

RELATIONS BETWEEN SOIL RESPIRATION, HUMUS QUALITY AND CATION EXCHANGE CAPACITY IN SELECTED SUBTYPES OF CHERNOZEM IN SOUTH MORAVIA REGION

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Abstract

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Soil organic matter (SOM) undergoes short and long-term transformation in the soil. Microorganisms through their enzymes are able to mineralize organic carbon while the rate of this process is different. Biological test though referred to one of the main diagnostic methods for evaluating soil quality/health. The aim of our work was to determine basal respiration, total carbon content, fractional composition of humus and basic parameters of soil colloidal complex in selected subtypes of chernozem in South Moravia region. Basal respiration was measured using Vaisala GMT220 apparatus. Total carbon content was determined by oxidimetric titration and basic parameters of soil colloidal according to Mehlich. Results showed that production of carbon dioxide varied from 0.09 to 0.27 mg CO₂/100g/h. Linear correlation between basal respiration and humification degree was found. Humus content varied from 2.15% to 4.6%. No correlation between quantity of humus and basal respiration was observed. Higher values of basal respiration were connected with higher quality of HS. Significant linear correlation between total carbon content (TOC) and cation exchange capacity (CEC) was found.

basal respiration, humus fractionation, cation exchange capacity, chernozem

Soil respiration, humus quality and character of soil colloidal complex are closely connected with plant nutrition and soil fertility. Soil respiration reacts differently to treatment and cultivation methods and has already been used for soil quality evaluation. Mineralization of organic compounds is represented by converting the substrate to CO₂, cell components, and products typical of the usual catabolic pathways most frequently for assessment on the side effects of different chemicals components in the soil (Alexander, 1994). Intensity of mineralization depends on quantity and quality of humic substances, texture, pH and others soil chemical properties. According to Sokolovska et al. (1989) humus surface properties were the highest in chernozem soils, which also displayed a large dispersion of humus within

the mineral horizon. The charge density of the humus and mineral colloids indicated the importance of the organic matter to the soil surface formation, as compared with its contribution to the process of exchange. Kahl et al. (1993) studied quality of SOM and cation content in soils that had been manured over a long period. They found significant correlation between total carbon content and cation exchange capacity.

Gao and Chang (1996) studied the soil cation exchange capacity (CEC), total organic carbon content (TOC) at the 0 to 15 and 15 to 30 cm depths increased with increasing rates of manure. The increases in CEC were attributed mainly to the increases in organic carbon content. Increases in soil CEC caused by increased in organic carbon through manuring

were smaller than those caused by increases in an equivalent amount of organic carbon through natural soil formation processes.

The aim of our work was to compare basal respiration, total carbon content, fractional composition of humus and CEC in selected subtypes of chernozems in South Moravia region.

MATERIAL AND METHODS

In 2005–2007 disturbed soil samples from the top soil were taken. We followed modal chernozem (locality–Bořetice), carbonate chernozem (locality–Březí), phaeoic chernozem (locality–Dubany), luvic chernozem (locality–Kašenec), modal chernozem (locality–Ostrožská Lhota), modal chernozem (locality–Prace), modal chernozem (locality–Syrovice) and modal chernozem (locality–Želeč). Region of these soils belongs to very warm agroclimatic macroregion, dry subregion, moderately cold winter with annual sum of precipitation amounting from 500 to 600 mm and average annual air temperature from 9 to 10 °C. Freshly collected soil samples were sieved (2 mm mesh) and basal respiration was monitored under laboratory condition using Vaisala GMT220 apparatus and the output of CO₂ was recorded. The detailed information about CO₂ output measurements is given in Foukalová and Pokorný (2006). Further the fundamental chemical analyses of soil samples were subjected. TOC content was determined by titrimetric oxidation (Nelson and Sommers, 1982). Fractional composition of humus was made according to Kononova–Belchikova method (Podlešáková et al., 1992). Parameters of soil colloidal complex were measured according to Mehlich (Hraško, 1962). To elucidate the effects of studying parameters on basal respiration correlation coefficients were calculated.

