Assessment of the long term impact of intense tillage on the chronoséquence of olive groves in south of Tunisia

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Introduction

Tunisia is the most important olive oil producer country of the Southern Mediterranean. More than 30 % of its cultivated land is devoted to olive growing; Tunisia is the 4th world producer of olives and the second exporter of olive oil representing 2/3 of the agronomical exports of Tunisia. (Karray et *al.*, 2009). The olive growing sector occupies thus a strategic place in the Tunisian economy.

In the district of Medenine in the south of the country, and in the whole coastal region, olive orchards occupy over 80% of the agrarian surface. With an average rainfall < 200mm year^{-1}, these rainfed olive trees are the only sustainable agricultural production of the area. It is the first economical incomes for many small holders.

If the production of olive oil is noticed for thousands years, the trees were located in mountain terraces or in valleys where water harvesting was possible. A new type of plantation was introduced during the colonial time in 1901 in littoral plains and spread to the whole district, in vast plantations on flat areas, with trees spaced by 24 meters (17 trees ha^{-1}).

In these olive orchards, intensive tillage (from 4 to over 8 operations per year) at a depth of 15 cm with a “swallow tail” plough is processed to eradicate weeds and to limit the soil evaporation by stopping the capillary rise. Soils are generally poorly differentiated aerosols, composed by aeolian quartz sands (over 90% sand in which 50% of the grain size is between 80 and 100 µm in diameter), 50cm-thick, overlaying a calcareous frangipan. The tillage practice has considerably altered these fragile soils, which are particularly depleted in organic carbon. They have a very weak soil structure leading to crusting rapidly especially in the low part of the furrows and are compacted with a plow pan 15cm depth limiting the infiltration of scares rains. The important question to be solved in the sandy soils of southern Tunisia is the following: how intense is the impact of the intensive tillage with the various ages of olive plantations?

Material and method

In the office of federal land plantation in Chammakh, Zarzis (33°35'40''N, 10°59'34''E), we compare the soil organic carbon (SOC) status of different plots, from grazing open areas and plantation of 1, 7, 15, 35 and over 110 years of age respectively. C and N were analyzed by combustion in each horizon of complete soil profiles (in the analytical platform of Bondy).

Results and discussion

Results show that soil organic carbon decreases after tillage from 3 g kg^{-1} in the soil reference to <1 g kg^{-1} in cultivated area. The soil carbon content decreases in the whole profile. We found very low values of C stock (0-30cm) from 954 g m^{-2} in the grazing open areas to 140 g m^{-2} in groves of 110 years (Figure 1). Same decrease has been observed in surface horizon in an other site (Dar Dhaoui) with uncultivated areas sine 1976 compared to olive grove (Table 1). Results also show that N values are below of the limit of detection in many horizons of 110 years old plantations. In these soils depleted in organic matter, tillage may have a negative impact not only on the organic carbon but also on the soil biologic activity.

Conclusion

Soils under intensive tillage seem also more prone to wind erosion and degradation (demonstrated in the site of Dar Dhoui). This intense tillage is only momently adapted for olive orchards, but is not sustainable in long term. Old olive trees show premature signs of ageing with lower yields. In this context what are the possible alternatives? If we change the usual tillage method, what would be the consequence on the plant water availability? The local alternatives to restore the soil organic matter stock and limit their intense loss could be the solution. However there is no systematic production of compost in these areas.

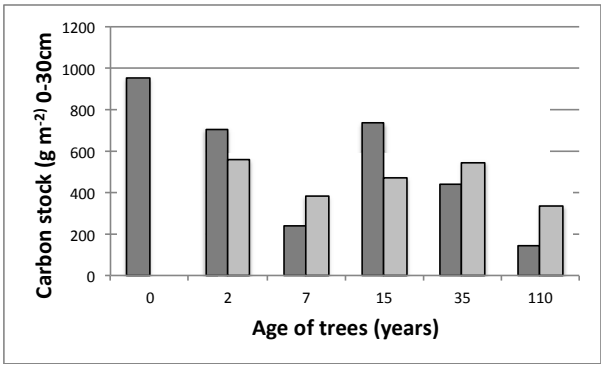

Figure 1: Carbon stock in the first 30 cm in olive orchards of different age.

Age (Years)	C (g kg^{-1}) in surface horizon				
0	3.11	0.58	1.45	0.41	3.78
2	1.76	1.34			
7	0.32	0.75			
15	0.99	1.39			
35	1.14	0.72			
110	0.44	0.85	0.87	0.36	

Table 1: Carbon content in surface horizon in olive orchards of different age
Site of Dar Dhaoui in gray (N33°17'42" E010°47'00")

References

Karray B., Kanoun .F. 2009.Potentiel de production et d'exportation d'huile d'olive tunisienne au marché européen: une analyse prospective. Série Etude 01/2009, 71 pages.

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Photo 1 : Agrarian landscape in the littoral plain of Jeffera close to Zarzis, district of Medenine, south Tunisia. Photo C. Lamontagne, IRD.

Photo 2: Soil tillage with arrowtail plough in the Chammakh study site

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