ISSN 1392-3196
Žemdirbystė=Agriculture, vol. 97, No. 3 (2010), p. 15–24
UDK 631.442:631.461.7:631.416

The influence of land use on soil organic carbon and nitrogen content and redox potential

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Abstract

The aim of this research was to evaluate organic matter status in the soil according to the organic carbon content, total and mineral nitrogen amounts, carbon to nitrogen (C:N) ratio and redox potential depending on land usage and plant species.

Soil samples were taken from the fields under different farming systems (conventional and organic) as well as abandoned lands. We chose the plants of two botanical species (*Poaceae* and *Fabaceae*) in organic and conventional farming systems as well as in abandoned lands.

Experimental results show that the best soil organic matter status according to the investigated indexes is in the soils of conventional and organic farming systems occupied with mixtures of *Poaceae* and *Fabaceae* and the worst – in the soils of abandoned *Poaceae* meadows. In the abandoned lands, *Fabaceae* (galega) had better influence on soil organic matter status than *Poaceae*.

Key words: farming system, abandoned land, organic carbon, nitrogen, redox potential.

Introduction

The amount of organic matter (OM) in the soil is a function of environmental soil factors that humans cannot control. However, human management of soils, including the decision to convert land in natural vegetation to agricultural use or, conversely, land abandonment, can produce significant alternations in soil organic matter status (Szajdak, Maryganova, 2009). Soil organic matter is a critical component of soil-plant ecosystem and it changes with land use or agricultural management practices (Ghani et al., 2003). It has been proved that soil productivity has positive relationship with soil OM status indices, such as organic carbon (OC), humus amount, total nitrogen, mineral nitrogen (ammonium and nitrate) amounts, C:N ratio, redox potential, etc. (Smith et al., 1993; Meysner et al., 2006; Szajdak, Maryganova, 2009).

Turnover of soil OM depends on the composition of OM and cropping system (Pedersen et al., 2007), its usage (Helfrich et al., 2006) as well as tillage method (Szajdak et al., 2003; Sleutel et al., 2007). Long-term studies have shown a decline in OM with tillage intensity while decreasing tillage intensity and increasing surface residue cover have been shown to inhibit loss of OM from soils (Skjemstad et al., 1998; Szajdak et al., 2003). Continuous cropping results in decrease of biological equilibrium of the agro-ecosystems and lower yields as compared with crop rotation.

Soil nitrogen (N) occupies a unique position among the elements essential for plant growth because of the rather large amounts required by most agricultural crops. As much as 93 to 97% of the total nitrogen in the soil is closely associated with OM (Meysner et al., 2006). Therefore soil N amount and constitution of N forms are significant indicators of soil OM status. The assumption is often made that from 1 to 3% of the organic N in soil is mineralized during the course of the growing season (Korsaeth et al., 2002). The increasing of soil exploitation, intensive farming, soil erosion can lead to increased soil OM mineralization and N loses, reduced soil productivity, as well as polluted surface waters and air with NH_3, greenhouse gas N_2O (Haag, Kaupenjohann, 2001). Mineral N forms (ammonium and nitrate) are mobile, therefore could be washed out from the soil. There is a danger of contaminating groundwater. The magnitude of the leaching of inorganic forms of nitrogen depends on the amount and time of rainfall, infiltration and percolation rates, evapo-transpiration, the water-retention capacity of the soil, and the presence of growing plants (Meysner et al., 2006). The highest loss of soil N is due to nitrate (NO_3^-) leaching. In terrestrial ecosystems of Central Europe every year by an average of 15 kg NO^{3-} ha^{-1} is washed out (Haag, Kaupenjohann, 2001). However there are variations in mineral N leaching between farming systems due to differences in the production mix within farm-types (Meysner et al., 2006). Manure fertilization of sandy soils increases while litter manure decreases nitrate leaching as its mineralization is slow (Tripolskaja, Romanovskaja, 2001).

Soil OM indexes, such as organic carbon, humus, total and mineral nitrogen amounts in the soil are related to the farming system. Farming system is characterized by the crop rotation, fertilization, plant protection, etc. (Meysner at al., 2006). Also there are great areas of abandoned lands where OM status has not been investigated in Lithuania.

Redox potential (Eh) is studied mostly in anaerobic soils but Bohrerova et al. (2004) suggest that this easily measured soil characteristic which is affected by many processes in the soil could be used as an important indicator of processes in aerobic conditions as well. Soil redox reactions as well as Eh are related to the soil aeration, soil moisture, temperature, pH, chemical composition of soil solution and solid phase, OM amount and status, climate, irrigation regime, agrochemistry and agricultural engineering (Cogger et al., 1992; Bohrerova et al., 2004). The ongoing degradation processes of soil organic residues could be predicted by Eh data (Ugwuegbu et al., 2001). Increasing organic carbon amount in soil leads to Eh decrease. This is because oxidation processes in soils rich in readily decomposed OM (or added with fertilizers) consume big amounts of oxygen which may lead to form a lot of organic compounds with reducing properties. This phenomenon lowers the quality of soil. Also Eh may serve as a good indicator of nitrogen loss during temporarily anaerobic conditions in arable soils (Bohrerova et al., 2004).

The aim of the current research was to assess variations of soil OM status according to the organic carbon, total nitrogen and mineral nitrogen amounts, C:N ratio and redox potential subject to land usage (conventional, organic farming system, uncultivated land) and plant species (*Poaceae* and *Fabaceae*).

