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## INFLUENCE OF CROPPING TECHNOLOGIES ON BIOLOGICAL SOIL CHARACTERISTICS.

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***Summary***

Field experiment started in 1994, in order to determine effect of tillage and residue management in different crop sequences on microbial activity and dynamic of soil organic carbon, at Experimental station of Slovak Agricultural University in Nitra - Dolná Malanta on Orthic Luvisol. No significant differences between fertilizer treatments in basal respiration of topsoil have been noted under any growing crops : maize ( *Zea mays* L.) – spring barley (*Hordeum vulgare* L.) –common pea ( *Pisum sativum* L.) – winter wheat (*Triticum aestivum* L.). The soil tillage management has a significant influence on microbial activity with basal respiration intensity of the soil under mouldboard ploughing - 22.7 mg $CO_2$ and 26.7 mg $CO_2$ per kg of the soil under shallow loosening soil. The same tendency was noted in organic carbon content in soil after seven years mouldboard ploughing - $C_{org}$ 1.21 % with comparison of $C_{org}$ 1.36 % by reduced cultivation using – shallov loosening.

***Keywords:*** basal respiration,organic carbon, tillage management, crop sequences

***Introduction***

In a mature natural ecosystem or a stable agroecosystem, the release of carbon as carbon dioxide by oxidation of soil organic matter (mostly by microbial respiration) is balanced by the input of carbon into the soil as a plant residues. Agroecosystem has some perturbation, results in a net loss of carbon from the soil system. Crop rotation has an important role in sustainable agriculture from aspect of biodiversity of agroecosystem in place and time Kováč et al.(1977) . Industrial cropping system and lack of farm yard manure have negative impact on soil biological activity. Cash crop production with high share of grain crops may influence soil biological activity (Pospišil et al.,1999). Respiration activity indicates the intensity of metabolic processes and it is an important characteristic of the carbon dynamics in soil (Kubát et al.,1999).
Material and Methods
The aim of this study was to evaluate the crop management practices on the biological activity of the soil and soil organic mater. The field trial was conducted at the Experimental station of Slovak Agricultural University in Nitra - Dolná Malanta, during 1994 – 2000 years. The experimental site belongs to warm and moderate arid climatic region in the south – west of Slovakia, the average rainfall is 561 mm, for the growing season 327 mm. Average air temperature is 9.7 $^0$C, for the growing season 16.2 $^0$C. The main soil type is Orthic Luvisol,. with 2.3 % of humus content and pH 5.7 in average, the parent material is silt loess. Maize ( *Zea mays* L.) – spring barley (*Hordeum vulgare* L.) –common pea ( *Pisum sativum* L.) – winter wheat (*Triticum aestivum* L.) were under different crop management practices. The impact of three fertilization levels and tillage treatments growing in different crop sequences have been studied. The crop rotation treatments were as follows: single cropped – maize rotation, double cropped - maize for corn – spring barley rotation, three crops rotation - maize for

corn – common pea – winter wheat rotation, four crops rotation – maize for corn – spring barley – common pea – winter wheat rotation.

Three basic tillage treatments were: B1 – conventional cultivation mouldboard plough tillage to a depth 0.3 m ( maize ), moldboard plough tillage to a depth 0.2 m and surface cultivation of topsoil( winter wheat, barley, common pea); B2 - offset disc ploughing( 0.15m deep) and combined cultivator; B3 – reduced cultivation – shallow loosening ( winter wheat, barley, common pea ), twice times shallow loosening(maize).

Each tillage treatments had three fertilizing levels: O – zero level without organic or inorganic fertilization, respectively; PH – balanced fertilizing to the designed yield level, specifically to the crop; PZ – incorporating all above-ground plant material and crop residues as a source of organic matter and inorganic fertilizer for the balance equilibrium level.

Common pest and disease control practices were applied. For weed control there were used both herbicides and stick harrow. Plots for tillage system were implemented in a split plot design. Plots were divided into subplots( 11 x 40 m ) non randomized within main plots and were subjected to fertilization treatments with four replications. The soil samples were collected from the 0 - 0.25 m topsoil profile, four or five times from April to November. The soil samples were incubated at 28 °C 35 days and basal soil respiration had been measured six times a week according Bernát and Seifert method (Seifert, 1977) and total soil organic carbon according to Tyurin method.

***Results and discussion***

Carboneum organic content ( $C_T$) has a close relationship with soil microbial activity. Changes in $C_T$ towards decreasing or increasing level of soil organic matter take many years to appear. After seven year trials of using differen crop mamagement practices soil reach a new equilibrium level of soil organic matter (SOM) . From starting level of 1.1 % $C_T$ to 1.28 % soil in average, for all tillage and fertilizer treatments of four crop sequences: maize- spring barley -common pea and winter wheat. Differences in $C_T$ content , predominantely between soil tillage treatments have been noted. The average value of $C_T$ content in soil under mouldboard ploughing and incorporating all above-ground plant material and crop residues as a source of organic matter and inorganic fertilizer for the balance was 1.23 % with comparison of 1.36 % by reduced cultivation using – shallov loosening. No significant differences between O and PH treatments in four crop rotation have been noted, but we are able to note tendency of appreciable increasing of $C_T$ content in treatments with incorporating all above ground material The rate of soil carboneum: nitrogen content from starting rate 8:1 has actual value 7.46 : 1, with seasonal dynamics: spring – 8.91:1, autumn - 6.57:1. The incorporation of common pea aboveground material influenced total nitrogen content in soil ( O– 1577 mg. $kg^{-1}$, PZ - 1928 mg. $kg^{-1}$) in both tillage treatments last year. No significant differences between fertilizer treatments in basal respiration of topsoil have been noted under any growing crops. The highest differences in daily $CO_2$ production was on winter wheat mouldboard ploughing plots O - 2.21 mg.$CO_2$ 100 $g^{-1}$ soil and PZ – 2.34 mg.$CO_2$ 100 $g^{-1}$ soil. The soil tillage management has a significant influence on microbial activity. See Table 1.

