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Assessment of Olive Tree-Barley Interactions in Mediterranean Agroforestry: Barley Grain and Straw Along a Rainfall Gradient in Morocco

Fida Temani[1], Karim Barkaoui[1], Ahmed Bouaziz[2], Jacques Wery[3]
[1]CIRAD, France, [2]Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco, [3]Montpellier SupAgro, France

Abstract: Rainfed cropping systems are critically affected by climate change in the South Mediterranean, especially by increasing rainfall scarcity and irregularity. Agroforestry which consists of the combination of trees and understory crops, can be a key agroecological adaptive innovation that may both mitigate the negative effects of climate change and promote more productive and efficient cropping systems. Inspired by ecological theory, the stress gradient hypothesis (SGH) suggests that positive interactions become more important than negative interactions between trees and crops with increasing environmental stress (e.g. drought intensity). To test the SGH in the context of Mediterranean agroforestry, a field survey was conducted along a rainfall gradient in Northern Morocco to quantify interactions between olive (*Olea europaea*) and barley (*Hordeum vulgare*). Three main sites with contrasting mean annual rainfall (534 mm, 560 mm and 655 mm) were selected. The responses of barley in terms of biomass production and grain yield were assessed along the rainfall gradient and compared between agroforestry and barley in sole cropping systems. Using 42 field surveys across the three sites, we determined how farmers manage barley in sole cropping systems, how they manage the interactions between olive and barley in agroforestry systems, and we estimate the final yield of barley at harvest. In agroforestry systems, barley biomass production and grain yield at harvest was significantly higher (4.04 t/ha and 1.11 t/ha respectively) under the intermediate rainfall level compared to the wettest site (1.85 t/ha and 0.58 t/ha respectively) and (2.37 t/ha et 0.71 t/ha respectively) in the driest one. While barley grain yield at harvest in the sole cropping systems was significantly higher under the driest site (2.37 t/ha) compared to the wettest site (1.31 t/ha). In all cases, barley biomass production was significantly reduced by its intercropping in olive trees, the gap between barley biomass production in agroforestry and sole cropping systems ranged from 3.36 t/ha under the intermediate rainfall level, 3.52 t/ha under the wettest site to 4.76 t/ha under the driest one. Barley grain yield in agroforestry was significantly reduced under the driest and the intermediate rainfall level compared to barley grain yield in sole cropping systems, where the gap between barley grain yields in agroforestry and sole cropping systems was largest in the driest site 1.65 t/ha and 0.73 t/ha in the intermediate rainfall level. These results suggest that the SGH do not apply in agroforestry systems where other limiting factor and farmers practices may interact with water. For better understanding of tree-crop interactions, the study of different mechanisms by which trees influence crop biomass and yield should be more studied.

Keywords: agroforestry, barley, Morocco, olive, rainfall gradient, stress gradient hypothesis, tree-crop interactions

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