Materials and methods

The soil samples were taken from the fields of training farm of the Lithuanian University of Agriculture, Kaunas district, Lithuania. Each of the plots was limited to 1 ha. Each plot was occupied by different farming system (conventional (CF) or organic (OF) farming), also abandoned lands (AbdL) and covered by different plant species (*Poaceae* and *Fabaceae*). The characteristics of investigated fields are presented in Table 1. Continuous cropping (spring barley) system was applied in plot 1 for long a time while this plot had been left uncultivated since the year 2008. Plots 2 and 3 had not been cultivated for more than 20 years. In plots 4–6 conventional farming system and in plots 7–8 organic farming system were applied.

Plot 1 till the year 2008 was occupied by spring barley (*Hordeum vulgare*) while in 2009 it was abandoned and quack-grass (*Elytrigia repens*) predominated there. Plot 2 was occupied by forbs where *Poaceae* dominated. In plot 3 there were untended eastern galega (*Galega orientalis*) crops. Plots 4–8 were occupied with grain crops where such crop rotation was performed: plot 4 – oat (*Avena sativa*) and vetch (*Vicia sativa*) mixture – winter wheat (*Triticum aestivum* L.) – spring barley (*Hordeum vulgare*) with clover (*Trifolium pratense*) undercrop; plot 5 – oat (*Avena sativa*) and vetch (*Vicia sativa*) mixture – spring barley (*Hordeum vulgare*); plot 6 – winter wheat (*Triticum aestivum* L.) – rape (*Brassica napus*) – fallow; plot 7 – oat (*Avena sativa*) and pea (*Pisum sativum*) mixture – spring barley (*Hordeum vulgare*) – spring barley (*Hordeum vulgare*) with clover (*Trifolium pratense*) undercrop; plot 8 – winter wheat (*Triticum aestivum* L.) – oat (*Avena sativa*) and pea (*Pisum sativum*) mixture – spring barley (*Hordeum vulgare*).

The soil samples were taken in July during 2007–2009 according to ISO 10381-1:2002. Three composite samples consisting of 50 separate samples were taken from each field. The soil samples were air-dried, crushed, passed through a 2-mm sieve, mixed thoroughly, and stored in plastic containers at room temperature (ISO 11464:1994).

For each chemical analysis three samples of this soil were taken. Organic carbon content in soil was determined by wet oxidation method (ISO 14235:1998). Total nitrogen content in soil was determined by the Kjeldahl method (ISO 11261:1995). Mineral nitrogen (nitrate and ammonium) content was determined in the aqueous extracts of soil (1:5) by spectrophotometry (LST EN ISO 7890-3:1998 E; LAND 38-2000). Results were calculated on mass of dry soil. Redox potential (Eh) was determined in the aqueous extract of soil (1:5) using 692 pH / ion potentiometer. Analyses for each sample were performed in three replicates.

Table 1. Experimental design

No.	Coordinates	Soil classification	Year	Crop rotation	pH (H_2O)	Fertiliza-tion
1.	54°52′8.40″N	*Hapli-*	2007	CF, continuous crop. (spring barley)	7.01 ± 0.07	$N_{120}P_{50}K_{60}$
	23°50′11.99″E	*Epihypogleyic*	2008	AbdL, quack-grass	7.40 ± 0.03	0
		Luvisol,	2009	AbdL, quack-grass	7.09 ± 0.10	0
		loam				
2.	54°53′40.83″N	*Hapli-Albic*	2007	AbdL, *Poaceae* (meadow)	6.97 ± 0.03	0
	23°51′43.61″E	*Luvisol*,	2008	AbdL, *Poaceae* (meadow)	7.42 ± 0.01	0
		loam	2009	AbdL, *Poaceae* (meadow)	6.87 ± 0.09	0
3.	54°53′48.32″N	*Hapli-Albic*	2007	AbdL, *Fabaceae* (galega)	7.00 ± 0.01	0
	23°51′40.85″E	*Luvisol*,	2008	AbdL, *Fabaceae* (galega)	7.30 ± 0.02	0
		loam	2009	AbdL, *Fabaceae* (galega)	6.70 ± 0.04	0
4.	54°51′57.66″N	*Albi-*	2007	CF, mixture (oat-vetch)	7.04 ± 0.07	$N_{60}P_{50}K_{60}$
	23°48′44.77″E	*Epihypogleyic*	2008	CF, *Poaceae* (winter wheat)	7.33 ± 0.01	$N_{120}P_{50}K_{60}$
		Luvisol,	2009	CF, mixture (spring barley-clover)	6.61 ± 0.02	$N_{60}P_{50}K_{60}$
		loam				
5.	54°52′21.99″N	*Albi-*	2008	CF, mixture (oat-vetch)	6,49 ± 0,08	$N_{60}P_{50}K_{60}$
	23°48′40.00″E	*Epihypogleyic*	2009	CF, *Poaceae* (spring barley)	6,85 ± 0,01	$N_{120}P_{50}K_{60}$
		Luvisol,				
		loam				
6.	54°52′26.32″N	*Hapli-*	2007	CF, *Poaceae* (winter wheat)	7.00 ± 0.05	$N_{120}P_{50}K_{60}$
	23°51′56.48″E	*Epihypogleyic*	2008	CF, rape	7.15 ± 0.01	0
		Luvisol,	2009	CF, fallow	6.78 ± 0.03	0
		loam				
7.	54°52′30.92″N	*Hapli-*	2007	OF, mixture (oat-pea)	7.11 ± 0.04	Manure[1]
	23°51′40.02″E	*Epihypogleyic*	2008	OF, *Poaceae* (spring barley)	7.30 ± 0.02	Manure[1]
		Luvisol,	2009	OF, mixture (spring barley-clover)	6.84 ± 0.01	Manure[1]
		loam				
8.	54°52′28.44″N	*Hapli-*	2007	OF, *Poaceae* (winter wheat)	7.09 ± 0.02	Manure[1]
	23°51′52.39″E	*Epihypogleyic*	2008	OF, mixture (oat-pea)	7.39 ± 0.03	Manure[1]
		Luvisol,	2009	OF, *Poaceae* (spring barley)	6.91 ± 0.01	Manure[1]
		loam				

Note. CF – conventional farming, AbdL – abandoned land, OF – organic farming, crop. – cropping, Manure[1] – 30 t ha^{-1} yr^{-1}.

