Comparison of Soil Compaction Under Conventional Agriculture and Conservation Agriculture Practices

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Background

This study took place at the National Institute for Field Crops in Tunisia, under the Project:" to Support Development of Conservation Agriculture" (a project funded by the French Agency for Development). In this study we tried to assess soil compaction under No-Till system. Two stations were selected to conduct this study, the first belongs to the INGC and it is at Bousalem, the second (a farmer site) in Krib. In these two stations eleven different fields conducted under different No-Ttill rotations and four fields under conventional system have been chosen to be subject of our experiments. Measurements of soil profiles have been taken.

Results

The results showed that there is no soil compaction at No-Till fields in all soil layers except where there has not been a soil decompaction before conversion to No-Ttill system. A soil compaction is widespread in the depths of 20 cm in soils conducted under conventional tillage due to the presence of a hardpan.

Applications and Implications for Conservation Agriculture

No tillage system does no induce soil compaction. Fields conducted under no tillage don't have compaction in all depths regardless of years under no tillage practice except fields where no decompacting achieved before converting to no tillage.

Soil compaction is widespread in soils conducted under conventional tillage at horizons located at 20 cm deep.

It is imperative to go through a diagnosis of the soil structural before the transition to no tillage**.**

Experimental Approach

The field work was conducted at two sites; the first belongs to the INGC, where we 8 fields, 2 under conventional tillage and 6 under no-tillage were chosen to establish assessments. For the second station, located in the Krib region, 7 fields were chosen, 2 under conventional tillage and 5 under no-tillage.

Table1: Characterization of fields under conventional tillage.

Field	site	Crop Rotation	Prvious Crop	water regime
SC_a	Kodiat	Cereal/legumes	Small Faba bean	irrigated
SC_b	Kodiat	Cereal/legumes	Small Faba bean	irrigated
SC_{cBD}	Krib	Cereal/legumes	Small Faba bean	rainfed
SC_{cFev}	Krib	Cereal/legumes	Durum Wheat	rainfed

Table 2: Characterization of fields under no tillage.

Field	site	Crop Rotation	Years Under No-Tillage	Previous Crop	water regime
SD_{1BD}	Kodiat	Cereal/legumes	1	chickpea	irrigated
SD_{1Fen}	Kodiat	Cereal/legumes	1	Durum Wheat	irrigated
SD_{2Fen}	Kodiat	Cereal/legumes	2	Durum Wheat	irrigated
SD_{2Avo}	Kodiat	Cereal/legumes	2	Small Faba bean	irrigated
SD6	Kodiat	Cereal/legumes	6	Small Faba bean	irrigated
SD8	Kodiat	Cereal/legumes	8	sorghum	irrigated
SD4	Krib	Cereal/legumes	4	Small Faba bean	rainfed
SD7	Krib	Cereal/legumes	7	Durum wheat	rainfed
SD_{10BD}	Krib	Cereal/legumes	10	Small Faba bean	rainfed
SD_{10Fev}	Krib	Cereal/legumes	10	Durum Wheat	rainfed
SD11	Krib	Cereal/legumes	11	Small Faba bean	rainfed

Assessments were about measurements of soil profiles.

Characterization of soil structure on a morphological basis was performed using two criteria. The first tests the size and the distribution of clods and how they are grouped (o, b, c). The second one is for the classification of these clods into three types (Δ, Γ, Φ), based on the importance and origin of their internal structural porosity (Roger et al, 2004). Soil profiles were installed in the following fields, Kodiat: SD_{1Fen}, SD_{2Fen}, SD_6, SD_8, SC_a and SC_b and Krib in fields: SD_7, SD_{10BD}, SD_{11} and SC_{cBD}. Rules for soil profile diagnostic are listed in Table 4:

Table 3: Rules for soil profile diagnostic (Roger et *al*, 2004)

Structure	Degree of compaction
oΓ	Not compacted
cΓ	Begining of compaction
cΦ	moderate compaction
cΔ	severe compaction

Results and Discussion

Soil profiles in SD_1, SD_2 and SD_8, have a structure that varies from oΓ to cΓ in all depths, soils are well aggregated, they are not compacted.

The soil profile of the field SD_6 has a structure Γ in the surface layer (10 cm), the soil is not compacted in this layer, this structure is due to a strong biological activity and also to a high content of organic matter. In the 10-40 cm layer, the structure is cΦ, the soil has a moderate compaction.

