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ECOLOGICAL AGRICULTURE AND ITS INFLUENCE ON AGROCHEMICAL SOIL PROPERTIES ON AGRICULTURAL FARM «LIPTOVSKA TEPLICKA»

The change of basic agrochemical soil properties in a farm with ecological system of farming («Liptovska Teplicka») during three years period was observed. It was found that with high rates of farmyard manure (60 t per ha) there is possible to keep the favourable pH value of soil and also the contents of available nutrients did not change very markedly. Triticale was found as the most suitable cereal in given climatic conditions. It is important to grow leguminous plants to secure relatively high yield of fodder plants. There is possible to reach the stability of agroecosystem with the biodiversity of farming area and with return of organic matter into the soil.

Key words: agrochemical soil properties, ecological system of farming, organic matter

Торма С., Фазекасова Д., Лісняк А. ЕКОЛОГІЧНЕ СІЛЬСЬКЕ ГОСПОДАРСТВО ТА ЙОГО ВПЛИВ НА АГРОХІМІЧНІ ВЛАСТИВОСТІ ҐРУНТУ НА СІЛЬСЬКОГОСПОДАРСЬКІЙ ФЕРМІ «ЛІПТОВСЬКА ТЕПЛИЦЯ»

Зміна основних агрохімічних властивостей ґрунту спостерігалась впродовж трьох років на фермі з екологічною системою ведення сільського господарства («Ліптовська Теплиця»). Було встановлено, що навіть при внесенні високих доз компосту (60 т на га) значення pH ґрунту утримувалося на сприятливому рівні, а вміст доступних поживних елементів помітно не змінювався. Найбільш підходящим хлібним злаком для вирощування у даних кліматичних умовах став тритікале. При цьому, важливо також вирощувати зернобобові культури, щоб забезпечити відносно високий вихід кормових культур. Це можливо досягти тільки за допомогою стабільних агроекосистем з біорізноманіттям на сільськогосподарських площах і з поверненням органічної речовини в ґрунт.

Ключові слова: агрохімічні властивості ґрунту, екологічна система ведення сільського господарства, органічна речовина

Торма С., Фазекасова Д., Лисняк А. ЭКОЛОГИЧЕСКОЕ СЕЛЬСКОЕ ХОЗЯЙСТВО И ЕГО ВЛИЯНИЕ НА АГРОХИМИЧЕСКИЕ СВОЙСТВА ПОЧВЫ НА СЕЛЬСКОХОЗЯЙСТВЕННОЙ ФЕРМЕ «ЛИПТОВСКА ТЕПЛИЦА»

Изменение основных агрохимических свойств почвы наблюдалось на протяжении трёх лет на ферме с экологической системой ведения сельского хозяйства («Липтовска Теплица»). Было установлено, что даже при внесении высоких доз компоста (60 т на га) значение pH почвы удерживалось на благоприятном уровне, а содержание доступных питательных элементов заметно не изменялось. Самым подходящим хлебным злаком для выращивания в данных климатических условиях явился тритикале. При этом, важно также выращивать зернобобовые культуры, чтобы обеспечить относительно высокий выход кормовых культур. Это возможно достигнуть только с помощью стабильных агроэкосистем с биоразнообразием на сельскохозяйственных площадях и с возвращением органического вещества в почву.

Ключевые слова: агрохимические свойства почвы, экологическая система ведения сельского хозяйства, органическое вещество

Introduction

Ecological farming is a sustainable agrosystem based on natural regularity. It is presented as a positive answer to the limits and problems of traditional, but also of modern agriculture. There is an ambition to take over the best from the traditional agriculture and at the same time to use the newest scientific knowledge [3].

Generally is presented that the farming systems, marked as low-input, organic, ecological, biodynamical or biological [2, 5, 6] are more sustainable and on the other side the system called as traditional agriculture is less sustainable. For the evaluation of sustainable of agroecosystems are used the basic physical, chemical and biological soil properties. The indicators concerning to the productivity of agriculture and to the ecological aspects of farming are the most observed nowadays.

This paper is a contribution to the solution of problem of soil chemical properties changes in the conditions with ecological system of farming in temporal and space dimension.

