ISSN 1392-3196
Zemdirbyste-Agriculture, vol. 97, No. 2 (2010), p. 15–24
UDK 631.41:631.434:631.465:631.48

Variation of land use and land cover effects on some soil physico-chemical characteristics and soil enzyme activity

Rıdvan KIZILKAYA, Orhan DENGİZ

Ondokuz Mayıs University
55139 Samsun, Turkey
E-mail: odengiz@omu.edu.tr

Abstract

The main objective of this study was to determine some chemical, physical properties and extracellular enzymatic activities of soil modified after forestland transformation into cropland and pasture in Çankırı-Uludere watershed. In this study, the changes in the properties of four different pedons classified as *Lithic Leptosol* (Lithic Xerorthent, *LPq*), *Dystric Cambisol* (Typic Dystroxerept, *CMd*) and *Haplic Cambisol* (Typic Haploxerept, *CMha*) located on three adjacent land use types which are native forest, pasture and cultivated fields include some extracellular enzymes, organic matter, pH, EC, $CaCO_3$, bulk density, total porosity, hydraulic conductivity and aggregate stability. The effects of agricultural practices on soil properties taken from each four adjacent land use types were most clearly detected in the past 50 years with the land use change. Land use change and subsequent tillage practices resulted in significant decreases in organic matter, total porosity, total nitrogen and soil aggregates stability. There was also a significant change in bulk density among cultivat, pasture and natural forest soils. Depending upon the increasing in bulk density and disruption of pores by cultivation, total porosity decreased accordingly. The data show that after long term continuous cultivation of the natural forest soils resulted in change in soils both in physical and chemical characteristics. In addition, it was found that changes of land use and land cover associated with organic matter content can alter the soil enzyme activities within the soil profile.

Key words: land use change, soil characteristic, soil enzyme activity.

Introduction

Land-use and land-cover change studies have provided critical inputs to large-scale biomass and forest cover assessments; future aims include reducing uncertainties in biomass estimates, understanding regional heterogeneities in changes, and quantifying linkages and feedbacks between land-use and land-cover changes, climate change, and other human and environmental components. Therefore, land-use and land-cover change will be the focus of scientific researches for a long time to come (Matson et al., 1997; Gol, Dengiz, 2008). Many researchers reported that the conversion of natural forest to other forms of land use can provoke soil erosion and lead to a reduction in soil organic content, lost soil quantity and modification of soil structure (Lichon, 1993; Chen et al., 2001).

Similar result was found by Jiang et al. (2006). In their study, they indicated that soil organic matter content decreased from 38.02 g kg^{-1} to 25.76 g kg^{-1} in the past 20 years (1982–2003) after transformation of forestland into cultivated land. These changes in organic matter content following land transformation can connect distribution and stability of soil aggregates (Elliott, 1986).

Soils sustain the forest and provide raw materials for its life by recycling fallen leaves, woody debris, and dead animals (Barreto et al., 2000). The soil in order to supply the main needs to trees has to be a mixture of air, water, decaying organic and inorganic material and billions of living organisms within the surrounding ecosystem. Land use changes such as forest clearing, cultivation and pasture introduction are known to result in changes in soil chemical, physical and biological properties (Houghton et al., 1999), yet the sign and magnitude of these changes vary with land cover and land management (Baskin, Binkley, 1998; Celik, 2005).

Soil is a complex system wherein chemical, physical and biochemical factors are held in dynamic equilibrium. Studies of enzyme activities provide information on the biochemical processes occurring in soil. There is growing evidence that soil biological parameters may be potential and sensitive indicators of soil ecological stress or restoration (Kızılkaya, Bayraklı, 2005) and management-induced changes in soil quality (Kennedy, Papendick, 1995). Measurements of several extracellular enzymatic activities such as urease, phosphatase, glucosidase and sulphatase have been used to establish indices soil biological fertility (Dick, Tabatabai, 1992). Therefore, it is thought that assessment of physical, chemical properties and extracellular enzymatic activities of soil upon conversion of natural pastures for agriculture is very significant to distinguish early variations in soil quality.

The objective of this study was to determine some chemical, physical properties and extracellular enzymatic activities of soil modified after forestland transformation into cropland and pasture in Çankırı-Uludere watershed. In this study, the changes in the properties of four different pedons located on three adjacent land use types which are native forest, pasture and cultivated fields include some extracellular enzymes, organic matter, pH, EC, $CaCO_3$, bulk density, total porosity, hydraulic conductivity and aggregate stability.

Materials and methods

Description of the study field. The study area is located in Çankırı-Uludere watershed, which extends from 40º 45′ to 40º 52′ N latitude and has an elevation between 1200–1846 m above sea level within longitude 33º 37′ and 33º 52′ E in Central Anatolia of Turkey (Figure 1). The study was carried out in 2009. According to Thorntwaite (1948), half humid micro thermal having abundant water supply in winter land climate and that was coded with C2B1's2d'. The long-term mean annual temperature and precipitation were 9.1ºC and 530.8 mm, respectively. Topography and slope show great variations and hilly and rolling physiographic units are particularly common in the study area. Geology of the study area is dominantly composed of ophiolitic series and basalts. In addition, there are marls, conglomerates and stone in the study area. The research area is located in the Iran-Turan flora zone that is one of the three major flora zones of Turkey and lies in the A_4 square according to the Davis's grid system (Davis, 1965). Dominant tree species of natural forest are *Pinus sylevestris* L. and *Abies nordmanniana* in Uludere watershed. Some part of natural forest has been fragmented and degraded by such human disturbances as clearance for agriculture activities and pasture. Forest has been cultivated for at least 50 years with wheat and barley in a rational manner.

