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Long-term rotation studies and the effect on soil organic carbon in cotton soils.

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Three long-term experiments conducted at the Australian Cotton Research Institute (ACRI) on vertosols examined the effect of tillage and stubble management over 26 years (E1), crop rotations over 9 years (E2) and the use of legumes over 16 years (E3) in maintaining soil quality and nitrogen contribution for subsequent cotton crops. Two of the experiments (E 1, 2) were on soils with a subsoil constraint of sodicity (ESP>10 %), while the third (E3) was on soil with less subsoil sodicity (ESP=5%). E1 compared continuous cotton with conventional tillage (CC_MXT), continuous cotton with minimum tillage (CC_MNT) and a cotton-wheat rotation with minimum tillage where wheat stubble was incorporated until 1999 and retained as standing stubble thereafter (CW_MNT). Cotton stubble was incorporated in all treatments. E2 compared cotton-vetch-cotton (CVC), cotton-fallow-cotton (CFC), cotton-wheat-fallow-cotton (CWFC), fallow-cotton-wheat-fallow-cotton (FCWFC), cotton-wheat-fallow-vetch-cotton-wheat (CWFVCW) and fallow-cotton-wheat-fallow-vetch-cotton-wheat (FCWFVCW). Vetch was retained as surface mulch, wheat stubble incorporated in both CWFC and FCWFC but retained as standing stubble in CWFVCW and FCWFVCW. E3 compared cotton-vetch-cotton-vetch (CVCV), cotton-fallow-cotton-fallow (CFCFC), cotton-wheat-fallow-cotton (CWFC), cotton-wheat-vetch-cotton (CWVC) and cotton-faba bean-fallow-cotton (CFbFC). Soils were sampled to 1.2 m in E1 and E2 and to 0.9 m in E3 and analysed for total soil organic carbon. Stubble was conserved in all experiments, but was incorporated in E3 and retained as standing stubble in E1 and E2 except as noted.

Results indicate that in E1, soil organic carbon decreased over time under continuous cotton for all tillage treatments, however including wheat in the rotation slowed the decline and tended to increase soil organic carbon in the immediate surface layer. In E2 soil organic carbon decreased with depth and remained relatively constant, while soil organic carbon increased slightly in the surface layer over time. For E3 soil organic carbon increased in the soil surface, and even more rapidly in the 30-60 cm soil layer. In the 0-30 cm layer there was an increase in soil organic carbon in E2 and E3 and a decrease in E1. Profile soil water tended to be greater with minimal tillage and surface stubble retained treatments.

It is concluded that a reduction in tillage when combined with crop rotation can reduce the rate of soil organic carbon decline and that there is potential for crop rotations to increase soil organic carbon in the 0-30cm soil layer over time. Exchangeable sodium percentage (ESP) tended to increase over time in E1 and remained constant in E2. ESP did not constrain growth in E3. Yield of cotton varied with seasonal conditions; however, yield has increased slowly with time in all experiments. Implications for tillage-stubble management are discussed.