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Moderate soil compaction: Implications on growth and architecture in seedlings of 17 woody plant species

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ABSTRACT

Generally, soil compaction is a stress factor affecting negatively the plant growth, but its effects vary between species and with the soil compaction range. The objective of this study is to know the different growth responses of 17 woody species subjected to moderate soil compaction, because most of the studies about this subject compare the effects in treatments with a wide and discrete compaction range. We explore the effects of moderate soil compaction on a continuous scale (0.1–1.0 MPa) on seedling growth. Seedlings of 17 woody species (deciduous and evergreens) mainly from Mediterranean ecosystems were grown in near optimal conditions (light, temperature and water) in a greenhouse with a sandy substrate. In general, there was a great variability of the responses depending on the species and the studied variable. About 53% of the species showed a higher total biomass with a moderate increase in soil compaction possibly being due to a greater root–soil contact. In the same way, 41% of species increase the relative growth rate and 35% the total area. Nevertheless, in spite of these positive effects on growth, for some species (23%) there was a decrease in the root proportion with soil resistance, as result of soil strength. These effects of moderate soil compaction could sum up in two general responses of woody plants: growth increment and architecture distortion. This might be relevant as a lower root investment may be a disadvantage under drought conditions. Finally, a simple conceptual model is proposed to understand the general effects of soil compaction on growth and biomass allocation.

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1. Introduction

Soil compaction is a well established corpus of investigation generating over 3000 references in the last quarter century (ISI Web of Knowledge, February 2008). Many aspects of the effects of soil compaction have been studied. Kirby (2007) in his note discussed what we know and what not about soil compaction, concentrating mainly on the effects on crops and farms and on the ways to ameliorate these effects.

Although most of the problem of soil compaction has a human origin, soils of natural areas also show a different degree of natural compaction (Pérez-Ramos, 2007; Quero et al., 2008; Gómez-Aparicio et al., 2008). A high soil compaction may have a strong effect on the first phase of establishment of wild plants (Pérez-Ramos, 2007; Gómez-Aparicio et al., 2008). Not many studies about soil compaction deals with these aspects and not much information is known about the response of wild woody species to soil compaction. In fact, Kirby (2007) appealed to re-direct compaction research on broader issues as for example natural resource management and biodiversity.

In general, at a whole plant level, it is assumed that soil compaction affects negatively root investment, due to the resistance of the substrate to be penetrated (Day and Bassuk, 1994; Kozłowski, 1999; Bassett et al., 2005). Verdú and García-Fayos (1996) found that root penetration of *Pistacia lentiscus* was negatively associated with soil compaction. Similarly, Bejarano et al. (2005) found in *Quercus pyrenaica* a decrease in root length with soil compaction. This may determine that in situations of water deficit, plants with a lower root mass proportion or shorter roots could suffer a higher water deficit which might seriously limit seedling survival. In fact, Lloret et al. (1999) stressed the importance of a greater root mass proportion (RMR, root mass ratio) in Mediterranean environments because species with a greater RMR displayed a greater survival after the period of summer drought, due to the ability to explore a greater soil surface and/or deeper soils.

Moreover of the effects on root investment, plant growth is in general negatively affected by soil compaction. Bassett et al. (2005) found in *Cordyline australis* that stem and root growth was negatively affected by soil compaction. As stated before, most of the studies on the effect of soil compaction on plants are done mainly on herbaceous species, and a minor proportion on wild woody species. Therefore, in the present study, we analysed the effects of soil compaction on the absolute growth and relative growth rate of 17 woody seedling species. Up to now, no work

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