Impact of biodiversity (pedo-fauna) in the biological qualities of soil in biological and conventional agro-ecosystems, in apple tree *(Malus domestica)*

[a]Albert Kopali; [b]Belul Gixhari ; [c]Hekuran Vrapi, [b]Hairi Ismaili; [c]Rexhep Uka
[a] Department of Agro-environment and Ecology, Faculty of Agriculture & Environment, Agricultural University of Tirana,1000. Albania.
[b] Faculty of Agriculture & Environment, Albanian Genebank, Agricultural University of Tirana, 1000. Albania.
[c] Department of Plant Protection, Faculty of Agriculture & Environment, Agricultural University of Tirana, 1000. Albania.

Abstract

The study of terrestrial resources and biodiversity present (pedo-fauna) is important both from the manufacturing and environmental agro-ecosystems. Ecological functions of soil as elements nutrient recycling, water retention, carbon storage reserves, more filtering pollutants as well as socio-economic functions of biomass production, supply of food for man and animals, the production of fibers for industry, a plant for agro-industrial use of those medical, depend not only on land use, but also the qualities of biological qualities. Biological attributes of soils which determine the fertility level of environmental attributes, affected by agronomic management practices of agricultural systems. In conventional agro-ecosystems, in contrast traditional soil biodiversity (pedo-fauna) and its biological qualities are threatened due to the accumulation of pollutant substances used in chemical synthesis. Protection of terrestrial biodiversity and its biological qualities remains a perennial target of agricultural systems more to ensure its functioning for a long period of time. This study conducted in two types of agro-ecosystems (biological and conventional) cultivated apple tree (*Malus domestica*), identifies differences in terrestrial biodiversity with the aim of adapting management practices to increase the sustainability of agricultural systems.

KEYWORDS: biodiversity, pedo-fauna, micro-arthropods, biological quality, agro-ecosystem

Introduction

Terrestrial environment in agricultural systems realizes a number of basic functions, not only the production but also environmental standpoint. Agricultural land is the primary means of food production, about 99% of the people's food supply comes from agriculture (FAO, 2007). Soil biodiversity contributes to a range of basic services for sustainability across ecosystems functional, acting as the main factor in the cycle of nutrients, regulating the dynamics of soil organic matter, carbon immobilization and release of greenhouse gases, by modifying the physical structure of the soil and water regime etc. These services are not only essential for the functioning of natural ecosystems, but also constitute an important source for the management of sustainable agricultural systems (FAO, 2001). All these ecological processes and their intensity depend on the choice of plant cultivation system which is essential for the conservation of terrestrial biodiversity and its functions. Biodiversity is bound and determines the functionality of ecosystems (Schlapfer & Schmid., 1999; Cardinale, et al. 2000). Soil biodiversity and ecological functions can be evaluated by means of bio-indicators. Estimates of biological qualities of soils through bio-monitoring are proposed by researchers at the international level (APAT, 2005). Biodiversity, soil density of microorganisms and biomass change as the type of soil, the type of plant and the cultural techniques implemented. A square m^2 soil usually contains a population of about 200 000 arthropods and billions of microbial organisms. One hectare of soil of good quality containing an average of 1300 kg of worms, arthropods 1000 kg, 3000 kg of bacteria, 4000 kg of mushrooms and a higher vegetable biomass (Pimentel, D., et al.1995). Different organisms that live together in rhizosphere as fungus, bacteria, nematodes, protozoa perform specific functions in different but coordinated their complex supporting the growth and development of plants (Bais, H.P., et al.1995, Buée, M. et al.2009). The diversity of microorganisms inside an agro-ecosystem is a major key to maintaining a quality health condition of agricultural soils (Bomeman, J., 1996). Soil microorganisms (pedo-fauna) interact and are dependent on terrestrial environment and can be used to evaluate its qualities. Separation of soil microorganisms in micro, meso and macro-networks (Pokarzhevskii, A.D., 1996, Lavelle,P., 1997), helps in the assessment. Meso-networks (mezo-fauna, size 2 to 0.2mm) acharie, collembola, larvae of dipters, coleopteres, enchitreides, pseudoscorpions, some miriapods, etc., are considered suitable for this assessment. Acharies and collembula usually comprise 90-95% of micro-arthropods and their density varies according to the environment. Acharies are arthropods category with the highest density in the terrestrial environment (Al-Deeb, et al., 2003). Selection, evaluation and implementation of soil arthropods as bio-indicators are handled by McGeoch (1998). To evaluate the functionality and biological qualities, used between the methodologies recommended by the literature, the use of biological indicators of soil qualities (Biological Quality Status “QBS”) (Parisi, V.,2001), which is based on the presence of micro-arthropods populations present and describing the functions and levels of biodiversity, is the adaptation and most widely used. Simplification of agricultural systems inevitably brings a qualitative and quantitative reduction of pedo-fauna, consequence of microbial activity (Nannipieri, P., et al., 2003). Conventional farming systems affect soil biodiversity by changing the structural balance of the communities of soil micro-organisms (Bolton, Jr.H. et al.1985, Doran, J.W., 1980, Ramsay, A.J., 1986). Composition and community structure in soil depend not only on the interactions between plant species present and also the physical-chemical nature of the soil (soil structure, moisture, pH, temperature and nutrients present) that affect microbial life and organisms out selection with appropriate (Garbeva, P., et al.2004). Several studies have shown links between existing soil biodiversity and its functions (Nannipieri, P.,et al., 2003). Environmental factors and soil typology affecting the microbial diversity of soil (Girvan, M.S., et al., 2003), and agricultural practices used or the type of treatment can be performed to identify significant changes in biodiversity (Gomez, E., et al.2006), with consequences sometimes difficult, if not impossible, to be recovered (Mocali, S., et al.2008). We sustainable agricultural systems that cultivate land they have by tradition a through understanding of biodiversity and its components, it is necessary to integrate the new agricultural schemes in order to maintain the rural territories and resources of their development (Altieri, M.A., Hech,t S.B.,1991). In practice agriculture required to play a multifunctional role (Jordan, N., et al., 2007),with the valence socio-economic and environmental. Just this study, through an analysis using bio-indicators is to define structural and functional differences of soil biodiversity (pedo-fauna) in the two types of agro-ecosystems.

