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Original Research Article

Inventory of Fauna and Physicochemical Analysis Soils of Different Agrosystems

Fatiha Tissouras[1*], Halima Kaddeche[2], Abdsselam Attia[3]

[1]Department of Agronomic Sciences, Faculty of Natural Sciences and Life Sciences, Abd Hamid Benbadiss University, Mostaganem, Algeria

[2,3]Laboratory of Biodiversity, Soil and Water Managementin, Department of Agronomic Sciences, Faculty of Natural Sciences and Life Sciences, Abd Hamid Benbadiss University, Mostaganem, Algeria

[*]Corresponding Author E-mail: fatiha.tissouras@univ.mosta.dz/tissouf31@gmail.com/
Phones: +213 549486946/551405466

Abstract

This study evaluated the effect of several soil management practices in three different agrosystems soils (Fallow, No Till Conventional Till) on physicochemical and fauna bio-indicators of fertility. The first control soil was left fallow for 4 years. Second soil was directly sown without any tillage and the last soil was previously conventionally tilled. The latter thow soils were used in rotation with a cereal crop (*Triticum aestivum*/ *Avena sativa*). The study determined the main physicochemical parameters of such as Texture, % moisture, pH and elements nutrients (OM, C, N, P) according to soil depth horizons during the summer period. The fauna soil (meso and macrofauna) was carried in the field and in the laboratory of biodiversity soil with different methods of observation (macr/microscopic). Indice Shannon-Weaver was calculated for the faun agrosystems soils. The results obtained show that fallow and no tillage soils had the best qualitative and quantitative indices. Significant variations were recorded for moisture, texture, pH and elements nutrients (OM, C, N, P). On the other hand, no significant variations were noted for some indices. Furthermore, the summer fauna inventory reveals a strong dominance of the *Fourmicidea* family, with a frequency of 56%. In contrast the frequencies of other invertebrate families (*Oniscidea*, *Lumbricidea*, *Carabedea* and *Julicidea*) were very low with a total absence in some horizons (H2, H3). Variations in physicochemical and faunal indices were very less significant in tilled soils compared to control soil. Taking into account the study period, the results confirmed the effect of tillage and the different agricultural systems implemented on the soils with respect to physicochemical and faunal indices that were assessed. Therefore, it would be worthwhile to continue this determination of biological indices to predict the impact of farming practices by using other methods in different periods.

Keywords: Agrosystems, Fauna, Physico-chemicals, Soil

INTRODUCTION

Fauna activity and pedological processes determine soil functioning, particularly in agricultural soils and their ecosystems. Several authors have highlighted through their works and publication, the important roles of fauna in soils and their various functional impacts positive or negative (Girard et al., 2011; Barros et al., 2002; Jinènez et al., 2008). For example microfauna was smaller than 0.1 mm act at the aggregates level (0.5 to 5 cm) of soil, with the exception of amides, which were highly mobile. Microfauna live in the pores or water films of the soil matrix (surface and interstitial), without physically impacting their environment. This microfauna has a quasi-aquatic lifestyle, with encysting capabilities to resist desiccation of soil. The second class of fauna was the mesofauna. Their diameters varied from 0.2 to 4 mm mineral matter. In addition to their bi-disturbance activities throughout the soil macrofauna were associated with the concept of soil engineers due to their important roles in soil functioning (Jones et al., 1994; Daniela et al., 2015). These last two classes of fauna were directly or indirectly exposed to most agricultural practices (tillage, use of chemical or biological inputs, cover crops etc.). Consequently, as a result of these practices some species were listed on the IUCN red list of threatened species. In this context, this work will be presented some results obtained on the estimation of meso and macrofauna with certain physicochemical parameters in the soils of three agrosystems different. The first system was uncultivated fallow field. The soils of two agrosystems were sowing directly or ploughed before sowing. Both soils were cultivated with a cereal crop rotation (*Triticum aestivum*/ *Avena sativa*).

