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| **Abstract / Content summary** | Understanding root development in soil profiles of agroforestry systems is challenging. It is uncertain to what extent the proximity of cash crops, such as cocoa and coffee, to shade trees reduces nutrient concentrations in the topsoil and whether the cash crops continue to develop fine roots in the topsoil when they are planted in close proximity to shade trees. We aimed to investigate micro- and macro-nutrient concentrations in the soil profile and understand root architecture using a novel DNA metabarcoding approach in an agroforestry system where cocoa and coffee were interplanted with a shade tree, canarium. Soil and root samples were collected from (1) cocoa-only, (2) cocoa-canarium, (3) canarium-only positions in a cocoa plantation, (4) coffee-only, (5) coffee-canarium and (6) canarium-only positions in a coffee plantation. Proximity of shade trees did not limit nutrient concentrations for cash crops. Topsoil concentrations of total N (TN: 0.59% and 0.69%), phosphorus (P: 7.28 and 6.65 mg/kg), potassium (K: 360 and 755 mg/kg) and calcium (Ca: 1865 and 1044 mg/kg) under cocoa and coffee trees, respectively, did not differ significantly from those under the corresponding canarium trees. Soil TN, K and Ca concentrations were well above minimum required concentrations under both cocoa and coffee. DNA metabarcoding showed that canarium trees occupied deeper rooting zones (30–80 cm soil depth) than cocoa and coffee trees (0–30 cm soil depth). DNA metabarcoding demonstrated greater root colonisation of the topsoil by cocoa and coffee than canarium, suggesting that canarium had the potential to extract nutrients from deeper soil layers. Soil Ca concentrations were associated with cocoa root biomass whereas soil NO3−-N concentrations were associatedwith coffee root biomass. Our study highlighted the value of selecting suitable shade trees that maintain soil nutrient concentrations for cash crops. Furthermore, DNA metabarcoding can facilitate root distribution studies in complex agroforestry systems, thus providing insights into appropriate tree-planting designs. KEYWORDS: agroforestry, canarium, cocoa, coffee, root DNA metabarcoding |
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