Average of 6 results was statistically evaluated in the order of reliability of $p < 0.05$. Intervals of confidence are presented in the tables and figures of results. Significance of data differences was evaluated by Student's t-test. Correlation coefficients were calculated by Pearson's technique.

There are presented data of the total rainfall and average month temperature during the period investigated in Fig. 1.

The year 2007 was warm and humid (average temperature 8ºC, annual precipitation 737.3 mm) compared to the average perennial climate conditions (1965–2007 years average temperature 7.19°C, annual precipitation of 623.8 mm). The year 2008 was also warm but drier (average temperature 8.1°C, annual precipitation of 589.9 mm). In 2009, the temperature matched the perennial average while precipitation was significantly more (average temperature 7.2°C, annual precipitation of 741 mm). Only April was extremely dry (precipitation of 8.6 mm).

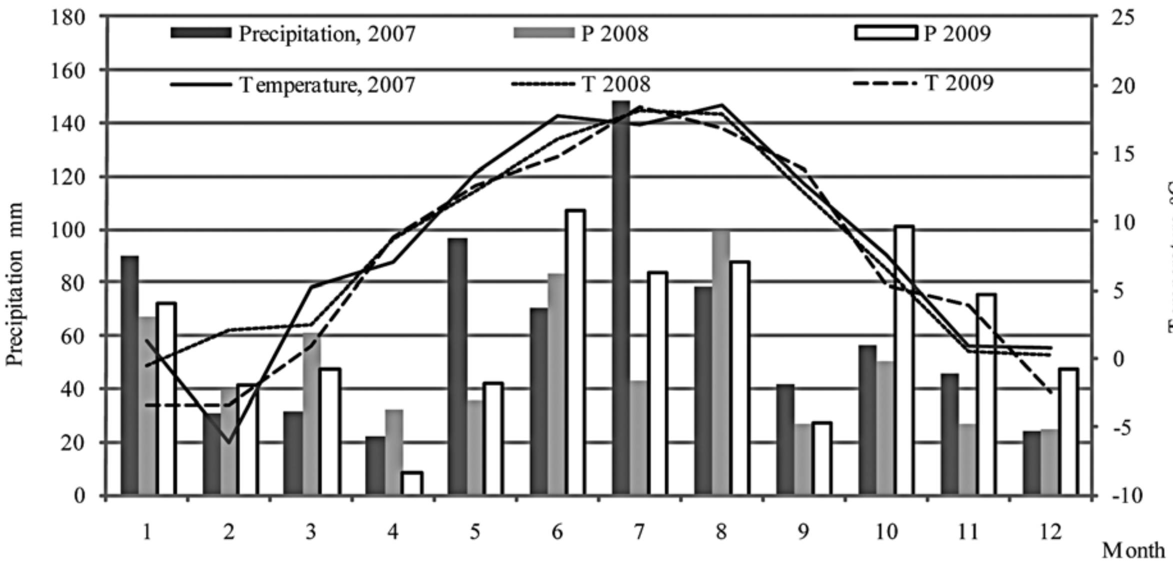


Figure 1. Monthly total of precipitation (mm) and average monthly temperature (ºC) (Kaunas Weather Station)

Results and discussion

Research findings showed that soil organic carbon (OC) accumulated similarly throughout the organic (OF) and conventional (CF) farming systems (13–20 g kg^{-1}) while less (8–15 g kg^{-1}) in the abandoned lands (AbdL) (Table 2). These findings confirm the Meysner et al. (2006) findings.

More OC accumulated in soils covered with *Fabaceae* (10–15 g kg^{-1}) than *Poaceae* (8–13 g kg^{-1}) in abandoned lands (AbdL). In OF and CF systems this difference was insignificant due to crop rotation. We determined an increase in OC amount from 12 to 17 g kg^{-1} in the fallow after green manure (rape) in CF system. In 2009 and 2008, OC amounts were greater than in 2007 in all soils of abandoned lands. This confirms the proposition that in natural ecosystems OC balance is stable due to natural nutrient cycling (Бабьева, Зенова, 1989; Smith et al., 1993). Moreover climate is an important factor regulating OC content in soil, as it determines to a great extent the vegetation type, the amount and nature of the organic residues that enter the soil. Additional factors such as topography, lithologic substrate, clay content, mineralogy, pH, redox potential and soil structure as well as land use, also influences soil OC levels (Meysner et al., 2006).