MATERIALS AND METHODS

Experimental site and soil sampling

The study site is located on the exploitation agricole farm Hassi-Mamèch in Mostaganem. This region situated in Northwestern of Algeria, characterized by mediterranean semi-arid climate. Three plots representing different agrosystems (Figure 1). For each plot, 10 profiles were dugged to a different depth (5 profiles 1/1m^2; 5 profiles Ø30cm/H1m) (Figure 1. D). The soils samples were taken according different horizons (H1: 0-30; H2: 30-50; H3: 50-90cm).

Figure 1. Plots, A: Fallow soil; B, C: Soil No-Tillage, Tillage; D: Profile 1m^2.

Physicochemical analyses

Soil texture was determined by particle size analysis of samples according to the method of Rouiller et al. (1972), using sieving, dispersion and sedimentation. The main chemical parameters of the soluble fractions elements were analyzed by using appropriate conventional methods. Classical methods of mineralization, volumetric titration and spectrometry were used to estimate the different fraction OM, C, N, P, $CaCO_3$ total and active (Landon, 1991; AFNOR, 2008).

Estimation of meso and macrofauna

The fauna inventory was carried out during the summer periods. Through observations and counting of species in the field according to the horizons soils. To estimate the biodiversity of fauna, different indices were calculated according to the Shannon-Weaver distribution. Finally, an ANOVA statistical analysis of data was performed by using IBM SPSS 25.

RESULTS AND DISCUSSION

Physicochemical properties

Physicochemical results were regrouped in table 1 for different agrosystems soils. A:Soil texture; B: %Humidity; C: pH; D: C%, N%, C/N, MO%; E: %$CaCO_3$Total, $CaCO_3$Actif; F:Pmg/kg. The results obtained of texture confirmed highly significant (*P*≤1%) in the proportions of different fractions physico-chemical and showed decreasing variations along the profiles and horizons. All soils exhibited a texture dominated by sand. The proportion of this fraction ranging from 64.97 ±0.01 to 72.39 ±0.46%. However, a highly significant variation was recorded for the silty fraction fallow and no-till soil (13.37 to 9.28 %), but in the ploughed soil it was insignificant (Figure 2 A). Regarding the clay fraction, fallow and no-tilage soils had superior values of 19.17 and 18.6% respectively. This fraction showed an increase of approximately 30% in the tilled soil. According to the texture triangle, fallow and no-tillage soils have a silty-clay-sandy texture, while the tilled soil has a clay-sandy soil texture. This texture presented low moisture 1.27% in tillage soil. Despite the significant presence of clay, which should normally retain more water than other soils. Chemical variable soil such as pH revealed slightly alkaline values for different agrosystems soils. The total $CaCO_3$ content of soils was ranging between 8.91 to 19.95 % for arosystems soils (Figure 2). Very low values of $CaCO_3$ active were noted between 4.75- 3.89% for fallow soil, no tillage and tillage soil. These values indicate $CaCO_3$ of the soils were low according to the standard 8% ≤$CaCO_3$≤25% (Lozet and Mathieu, 1990). Organic carbon content was highest in fallow and no-tillage soils but decrease in tillage soil. Low organic nitrogen content observed was low in the no-tillage and tillage soils (0,007-0,05%), with the exception of fallow