Material and methods

The study analyzes two farms in the area of Luz in Kavaja, Mediterranean area field, a farm cultivated apple (*Malus domestica*) "*Golden Delicious cv*." in biological management and other holdings, cultivated apple (*Malus domestica*) in conventional cultivation, in this area. We apply biological farm practices allowed in biological agriculture (plant association, turnover, treatments for fertilization with compost and integrated protection of plants without the use of pesticides, preparations only by Albanian law allowed for biological agriculture (Law No.9199, date 26.02.2004, Annex II). The apple orchard with conventional breeding is treated with intensive techniques (works the soil, keeping the area free of vegetation, manures and complementary treatments with pesticides and herbicides). The study was conducted during the years 2011 - 2012 (the period from April to June), in order to compare the impact of farming practices on soil biodiversity (pedo-fauna) and its quality. Analysis of soil biological communities through the study of arthropods, serves as proof to verify the difference in the two types of agro-ecosystems (Paris V, 2001, Finnamore, A.T., et al., 2002)). For the series of samples, taken analyzed the level of diversity through indicators QBS (Quality Biological Status) (Parisi V., 2001) and indicators of diversity (Shannon C. E. and Weaver W., 1948) dhe (Simpson E.H., 1949). Simpson's Diversity Index (1949), $\boldsymbol{D=1/\Sigma pi^2}$, serves expressed as the number of species of community and the way in which organisms are distributed in different species. Optimal value X> 25. Indicator Shannon-Wiener (H '): $\mathbf{DST = -\Sigma^n{}_1(Ps * log_n\, Ps)}$ where: s = n ° of species identified; Ps =% the presence of each species to the total, said structural diversity. Optimal Value: X> 2. (ISPRA,2008). It is commonly used indicator of ecological analyzes (Vincent, P., et al., 2002; Bouchet, V.M.P. & Sauriau, P.G., 2008). Allows to measure the diversity of species (*taxa*) present, by considering the specific richness and balance: $\boldsymbol{H = -\Sigma(ni/N)log(ni/N)}$, where: ni = number of individuals of the species-*i*: N = total number of individuals. Reputation to Shannon Index is made through EcoQ (Ecological Quality Status) where the threshold value of this indicator are taken as those given stabilized by Vincent P., (2002). We parcels in conventional and biological breeding samples were taken for entomological target species (arthropod) (sample spring from April to June) through the fall traps (Pitfall Traps). In each plot were set three different positions, 3-5 traps along a line 120 m, located 10 m between them, between March and June every 15 days. During sampling data were recorded in the seized files and species have been identified in laboratory. According to standard methodology samples were taken (soil samples) in both systems, which is analyzed by the presence of micro-arthropods through Berlese-Tüllgren selector (1905), (Dry-funnel methods). Samples were analyzed in the laboratory to their identify (respective classes) and are calculated for both cultivation systems. Biological soil quality is assessed through the use of indicators QBS (Parisi, V., et al.2005, Menta, C., et al. 2008). Differences of biodiversity values (calculation based on the values of diversity indices, Shannon-Wiener H'), were evaluated using analysis of variance (Anderson, M.J.,2001, Anderson M.J.,2005).

