variants D1, D2, where Fostim was used (Fostim contains not only nitrogen, but also phosphorus). The lowest average yield was achieved on control variant (7,15 t . ha^{-1}), the greatest yield was on variant C1 (7,59 t . ha^{-1}), where nitrogen was used in rate 20 kg per hectare (fertilizer DAM-390) at the end of tillering. The difference was statistically significant. Yield on other variants was non-significantly higher compare to variant A. Crude protein content in spring barley grain was not statistically significantly influenced by fertilization.

Discussion

Year conditions and varieties highly significantly influenced all evaluated characteristics. The year had the greatest proportion on total variability of yield forming components and crude protein content. Variability of yields was most affected by varieties.
Results confirmed earlier findings of Frančáková (1985), the more nitrogen is used for yield formation, the less nitrogen deteriorates protein content in grain and malting quality of barley. There is interesting finding, that variety Garant achieved the most favourable crude protein content in grain compared to other varieties. Garant belongs on the base of malting quality into group „B“ (standard varieties) and another varieties into group „A“ (malting varieties). Decrease of thousand grains weight as a consequence of higher nitrogen rates was observed also by Frančáková (1985). Results showed, that when nitrogen rate for spring barley is determined on the base of soil analysis (on mineral nitrogen content in soil), risks of harmful effects of foliar nitrogen aplication on malting quality of barley can be eliminated.

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Table 2 Average values of yield forming components, yields and crude protein content of spring barley

Factor	Levels of factor	n	Number of ears per m^2		Thousand grains weight		Yield		Crude protein content	
Year	1997	84	725,00	a	49,36	c	7,48	b	9,76	a
	1998	84	831,62	b	46,28	a	7,34	ab	11,12	b
	1999	84	859,05	b	46,87	b	7,16	a	11,26	b
Variety	Kompakt	63	803,05	b	46,62	a	6,92	a	10,52	ab
	Garant	63	878,10	c	46,86	a	7,60	c	10,39	a
	Atribut	63	789,78	ab	48,63	c	7,27	b	11,15	c
	Expres	63	749,97	a	47,90	b	7,52	bc	10,79	b
Fertilization	A	36	787,33	ab	47,82	c	7,15	a	10,59	a
	B1	36	812,11	ab	47,55	bc	7,36	ab	10,85	a
	B2	36	815,00	ab	47,16	ab	7,26	ab	10,77	a
	C1	36	770,00	a	47,68	c	7,59	b	10,70	a
	C2	36	847,33	b	47,02	a	7,35	ab	10,82	a
	D1	36	819,89	ab	47,70	c	7,29	ab	10,79	a
	D2	36	784,89	ab	47,60	bc	7,28	ab	10,47	a

Averages with different letters are statistically significant at $P \leq 0,05$

SOME INDICATORS OF SOIL QUALITY IN SEVERAL CROP PRODUCTION SYSTEMS

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Summary

In 1999-2000 the microbial soil activity (presented by CO_2 release, ammonification and nitrification activities) has been evaluated in four crop production systems (ecological and conventional I, integrated and conventional II). The ammonification and nitrification activities have been observed between the ecological and integrated production systems only. In the integrated system, there were detected the statistically significantly highest microbial activity. The differences among the other crop production systems were not statistically significant. The activity of soil microorganisms in the integrated production system was promoted by the ploughless soil tillage that increased the content of the organic matter in the topsoil.

Key words: production systems, CO_2 release, ammonification, nitrification

Introduction

The environment is very changed by agricultural activities. The conventional intensive agriculture decreases soil quality, causes water pollution and reduses biodiversity of the countryside. Therefore, it is necessary to find the way to the productive farming system without environmental damage.
The aim of the paper is to compare the ecological and integrated (ploughless) crop production systems with conventional ones from the viewpoint of the soil microbial activity evaluation. The soil organic matter, soil respiration, ammonification and nitrification activities are the microbiological characteristics that indicate possible negative ecological consequences of the anthropogenical activity (Cannell, Hawes, 1994; Filip, Berthelin, 1999).

