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Plant available water content and water use in a fruit-crop agroforestry practice on sloping land

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Abstract

Fruit tree cultivation has expanded strongly on sloping lands of Vietnam, often in agroforestry systems. Agroforestry has been proposed as an alternative to sole-cropping systems based on benefits such as soil conservation, biodiversity, and increasing farmers' livelihood. However, there are constraints in agroforestry with several systems under-performing compared with expectations, and competition for water between system components may be one reason. Water is a vital resource used by all system components, and strongly affects yields and productivity. Understanding the distribution and use of plant-available water in soils is important to manage competition for water and to redesign the systems and their management. Our study assessed the distribution of plant-available water in a fruit tree-maize agroforestry system and compared it with a control sole-maize system. The agroforestry system included longan, mango, maize, and guinea grass planted in rows along the contour and was established in 2017. The trial was designed as Complete Randomised Block Design with 4 replicates on sloping land in the mountainous Northwest Vietnam. Nine zones were defined at different distances from the tree rows; maize zones 1 to 4 upslope of the tree rows (being zone 5), zones 6 (being grass strips), and maize zones 7–9 downslope of the trees. Soil water was monitored using gravimetric samples at four maize growth stages including 3–4 leaves, 6–7 leaves, 10–11 leaves, and silking in 2022 and 2023. Additional samples were collected before and after the maize season. Soil water evaporation and infiltration rates were also measured in 2023. Our results show that the agroforestry system stored more water than the sole-maize system, resulting in higher plant available water in the soil around tree rows. There was, however, no significant difference between soil water content in the maize zones upslope and downslope of the tree rows. Water competition was found at some sensitive periods as a consequence of low plant-available water in the soil profile, suggesting that this limited maize yield. Changing component species and/or management approaches are needed for system sustainability. An additional study on nutrient competition would complement.

Keywords: Water use efficiency, agroforestry, available water content