Total nitrogen (N) amounts in the soils under different land usage decreased in order CF (1.403 g kg^{-1}) ~ OF (1.357 g kg^{-1}) > AbdL (1.193 g kg^{-1}) (Table 2). Meysner et al. (2006) found that the highest total N and OC amounts, as well humus in soils were in OF and CF systems compared with integrated and continuous cropping systems. Total N amounts in different years varied greatly because of climatic conditions. It was greater in 2009 (1.374–1.754 g kg^{-1}) than 2007 (0.690–0.851 g kg^{-1}) and 2008 (1.134–1.252 g kg^{-1}) in AbdL soils (Table 2). Also, total N amount was less in the soil of the recently uncultivated quack-grass land (1.155 g kg^{-1}) than in the soil with for a long time abandoned *Poaceae* meadow (1.193 g kg^{-1}), and greater in the soil covered with *Fabaceae* (0.851–1.592 g kg^{-1}) than *Poaceae* (0.690–1.134 g kg^{-1}). Total N amount also varied depending on plant species in the soils of OF and CF systems. In 2009, it decreased (CF system) or remained unchanged (OF system) in soils covered with *Poaceae* while increased in soils covered with *Fabaceae*. These findings agree with Campbell et al. (1991) who suggest that wheat depletes soil organic N while inclusion of *Fabaceae* in *Poaceae*-based rotation tends to reduce the rate of depletion of soil OM and increases total N content. However, results of this research showed that OF was more beneficial for N balance as nitrogen amount remained stable under crop rotation. Fallow after green manure (rape) had positive influence on soil N as well as OC balance. Nitrogen cycling in soil is managed by mineralization of organic N compounds, nitrogen immobilization in soil microorganisms and solids, denitrification, ammonia evaporation, biological nitrogen fixation, fertilization, plant uptake and accumulation, runoff and erosion. Also cropping system has influence on soil N. Continuous cropping of winter wheat is followed by the decrease of the total N as it results in accumulation of identical metabolites of microbes and products of plant biomass decay (Meysner et al., 2006).

Table 2. Organic carbon (OC), total nitrogen (N) and C:N ratio (±95% confidence interval) in the soils

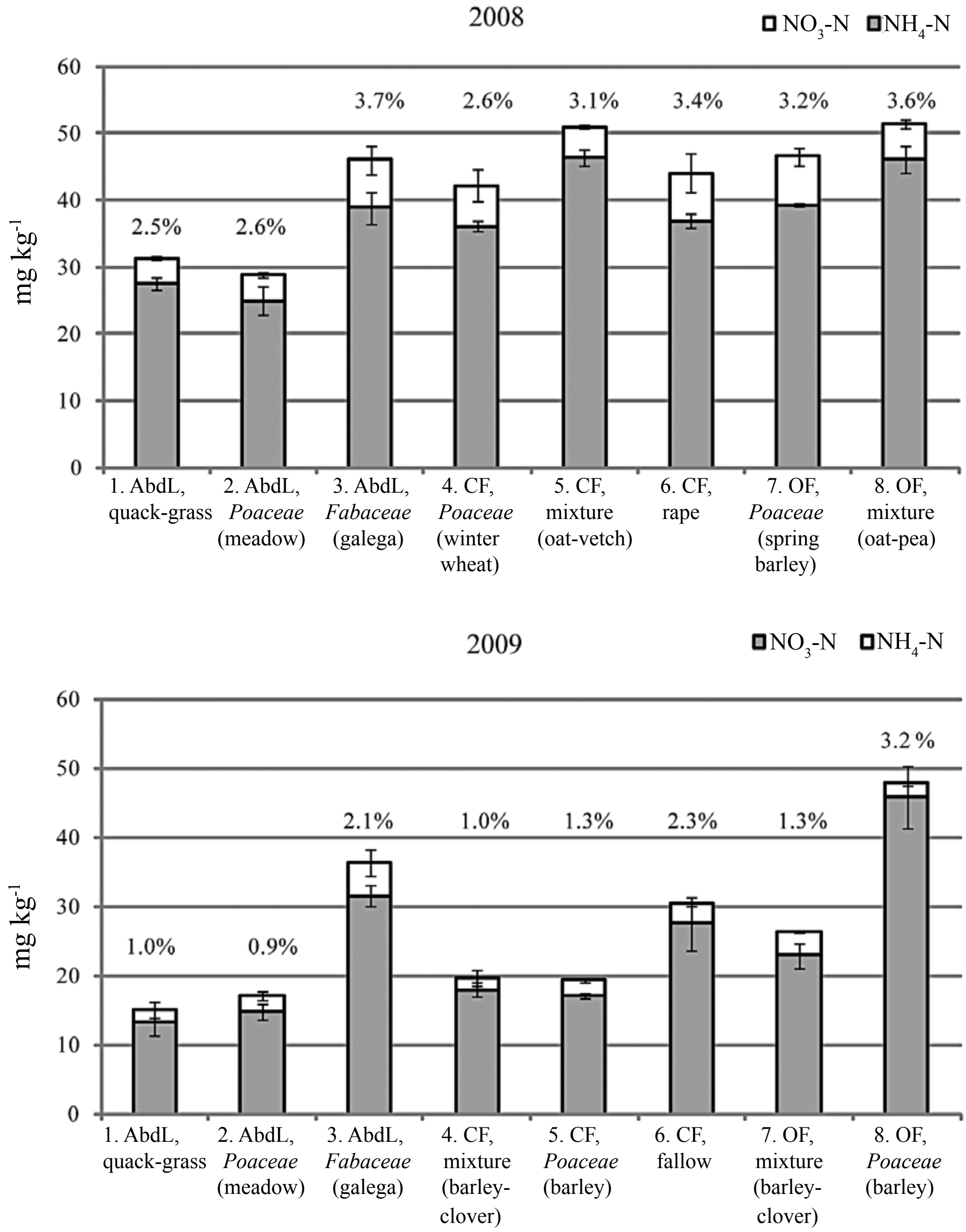
No.	Crop rotation	Year	OC g kg^{-1}	N g kg^{-1}	C:N
1.	CF, continous crop. (spring barley)	2007	13 ± 1.51	0.840 ± 0.012	15 ± 0.48
	AbdL, quack-grass	2008	15 ± 0.44	1.252 ± 0.135	12 ± 0.97
	AbdL, quack-grass	2009	15 ± 1.61	1.374 ± 0.110	10 ± 0.92
	Average		14	1.155	12
2.	AbdL, *Poaceae* (meadow)	2007	8 ± 1.12	0.690 ± 0.027	11 ± 0.56
	AbdL, *Poaceae* (meadow)	2008	12 ± 0.82	1.134 ± 0.352	10 ± 0.61
	AbdL, *Poaceae* (meadow)	2009	13 ± 0.21	1.754 ± 0.105	7 ± 0.42
	Average		11	1.193	9
3.	AbdL, *Fabaceae* (galega)	2007	10 ± 1.91	0.851 ± 0.014	11 ± 0.69
	AbdL, *Fabaceae* (galega)	2008	14 ± 0.55	1.251 ± 0.064	10 ± 0.79
	AbdL, *Fabaceae* (galega)	2009	15 ± 0.51	1.592 ± 0.028	11 ± 0.21
	Average		13	1.231	10.5
	Mean AbdL		**13**	**1.193**	**10.5**
4.	CF, mixture (oat-vetch)	2007	13 ± 1.24	0.951 ± 0.014	13 ± 0.63
	CF, *Poaceae* (winter wheat)	2008	20 ± 0.81	1.632 ± 0.020	12 ± 0.25
	CF, mixture (spring barley-clover)	2009	17 ± 0.22	2.101 ± 0.028	8 ± 0.20
	Average		17	1.561	11
5.	CF, mixture (oat-vetch)	2008	20 ± 0.61	1.654 ± 0.041	12 ± 0.39
	CF, *Poaceae* (spring barley)	2009	18 ± 1.12	1.350 ± 0.044	13 ± 0.34
	Average		19	1.502	12.5
6.	CF, *Poaceae* (winter wheat)	2007	12 ± 2.14	0.804 ± 0.022	14 ± 0.75
	CF, rape	2008	16 ± 0.22	1.280 ± 0.010	12 ± 0.64
	CF, fallow	2009	17 ± 0.71	1.351 ± 0.087	12 ± 0.78
	Average		15	1.145	13
	Mean CF		**17**	**1.403**	**12**
7.	OF, mixture (oat-pea)	2007	20 ± 0.83	1.110 ± 0.017	18 ± 0.15
	OF, *Poaceae* (spring barley)	2008	16 ± 0.51	1.430 ± 0.014	11 ± 0.33
	OF, mixture (spring barley-clover)	2009	17 ± 0.71	1.830 ± 0.011	9 ± 0.28
	Average		18	1.457	13
8.	OF, *Poaceae* (winter wheat)	2007	13 ± 3.51	0.880 ± 0.014	14 ± 0.86
	OF, mixture (oat-pea)	2008	18 ± 1.01	1.440 ± 0.010	12 ± 0.51
	OF, *Poaceae* (spring barley)	2009	20 ± 0.72	1.450 ± 0.041	13 ± 0.70
	Average		17	1.257	13
	Mean OF		**17.5**	**1.357**	**13**

