validation results corroborate the ability of the established models to predict above ground and total biomass of *A. mauritanicus* and *P. setaceum*. We also evaluated the total biomass per hectare for each species. The highest biomass per hectare was found for *A. mauritanicus*, whereas biomass was higher for *H. hirta* than for *P. setaceum*. The replacement of *H. hirta* by *P. setaceum* may reduce the total carbon storage in the ecosystem; however, *P. setaceum* allocates more resources to the roots, thus increasing the more stable and durable pool of carbon in grasslands.

Keywords: *Ampelodesmos mauritanicus*, carbon storage, *Hyparrhenia hirta*, Mediterranean grasslands, *Pennisetum setaceum*.

Resumen

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Los pastizales secundarios son uno de los tipos de vegetación más comunes en todo el mundo. En Europa y en la cuenca mediterránea, las actividades humanas han transformado muchos bosques en pastizales secundarios. A pesar de su reconocido papel en el ciclo global del carbono, hay muy pocos datos disponibles para la estimación de la biomasa de los pastizales mediterráneos. Hemos desarrollado modelos de regresión lineal con el fin de predecir la biomasa de dos gramíneas nativas del Mediterráneo (*Ampelodesmos mauritanicus* e *Hyparrhenia hirta*) y otra exótica e invasora (*Pennisetum setaceum*). *Ampelodesmos mauritanicus* es muy común en toda la cuenca mediterránea, sobre todo en pendientes orientadas al norte, *Hyparrhenia hirta* es característica de pastizales termo-xerófilos, mientras que *Pennisetum setaceum* es una especie exótica que se está extendiendo rápidamente a lo largo de las zonas costeras. Se consideraron los caracteres morfológicos de plantas individuales como factores de predicción potenciales. Los resultados han corroborado la capacidad de los modelos establecidos para predecir la biomasa aérea total de *A. mauritanicus* y *P. setaceum*. También se ha medido y evaluado la biomasa total por hectárea de cada especie: la mayor fue la que correspondía a *A. mauritanicus*, mientras que la *H. hirta* fue mayor que la de *P. setaceum*. Así pues, la sustitución de *H. hirta* por *P. setaceum* puede reducir el carbono almacenado en el ecosistema, sin embargo, *P. setaceum* asigna más recursos a las raíces, lo que implica un almacenaje de carbono más estable y duradero.

Palabras clave: almacenamiento de carbono, *Ampelodesmos mauritanicus*, *Hyparrhenia hirta*, pastizales mediterráneos, *Pennisetum setaceum*.

INTRODUCTION

Grasslands are among the most widespread plant communities, being present on all continents except Antarctica, and covering about 24×10^6 km² or nearly one-fifth of the planetary land area (Parton & al., 1995; Scurlock & Hall, 1998). According to the UNESCO (1973), grasslands are those areas where the coverage of woody species does not exceed 10% of their surface. In some regions of the world, mainly in Asia and North America, grasslands are often mature communities where the absence or near absence of woody species is related to local limiting factors. Elsewhere, and especially in Europe, where humans have greatly modified the landscape and have used lands that originally had woody cover for raising cattle and cultivating crops, most grasslands are considered secondary communities (Pärtel & al., 2005; Zarovali & al., 2007).

In the enlarged European Union (EU-25, with 25 member states), grasslands cover an estimated area of 0.57×10^6 km² (15% of the whole territory, cf. Ciais & al., 2010). The FAO (2006), however, reported a reduction of almost 13% of the European grassland covering between 1990

and 2003. This trend is due to the adoption of more intensive cultivation techniques with relatively high environmental impact (Bonanomi & al., 2006) or, conversely, to the social and economic marginalization of the least accessible areas and the abandonment of traditional agro-pastoral activities, resulting in an encroachment by woody species. Woodlands, in contrast, have increased their covering in all European countries between 1960 and 2010 (Young & al., 2005; FRA, 2010) because of their increased protection resulting from conservation efforts and, as noted earlier, because of the spontaneous colonization (secondary succession) of abandoned pastures and grasslands. Similar trends have been recorded between 1990 and 2008 in Italy, where grassland covering decreased by 14%, while woodlands increased by 5.6% (Corona & al., 2012).

Grasslands contain a wide range of annual and perennial herbaceous species, and are among the most species-rich communities of semi-natural ecosystems. Because many plants and animals are exclusively linked to such habitats, grasslands have a prominent biogeographical and conservation value (Callis de Vries & al., 2002; Grill & al., 2005;

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