Soil sampling and analysis. Four soil profiles were selected for this study from four sites in each of four adjacent land use types which are native forest, pasture and cultivated fields. These adjacent four profiles locate on the similar aspect, elevation and slope. Morphological properties of these four soil profiles in the field were identified and sampled by genetic horizons and classified according to Soil Survey Staff (1993 and 1999) and FAO/ISRIC (2006). 18 disturbed and 16 undisturbed soil samples were taken to investigate for their physical and chemical properties at the laboratory. Disturbed soil samples were then air-dried and passed through a 2 mm sieve to prepare for laboratory analysis.

Soil physico-chemical analysis. Undisturbed soil samples were taken by using a steel core sampler of a 100 cm volume. Bulk density and total porosity were determined with the undisturbed soil samples. Dry bulk density was determined by the core method (Blake, Hartge, 1986). Total porosity was calculated in undisturbed water-saturated samples of 100 cm^3 assuming no air trapped in the pores and validated using dry bulk density and a particle density of 2.65 g cm^{-3} (Danielson, Sutherland, 1986). After disturbed soil samples were then air-dried and passed through a 2 mm sieve, particle size distribution was determined by the hydrometer method (Bouyoucos, 1962). A wet sieving method was used to determine the percentage of aggregate stability (water stable aggregates, WSA%) (Kemper, Rosenau, 1986). Soil organic carbon was measured by wet digestion (Nelson, Sommers, 1982). Values of soil organic carbon were multiplied by a factor 1.72 to obtain soil organic matter. pH, EC-electrical conductivity (of the saturation) by method of the (Soil Survey Staff, 1992).

Soil enzyme activities. β-glucosidase (EC 3.2.1.21) activity (GA) was measured according to Eivazi and Tabatabai (1988). 0.25 ml toluene, 4 ml TRIS (hydroximethyl) aminomethane buffer (pH, 12) and 1 ml of 0.05 M *p*-nitrophenyl β-D-glucopyranoside solution were added to the 1 g sample and the samples were incubated for 1 h at 37ºC. The formation of *p*-nitrophenol was determined spectrophotometrically 410 nm and results were expressed as μg *p*-nitrophenol g^{-1} dry sample.

Urease (EC 3.5.1.5) activity (UA) was measured by the method of Hoffmann and Teicher (1961). 0.25 ml toluene, 0.75 ml citrate buffer

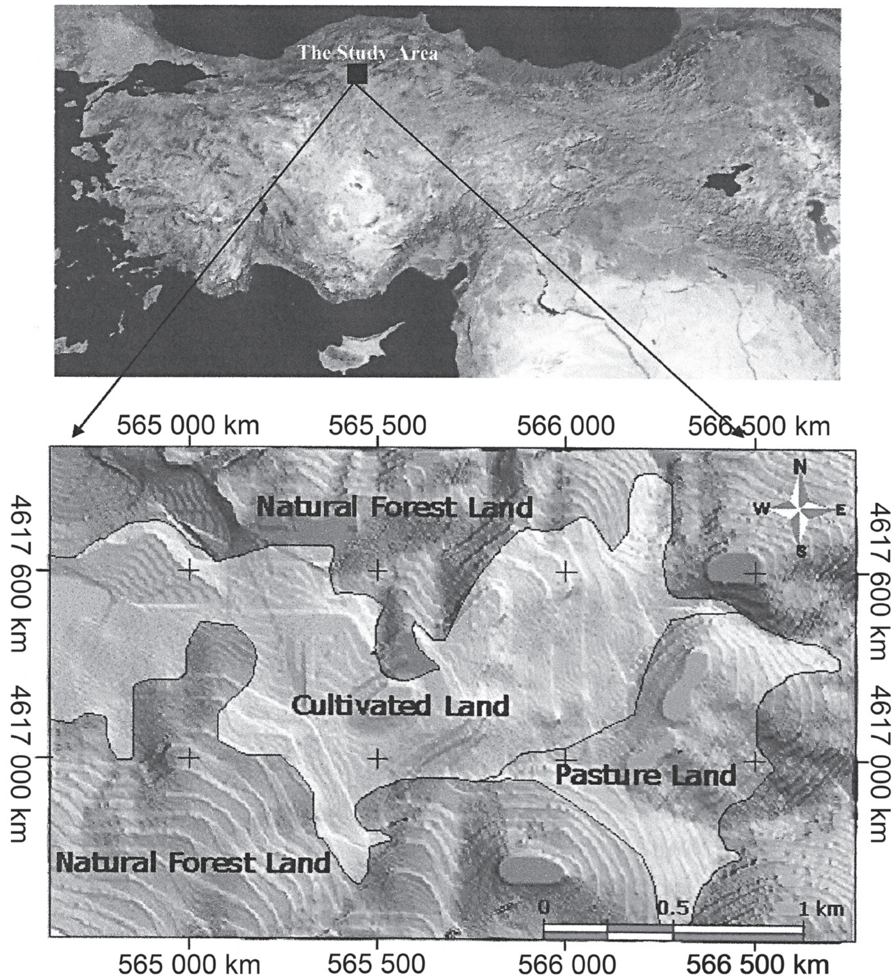


Figure 1. Location map of the study area

(pH 6.7) and 1 ml of 10% urea substrate solution were added to the 1 g sample and the samples were incubated for 3 h at 37ºC. The formation of ammonium was determined spectrophotometrically at 578 nm and results were expressed as μg N g^{-1} dry sample.

Alkaline phosphatase (EC 3.1.3.1) activity (APA) was determined according to Tabatabai and Bremner (1969). 0.25 ml toluene, 4 ml phosphate buffer (pH 8.0) and 1 ml of 0,115 M *p*-nitrophenyl phosphate (disodium salt hexahydrate) solution were added to the 1 g sample and the samples were incubated for 1 h at 37ºC. The formation of *p*-nitrophenol was determined spectrophotometrically at 410 nm and results were expressed as μg *p*-nitrophenol g^{-1} dry sample.