Note. CF – conventional farming, AbdL – abandoned land, OF – organic farming, crop. – cropping.

Soil OM status and alternation processes greatly depend on soil C:N ratio (Uhlířová et al., 2007). The nitrogen content of soil OM as reflected through the C:N ratio, is of primary importance in regulating the magnitude of OM mineralization and immobilization (Meysner et al., 2006). The C:N ratio in soils of the OF system ranged from 9 to 18 (mean 13), conventional – from 8 to 14 (mean 12), abandoned land – from 7 to 15 (mean 10.5) (Table 2). Values above 10 indicate processes permitting retention of the balance in the decomposition and formation of humus in soils while values below 10 show soil OM degradation (Hadas et al., 2004). Thus C:N ratio shows possible soil OM degradation in abandoned lands. It was determined that in 2007 C:N ratio (18) was greater in soil of OF system. Covaleda et al. (2006) found out that OC accumulates more in soil of OF system but soil C:N ratio is also greater resulting in worse organic residue quality and N imbalance.

There were determined large amounts of mineral N (14.96–51.36 mg kg^{-1} or 0.9–3.7% of total N) in the soils, although in 2009 it was significantly less than in 2008 (Fig. 2). Because the year 2009 was very humid more mineral N could be leached.

Mineral N amount in soil is unstable. It just shows the balance between the mineral N formation and fixation, as well as immobilization at the investigated moment. When nitrate N concentration is less 5 mg kg^{-1}, it is considered a lack of mineral N; when 5–10 mg kg^{-1} – little amount; 10–15 mg kg^{-1} – large amount; 15–20 mg kg^{-1} – very large amount (Staugaitis et al., 2008). Least mineral N amount was in the soils of uncultivated quack-grass (14.96–31.30 mg kg^{-1}) and *Poaceae* meadow (16.98–28.85 mg kg^{-1}), also in the soil of CF system (19.30–19.58 mg kg^{-1}) in 2009. Soils of AbdL *Fabaceae* (galega) (36.26–45.96 mg kg^{-1}) and OF system (47.77–51.36 mg kg^{-1}) contained more mineral N.



Note. % – mineral N percentage of total N, ±95% confidence intervals.

