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Soil structure, microbial biomass and carbon and nitrogen stocks as influenced by conventional tillage and conservation techniques

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To evaluate the impact of tillage systems on soil environment, it is necessary to quantify the modifications to physical, chemical and biological properties. The objective of this study was to evaluate the short-term impact of different tillage systems in organic farming on soil resistance to penetration, bulk density, microbial biomass, organic matter, and carbon and nitrogen stocks. The tillage systems included conventional tillage (CT), 'agronomic' tillage (AT) and superficial (shallow) tillage (ST), with ST being a non-inversion practice. Tests were carried out on alluvial poorly developed soil (10% clay, 57% silt, 33% sand) in the Higher Institute of Agronomy of Chott Meriem (Tunisia).

The soil resistance to penetration was measured with a penetrologger till 50 cm depth along with soil water content measurements. Bulk density (g cm^{-3}) was measured by a cylinder densimeter on samples collected every 10 cm till 30 cm depth. Microbial biomass is a determining factor in soil biological quality because of its role in the regulation, transformation and storage of nutrients. To count the germs, we used the method of enumeration after incorporation into agar. The Walkley and Black method was used for the determination of soil organic matter, and Kjeldahl's for the analysis of total nitrogen content. Carbon and nitrogen stocks (t ha^{-1}) were then calculated as a function of carbon and nitrogen contents, bulk density and the horizon depth.

Shallow tillage without inversion ST showed the best values in terms of soil resistance and bulk density. Indeed, soil resistance was 3.1, 2.4 and 2 MPa under CT, AT and ST respectively at 40 cm depth. By adopting this conservation technique, we noted an increase in organic matter with 53% as compared to CT (from 1.9% to 2.9%) and thus a significant increase in C (from 12.5 to 14.5 g kg^{-1}) and N (from 5 to 8 g kg^{-1}) stocks, particularly in the topsoil. In fact, the increase of organic matter in the topsoil constituted a reserve of essential nutrients which allowed the development and boosted the activity of living beings from 756 to 780 UFC g^{-1} x 10^5 in the topsoil as compared to CT. The overall increase of C stocks in the topsoil for ST significantly contributes to carbon sequestration.