Arylsulphatase (EC 3.1.6.1) activity (ASA) was measured according to Tabatabai and Bremner (1970 a). 0.25 ml toluene, 4 ml acetate buffer (pH 5.5) and 1 ml of 0.115 M *p*-nitrophenyl sulphate (potassium salt) solution were added to the 1 g sample and the samples were incubated for 1 h at 37ºC. The formation of *p*-nitrophenol was determined spectrophotometrically 410 nm and results were expressed as μg *p*-nitrophenol g^{-1} dry sample.

Statistical analysis. All determinations of enzymatic activities were performed in triplicate, and all values reported are averages of the three determinations expressed on an oven-dried soil basis (105ºC). Statistical analyses were performed by using the *Statistical Package for Social Science* (SPSS 10.0) program. The asterisks, * and ** indicate significance at $P < 0.05$ and $P < 0.01$, respectively.

Results and discussion

Physico-chemical properties of soil. Conversion of the natural forest into continuous cultivation had resulted in significant reductions of both the concentration and stock of organic matter. Lobe et al. (2001) reported that the organic matter content in soils decreased rapidly in the first few years they were cultivated. On the long-term cultivated lands and pasture, the topsoil contained less organic matter than the continuously natural forestland due to forest clearance and high decompositions in the study area. Cultivated soils generally have low organic matter content compared to native ecosystems, since cultivation increases aeration of soil, which enhances decomposition of soil organic matter. In addition, most of the soil organic matter produced in cultivated lands was removed with harvest while crop residues left over the soil and were placed under the soil with plough. The previous studies also reported that conversion of forest to cultivated land significantly decreased soil organic matter content (Riezebos, Loerts, 1998; Jaiyeoba, 2003). Organic matter content showed a decreasing trend through soil profile in land use types. In this study, soil pH tends to increase in the cultivated lands. The pH values of the natural forest, pasture and cultivated lands varied significantly from 6.03 to 7.71 (Table). Natural forest and pasture soils were more acidic than those of the cultivated sites. However, soil pH slightly increases with soil depth due to accumulation of basic cations in cultivated lands. Lime content in forest and pasture soil was similar while lime content significantly increased under cultivated land. The highest lime content was obtained at 43–50 cm depth of the cultivated land.

Table. Selected physical, chemical properties for the four typical soil profiles under different land uses

Horizon	Depth cm	Particle size %				pH	EC dS m^{-1}	OM %	$CaCO_3$ %	T.P m^3 m^{-3}	B.D g cm^{-3}	WSA %
		Sand	Silt	Clay	Class							
Profile 1. Land use type: natural forest (*Pinus sylvestris* L.) / soil class: *Lithic Leptosol* (Lithic Xerorthent)												
A	0–13	58b	25c	17a	SL	6.68b	1.63a	6.55a	0.72a	0.618a	1.01b	86a
C1	13–20	58b	27b	15b	SL	6.83a	1.45b	1.84b	0.61b	0.475b	1.39a	75b
C2	20–38	59a	30a	11c	SL	6.24c	1.19c	1.30c	0.15c	0.467b	1.41a	56c
R	38+	–	–	–	–	–	–	–	–	–	–	–
Profile 2. Land use type: natural forest (*Abies nordmanniana)* / soil class: *Dystric Cambisol* (Typic Dystroxerept)												
A1	0–28	47c	28c	25a	SCL	6.03d	1.11d	6.24a	0.45b	0.645a	0.94d	88a
Bw1	28–38	48c	38a	13e	L	6.24c	1.19b	5.21b	0.40c	0.513c	1.29c	80c
Bw2	38–58	51b	30b	19d	L	6.67b	1.25a	1.96c	0.45b	0.521b	1.27c	82b
C1	58–70	72a	7d	22c	SCL	6.66b	1.12d	0.96d	0.41c	0.471d	1.40b	68d
C2	70+	73a	4e	23b	SL	6.72a	1.14c	0.52e	0.53a	0.430e	1.51a	65e
Profile 3. Land use type: pasture area / soil class: *Dystric Cambisol* (Typic Dystroxerept)												
A1	0–20	41d	34b	25c	L	6.13e	1.45a	1.81a	0.91b	0.528a	1.25b	83a
A2	20–46	47b	36a	17d	L	6.28d	1.36b	1.55b	0.96a	0.498c	1.33a	76c
Bw1	46–80	45c	28c	27b	L	6.60c	1.23c	0.69c	0.61c	0.509b	1.30b	78b
Bw2	80–100	34e	26c	40a	CL	6.78b	1.21d	0.61d	0.00e	0.498c	1.33a	51d
C	100+	55a	27c	18d	SL	7.46a	1.23c	0.56e	0.46d	–	–	–
Profile 4. Land use type: cultivated area / soil class: *Haplic Cambisol* (Typic Haploxerept)												
Ap	0–10	45a	26b	30e	L	6.94d	1.88a	2.81a	0.40e	0.521a	1.27d	62a
Ad	10–43	31e	28a	41a	L	7.46b	1.76b	1.55b	1.45d	0.422d	1.53a	51c
Bw	43–50	37d	24c	39b	CL	7.71a	1.75c	0.69c	3.62a	0.513b	1.29c	59b
BC	50–70	43b	25c	32d	CL	7.09c	1.68d	0.61d	2.53b	0.498c	1.33b	52c
C	70+	39c	24c	37c	L	7.48b	1.47e	0.56e	1.57c	–	–	49d

Notes. EC – electric conductivity, OM – organic matter, BD – bulk density, TP – total porosity, WSA – water stable aggregates.
Similar letters are not different in each soil profile.

