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Competition with winter crops induces deeper rooting of walnut trees in a Mediterranean alley cropping agroforestry system

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Abstract :
Background and aims Characterising the spatial distribution of tree fine roots (diameter≤2 mm) is fundamental for a better understanding of belowground functioning when tree are grown with associated crops in agroforestry systems. Our aim was to compare fine root distributions and orientations in trees grown in an alley cropping agroforestry stand with those in a tree monoculture. Methods Fieldwork was conducted in two adjacent 17 year old hybrid walnut (Juglans regia×nigra L.) stands in southern France: the agroforestry stand was intercropped with durum wheat (Triticum turgidum L. subsp. durum) whereas the tree monoculture had a natural understorey. Root intercepts were mapped to a depth of 150 cm on trench walls in both stands, and to a depth of 400 cm in the agroforestry stand in order to characterise tree root distribution below the crops maximum rooting depth. Soil cubes were then extracted to assess three dimensional root orientation and to establish a predictive model of root length densities (RLD) derived from root intersection densities (RID). Results In the tree monoculture, root mapping demonstrated a very high tree RID in the top 50 cm and a slight decrease in RID with increasing soil depth. However, in the agroforestry stand, RID was significantly lower at 50 cm, tree roots colonized deeper soil layers and were more vertically oriented. In the agroforestry stand, RID and RLD were greater within the tree row than in the inter-row.

Conclusions Fine roots of intercropped walnut trees grew significantly deeper, indicating a strong plasticity in root distribution. This plasticity reduced direct root competition from the crop, enabling trees to access deeper water tables not available to crop roots.

Keywords:
Deep roots . Intercropping . Fine roots . Juglans sp . Root anisotropy. Root intersection density. Root length density. Root mapping . Specific root length

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