Material And Methods

The observed area of agricultural farm «Liptovska Teplicka» is situated in the Northern part of Slovakia in National Park Nizke Tatry (846-1492 m a.s.l.). The whole area belongs to the mild cold region with sum the temperature more than 10 °C - 1600-2000 °C and with the mean sum of year precipitation 800-1100 mm.

The area of agricultural land in this farm is 1567 ha, of which to the pasture belongs 1267 ha and to the meadows 200 ha. Only 100 ha (6.4 %) is used as arable land. Eutric Cambisols are the most wide-spread soil type (960 ha), 480 ha occur the Rendzinas. The soils are middle heavy, shallow and skeleton. The chemical soil properties are on the good level. Almost 93 % of soil has neutral or slight alkaline soil reaction and almost whole area of arable land is good supplied with available forms of phosphorus, potassium and magnesium. The less favourable situation is in the meadows and pastures where 55 % of grassland have acid and extremely acid soil reaction. The nutrient supply is relatively good, only 20 % of grassland has low contents of phosphorus and 30 % of grassland has low contents of potassium.

In framework of ecological system of farming which is running since 1996 the following crop rotation is used:

1. perennial fodder-crops (clover - grass mixture);
2. perennial fodder-crops (clover - grass mixture);
3. winter cereals (winter wheat, winter rye, triticale, winter barley), fertilised with Biomin[1*] (50-124 l.ha^{-1}) and Vermisol[**2] (100 l.ha^{-1});
4. root crops (potatoes), fertilised with manure (60 t.ha^{-1});
5. spring cereals (spring barley, oats) fertilised with Biomin* (50-100 l.ha^{-1});
6. oats for green fodder with clover - grass mixture.

The conditions of site, cultivation, fodder need, area of grassland, work capacity and the aspects to the fodder crops area extension and cereals area reduction are regarding in this crop rotation.

The soil samples were taken in the last decade of May in 2008-2010 from the soil depth 0.05-0.20 m. The mean soil sample consists from the 10 particular soil samples.

Six chemical properties were observed: total nitrogen (according to Jodlbauer), available phosphorus (according to Egner), available potassium and magnesium (according to Schachtschabel), humus contents (according to Tjurin) and pH value in 1 N solution of KCl.

[1] *Biomin - liquid fertiliser with 3.7 g N, 1.5 g P_2O_5, 1.3 g K_2O, 2.1 g Ca a 1.26 g Mg per 1 litre. The other elements in this fertiliser are copper, zinc, iron and manganese. pH value of fertiliser is 6.5-9.3.

[2] **Vermisol - liquid fertiliser with 18 g N, 1.4 g P_2O_5, 30 g K_2O, per 1 litre. The other elements in this fertiliser are calcium, sodium, copper, zinc, iron, manganese, boron and molybdenum. pH value of fertiliser is 6.5.

Results And Discussion

In framework of soil chemical properties observing in the mentioned agricultural farm there were monitored the soil reaction, contents of nutrients (total nitrogen, available forms of phosphorus, potassium and magnesium) and humus contents. These parameters are taken as the basic at chemical soil status evaluation. Table 1 presents the value from 2008 which are in our case as the initial values. Only the determination of total nitrogen contents was not made in this year, therefore the initial status for this nutrient is from 2009.

Table. 1: The basic chemical soil properties (2008, nitrogen contents - 2009)

Identification of field	pH_{KCl}	N_{total}	P	K	Mg	Humus
		mg.kg^{-1} soil				%
I.	6.5	2800	21	222	237	4.52
II.	5.9	3515	46	210	218	6.49
III.	6.7	2700	69	307	271	5.62
IV.	5.9	2910	53	435	216	5.55
V.	6.2	2575	10	231	254	3.72
VI.	6.9	3080	142	430	282	6.12

From these data can be seen that soil reaction occurs in two categories - slight acid and neutral, contents of total nitrogen and available magnesium is in all fields in category high, contents of available potassium in categories good and high and contents of available phosphorus occurs in categories low, medium and good. The humus supply in the observed soils is good and very good. The changes of these parameters during the observation duration (2008-2010) are presented in Figures 1 and 2.