Soil physical properties modified significantly after natural forestland transformed into cultivated and pasture lands. Particle size distributions of forest, pasture, and cultivated lands were presented in Table. Sand contents of the three land uses were greater than clay and silt content. Clay content was greater in cultivated land compared to forest and pasture lands. However, clay content of the cultivated soil was slightly greater than the other managements. The distributions of soil particles through profile were the similar in each land use types with lower variation. Similarly, Jaiyeoba (2003) indicated that clay contents of deeper depths increase with the increases of cultivation year due to either increases of clay translocation from the surface horizon or removal of clay from the surface by runoff.

Loss of organic matter by conversion of the natural forest into pasture and cultivated land caused a higher bulk density in cultivated soils. The greatest soil bulk density was observed in cultivated and fallowed by pasture and forest lands. This difference can be explained and ascribed to the compaction of the surface soil due to overgrazing and intensive field traffic. Similar results were reported by Islam and Weil (2000) that over the years, continuous tillage practices resulted in a bulk density increase from 1.22 g cm^{-3} to 1.38 g cm^{-3} in a tropical forest ecosystem of Bangladesh. Some studies have shown that when forest land is converted to pastureland, soils are subject to compaction and subsequently decreased porosity (Deuchars et al., 1999). Conversely, Carter et al. (1998) reported that when pasture is converted to woodland, infiltration increases with increasing forest age. In the study area, porosity also changes due to transformation of natural forestland into pasture and cultivated lands. Natural forestland has high organic matter led to low bulk density and increasing total porosity. However, amount of total porosity in cultivated lands diminished due to tillage causing to compaction.

Tillage of the soils breaks soil water stable aggregates (WSA). WSA values of soil aggregates were greater in the forest and pasture soils than in the cultivated soils. After long term continuous cultivation, the amount of WSA was significantly reduced 88% in the natural surface forest soil to 62% in cultivated surface soil (Table). Duiker et al. (2003) and Celik (2005), Gol and Dengiz (2008) reported that the presence of the aggregates is usually and positively associated with soil organic matter concentration. Loss of organic matter is expected to have soil aggregates easily detach each other and finally the finer particles are transported by water erosion.

Soil enzyme activities. There were significant differences in extracellular enzyme activities for each land use type and soil pedon. To determine variation of soil enzyme activities of different land use and land covers in the study area, levels of soil enzyme activities through soil profile in each land use types are given in Figure 2. According to present results, it was determined that extracellular enzyme activities showed a significantly decreasing trend through all sub soil horizons of each land use types and soil pedons and the minority of extracellular enzymes has generally remained in the C horizon of the all profiles. The decrease in extracellular enzyme activities with depth can be mainly attributed to the diminution of biological activity down the profile. This result is supported by Tabatabai, Bremner (1970 b), Deng and Tabatabai (1997), Dengiz et al. (2007). On the other hand, all extracellular enzyme activities were found the highest level in surface horizons of all pedons due to organic matter content and high rhizosphere condition. Enrichment of organic matter and enzyme activities in surface soil is also reported by many researchers (Estermann, McLaren, 1961; Frankenberger, Tabatabai, 1982).

Glucosidases are widely distributed in nature and their hydrolysis products as low molecular weight sugars are important source of energy for soil microorganisms. β-glucosidase catalyzes the hydrolysis of β-D-glucopyranoside and is one of the three or more enzymes involved in the saccharification of cellulose (Bandick, Dick, 1999; Turner et al., 2002). In the study area, the higest β-glucosidase activity was determined in natural forest soils whereas, the lowest level of it was found in cultivated soil (Figure 2). This might have resulted from high organic matter content of forest lands (Table).

Urease is involved in the hydrolysis of urea to carbon dioxide and ammonia, which can be assimilated by microbes and plants. It acts on carbon-nitrogen (C-N) bonds other than the peptide linkage (Bremner, Mulvaney, 1978). In the study area, the highest urease activity was determined in pasture land whereas, the lowest level of it was found in cultivated soil. Although organic matter content is lower in pasture land than that of forest land, this enzyme activity was found high level in pasture land. This case can be explained that pasture lands in the study area have been used for grazing and animal liquid and solid manure including urea contaminate and accumulate in the soil. Therefore, this enzyme activity increases in soil. Kızılkaya and Ekberli (2008) reported that urease activity was significantly increasing with increasing urea concentration.

As for alkaline phosphatase and arylsulphatase activities, phosphatase is an enzyme of great agronomic value because it hydroles compounds of organic phosphorus and transforms them into different forms of inorganic phosphorus, which are assimilable by plants (Amador et al., 1997). Variations in phosphatase activity apart from indicating changes in the quantity and quality of a soil's phosphorated substrates are also a good indicator of its biological state (Pascual et al., 1998; 2002). Arylsulphatase is the enzyme involved in the hydrolysis of arylsulphate esters by fission of the oxygen-sulphur (O-S) bond. This enzyme is believed to be involved in the mineralization of ester sulphate in soils (Tabatabai,