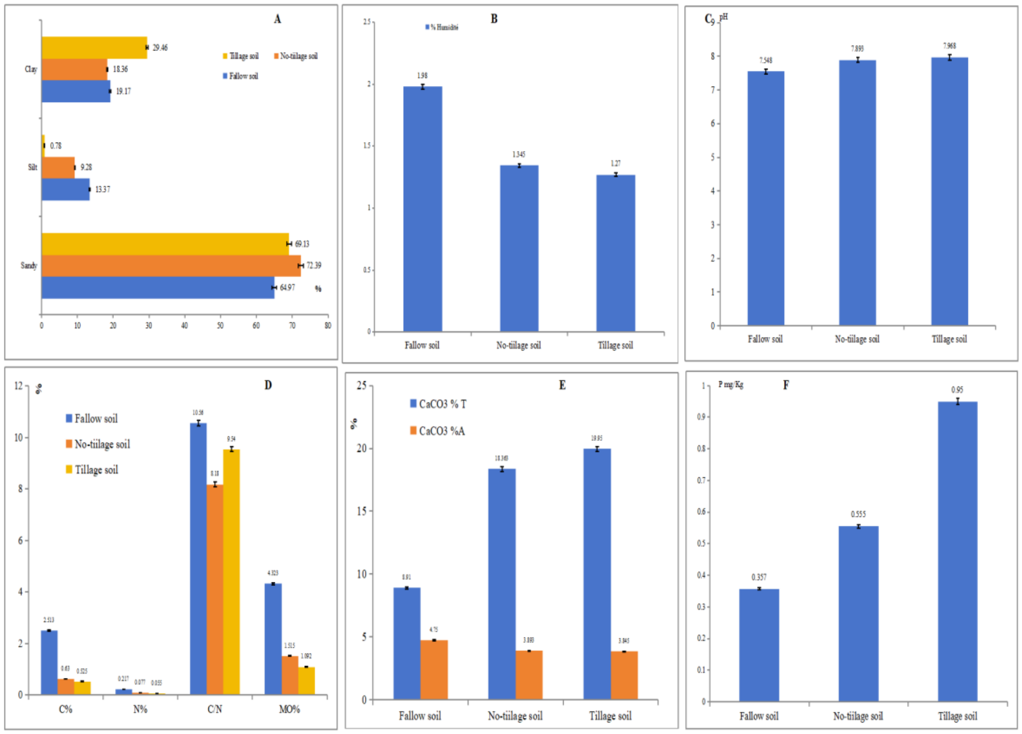

Figure 2. Physicochemical parameters of different agrosystems soils.

soil the value was very high 0.217%. The ratio C/N was ranging from 8≤ C/N ≤12 considered acceptable for good humidification or poor mineralization (Baise et al., 2000).Organic matter (OM) content of soil fallow was high significant, followed by the no-tillage, slight decrease noted on tillage soil. It was observed that the fallow soil (rest) had well regenerated the OM, with a high value compared to the cultivated or tillage soils (Figure 2). Phosphorus an important macronutrient for fertility soil, the variations concentration was found in the different agrosystems soils Fallow and no-tillage 0.357 ±0.35 and 0.555 ±0.07 mg/Kg respectively. In contrast to the other physico-chemical indices obtained for tillage soil, the P content was the highest 0.95 ±0.07mg/Kg (Figure 2). Overall these values can be considered indicators of fertility. Despite the different practices the phosphorus levels exceeded the deficiency threshold 15 and 26 ppm (Laurent and Brossard, 1991). Consequently, the significant effect of tillage practice was observed on texture and most chemical parameters.

Fauna assessment of Agrosystems oils

The biodiversity fauna showed highly significant variation from agrosystems soils (Figure 3, 4). It was determined according to several factors, including the cultivation system (tillage soil-concentional plowing) soil, a crop ratation (*Triticum aestivum*/ *Avena sativa*), summer period (temperature) and topograohy of zone study. The unplowed soils revealed highly significant intra and extra-group variations in fauna communities. These variations were noted not only in relation to the soil horizons but also to the soil types of each agrosystems studied. The total number of individuals ranged from 227 to 251, with frequencies F of 35.24 to 38.97% in the unplowed soils for no-till and fallow respectively (Figure 3). This number decreased sgnificantly in the tilled soil to n = 166, with an low frequency F= 25.77%.