The soil reaction is one of the important factors of soil fertility. Its value is normally very dynamic and it is changing in dependence of so called internal and external factors. During our observation this parameter was changing only minimal. This phenomenon can be caused even by ecological farming due to no fertilising with physiologically acid fertilisers. On the other side there was applied the manure in rates 60 t.ha^{-1} and the liquid organic fertilisers Biomin and Vermisol during three years. The organic matter influences positive on the soil buffering and also therefore the pH value was kept on the initial status. However, there is a need to dedicate more attention to the soil reaction because of natural acidification due to acid precipitation and calcium offtake by grown plants, too.

According to Bielek [1] there is a little likely assumption about positive influence of increasing of total nitrogen contents in the soil on its fertility. This can be valid only for very productively soil (with 70-80 and more points). The soils with low productivity are characterised by indirectly relative between total nitrogen contents and fertility. Because of 95-98 % of total nitrogen contents in the soil there is bounded in organic forms, the mechanism of its accessing for the plants has the important role. In a great part it is concerning to the mineralization of organic nitrogen. The mineralization overshoots less intensive in the soil-ecological conditions of the farm due to cold climate (the optimal temperature for the intensive process is 28-30 °C). The content of available nitrogen for the plants is not very high even at high contents of total nitrogen. It is resulting in not ideal plant nutrition, what is it seen in crop yields (Table 2). There is assumed that with high rates of organic fertilisers comes to the increase of total nitrogen contents, but for increasing of available nitrogen for the plants will be necessary to grow the legumes. These plants leave in soil the great