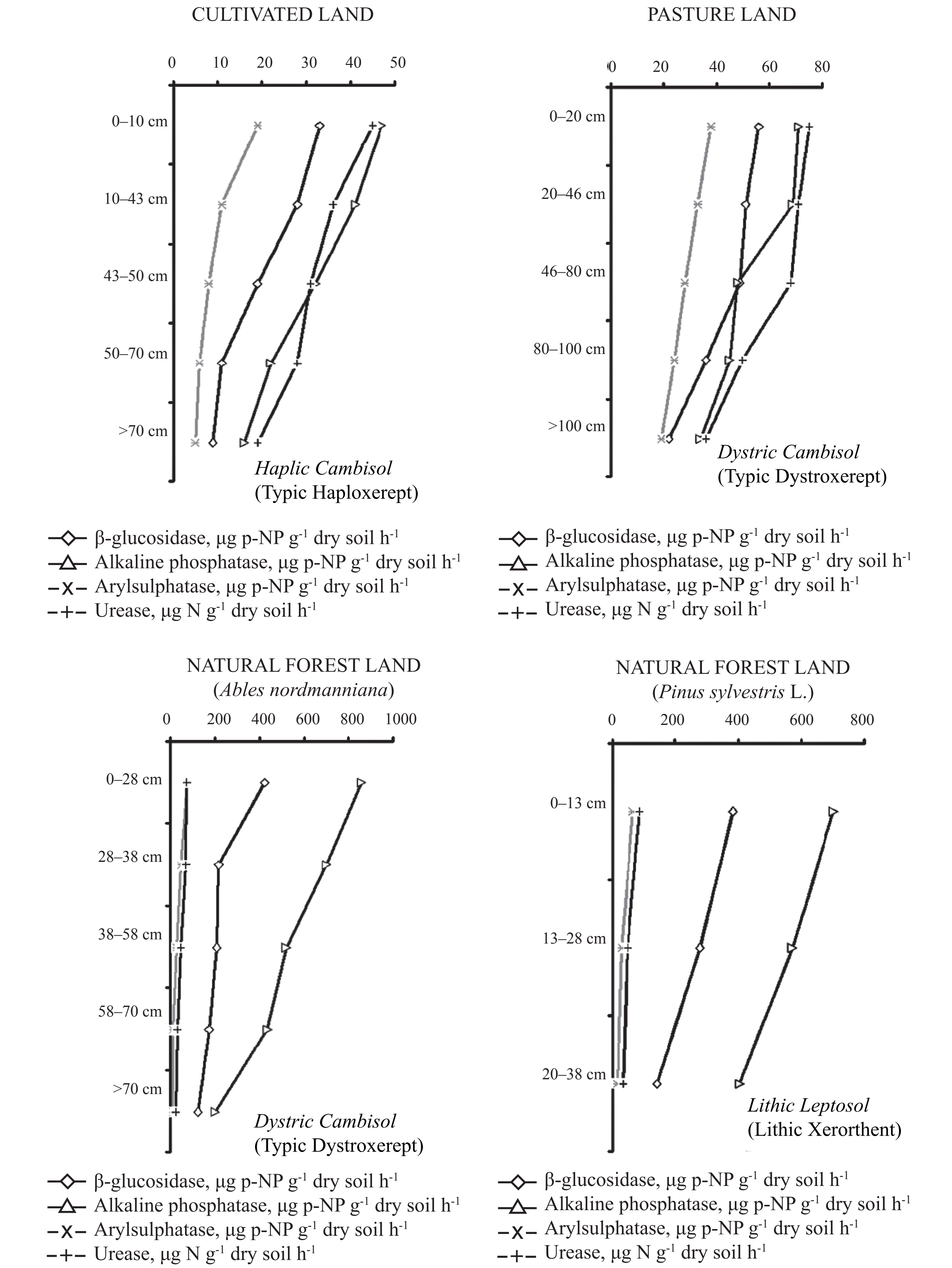
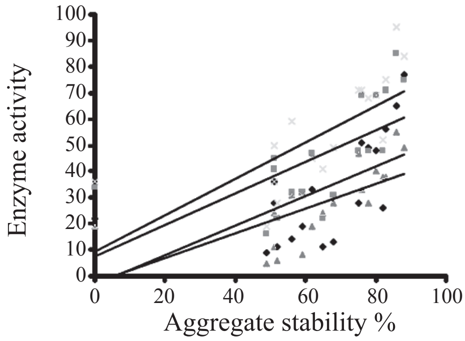


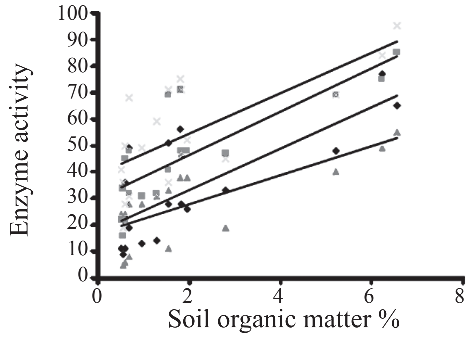
Figure 2. Changes in extracellular enzyme activities at various soil depths

1994). Also, it may be an indirect indicator of fungi as only fungi (not bacteria) contain ester sulphate, the substrate of arylsulphatase (Bandick, Dick, 1999) and this enzyme is believed to be involved in the mineralization of ester sulphate in soils (Tabatabai, 1994). In the study area, the highest alkaline phosphatase and arylsulphatase activities were determined in natural forest soils whereas, their lowest levels were found in cultivated soil (Figure 2). The soil organic matter gave also the significant correlations with alkaline phosphatase and arylsulphatase activities. On the contrary, extracellular enzyme activities were found different level in each natural forest types (*Pinus sylvestris* L. and *Abies nordmanniana*). *Abies nordmanniana* has higher level extracellular enzyme activities than that of *Pinus sylvestris* L. This might have resulted from organic matter component of these trees. According to some studies, it was reported that different organic matters and their components significantly influence soil extracellular enzyme activities (Hadas et al., 2004; Jezierska-Tys, Frac, 2005).

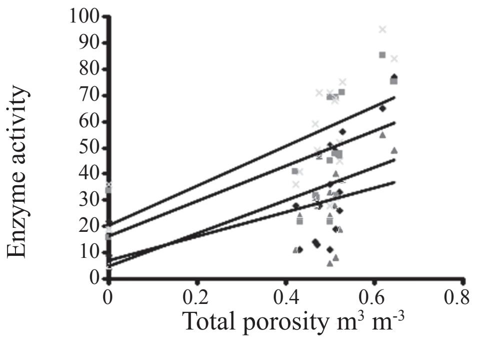
The relationships between soil enzyme activities and physico-chemical properties of soil. Correlation analysis was carried out to determine relationships between extracellular enzyme activities and soil physico-chemical properties. Significantly positive relationships between β-glucosidase, urease, alkaline phosphatase, arylsulphatase and WSA, total porosity (TP) and organic matter (Figure 3) were found.