The observations showed less significant vertical distributions in the horizon H2 (30-50 cm) and insignificant in the H3 (50-90 cm) (with n and F 0 %) (Figure 3). During the summer months, the soils of different agrosystems were characterized by a very limited biocenosis and were strongly dominated by the taxon *Fourmicidea*. In unplowed soils, the number of *Fourmicidea* individuals ranged between 200 to 240, with frequencies of 37.26 to 31.05 % in the direct seeding and fallow respectively. In plowed soils the frequency of Fourmicidea decreased to 23.29 % with n = 150. The second most common taxon was *Helicidea* with number of 5 to 11 individuals in unplowed soils (direct seeding and fallow). The next taxon *Oniscidea* was founded with a low presence 3 to 7 of individuals in both plowed and unplowed soils. The inventory revealed the presence of *Carabedea* in small number, ranging from 3 to 5 in both plowed and unplowed soils. *Lumbricidea* were presented in less frequencies in different soils, with a maximum n= 3

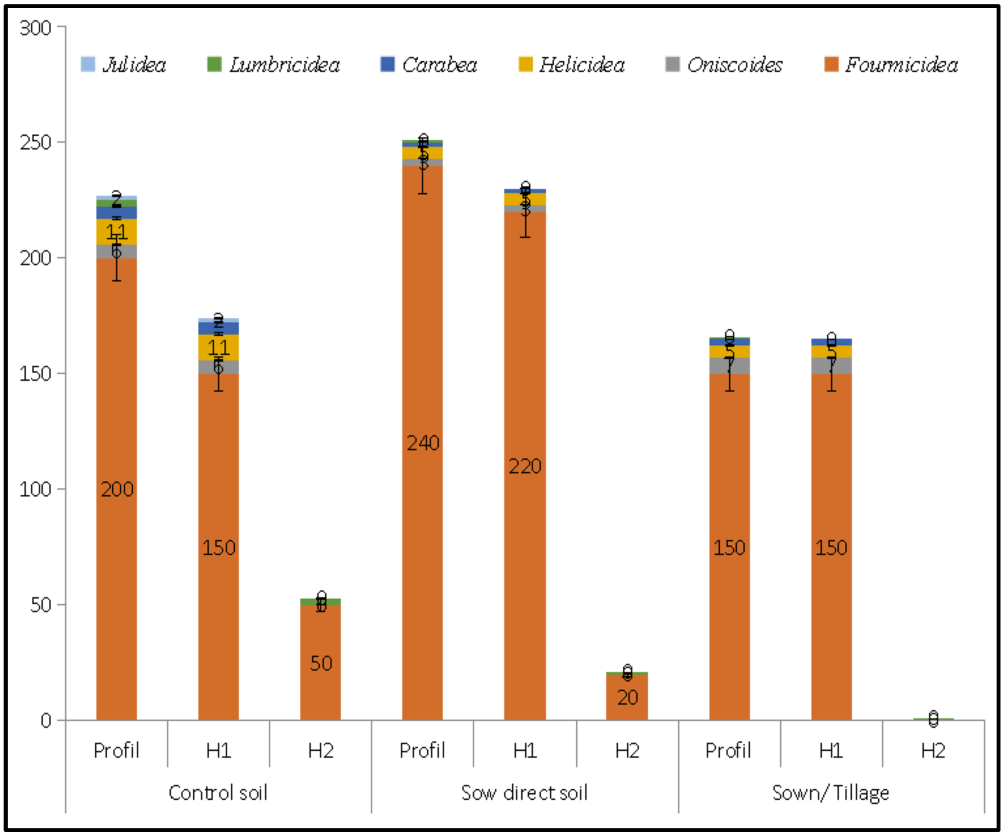

Figure 3. Fauna estimation in different horizons of agrosystems soils.