Material and methods

In the years 1999-2000 some soil chemical characteristics and mineralization processes like CO_2 release, ammonification and nitrification have been determined in several crop production systems in Borovce near Piešťany (the maize growing region on chernozem soils). The characterization of the crop production systems is presented in Table 1.
The soil samples have been taken from the constant sampling plots four times (April, May, June/July, October/November) in 1999 and 2000. The depth of sampling was 2-20 cm in all plots. Immediately after sampling, the fresh soil samples were passed through 2-mm sieve and several microbiological analyses were performed. The chemical characteristics (pH_{KCl}, C_{ox}, C_{tot}, N_{tot}, N_{in}) were determined from air-dried soil samples.
Microbiological analyses:

- basal soil respiration - CO_2 release (titration method of Bernát and Seifert)
- ammonification activity - the increase in content of ammonium nitrogen ($N\text{-}NH_4^+$) after 14 days aerobic incubation
- nitrification activity - the increase in content of inorganic nitrogen ($N\text{-}NH_4^+$ + $N\text{-}NO_3^-$) after 14 days aerobic incubation

The content of ammonium nitrogen was detected by colorimetric method with Nessler' agent and content of nitrate nitrogen by isotachophoresis method with EA 100 analyser (of LEBACO firm).
The results were statistically evaluated by variance analysis.

Results and discussion

The soil chemical characteristics are shown in Table 2. The soils are moderately acid (pH_{KCl} 6,0-6,9 according to Šály, 1996), with medium resource of good quality humus (2-3% humus content, C/N about 10 according to Hraško, Bedrna, 1988). During two years period of 1999-2000 the highest contents of soil carbon (C_{ox}, C_{tot}) and nitrogen (N_{tot}, N_{in}) have been observed in the integrated system without ploughing. The statistically significant differences among the compared crop production systems were detected only in C_{tot} contents. The differences in other chemical characteristics were not significant. These results support the fact that the ploughless tillage increases the content of the organic matter in the topsoil. The organic matter accumulation in the upper soil layer has been identified by several research projects about the ploughless soil tillage (Cannell, Hawes, 1994; Rasmussen, 1999; Tebrügge, Düring, 1999). The litter left on the surface of non-ploughed soils can be considered as a key factor for promoting the microbial activity, improving the aggregate stability and protecting against erosive water forces (Tebrügge, Düring, 1999).
The substrate quantity and quality have significant influence to the microbial activity. The soil respiration is an important characteristics of the carbon dynamics in soil (Kubát et al., 1999). It represents the rate of the soil organic matter decomposition. The basal soil respiration activity was statistically significantly the highest in the integrated production system (Table 3), where the most quantity of soil organic matter was accumulated.

Table 1: Agrotechnical characterization of crop production systems

Systems	Soil tillage	Crop rotation	Manure	Plant protection	Weed control

ecological	ploughing	6 crops rotation	stable manure stubble remains	biological	mechanical
Conventional I	ploughing	6 crops rotation	stable manure stubble remains NPK fertilizers	chemical	chemical (weedkillers)
integrated	ploughless	4 crops rotation	compost stubble remains NPK fertilizers	chemical (integrated)	chemical (integrated)
conventional II	ploughing	4 crops rotation	compost NPK fertilizers	chemical	chemical (weedkillers)

Six crops rotation: pea (1999), winter wheat (2000), potatoes (stable manure application), spring barley and additional sowing of meadow clover, meadow clover, winter wheat
Four crops rotation**:** pea (1999), winter wheat (2000), maize (compost application), spring barley

Table 2: Soil chemical characteristics

		System				
		ecological	conventional I	integrated	conventional II	average
PH $_{KCl}$	1999	5,8	5,9	6,1	6,5	6,1
	2000	6,0	6,0	5,9	6,1	6,0
	average	5,9 a	6,0 a	6,0 a	6,3 a	6,1
$\%C_{ox}$	1999	1,16	1,23	1,44	1,29	1,28
	2000	1,26	1,17	1,40	1,18	1,25
	average	1,21 a	1,20 a	1,42 a	1,24 a	1,27
$\%C_{tot}$	1999	1,30	1,35	1,53	1,37	1,39
	2000	1,37	1,33	1,60	1,29	1,40
	average	1,34 a	1,34 a	1,57 b	1,33 a	1,40
$\%N_{tot}$	1999	0,12	0,13	0,14	0,13	0,13
	2000	0,13	0,13	0,16	0,13	0,13
	average	0,13 a	0,13 a	0,15 a	0,13 a	0,13
N_{in} (mg/kg)	1999	14,1	17,5	22,1	18,6	18,1
	2000	11,8	9,0	23,3	11,9	14,0
	average	13,0 a	13,3 a	22,7 a	15,3 a	16,1

Values followed by the same letter within lines are not significantly different (ANOVA, α=0,05).