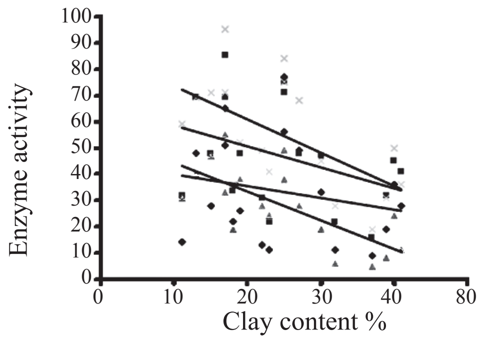
β-glucosidase activity, y = 0.5656x − 3.3722
r = 0.579**
Urease activity, y = 0.6978x + 9.3776
r = 0.696**
Alkaline phosphatase activity, y = 0.6018x + 7.5734
r = 0.622**
Arylsulphatase activity, y = 0.4718x − 2.4875
r = 0.657**



β-glucosidase activity, y = 7.8393x − 17.424
r = 0.579**
Urease activity, y = 7.6426x + 39.095
r = 0.717**
Alkaline phosphatase activity, y = 8.1707x + 30.038
r = 0.795**
Arylsulphatase activity, y = 5.4417x + 17.055
r = 0.713**



β-glucosidase activity, y = 62.314x + 4.9761
r = 0.530*
Urease activity, y = 75.36x + 20.364
r = 0.624**
Alkaline phosphatase activity, y = 66.829x + 16.216
r = 0.574**
Arylsulphatase activity, y = 46.146x + 7.1095
r = 0.533*



β-glucosidase activity, y = −0.4359x + 44.032
r = −0.206^{ns}
Urease activity, y = −1.2744x + 86.32
r = −0.585**
Alkaline phosphatase activity, y = −0.7932x + 66.264
r = −0.378^{ns}
Arylsulphatase activity, y = −1.0914x + 55.29
r = −0.700**

Figure 3. The relationships between soil physico-chemical properties and extracellular enzyme activities

According to some researchers (Leirós et al., 2000; Kızılkaya et al., 2004), soil organic matter content is usually and positively associated with soil enzymes activities. The decrease in enzyme activities with depth can be mainly attributed to the diminution of biological activity down in all pedons. The same results were found by Bergstrom et al. (1998). They suggested that higher proportion of organic matter and enzyme activities such as urease, phosphatase, arylsulphatase, β-glucosidase and dehydrogenase in A horizon in a Grey Brown Luvisol (Hapludalf). In this study, positive relation results were determined between extracellular enzyme activities and WSA and TP. In this case, WSA and TP are usually and positively associated with soil organic matter content. In addition, statistically positive relation was found between organic matter and WSA (r = 0.489*) and TP (r = 0.489*). On the contrary, significantly negative relationships were determined among urease and arylsulphatase and soil clay content, whereas no relationship was found among β-glucosidase, alkaline phosphatase and clay content.

Conclusion

The study of land use changes from the past to the present will contribute greatly to the planning work to be done concerning the future. It will also be of help in the determination of precautions needed to be taken for a sustainable environment, which is a concept frequently discussed nowadays (Gulgun et al., 2009).

Long periods of continuous cultivation of natural forest land led to changes in some of the physical, chemical properties and enzyme activities of soils. Soil characteristics negatively affected by tillage practices are soil organic matter, total porosity, aggregate stability and bulk density. Especially, after natural forest land transformation into cultivated land, decreases of organic matter have crucial effects on soil physical and chemical properties well explained the vulnerability of the structure and function of the natural forest system. Therefore some measurements should be taken. For example, Reeves (1997) reported that conservation tillage practices generally result in higher amounts of soil organic matter, reduced erosion, increased infiltration, increased water stable aggregates, and greater microbial activities when compared to conventional tillage systems.

Received 26 04 2010
Accepted 31 05 2010

References

Amador J. A., Glucksman A. M., Lyons J. B., Gorres J. H. Spatial distribution of soil phosphatase activity within a riparian forest // Soil Science. – 1997, vol. 162, p. 808–825

Bandick A. K., Dick R. P. Field management effects on soil enzyme activities // Soil Biology and Biochemistry. – 1999, vol. 31, p. 1471–1479

Barreto R., Tsegaye T., Coleman L. et al. Land use effect on the distribution of soil physical and chemical properties under tropical rainforests of Puerto Rico: International Geosciences and Remote Sensing Symposium (IGARSS). – Honolulu, Hawaii, 2000, p. 605

Baskin M., Binkley D. Change in soil carbon following afforestation in Hawaii // Ecology. – 1998, vol. 79, p. 828–833

Bergstrom D. W., Monreal C. M., Millette J. A., King D. J. Spatial dependence of soil enzyme activities along a slope // Soil Science Society of America Journal. – 1998, vol. 62, p. 1302–1308

Blake G. R., Hartge K. H. Bulk density: methods of soil analysis. Part 1: Physical and mineralogical methods // Agronomy Monograph No. 9, ASA-SSA. – Madison, USA, 1986, p. 363–375

Bouyoucos G. J. Hydrometer method improved for making particle size analyses of soils // Argronomy Journal. – 1962, vol. 54, p. 464–465

Bremner J. M., Mulvaney R. L. Urease activity in soils // Soil enzymes. – New York, 1978, p. 149–196

Carter M. R., Gregorich E. G., Angers D. A. Organic C and N storage, and organic C fraction, in adjacent cultivated and forested soils of Eastern Canada // Soil and Tillage Research. – 1998, vol. 47, p. 253–261

Celik I. Land-use effects on organic matter and physical properties of soil in a southern Mediterranean highland of Turkey // Soil and Tillage Research. – 2005, vol. 83, p. 270–277