The soil profile in both fields conducted under conventional tillage (SC_a and SC_b) shows good structure in the surface horizons 0-20 cm, these horizons are often prone to intensive tillage, and a compacted structure for SC_a at the top 5 centimeters due to the effect of irrigation which generates a hardpan. As against, between 20 and 50 cm of the soil structure is moderately to highly compacted. This situation is due to the compaction effect of the plowing tools which create a hardpan.

Table 4: morphological structure of soil profiles in Krib station

Depth	SD7	SD10BD	SD11	SCCBD
0-5	**oΓ**	**oΓ**	**oΓ**	**TF**
5-10	**cΓ**	**cΓ**	**cΓ**	**oΓ**
10-20	**cΓ**	**cΓ**	**cΓ**	**cΓ**
20-30	**cΓ**	**cΦ**	**cΓ**	**cΦ**
30-40	**cΓ**	**cΦ**	**cΓ**	**cΦ**
40-50	**cΓ**	**cΦ**	**cΓ**	**cΦ**

Comparing the structure of the soil throughout the soil profile between conventional tillage and no tillage reveals a good structure in the 0-20 cm levels for both cropping systems. A difference is observed at 20-50 horizons where the structure becomes highly compacted in conventional tillage, except for the plot SD6 where there's no decompacting before moving to no tillage. This compacted structure under conventional tillage (cΦ to cΔ) is due to tillage causing a hardpan, the presence of taproots and a high biological activity confer soil under no tillage good structure.

In the SD7 and SD11 fields, soils have a good structure, the clods are aggregated and with good porosity throughout the soil profile, this structure is more porous than in fields SD1, SD2 and SD8 because the texture of the soil is predominantly sandy.

For both SD10 and SCc, compaction starts from 20 cm depth where the structure becomes more compacted and less porous (cΦ).

Table 5: morphological structure of soil profiles in koudiat station

Depth	SD1	SD2	SD6	SD8	SCa	SCb
0-5	**oΓ**	**oΓ**	**oΓ**	**oΓ**	**cΓ**	**oΓ**
5-10	**oΓ**	**oΓ**	**cΓ**	**cΓ**	**cΓ**	**cΓ**
10-20	**oΓ**	**oΓ**	**cΦ**	**cΓ**	**cΓ**	**cΓ**
20-30	**oΓ**	**oΓ**	**cΦ**	**cΓ**	**cΓ**	**cΦ**
30-40	**oΓ**	**oΓ**	**cΦ**	**cΓ**	**cΔ**	**cΦ**
40-50	**oΓ**	**oΓ**	**TF**	**cΓ**	**cΔ**	**TF**

Fields conducted under no tillage don't have compaction in all depths regardless of years under no tillage practice except fields where decompacting achieved before converting to no tillage. No tillage system does no induce soil compaction. Soil compaction is widespread in soils conducted under conventional tillage at horizons located at 20 cm deep. It is imperative to go through a diagnosis of the soil structural before the transition to no tillage**.**

References

Bronick, C. J et Lal, R. 2005. Soil structure and management: a review. Geoderma. 1-2, 124: 3-22.

Busscher, W. J. Bauer, P. J. et Frederick. J. R. 2002. Recompaction of a coastal loamy sand after deep tillage as a function of subsequent cumulative rainfall. Soil and Tillage Research. 68: 49-57.

Eduardo, M., Juan, P. F., Paola, S., Susana, V. et Edmundo, A. 2008. Soil physical properties and wheat root growth as affected by no tillage and conventional tillage systems in a Mediterranean environment of Chile. Soil and Tillage Research. 2, 99: 232-244.

Gill, J.S, Sale, P.W.G., Peries, R.R. et Tang. C. 2009. Changes in soil physical properties and crop root growth in dense sodic subsoil following incorporation of organic amendments. Field Crops Research. 1, 114: 137-146.

Oliver Stock, Nigel. K. Downes., 2008. Effects of additions of organic matter on the penetration resistance of glacial till for the entire water tension range. Soil and Tillage Research. 2, 99: 191-201.

Roger Estrade. J, Richard. G, Caneill. J, Boizard. H, Coquet. Y, Defossez. P, Manichon. H., 2004. Soil and Tillage Research. Morphological characterisation of soil structure in tilled fields: from a diagnosis method to the modeling of structural changes over time.1, 79: 33-49. Tolon Becerra, Botta. G.F, Lastra Bravo X, Tourn. M, Bellora Melcon. F, Vazquez. J, Rivero. D, Linares. P, Nardon. G., 2010. Soil compaction distribution under tractor traffic in almond (Prunus amigdalus L.) orchard in Almeria Espana. Soil and Tillage Research. 1, 107: 49-56.