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Effects of tractor loads and tyre pressures on soil compaction in Tunisia under different moisture conditions

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Vegetables in Tunisia demand frequent tractor traffic for soil tillage, cultural operations and phytosanitary treatment, resulting in soil compaction. This study evaluates the effects of four levels of compaction by using different loads and tyre pressures of tractors, i.e., load 1 (C1) = 1460 kg, load 2 (C2) = 3100 kg, tyre pressure 1 (C3) = 800 kg cm^{-2}, tyre pressure 2 (C4) = 1500 kg cm^{-2} on the hydraulic and physical properties of a sandy loam (10% clay, 20% silt, 68% sand) under three natural moisture conditions H0, H1 (15 days later), H2 (30 days later). At H0 average water content between 0 and 30 cm depth varied from 0.04 to 0.06 kg kg^{-1}, at H1 between 0.13 and 0.07 kg kg^{-1}, and at H2 between 0.10 and 0.09 kg kg^{-1}. Each test run was limited to one pass. Undisturbed soil cores were collected in the topsoil (0–10 cm), at 10–20 cm and in the subsoil (20–30 cm) below the trace of the wheel at sites in the Higher Institute of Agronomy of Chott Mariam, Sousse, Tunisia. Soil compaction level was determined by penetration resistance using a penetrologger. Porosity, bulk density and permeability were then determined to evaluate the impact of the four load/tyre pressure combinations at the three moisture conditions on soil compaction. Prior to the experiment (C0), bulk density was 1.4 Mg m^{-3}. After the tractor pass, the highest degree of compaction was observed with tractor load C2 and tyre pressure C4 which significantly changed soil bulk density resulting in values of up to 1.71 Mg m^{-3} in the topsoil and compacted subsoil under H2, which is significantly above the critical value of 1.6 Mg m^{-3} for soils with clay content below 17.5%. The high degree of compaction significantly affected penetration resistance and porosity of both topsoil and subsoil layers accordingly. Permeability was significantly reduced as a result of the induced compaction. The results demonstrate that different degrees of soil compaction under different moisture levels could greatly influence hydraulic and physical properties in different ways. Even under relatively low water contents, i.e., below or near field capacity, substantial top and subsoil compaction was induced after one tractor pass.