Chen G., Gan L., Wang S. A comparative study on the microbiological characteristics of soils under different land-use conditions from karst areas of Southwest China // Chinese Journal of Geochemistry. – 2001, vol. 20, No. 1, p. 52–58

Danielson R. E., Sutherland P. L. Porosity: methods of soil analysis. Part 1: Physical and mineralogical methods // Agronomy Monograph No. 9, ASA-SSA. – Madison, USA, 1986, p. 443–461

Davis P. H. Flora of Turkey and the East Aegean Islands. – Edinburgh, 1965, vol. 1, p. 119–134

Dengiz O., Kizilkaya R., Gol C., Hepsen S. Effects of different topographic positions on soil properties and soil enzymes activities // Asian Journal of Chemistry. – 2007, vol. 19, No. 3, p. 2295–2306

Deng S. P., Tabatabai M. A. Effect of tillage and residue management on enzyme activities in soils. III. Phosphatases and arylsulfatase // Biology and Fertility of Soils. – 1997, vol. 24, p. 141–146

Deuchars S. A., Townend J., Aitkenhead M. J., FitzPatrick E. A. Changes in soil structure and hydraulic properties in regenerating rain forest // Soil Use and Manage. – 1999, p. 183–187

Dick W. A., Tabatabai M. A. Potential uses of soil enzymes // Soil microbial ecology: applications in agricultural and environmental management. – New York, 1992, p. 95–127

Duiker S. W., Rhoton F. E., Torrent J. et al. Iron (hydr) oxide crystallinity effects on soil aggregation // Soil Science Society of America Journal. – 2003, vol. 67, p. 606–611

Eivazi F., Tabatabai M. A. Glucosidases and galactosidases in soil // Soil Biology and Biochemistry. – 1988, vol. 20, p. 601–606

Elliott E. T. Aggregate structure and carbon, nitrogen and phosphorous in native and cultivated soils // Soil Science Society of America Journal. – 1986, vol. 50, p. 627–633

Estermann E. F, McLaren A. D. Contribution of rhizoplane organisms to the total capacity of plants to utilize organic nutrients // Plant and Soil. – 1961, vol. 15, p. 243–260

FAO/ISRIC. World references base for soil resources // World Soil Resources Report, No. 103. – Rome, 2006. – 128 p.

Frankenberger Jr. W. T., Tabatabai M. A. Amidase and urease activities in plants // Plant and Soil. – 1982, vol. 64, p. 153–166

Gol C., Dengiz O. Effect of modifying land cover and long-term agricultural practices on the soil characteristics in native forest-land // Journal of Environmental Biology. – 2008, vol. 29, No. 5, p. 667–682

Gulgun B., Yörük I., Turkyilmaz B. et al. Determination of the effects of temporal change in urban and agricultural land uses as seen in the example of the town of Akhisar, using remote sensing techniques // Journal of Environmental Monitoring and Assessment. – 2009, vol. 150, p. 427–436

Hadas A., Kautsky L., Goek M., Kara E. E. Rates of decomposition of plant residues and available nitrogen in soil, related to residue composition through simulation of carbon and nitrogen turnover // Soil Biology and Biochemistry. – 2004, vol. 36, p. 255–266

Hoffmann G. G., Teicher K. Ein Kolorimetrisches Verfahren zur Bestimmung der Urease Aktivitat in Böden // Zeitschrift für Pflanzenernährung und Bodenkunde – 1961, Bd. 91, S. 55–63

Houghton R. A., Hacker J. L., Lawrence K. T. The U.S. carbon budget: contributions from land use change // Science. – 1999, vol. 285, p. 574–578

Islam K. R., Weil R. R. Land use effects on soil quality in a tropical forest ecosystem of Bangladesh // Agriculture, Ecosystems and Environment. – 2000, vol. 1, p. 9–16

Jaiyeoba I. A. Changes in soil properties due to continuous cultivation in Nigerian semiarid Savannah // Soil and Tillage Research. – 2003, vol. 70, p. 91–98

Jezierska-Tys S., Frac M. Changes in enzymatic activity and the number of proteolytic microorganisms in brown soil under the influence of organic fertilization and cultivation of spring wheat // Polish Journal of Soil Science. – 2005, vol. 38, p. 81–68

Jiang Y. J., Yuan D. X., Zhang C. et al. Impact of land use change on soil properties in a typical karst agricultural region of Southwest China: a case study of Xiaojiang watershed, Yunan // Environmental Geology. – 2006, vol. 50, p. 911–918

Kemper W. D., Rosenau R. C. Aggregate stability and size distribution // Methods of Soil Analysis. Part 1: Physical and mineralogical methods // Agronomy Monograph No. 9, ASA-SSA. – Madison, USA, 1986, p. 425–442

Kennedy A. C., Papendick R. I. Microbial characteristics of soil quality // Journal of Soil and Water Conservation. – 1995, vol. 50, p. 243–428

Kızılkaya R., Aşkın T., Bayraklı B., Saglam M. Microbiological characteristics of soils contaminated with heavy metals // European Journal of Soil Biology. – 2004, vol. 40, p. 95–102

Kızılkaya R., Bayraklı B. Effects of N-enriched sewage sludge on soil enzyme activities // Applied Soil Ecology. – 2005, vol. 30, p. 192–202

Kizilkaya R., Ekberli İ. Determination of the effects of hazelnut husk and tea waste treatments on urease enzyme activity and its kinetics in soil // Turkish Journal of Agriculture and Forestry. – 2008, vol. 32, p. 299–310

Leirós M. C., Trasar-Cepeda C., Seoane S., Gil-Sotres F. Biochemical properties of acid soils under climax vegetation (Atlantic oakwood) in an area of the European temperate-humid zone (Galicia, NW Spain): general parameters // Soil Biology and Biochemistry. – 2000, vol. 32, p. 733–745

