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Carbon contributions from roots in cotton based rotations

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Most research on the decline in soil organic carbon (SOC) stocks in Australian cotton farming systems has focussed on the inputs from above-ground crop residues, with contribution from roots being less studied. This paper aims to outline the contribution of cotton roots and roots of other crops to soil carbon stocks in furrow-irrigated Vertisols in several cotton (Gossypium hirsutum L.)-based rotations. Data was collected from cotton-based rotation systems: cotton monoculture, cotton-vetch (Vicia benghalensis) Roth.), cotton-wheat (Triticum aestivum L.), cotton-wheat-vetch, cotton-corn, corn-corn, cotton-sorghum (Sorghum bicolor L.) and from BollgardTM II (Bt) and non-Bt cotton. Land management systems were permanent beds, with or without standing stubble, and conventional tillage. Root growth in the surface 0.10 m was measured with the core-break method, and that in the 0.10 to 1.0 m depth with a minirhizotron and I-CAP image capture system. These measurements were used to derive root C added to soil through intra-seasonal root death (Clost), C in roots remaining at the end of season (Croot), and total root C added to soil (Ctotal = Croot + Clost). Ctotal in non-Bt cotton (Sicot 80RRF, 0.9 t C/ha/year) was higher than in Bt cotton (Sicot 80RRF, 0.6 t C/ha/year). Overall, Ctotal from cotton roots ranges between 0.5 to 5 t C/ha/year, with Clost contributing 25-70%. Ctotal was greater with vetch than with wheat and was in the order of vetch in cotton-wheat-vetch (5.1 t C/ha/year) > vetch in cotton-vetch (1.9 t C/ha/year) > wheat in cotton-wheat (1.6 t C/ha/year) = wheat in cotton-wheat-vetch (1.7 t C/ha/year). Intra-seasonal root mortality accounted for 12% of total root carbon in vetch and 36% in wheat. Average corn Ctotal with monoculture was 9.3 t/ha and with cotton-corn 5.0 t/ha. Ctotal averaged between both treatments was, thus, of the order of 7.7 t C/ha/year and average Clost 0.04 t/ha/yr. Sorghum roots contributed less carbon with conventional tillage (8.2 t C/ha/year) than with no-tillage (16.8 t C/ha/year), although values were higher than those of corn. A large proportion of the carbon inputs from sorghum roots came from depths > 0.6 m. Averaged between both treatments, 65% of the total root mass was located in the 0.6-1.0 m depth. Carbon added to soil by roots of C4 crops such as corn and sorghum was higher than that added by roots of C3 crops such as wheat, vetch and cotton. Carbon added by roots of a Bollgard cotton variety was less than that added by roots of its non-Bollgard counterpart.