RESULTS AND DISCUSSION

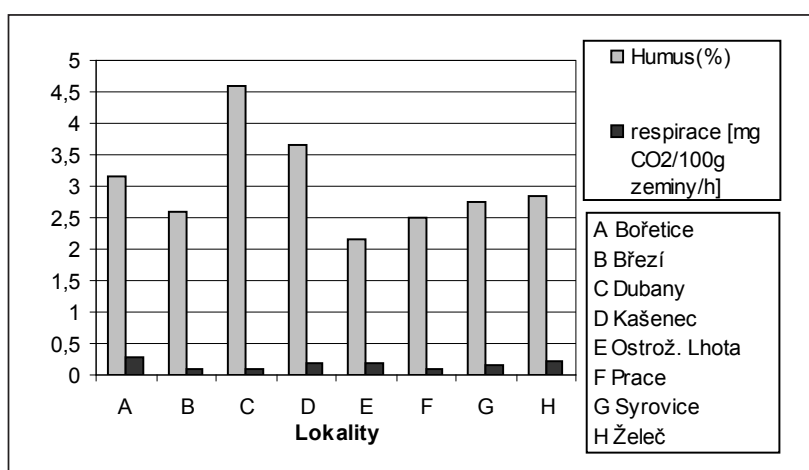
We have found out that humus quality and humification degree were important parameters affecting microbial activity and basal respiration. Generally production of CO₂ varied from 0.09 to 0.27 mg

CO₂/100g/h. The highest CO₂ output (0.27 mg CO₂/100g/h) was found in modal chernozem (Bořetice) and the lowest CO₂ output (0.08 mg CO₂/100g/h) was found in modal chernozem (Prace) – listed at Fig. 1. Basal respiration was not effected by humus quantity (Fig. 1). Humus quality given by its fractional composition is listed at Fig. 2. In generally sum of HS varied from 4 to 11.1 g/kg. The highest value was found (11.1 g/kg) in phaeoic chernozem (Dubany). The lowest value of HS (4 g/kg) was found in carbonate chernozem (Březí). Generally humic acids (HAs) content varied from 2 to 4.5 g/kg. HAs content was highest in phaeoic chernozem (Dubany) and lowest in carbonate chernozem. FAs content varied from 2.4 to 3.4 g/kg. Calculated ratio between HAs/FAs was always higher than 1. Highest quality of humus was in phaeoic chernozem (Dubany) and lowest in carbonate chernozem (Březí). Humification degree (calculated as ratio of HAs/TOC*100) varied from 13.2% (carbonate chernozem–Březí) to 48.8% (modal chernozem–Bořetice). Linear correlation between CO₂ output and humification degree was found (Fig. 3, 4).

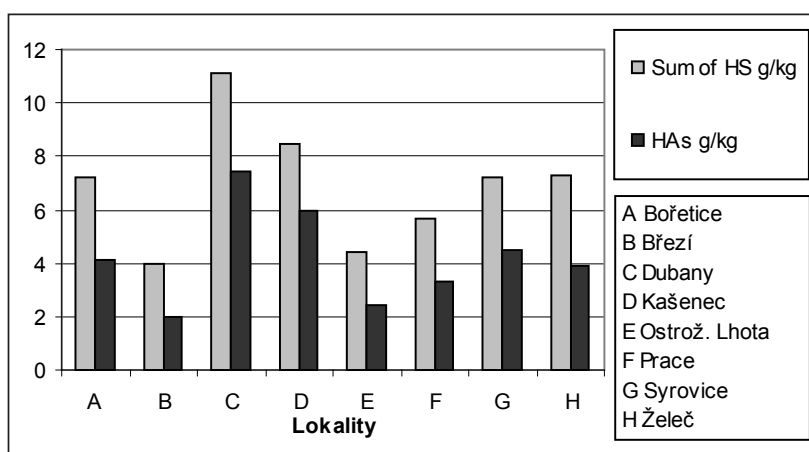
TOC content varied from 1.45% (modal chernozem, Prace) to 2.65% (phaeoic chernozem, Dubany). Comparison of TOC and CO₂ production showed that carbon content did not directly influence basal respiration, linear correlation was not found (Fig. 5, 6). Further we followed how is TOC content, humus quality influenced by basic CEC. Linear correlation between TOC content and cation exchange capacity was found Fig. 7, 8. The last corresponded with literature data given by Kahl et al. (1993), Gao and Chang (1996). Sum of HS also correlated significantly with cation exchange capacity (Fig. 9, 10).