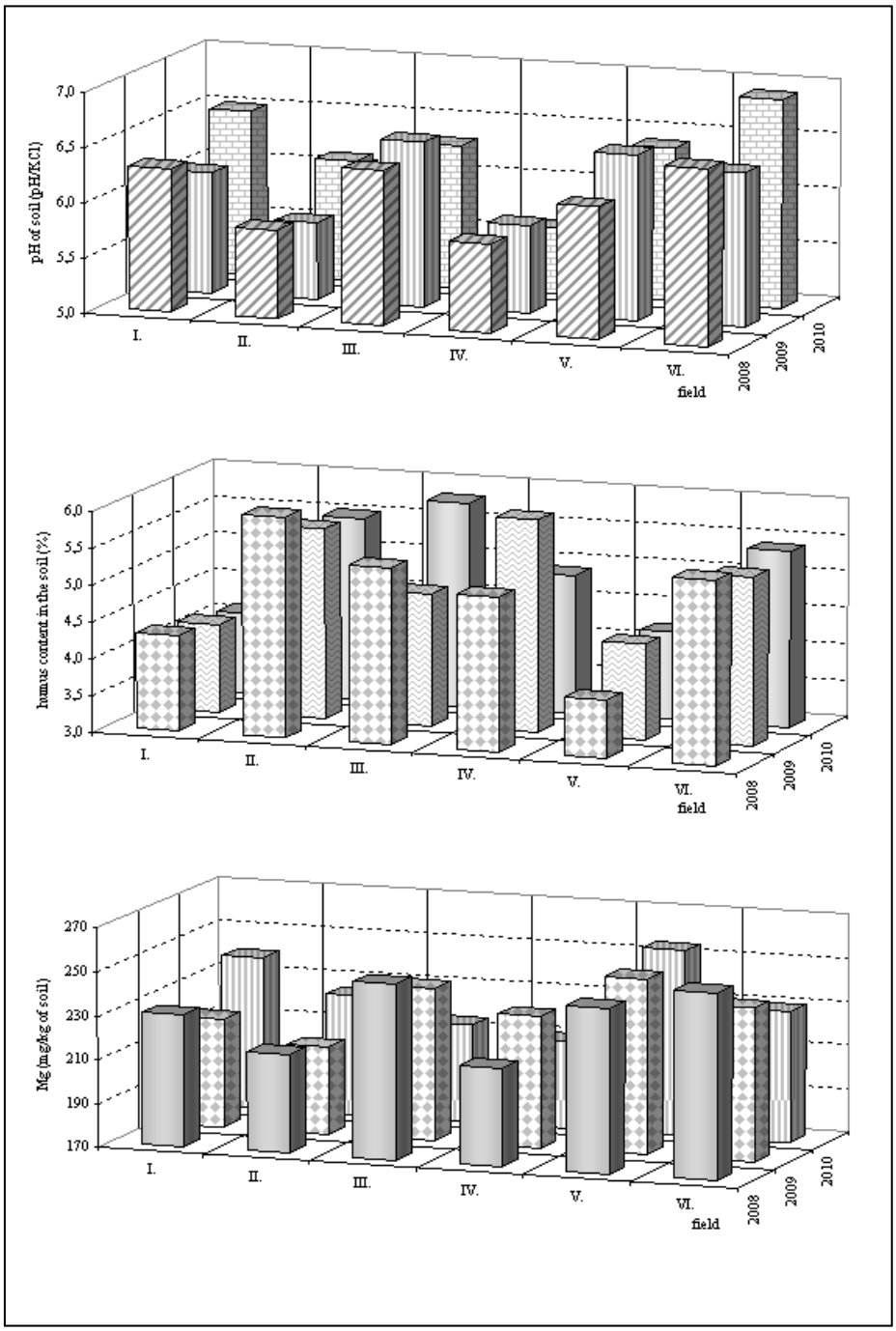

Fig. 1 – Soil reaction, humus and available magnesium contents in agricultural soils in the farm Liptovska Teplicka

amount of nitrogen (more than 100 kg $N.ha^{-1}$) which is disposable for next grown plants [4].

Phosphorus is in the soil relatively strongly fixed, its contents is stable and depends on the soil pH value. Due to soil reaction minimal changes in observed fields the phosphorus contents was changed also minimal. The maximal value of phosphorus contents was determined in the field VI. what can be caused by intensive fertilising in recent years. The phosphorus content in the other fields occurs in regular interval of contents in Slovakia.