Figure 2. Mineral nitrogen (NO_3-N and NH_4-N) amounts mg kg^{-1} in the soils

Mineral N amount in the soil depends on humus amount, C:N ratio, fertilization and climate conditions. Therefore mineral N concentrations in different years as well as through the year can vary greatly (Meysner et al., 2006). Influence of climate conditions on the mineral N amount in the soil depends on the season of the year. Nitrification intensifies in warm season as intensive vegetation is in progress at that time. More nitrate N accumulates in the topsoil at the drought (Aksomaitienė, 2001). These conditions governed alterations of soil mineral N in different years. Also fertilization is of great importance as fertilizing in summer time increases nitrate N while ammonium N varies insignificantly (Vai vila et al., 2002). Mineral N amount in the soil depends also on plant species. It is concluded that soil occupied with perennial grasses accumulates more mineral N than that with winter wheat as well as more than fallow (Šileika, 2003). We found out higher mineral N amounts in soil of abandoned land occupied with *Fabacea*. Also in all fields in spite of land usage mineral N was higher in soils occupied with *Fabaceae* or mixtures than *Poaceae* in 2008. Soils of non-fertilized AbdL quack-grass and *Poaceae* meadows contained less mineral N compared to CF and OF systems. Other authors found increased amounts of ammonium N in soils of CF system as well as an especially high ammonium (45.5 mg kg^{-1}) and nitrate (41.0 mg kg^{-1}) in continuous cropping system (Meysner et al., 2006).

Redox potential (Eh) varied in the range of 175.7–254.2 mV in the investigated soils (Fig. 3).

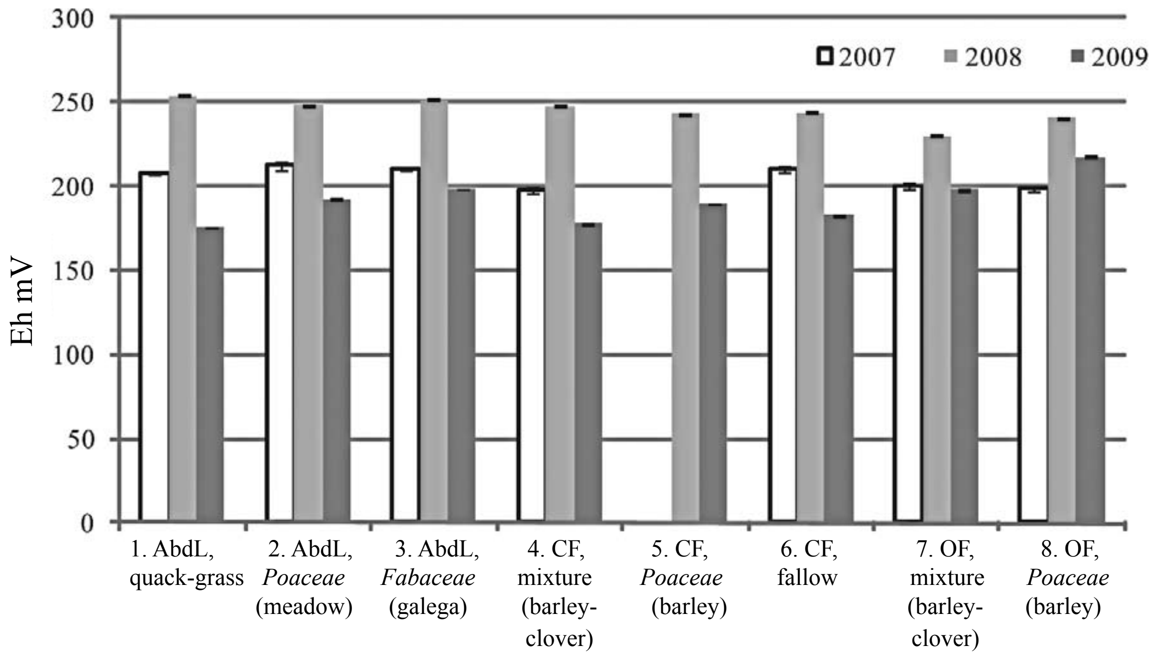


Figure 3. Redox potential (Eh) in the soils (±95% confidence intervals)

Limits for plant growth are Eh from +300 to +700 mV (Volk, 1993). When Eh decreases to +200 mV, intensive reduction happens with gleyic features, such as denitrification process instead of nitrification, increased mobility of iron and manganese, discontinued OM decomposition.

Soil Eh varied in different years. This was because of different climatic conditions and soil moisture. It was higher in dry 2008 year (230.1–254.2 mV) while lower in wet year (2007 – 197.9–210.5 mV, 2009 – 175.7–217.2 mV). Low Eh develops with increasing soil moisture content because of the partial or complete displacement of oxygen from soil and rapid consumption of oxygen by soil microbes (Savant, Ellis, 1964).

Soil aeration conditions and soil OM transformation processes are related to the Eh. Also soil gas composition is related to the soil Eh. It is proposed that optimum Eh for the soil methane gas formation is 150–180 mV. When Eh is 200–500 mV denitrification and N_2O gas formation is in progress in the soil which also contributes greatly to the greenhouse effect. But if there is a big OM amount in soil, denitrification and N_2O gas formation begins at Eh = 0 mV (Yu et al., 2007).

We did not find differences of Eh values in the soils of different land usage and different plant species while Bohrerova et al. (2004) in aerobic field conditions found a significant difference in Eh values between cropping sequences.

Soil Eh had strong negative correlation with total N content (r = −0.88) and moderate positive correlation (r = 0.51) with C:N ratio (Table 3).