Results and discussion

Analysis pedo-fauna in both types of agro-ecosystems is performed by the data obtained from the sample. For each indicator of biodiversity is calculated as a percentage the loss of diversity in the orchard that conventional with biological respectively. Analysis of terrestrial biodiversity (pedo-fauna) the impact of farming systems the richness and diversity of entomological target species (carbides) in plots planted with apple tree *(Malus domestica*) through indicators shows a greater wealth and higher variability in biological systems.

Table 1: Values of indicators of entomological species richness (Simpson) and structural diversity (Shannon) in two cultivation systems

Cultivation system	***Year 2011***		***Year 2012***	
	Indicator species richness Simpson (no.) (Optimal value X> 25)	**The Shannon diversity index (Optimal value X> 2)**	**Indicator species richness (no.) (Optimal value X> 25)**	**The Shannon diversity index (Optimal value X> 2)**
Biological cultivation	33	3.1	38	3.4
Conventional cultivation	13	1.5	16	1.8
The loss of diversity	20	51%	22	43%

The analysis result of the apparent difference between conventional farming and the biological regarding pedo-fauna, which is evidenced by the values of diversity indices as indicated by previous works (Gomez, E., et al., 2006). Cultivation practices implemented in biological systems, apparently favor a greater presence and a greater variability in the level order / family groups entomological different target species, as seen from the data, where the values of species richness and diversity indices of Shannon, exceed the optimal threshold values. Seen a great loss to 51% in 2011 and 43% in 2012 the level of diversity by conventional breeding practices. Even species richness indices have decreased 20 species in 2011 and 22 species in 2012. According to the technical files show that treatment is carried a relatively high number of works, especially reaming, threading, where it seems that the compression of soil and lack of ventilation are the main factors in this process as from other studies conducted is observed that the structure of the soil affects the diversity and community structure more visible than pH and organic matter (Sessitsch, A., et al.,2001). Frequent treatments performed with herbicides and pesticides, their submission to the underground layer has impoverished the presence of arthropods on land. Similar results have been achieved by other authors (Paoletti, M.G., 1999).

Table 2: Threshold values for the indicator to EcoQ H' in two cultivation systems

Cultivation system	EcoQ	H’	Threshold values of EcoQ different for H '
Biological cultivation (average)	good	3.1	3 < H’ < 4
Conventional cultivation (average)	poor	1.2	1 < H’ < 2

The results presented in table 2 demonstrate that administred parcels practices with biological the community of pedo-fauna is a rich and diversified though not the value "*high*", according to indicators EcoQ (Ecological Quality Status), whereas in conventional breeding value index gives EcoQ "*poor*". Conventional cultivation practices sometimes have consequences that are difficult, if not impossible, to be recovered for the pedo-fauna communities (Mocali, S., et al., 2008).

