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Tillage-residue management affects the distribution, storage and turnover of mineral-associated organic matter – A case study from northern Mexico

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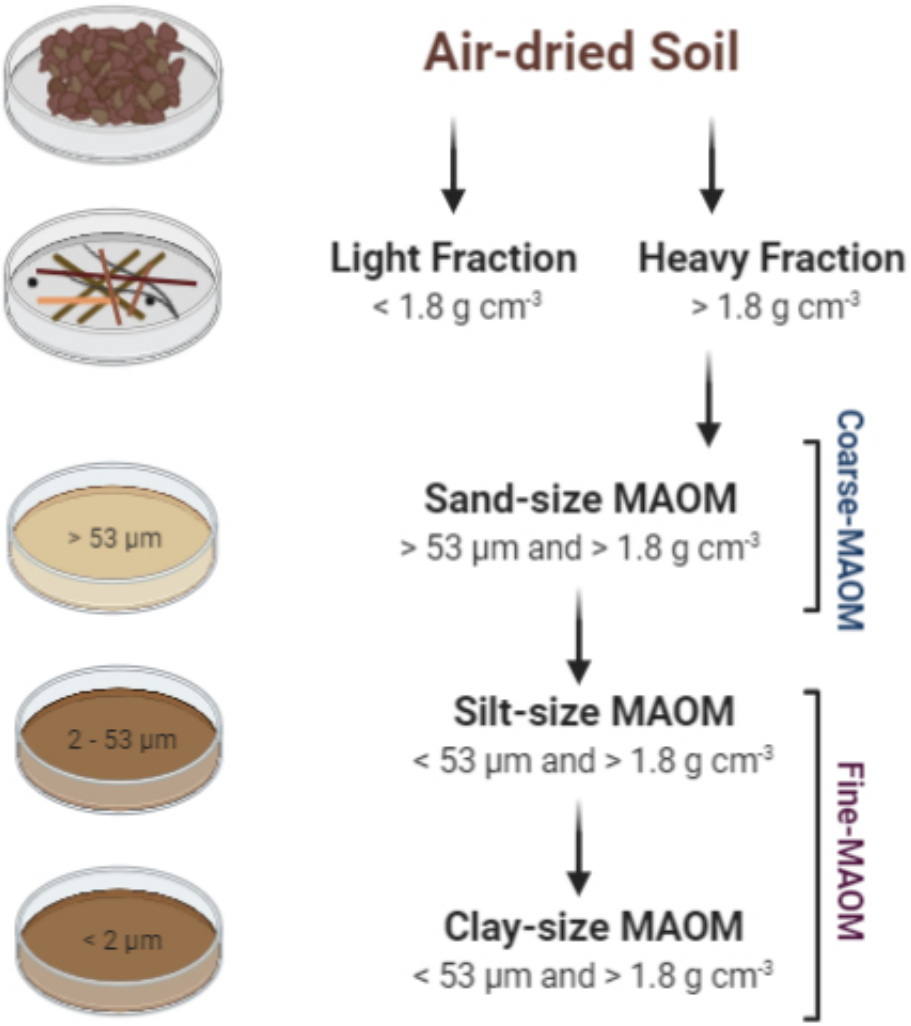
Managing croplands for increased storage of soil organic matter (SOM) is a critical step towards developing resilient farming systems in a changing climate. We examined SOM dynamics in a wheat (Triticum durum L.) – maize (Zea mays L.) irrigated bed planting system established near Ciudad Obregón, Sonora, Mexico. Soil samples (0 – 15 cm) were collected from conventionally tilled raised beds (CTB) with all crop residues incorporated (CTB-I) and permanent raised beds (PB) with crop residues burned (PB-B), removed (PB-R), partly retained (PB-P) or fully retained (PB-K) receiving 0, 150 or 300 kg N ha^{-1}, and analyzed for organic C (OC), total N (TN) and $\delta^{13}C$ in whole-soil, light fraction (LF) and coarse- (sand) and fine- (silt and clay) mineral-associated organic matter (MAOM). Results indicated that PB-K and PB-B increased soil OC ($P < 0.05$) in whole-soil relative to CTB-I, mainly through increases in sand- and silt-size MAOM, respectively. Similarly, N-fertilization increased soil OC and TN contents in whole-soil, coarse-MAOM, and fine-MAOM, but not in the LF pool. Soil $\delta^{13}C$ was higher ($P < 0.05$) in PB-K (-20.18‰) relative to PB-B (-20.67‰), possibly due to the stabilization of partly decomposed maize-C in silt- and clay-size MAOM. The composition of SOM surveyed by CPMAS ^{13}C NMR was not affected by tillage-residue management and roughly consisted of 35% O-alkyl-C, 31% alkyl-C, 24% aromatic-C, and 10% carboxyl-C. Our results indicate that long-term PB-K and PB-B adoption increased surface soil OC contents relative to CTB-I, even though pathways of SOM stabilization differed between systems. Under PB-K, accumulation of fine-MAOM was mostly related to straw-C inputs, whereas in PB-B it was closely associated with black-C precursors. Fine-MAOM appeared responsive to crop residue management and should be therefore considered when analyzing mechanisms of SOM stabilization in irrigated croplands.


Air-dried Soil
Light Fraction
< 1.8 g cm-3
Heavy Fraction
> 1.8 g cm-3
> 53 µm
Sand-size MAOM
> 53 µm and > 1.8 g cm-3
Coarse-MAOM
2 - 53 µm
Silt-size MAOM
< 53 µm and > 1.8 g cm-3
< 2 µm
Clay-size MAOM
< 53 µm and > 1.8 g cm-3
Fine-MAOM