Table 3. Correlation coefficients of investigated indexes of soil organic matter status ($p < 0.05$)

	r				
	OC %	Eh mV	N %	C:N	NO_3-N mg kg^{-1}
Eh mV	−0.36				
N %	0.50	**−0.88**			
C:N	0.49	0.51	−0.29		
NO_3-N mg kg^{-1}	0.11	0.35	−0.09	0.54	
NH_4-N mg kg^{-1}	0.10	−0.42	0.35	−0.17	0.25

Eh correlation with NH_4-N and NO_3-N was weak and opposite ($r = 0.35$ and $r = −0.42$, respectively). Other authors found negative topsoil Eh correlation with potential nitrification under various cropping sequences (Bohrerova et al., 2004).

Conclusions

1. More organic carbon, total and mineral nitrogen accumulated in the soils of conventional and organic farming systems than in uncultivated lands.

2. More organic carbon, total and mineral nitrogen accumulated in the soils covered with *Fabaceae* than *Poaceae* in the abandoned lands while in the cultivated lands in both systems conventional and organic this difference was insignificant due to crop rotation.

3. Fallow after green manure (rape) had positive influence on increase of soil organic carbon and total nitrogen amounts.

4. C:N ratio in soils decreased as follows: organic farming system (13), conventional farming system (12), abandoned land (10.5). C:N ratio close to 10 or lower in soils of abandoned lands show possible soil organic matter degradation.

5. Soil redox potential varied in different years depending on climatic conditions and did not differ between soils of different land usage. It correlated strongly only with total nitrogen amount ($r = −0.88$) while the correlation with organic carbon and mineral nitrogen amounts was weak.

6. Our experimental evidence suggests that the best soil organic matter status according to such indexes as organic carbon, total nitrogen, C:N ratio, and redox potential is in the soils of conventional and organic farming systems occupied with mixtures of *Fabaceae* and *Poaceae* while worse in the soils of uncultivated *Poaceae* meadow.

Acknowledgements

This study was financially supported by the Lithuanian Ministry of Agriculture.

Received 26 02 2010
Accepted 30 07 2010

References

Aksomaitienė R. Mineralinio azoto kiekis dirvožemyje skirtingose agroekosistemose [Mineral nitrogen amount in different agroecosystems (summary)] // Vandens ūkio inžinerija. – 2001, vol. 17, No. 39, p. 35–40 (in Lithuanian)

Bohrerova Z., Stralkova R., Podesvova J. et al. The relationship between redox potential and nitrification under different sequences of crop rotations // Soil and Tillage Research. – 2004, vol. 77, p. 25–33

Campbell C. A., Schnitzer G. P., Lafond G. P. et al. Thirty-year rotations and management practices effects on soil and amino nitrogen // Soil Science Society of America Journal. – 1991, vol. 55, p. 739–745

Cogger C. G., Kennedy P. E., Carlson D. Seasonally saturated soils in the puget lowland. II. Measuring and interpreting redox potentials // Soil Science. – 1992, vol. 154, No. 1, p. 50–58

Covaleda S., Pajares S., Gallardo J. F., Etchevers J. D. Short-term changes in C and N distribution in soil particle size fractions induced by agricultural practices in a cultivated volcanic soil from Mexico // Organic Geochemistry. – 2006, vol. 37, No. 12, p. 1943–1948

Ghani A., Dexter M., Perrott K. W. Hot-water extractable carbon in soil: a sensitive measurement for determining impacts of fertilization, grazing and cultivation // Soil Biology and Biochemistry. – 2003, vol. 35, p. 1231–1243

Haag D., Kaupenjohann M. Landscape fate of nitrate fluxes and emissions in Central Europe: a critical review of concepts, data, and models for transport and retention // Agriculture, Ecosystems and Environment. – 2001, vol. 86, No. 1, p. 1–21

Hadas A., Kautsky L., Mustafa G., 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

Helfrich M., Ludwig B., Buurman P., Flessa H. Effect of land use on the composition of soil organic matter in density and aggregate fractions as revealed by solid-state ^{13}C NMR spectroscopy // Geoderma. – 2006, vol. 136, No. 1–2, p. 331–341

Korsaeth A., Henriksen T. M., Bakken L. R. Temporal changes in mineralization and immobilization of N during degradation of plant material: implications for the plant N supply and nitrogen losses // Soil Biology and Biochemistry. – 2002, vol. 34, p. 789–799

Meysner T., Szajdak L., Ku J. Impact of the farming systems on the content of biologically active substances and the forms of nitrogen in the soils // Agronomy Research. – 2006, vol. 4, iss. 2, p. 531–542

Patric W. H., Gambrell R. P., Faulkner S. P. Redox measurements of soils // Methods of soil analysis. Part 3. Chemical methods. – SSSA, Book Series No. 5. – Madison, USA, p. 1255–1273

Pedersen A., Petersen B. M., Eriksen J. et al. A model simulation analysis of soil nitrate concentrations. Does soil organic matter pool structure or catch crop growth parameters matter most? // Ecological Modelling. – 2007, vol. 205, No. 1–2, p. 209–220

Savant N. K., Ellis R. Changes in redox potential and phosphorus availability in submerged soil // Soil Science. – 1964, vol. 98, No. 6, p. 388–394

Skjemstad J. O., Janik L. J., Taylor J. A. Non-living soil organic matter: what do we know about it? // Australian Journal of Experimental Agriculture. – 1998, vol. 38, p. 667–680