By analyzing the populations of micro-arthropods sampled (Berlese-Tüllgren,1905), in both biological and conventional systems of cultivation evidenced the presence of different groups of their underground layer. We plot the practice of managing biological noticed a higher presence of these groups. So the highest observed value of QBS, based on the assessment of indicators of Shannon-Wiener diversity-H' (Shannon,F.P.,Weaver,W.,1963).

Table 3: Values of indicators of diversity micro-arthropods of soil

Cultivation system	Indicators (2011)				Indicators (2012)			
	The number of biological groups	Density (individ/m^2)	QBS	Shannon-Wiener - H’.	The number of biological groups	Density (individ/m^2)	QBS	Shannon-Wiener - H’.
Biological cultivation	22	38 500	92	3.1	28	39 000	98	3.4
Conventional cultivation	14	22 000	43	1.5	17	28 500	46	1.8
The loss of diversity	8	16 500	56 %	51 %	11	11 500	52%	43%

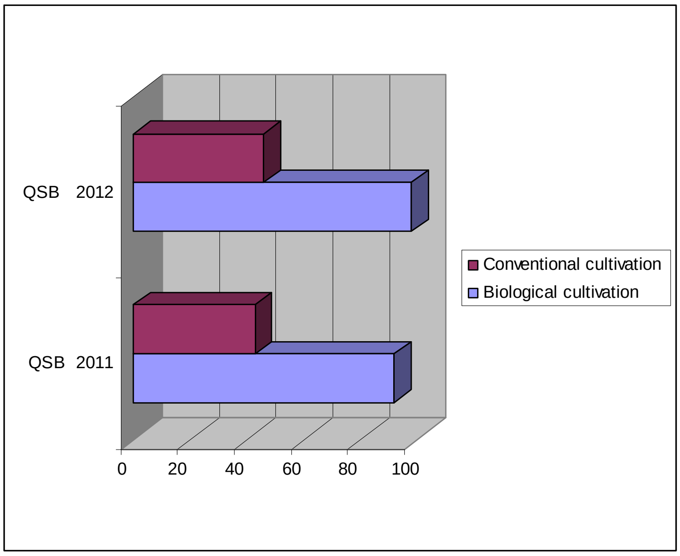

Figure 1: Indicator values the diversity of QBS (Quality Biological Status) in biological and conventional systems of cultivation.

From the analysis, we have seen that the highest value number of biological groups, the density individ/m^2, the QBS indicators and indicators of Shannon H', in the biological system of cultivation. The presence of higher systemic groups of micro-arthropods for biological cultivation system owes practices used, the model of farm where different typologies of ecological infrastructures serve as soil arthropods sites and the presence of ecological compensation spaces (with vegetation generations) significant impact on the level of soil arthropods. We plot conventional chemical manures, treatments with pesticides and other intensive practices, seen a smaller number of biological groups, with small density of individ/m^2, the index of Shannon H 'and the indicators QBS (Quality Biological Status). Evidence that the biological farming system through bio-monitoring of soil arthropods as bio-indicators, there is a higher quality biological soil.

Conclusions

Analysis of the above indicators identifies a higher presence of soil biodiversity in the system of biological cultivation of apple tree (*Malus domestica*) from cultivation practices that increase the system stability and reduce negative impacts. Biological indicator of soil qualities QBS which results in higher values for biological system, confirms the positive effects of this system. Lower values of indicators QBS in the conventional system with 56% in 2011 and 52% in 2012 to less show that this system, through management practices that bring negative impacts applies with regard to soil microorganisms and its biological qualities. Recent studies have proven that the administration of land, as flows, work, treatments with pesticides and chemical fertilizers, use of compost and irrigation significant impact on microbial parameters (Schonfeld, J., 2002, Bonanomi, G., 2011). The data obtained from this study are useful as evidence the fact that sustainable practices used in biological agriculture bring to preserve the land resource, the biological qualities of its internal balances and agro-ecosystem functioning.

The data this study highlight the importance of using Bio indicator system as an important indicator for assessing the biological qualities of soil, sustainability and environmental qualities of agricultural systems. The conclusions of this study are to converge with those obtained by other authors (Dauvin, J.C.,et al., 2007) and show that there exists a universal indicator that can be applied in all situations and that the sustainability of these indicators is questionable (Borja, A.,et al., 2009).

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