Lichon M. Human impacts on processes in karst terrenes, with special reference to Tasmania // Cave Science. – 1993, vol. 20, No. 2, p. 55–60

Lobe I., Amelung W., Du Preez C. C. Losses of carbon and nitrogen with prolonged arable cropping from sandy soils of the South African Highveld // European Journal of Soil Science. – 2001, vol. 52, p. 93

Matson P. A., Parton W. J., Power A. G., Swift M. J. Agricultural intensification and ecosystem properties // Science. – 1997, vol. 277, No. 25, p. 504–509

Nelson D. W., Sommers L. E. Total carbon, organic carbon, and organic matter // Methods of soil analysis. Part 2: Chemical and microbiological properties // Agronomy Monograph No. 9, ASA-SSA. – Madison, USA, 1982, p. 539–579

Pascual J. A., Hernandez T., Garcia C., Ayuso M. Enzymatic activities in an arid soil amended with urban organic wastes: laboratory experiment // Bioresource Technology. – 1998, vol. 64, p. 131–138

Pascual J. A., Moreno J. L., Hernández T., Garcfa C. Persistence of immobilized and total urease and phosphates activities in a soil amended with organic wastes // Bioresource Technology. – 2002, vol. 82, p. 73–78
Reeves D. W. The role of organic matter in maintaining soil quality in continuous cropping systems // Soil and Tillage Research. – 1997, vol. 43, p. 131–167
Riezebos H. T., Loerts A. C. Influence of land use change and tillage practice on soil organic matter southern Brazil and eastern Paraguay // Soil and Tillage Research. – 1998, vol. 49, p. 271–275
Soil Survey Staff. Procedures for collecting soil samples and methods of analysis for soil survey / Soil Survey, Invest. Rep. I, U.S. Gov. – Washington D.C., 1992, p. 687
Soil Survey Staff. Soil survey manual, USDA. Handbook No. 18. – Washington D.C., 1993, p. 342
Soil Survey Staff. Soil taxonomy, a basic of soil classification for making and interpreting soil survey, USDA. Handbook No. 436. – Washington D.C., 1999, p. 332
Tabatabai M. A., Bremner J. M. Arylsulphatase activity of soils // Soil Science Society of America Journal. – 1970 (a), vol. 34, p. 225–229
Tabatabai M. A, Bremner J. M. Factors affecting soil arylsulfatase activity // Soil Science Society of America Journal. – 1970 (b), vol. 34, p. 427–429
Tabatabai M. A., Bremner J. M. Use of p-nitrophenyl phosphate for assay of soil phosphatase activity // Soil Biology and Biochemistry. – 1969, vol. 1, p. 301–307
Tabatabai M. A. Soil enzymes // Methods of soil analysis. Part 2: Microbiological and biochemical properties. Soil Science Society of America Journal. – Madison, USA, 1994, p. 775–826
Thorntwaite C. W. An approach to a rational classification of climate // Geographic Review. – 1948, vol. 38, p. 55–94
Turner B. L., Hopkins D. W., Haygarth P. M., Ostle N. β-glucosidase activity in pasture soils // Applied Soil Ecology. – 2002, vol. 20, p. 157–162

ISSN 1392-3196
Žemdirbystė-Agriculture, t. 97, Nr. 2 (2010), p. 15–24
UDK 631.41:631.434:631.465:631.48

Įvairios žemėnaudos ir žemės dangos poveikis kai kurioms dirvožemio fizikinėms bei cheminėms savybėms ir dirvožemio fermentų aktyvumui

R. Kizilkaya, O. Dengiz
Turkijos Ondokuz Mayıs universitetas

Santrauka

Tyrimų tikslas – nustatyti kai kurias dirvožemio chemines bei fizikines savybes ir ekstraląstelinių fermentų veiklą po to, kai miško žemė buvo transformuota į dirbamą žemę ir ganyklą Çankırı-Uludere baseine. Tyrimų metu keturių skirtingų pedonų, klasifikuojamų kaip *Lithic Leptosol* (Lithic Xerorthent), *Dystric Cambisol* (Typic Dystroxerept) ir *Haplic Cambisol* (Typic Haploxerept) ir išdėstytų trijose greta esančiose žemėnaudos tipuose – miške, ganykloje bei dirbamame lauke, pokyčiai buvo nustatyti tiriant ekstraląstelinius fermentus, organinę medžiagą, pH, EC, $CaCO_3$, dirvožemio tankį, hidraulinį laidumą ir dirvpožemio trupinėlių stabilumą. Iš visų keturių žemėnaudos tipų paimto dirvožemio savybėms žemės naudojimo poveikis per pastaruosius 50 metų buvo ryškiausias ten, kur žemėnauda buvo pakeista. Dėl žemės naudojimo pakeitimo ir su tuo susijusio žemės dirbimo smarkiai sumažėjo dirvožemio bendrasis poringumas, organinių medžiagų bei suminio azoto kiekis ir dirvožemio trupinėlių stabilumas. Taip pat įvyko dideli dirvožemio tankio pokyčiai dirbamame, ganyklos ir miško dirvožemiuose. Priklausomai nuo padidėjusio dirvožemio tankio ir aeracinio poringumo sumažėjimo dirbant žemę, dirvožemio bendrasis poringumas atitinkamai sumažėjo. Tyrimų duomenys parodė, kad dėl natūralaus miško dirvožemio ilgalaikio nuolatinio dirbimo įvyko ir dirvožemio fizikinių bei cheminių savybių pokyčiai. Nustatyta, kad žemėnaudos ir žemės dangos pakeitimas, susijęs su organinės medžiagos kiekiu, dirvožemio profilyje gali pakeisti fermentų veiklą.

Reikšminiai žodžiai: žemėnaudos pakeitimas, dirvožemio savybės, dirvožemio fermentų aktyvumas.