Geophysical Research Abstracts,
Vol. 11, EGU2009-13871-1, 2009
EGU General Assembly 2009

Root profile in Multi-layered Dehesas: an approach to plant-to-plant Interaction

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Assessing plant-to-plant relationship is a key issue in agroforestry systems. Due to the sessile feature of plants most of these interactions take place within a restricted space, so characterizing the zone where the plant alters its environment is important to find overlapping areas where the facilitation or competition could occur. Main part of plan-to-plant interactions in the dehesa are located at belowground level, thus the main limited resources in Mediterranean ecosystems are soil nutrient and water. Hence a better knowledge of rooting plant profile can be useful to understand the functioning of the dehesa.

The Iberian dehesa has always been considered as a silvopastoral system where, at least, two strata of vegetation coexist: native grasses and trees. However the dehesa is also a diverse system where cropland and encroached territories have been systematically combined, more or less periodically, with native pasture in order to obtain agricultural, pastoral and forestry outputs. These multipurpose mosaic-type systems generate several scenarios where the plant influence zone may be overlapped and the interaction, competition or facilitation, between plants can play an important role in the ecosystem functioning in terms of productivity and stability.

In the present study our aim was to characterize the rooting profile of multi-layered dehesas in order to understand the competitive, and/or facilitative, relationships within the different plant strata. The root profile of *Quercus ilex* subsp. *ballota*, *Cistus ladanifer, Retama spaherocarpa* and natural grasses was studied. So 48 trenches, up to 2 meters deep, were excavated in 4 different environments: (i) grass; (ii) tree-grass; (iii) tree-shrub and (iv) tree-shrub-grass (12 trenches in each environment). The study was carried out in 4 dehesas, 2 encroached with *C. ladanifer* and 2 with *R. spaherocarpa*.

In every trench soil samples were taken each 20 cm. Subsequently, all samples were sieved using different

mesh size filters in order to avoid fine root loosing. Different plant roots were separated visually. Q. ilex roots were identified by their black cork, pasture roots were white, *C. ladanifer* roots were dark red and *R. spaherocarpa* roots were yellow clear. Besides, all them exhibited a different texture. Weight, length, surface and average diameter were measured in each root sample using the WinRHIZOpro program.

The results showed a clear rooting pattern, high root density in the first soil layers decreasing in depth, in all the plant strata studied. The coexistence of, at least, two plant stratas modified most of the rooting profiles. In this way, natural grasses growing alone kept 90% of root density in the first 30 cm. In *R. sphaerocarpa* dehesas pasture reached up to 170 cm although the root density decreased much faster than in *C. ladanifer* dehesas where pasture had a higher density in the overall profile, but reaching a much lower depth. The introduction of shrubs lowered highly the pasture root density. This effect was higher growing with *C. ladanifer* than with *R. sphaerocarpa*, which slightly modified the pasture rooting profile. The effect of trees in the pasture root system was less clear.

Trees growing alone stored 70 % of their root density in the first 30 cm. The tree root system reached the deepest soil layer explored in all the profiles. The introduction of shrub reduced highly the tree root density in the first soil layer. This effect was higher in presence of *C. ladanifer* whose influence reduced 40 % of tree root density in the first soil layer; nevertheless tree root density increased in deep layers when growing with *C. ladanifer* while it decreased throughout the profile when growing with *R. sphaerocarpa*.

R. sphaerocarpa root system stored less root density in the first soil layer than *C. ladanifer*, reaching up to 190 cm depth. The influence of the tree increased a 20% the *R. sphaerocarpa* root density in the first soil layers; however the rest of the profile was highly overlapped. The *C. ladanifer* root density decreased much faster growing alone than growing with tree although the overall profile of *C. ladanifer* did not differ significantly under the influence of the tree.

We can conclude that root traits of different plants in multi-layered Dehesa systems are modified in interacting plant-to-plant scenarios. The introduction of shrubs as a new competitive element for soil nutrient and water can be understood as a new hazard for tree functioning. Nevertheless the different exploration of soil layers due to a deeper root profile of trees could avoid the impoverishment in their nutritional and water state. Although further studies will be needed.