The ammonification and nitrification activities of the soil microorganisms have been determined between the ecological and integrated systems. In the integrated system the ammonification and nitrification microorganisms were more active than in ecological production system (Table 4).

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Table 3: Basal soil respiration activity

System	CO_2 release (mg / 100 g / 24 h)		
	1999	2000	average
Ecological	4,6	4,8	4,7 a
Conventional I	4,6	4,7	4,7 a
Integrated	7,7	8,4	8,1 b
Conventional II	5,3	5,1	5,2 a

Average	5,6	5,8	5,7

Values followed by the same letter within column are not significantly different (ANOVA, α=0,05).

Table 4: Ammonification and nitrification activity

		System		
		Ecological	integrated	average
ammonification (mg/kg)	1999	7,6	10,4	9,0
	2000	12,4	19,8	16,1
	average	10,0 a	15,1 b	12,6
nitrification (mg/kg)	1999	7,4	10,1	8,8
	2000	12,7	20,8	16,7
	average	10,1 a	15,5 b	12,8

Values followed by the same letter within lines are not significantly different (ANOVA, α=0,05).

OCCURRENCE AND DEGRADATION OF NITRATE IN SOME SOIL PROFILES IN HUNGARY

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Summary

We studied the profiles of three Fertilization Experimental Farms of Debrecen Agricultural University in Hungary. The soil samples were usually taken by drilling by 20 cm layers from 0 to 200 cm, by 25 cm from 200 to 300 and by 50 cm from 300 to 600 cm. The soil types of profiles differed basically in moisture, clay and silt and organic carbon content. The pH values in the upper layers of all soil types were slightly acidic then increased and became alkalic because of the appearance of $CaCO_3$. In the control chernozem profile the nitrate content decreased from the top to the bottom of profile. There was an accumulation detected in the control meadow soil.
The effect of fertilization can be shown clearly, because the nitrate accumulated in lower layers. As an effect of fertilization, the nitrate content increased remarkably in layers 160-350 cm and 450-600 cm of calcareous chernozem. The nitrate content was two and three times higher from 40 cm to 200 cm in the treated meadow soil, than in the control, because of the fertilization. In the upper layer of the blownsand the nitrate content was remarkable high then it decreased to 100 cm and increased again down to the bottom of the profile. Nitrate degradation - in which bacteria plaid an important role - was the most expressed in the layers of 0-40 cm in all the three soil types. It decreased with depth, but increased again in the lower layers.

Keywords: nitrate accumulation, nitrate degradation, soil profiles, effect of fertilization on nitrate content of soil.

Introduction

Presently, at a time of intensive use of chemicals in agriculture, the leaching and accumulation of fertilizers containing nitrogen represents a global hazard. Since 1990, the amount of applied fertilizers in Hungary has dramatically decreased. In spite of this fact, it is very important to focus on their ecological and environmental effects.
Increasingly more data may be found in the special literature in Hungary concerning the investigation of the spread of nitrate ion into soil profiles (HELMECZI, 1983; NÉMETH, et al. 1989; RUZSÁNYI, 1991; PEPÓ et al. 1997, PEPÓ, 2001). However, long term fertilizer experiments also provide a very good possibility for the study of leaching and accumulation of nitrate ion in different soil types (NÉMETH, 1993, 1994).
Debrecen Agricultural University joined an EC project, which partly concerned itself with the nitrate problem. The two participating departments were the Central Laboratory of the Faculty of Agronomy and the Departmant of Soil Science and Microbiology.
Our aims were
- to investigate the physical and chemical characteristics of profiles of different soil types ,
- to compare the nitrate content of fertilized and non fertilized soil profiles,
- to estimate nitrate disappearance (denitrification activity) during the degradation experiment.

In this paper, we present a portion of these results.

Material and methods

Soil samples were collected from the profiles of three experimental farms of Debrecen Agricultural: University:Debrecen-Látókép Experimental Farm (calcareous chernozem), Hajdúböszörmény Experimental Farm (meadow soil), Debrecen-Pallag Experimental Farm (blownsand / sand mantle). The soil samples were usually taken in 20 cm layers from 0 to 200 cm, by 25 cm from 200 to 300 and by 50 cm from 300 to 600 cm.