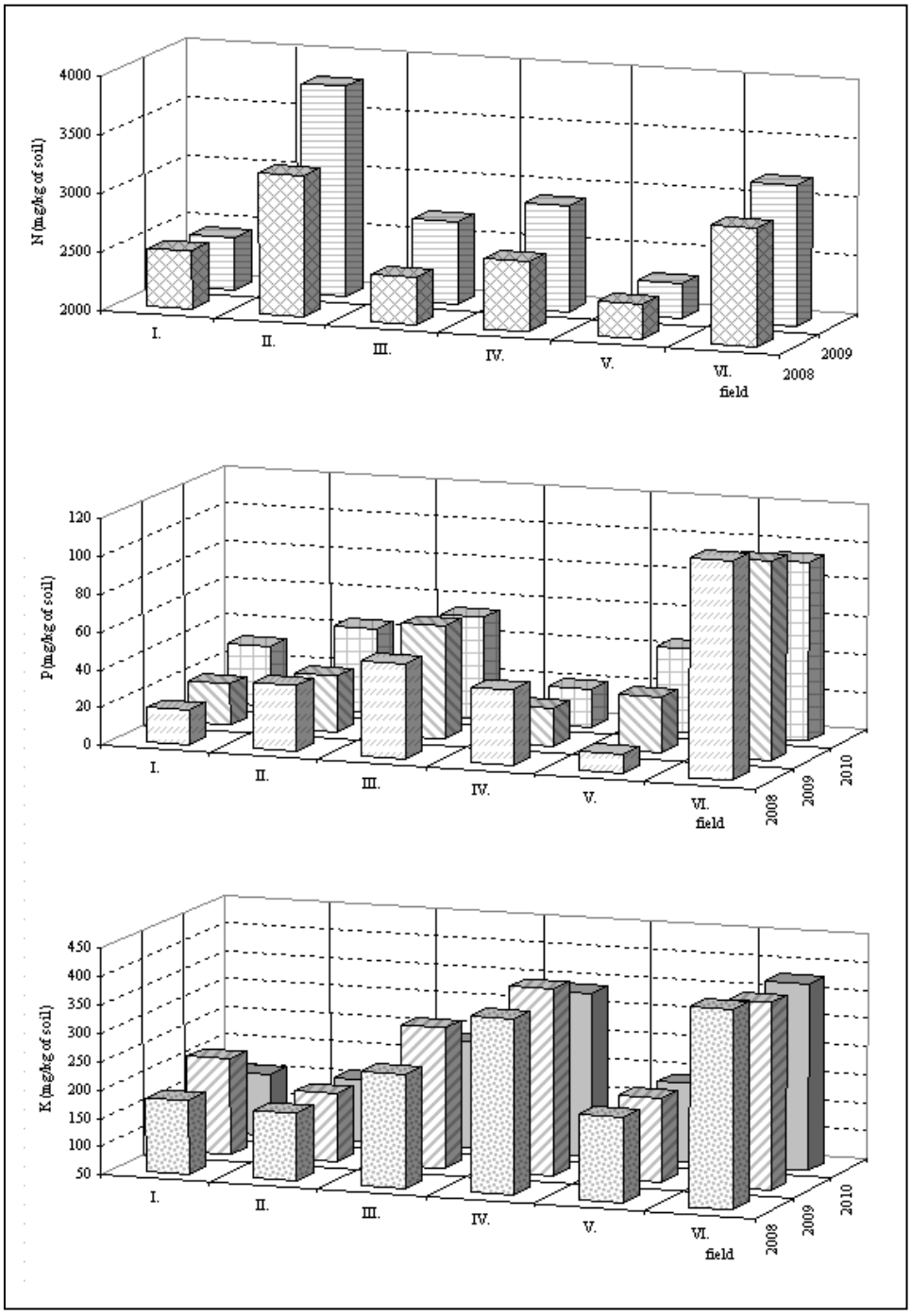

Fig 2 – Total nitrogen, available potassium and magnesium contents in soils in farm Liptovska Teplicka

The potassium and magnesium content in the soils is also relatively stable during the whole observed period. Concerning to soil structure (medium heavy and heavy soils) these nutrients have a lot of possibilities for the fixing to the soil parts and do not underlie to the leaching from the topsoil in spite of high precipitation during the year (800-1100 mm).

Humus contents in the soil underlies to the strong changes only in long period. Because of the fact, that humus content belongs to the stable soil properties; it is no possible to expect the changes during three years.

The cereals yield has decreased since 2008 in comparison with the earlier years in the farm Liptovska Teplicka. There is showed that by growing of triticale even this crop by its productivity potential is suitable to grow in such climatic condition (4.5-4.7 t.ha^{-1}). The potatoes yield reached 12-16 t.ha^{-1} and there were no recorded the significant differences in long observed period. The specific composition of fodder crops grown on the arable land registered itself by stable yields.

Table 2

Yields of grown crops in the farm Liptovska Teplicka (t.ha^{-1})

Name of field	2008		2009		2010	
	Crop	Yield	Crop	Yield	Crop	Yield
I.	winter wheat	1.6	spring barley	1.6	clover-grass mixture	46.6
II.	spring barley	1.5	oats + pea	34.4	spring barley	2.0
III.	winter rye	3.2	spring barley	1.5	clover-grass mixture*	27.6
IV.	potatoes	12.1	triticale	4.5	clover-grass mixture*	21.4
			oats + pea + annual ryegrass*	24.5		
V.	clover	39.5	clover	48.8	clover-grass mixture*	23.8
VI.	potatoes	14.5	spring barley	4.0	triticale	4.7
	winter barley	1.6	oats + pea + annual ryegrass	41.4		
	oats + pea + annual ryegrass	39.5	potatoes	15.5		
	spring barley	1.6				

Notice: yields of clover, clover-grass mixture and annual mixture are given in a fresh mass
* one cut

Conclusion

The observed chemical soil properties (contents of total nitrogen, available phosphorus, potassium and magnesium, humus and soil reaction) have changed only minimal in the farm with ecological farming system during the three years period. The high rates of organic fertilisers have had the positive influence on the soil buffering and so indirect on the soil reaction, as well. The triticale is the most suitable cereal in given soil-climatic conditions, its yield have reached 4.5-4.7 t per ha. The unfavourable temperature conditions are the main reason of low intensity of nitrogen mineralization and thereby of higher offer of mineral nitrogen for the grown plants.

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