Sleutel S., Kader M. A., Leinweber P. et al. Tillage management alters surface soil organic matter composition: a pyrolysis mass spectroscopy study // Soil Science Society of America Journal. – 2007, vol. 71, p. 1620–1628

Smith J. L., Papendick R. I., Bezdicek D. F., Lynch J. M. Soil organic matter dynamics and crop residue management // Soil microbial ecology: application in agricultural and environmental management. – New York, USA, 1993, p. 65–94

Staugaitis G., Mažvila J., Vaišvila Z. et al. Mineral nitrogen in Lithuanian soils // Soil in sustainable environment [Dirvožemis tvarioje aplinkoje]: the international conference at the Lithuanian Academy of Sciences // Lithuanian University of Agriculture. – 2008, p. 27–28 (in Lithuanian)

Szajdak L., Jezierski A., Cabrera M. L. Impact of conventional and no-tillage management on soil amino acids, stable and transient radicals and properties of humic and fulvic acids // Organic Geochemistry. – 2003, vol. 34, p. 693–700

Szajdak L., Maryganova V. Impact of age and composition of shelterbelts plants on IAA content as allelochemical in soils // Allelopathy Journal. – 2009, vol. 23, No. 2, p. 461–468

Šileika A. S. The performance and coordination of monitoring of agroecosystem of the land use, agricultural activities, groundwater and surface water and precipitation chemistry according the agroecosystem monitoring program (Agrostacionaras) [Žemėnaudos, žemės ūkio veiklos, gruntinio bei paviršinio vandens ir kritulių cheminės sudėties monitoringo pagal agroekosistemų monitoringo programą (Agrostacionaras) vykdymas ir agroekosistemų monitoringo koordinavimas] // Water Management Institute of the Lithuanian University of Agriculture. <http://193.219.133.6/aaa/pranesimai/ moksliniu_tyrimu_ataskaitos/Zemenaudos_vandens_irkrituliu_cheminies_sudeties_ir_savybiu_tyrimai_tipiskoje_vidurio_Lietuvos_agroekosistemoje/2003.doc> [accessed 17 02 2010]

Tripolskaja L., Romanovskaja D. Trąšų poveikis cheminių elementų migracijai [Fertilizer effects on migration of chemical elements (summary)] // Vandens ūkio inžinerija. – 2001, vol. 17, No. 39, p. 16–25 (in Lithuanian)

Ugwuegbu B. U., Prasher S. O., Ahmad D., Dutilleul P. Bioremediation of residual fertilizer nitrate. II. Soil redox potential and soluble iron as indicators of soil health during treatment // Journal of Environmental Quality. – 2001, vol. 30, p. 11–18

Uhlířová E., Šantrůčková H., Davidov S. P. Quality and potential biodegradability of soil organic matter preserved in permafrost of Siberian tussock tundra // Soil Biology and Biochemistry. – 2007, vol. 39, No. 8, p. 1978–1989

Vaišvila Z., Arbačiauskas J., Mažvila J. Pagrindinės augalų maisto medžiagos skirtingos genezės dirvožemiuose [The main plant nutrients in soils of different genesis (summary)] // Žemės ūkio mokslai. – 2002, No. 3, p. 3–13 (in Lithuanian)

Volk N. J. The effect on oxidation-reduction potential on plant growth // Agronomy Journal. – 1993, vol. 31, No. 8, p. 665–670

Yu K., Böhme F., Rinklebe J. et al. Major biogeochemical processes in soils – a microcosm incubation from reducing to oxidizing conditions // Soil Science Society of America Journal. – 2007, vol. 71, p. 1406–1417

Бабьева И. П., Зенова Г. М. Экология почв [Soil ecology]. – Ленинград, 1989. – 335 с. (in Russian)

ISSN 1392-3196
Žemdirbystė=Agriculture, t. 97, Nr. 3 (2010), p. 15–24
UDK 631.442:631.461.7:631.416

Žemės naudojimo įtaka dirvožemio organinės anglies bei azoto kiekiui ir oksidacijos-redukcijos potencialui

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Santrauka

Tyrimų tikslas – įvertinti dirvožemio organinės medžiagos būklę pagal organinės anglies, suminio bei mineralinio azoto kiekį, C:N santykį ir oksidacijos-redukcijos potencialą, priklausomai nuo žemės naudojimo būdo ir augintų augalų rūšių.

Dirvožemio ėminiai buvo paimti iš išplautžemių (*Hapli-Epihypogleyic Luvisol*, *LVg-p-w-ha*, arba *Albi-Epihypogleyic Luvisol*, *LVg-p-w-ab*), kuriuose taikytos skirtingos žemdirbystės sistemos (intensyvioji bei ekologinė), ir apleistų dirvožemių. Kiekvienos žemdirbystės sistemos ir apleistuose dirvožemiuose buvo pasirinktos dvi botaninių augalų rūšys (migliniai ir pupiniai).

Pagal tyrimų rezultatus galima daryti išvadą, kad geriausia dirvožemio organinės medžiagos būklė pagal organinės anglies, suminio bei mineralinio azoto kiekio, C:N santykio ir oksidacijos-redukcijos potencialo rodiklius yra intensyviosios ir ekologinės žemdirbystės sistemų dirvožemių, kuriuose auginti pupinių augalų mišiniai, o prasčiausia – apleistos miglinių augalų pievos dirvožemio. Apleistose žemėse dirvožemio organinės medžiagos būklę geriau veikė pupiniai augalai (ožiarūtis) nei migliniai.

Reikšminiai žodžiai: žemdirbystės sistema, apleistos žemės, organinė anglis, azotas, oksidacijos-redukcijos potencialas.