Table 1 Daily basal respiration intensity in mg $CO_2$ per 100g of the soil, average 1994-2000

| treatments | maize for corn | barley | common pea | winter wheat |
|---|---|---|---|---|
| mouldbord ploughing | 2.27 | 2.29 | 2.23 | 2.31 |
| shallow loosening | 2.65 | 2.62 | 2.76 | 2.63 |

Due to enhance microbial activity, basal respiration of the soil was in conventional tillage soil in average 2.27 mg $CO_2$ 100 $g^{-1}$ soil and 2.67 mg $CO_2$ 100 $g^{-1}$ in shallow loosening soil. The soil microbial activity and turnover of organic material have been assessed. After seven year trials incorporation of aboveground material has no significant effect on basal respiration intensity of topsoil but increasing tendency of total carbon content to average value 1.28 %. The differences in $C_T$ on the same type of the soil in ecological system(1.31 %) and integrated system (1.25 %) noted also Szombathová (1999) and $C_T$ used for C pool index calculation, but more susceptible carbon fraction mentioned labile carbon. Zaujec and Kováč (2000) revealed positive tendency and statistical signification of increasing soil organic carbon content only in different cultivation treatment. Also in this trial the relationship between soil microbial activity and $C_T$ content revealed benefit of minimum tillage treatment -shallow loosening for improving soil fertility due to increasing of total carbon content ( 1.36 %) with comparison by seven year mouldboard ploughing 1.21 %. The assessment of basal respiration indicated the changed tendency in soil organic mater status. In the same way Mühlbachová and Rüžek (2000) mentioned correlation between content of total organic carbon and basal respiration of soil. Nitrogen level by plough in plant material as a source of organic matter has been depleted. Imobilization of N, due to incorporating cereals straw positively affected N loses by leaching during autum. Conversaly shallov incorporation of common pea plantmass supported leaching of nitrate during autumn.

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## ENERGY BALANCE AND SUSTAINABLE AGRICULTURE

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***Summary***

Ffour different crop production systems were evaluated at the Experimental station of Slovak Agricultural University In Nitra-Dolná Malanta, during 1994 – 2000. From comparison of energy balance parameters( total energy input, energy output of dry matter of plant biomass, an energy gain and efficiency) resulted that the highest energy inputs are by single cropping system of maize. By using this method we defined the energy flow with aim – to reduce energy consumption. The four crop sequences cropping system saved 39% of total energy consumption and works with higher energy efficiency( 9.97 %). For acceptable energy input and energy efficiency we recommende more diverse crop rotation than double crop sequences .

***Keywords***: energy balance, cropping systems, crop management practice

***Introduction***

Food production systems must be environmentally sustainable and their products must be accesseble and safe.The yield production and input of direct and indirect fossil energy and its agri-environmental causalities is especially important in view of the ongoing EU accession proces. Purposeful assert of saving energy consumption requires analysing of cropping technologies and their impact and sustainability(Pospišil, Vilček,2000). Present cropping technologies are energy and economical demanding with comparison to price of agricultural products.The basic tillage systems have a big share of total energy input into Agricultural systems (Pospišil,Macák,1999). Sustainable agricultural practices are under scrutiny by researches and producers. The advanced agricultural production system requires to solve many questions with direct impact on crop production and environment like reducing fossil energy (Rumpel,1992). In addition to stable yield production - account of energy balance is required for assessment of fossil energy saving technologies (Hančárová,1989).
Material and Methods
The objective of this study was to evaluate productivity of four cropping systems with focus on cash crops and to design cropping technology with aims: to produce foodstuff of nutritional quality and sufficient quantity and to reduce the use of fossil energy in agricultural practice. The experimental site is located at the Experimental station of Slovak Agricultural University in Nitra - Dolná Malanta. During 1994 – 2000 years,
three fertilization and tillage treatments in four agricultural systems have been studied.
The crop rotation treatments were as follows: single cropped – maize rotation, double cropped - maize for corn – spring barley rotation, three crop rotation - maize for corn – common pea – winter wheat rotation, four crop rotation – maize for corn – spring barley – common pea – winter wheat
Three basic tillage treatment were:
B1 – conventional cultivation mouldboard plough tillage to a depth 0.3 m (maize), moldboard plough tillage to a depth 0.2 m and surface cultivation of topsoil (winter wheat, barley, common pea)
B2 - offset disc ploughing( 0.15 deep) and combined cultivator
B3 – reduced cultivation – shallov loosening (winter wheat, barley, common pea), twice times shallov loosening(maize)
Each tillage treatments had three fertilizing levels:
O – zero level without organic or inorganic fertilization, respectively