individuals in fallow soil. The last taxon identified was *Julicidea* with a very small of presence only 2 individuals in fallow soil compared to other cultivated soils (Figure 3). The Shannon-Weaver index confirmed significant biodiversity associated with unplowed soils (fallow/ direct seeding). The dominance of the stands by ants expressing the Shannon low at 0.49, was specifically confirmed by the dominance of the species «*Pheidol pollidule*». This specie was identified according to Nylander's, (1849) taxonomic key, appears mainly in large groups at the beginning of summer and digs tunnels of varying sizes. The mollusc count was dominated by the species «*Otela lactea*», native to the Mediterranean basin and recorded on the IUCN red list. The specie was identified according to the morphological criteria of Muller (1774) and Arrebola, (2011). The color was varying from white to dark brown and it has 4 to 5 striations. The taxon Oniscidea was dominated by the crustacean «*Armidillium vulgare*». It was identified to according Latteille, (1796) and Helmust, (2003). The coiling and movement of these isopods improves soil structure through the consumption and excretion of OM. The effect of plowing affected their abundance in the tilled soil. The inventory of *Lumbricidea* was limited to the identification of a single gender dominated by «*Lumbricus terrestris*». Traces of these earthworms were observed through their burrows in different soils horizons. This confirmed that the earthworm was an anecic specie (Bouché, 1972; Lacorddaire, 2000). Based on their morphological characteristic, the last two taxons Coleoptera and Diplopoda were identified with «*Carabus nemoralis*» and «*Jule scandinavius*» respectively being dominant (Muller, 1764; Latzel, 1884). In this study, the inventory of some fauna biodiversity showed highly significant variation in relation to the with the the summer period and the agrosystems. Literature on the assessment of fauna biodiversity remains very scarce, especially concerning arid soils. Several authors have worked on the fauna of wetlands or aquatic environments, evaluating the importance of the impact of antropogenic and pressures and climate change on certain physicochemical parameters and some species of fauna (Zulka, 1996: Tuf, 2003; Barbault R, 2011; Yan et al., 2012; Edwards et al., 2014; Sterzynska et al., 2015; Tissouras et al., 2026). The results suggest that both agroecosystems (fallow and no-till) can contribute to increasing the resilience of soil fauna to water stress, particularly during the driest periods. The effect of tillage in the agricultural system on certain physicochemical and faunal parameters was clearly observed, indicating a moderate disturbance in faunal assessment over the experimental period. In agricultural soils, despite the apparent uniformity of the surface horizons, the faunal composition varied considerably in proportions, particularly depending on the degree of agricultural intensification, compared to control soils. The massive use of pesticides and intensive soil work in conventional agriculture leads to a sharp reduction in the diversity and abundance of soil fauna. The impact of soil fauna on the biological control of pests has been estimated at 4.5 billion $ per year in benefits for farmers and ecosystem services. To a large extent, the activities of beneficial arthropods, including ground beetles, through their predatory lifestyle in agricultural plots. Their larvae are quite mobile and can attack gastropods, mollusks, and their eggs. The literature also describes other, less well-documented, larval development techniques, such as ectoparasitism, which involves parasitizing crop pests. The biological functioning of the soil corresponds to a system of interactions between different compartments of the soil cover microorganisms, fauna, and roots. These interactions induce a number of agronomic functions and behaviors of the soil. Soil functioning occurs over a very short period, much like pedogenesis. However, the soil's behavior, in terms of its reaction to an action such as clearing, cultivation, plowing, etc., or a disruption of its normal functioning such as flooding, ashfall, etc., requires a timeframe that can be measured in years. The organization, energy, modification and alteration, differentiation, vegetation, fauna soil and human actions vary over time. The durations of evaluation are therefore very different, and the same is true for the periodicities which can be hourly (redox reactions), daily (variations in surface temperatures, water transfer), annual (burning, application of fertilizers, plowing, etc.), decadal (subsoiling, landslides, flooding), secular (drainage) or multi-millennial (weathering, desertification, glaciation, etc.). However, the cumulative effect of minor transformations occurring annually, and the effect of abrupt transformations occurring every century or millennium, are both responsible for the evolution of soil cover over time. The main objective of this study has been achieved, but other results obtained over the long seasons (autumn, winter, spring) remain, with the objective of mapping agricultural soils, which are being developed for future use. No work has been devoted to studying soil fauna in this region, making it difficult to compare results. The application of management methods for preserving biodiversity in agricultural soils and the integration of the value of ecosystem services into the evaluation of projects affecting soil fauna is essential, if we want to maintain soil productivity while respecting agricultural land.

CONCLUSION

The results of this comparative approach study allowed us to draw several observations, the cultivation practices used: fallow, no-tillage and crops rotation significantly influence some physico-chemical parameters and fauna of soil. Results also suggests that OM from no-tillage soils were a potential indicator of improved edaphic and biological properties soils.

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