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Interaction of legume tree and legume crop for improved crop productivity and soil fertility

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Abstract

Legume tree-based agroforestry systems play a crucial role in enhancing crop productivity and soil health, particularly in low-input agricultural systems. However, the amount of nitrogen (N) derived from atmospheric fixation is highly variable among different tree species resulting in differences in the effect of the tree-crop interactions. Our study focuses on examining the legume tree-legume crop interaction and their effect on crop yield and soil fertility. A field experiment was conducted in Tigray, Ethiopia (13°38' N, 39°10' E; elevation: 1350–2835 m) taking *Vachellia seyal*-*Cicer arietinum* (chickpea) as test tree-crop. Three *Vachellia seyal* trees were selected for the experiment. Soil fertility status and grain yield under and outside the tree canopy were evaluated from 24 plots arranged in four directions per tree, spaced 1 m apart. Results showed a 200 % increase in total nitrogen (N) and 180 % in soil organic carbon (SOC) near the *Vachellia seyal* tree compared to the outside tree canopy along with a 123 % chickpea yield increment. The soil moisture content near the tree was also 162 % higher, with an 81 % reduction in bulk density. These all factors resulted in 119 % increase in above-ground biomass and 211 % increase in root biomass of the chickpea. However, phosphorus (P) and potassium (K) declined by 66 % and 61 %, respectively. This could likely be due to the combination of factors including high P and K demand of the legume crops, the vigorous crop growth effect from the biological nitrogen fixation and increased P solubility. These findings suggest that legume tree-legume crop interaction significantly improved N, SOC and crop yield which could benefit the subsequent cropping season especially with P and K supplemental fertilisation to sustain long-term productivity.

Keywords: Biomass, chickpea, crop harvest index, root biomass, soil chemical properties, *vachellia seyal*