CONCLUSIONS

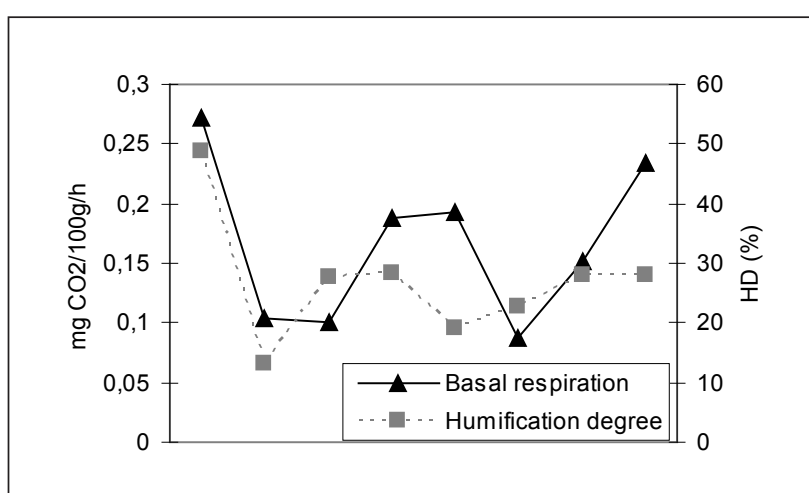
We can conclude that humus quality and humification degree mostly influenced microbial activity and basal respiration. Humus quality was directly influenced by cation exchange capacity. Linear correlation between humus content and basal respiration was not found.



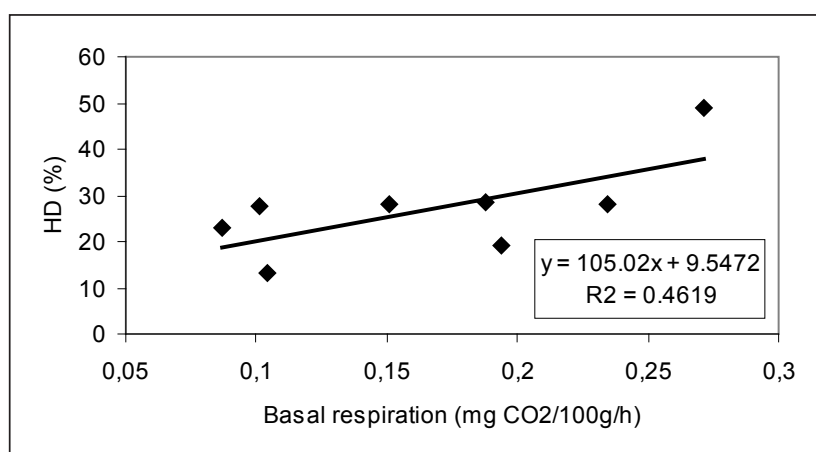
1: Basal respiration (mg CO₂/100g/h) and humus content (%) in selected chernozem subtypes



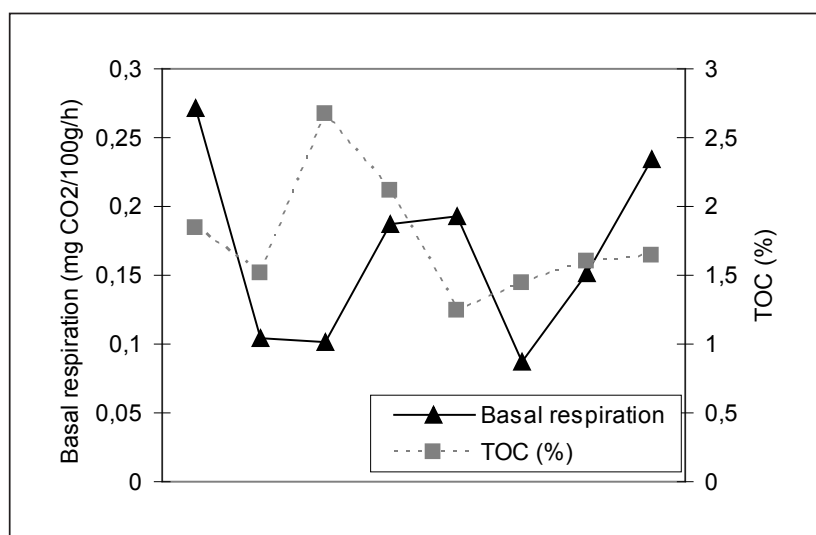
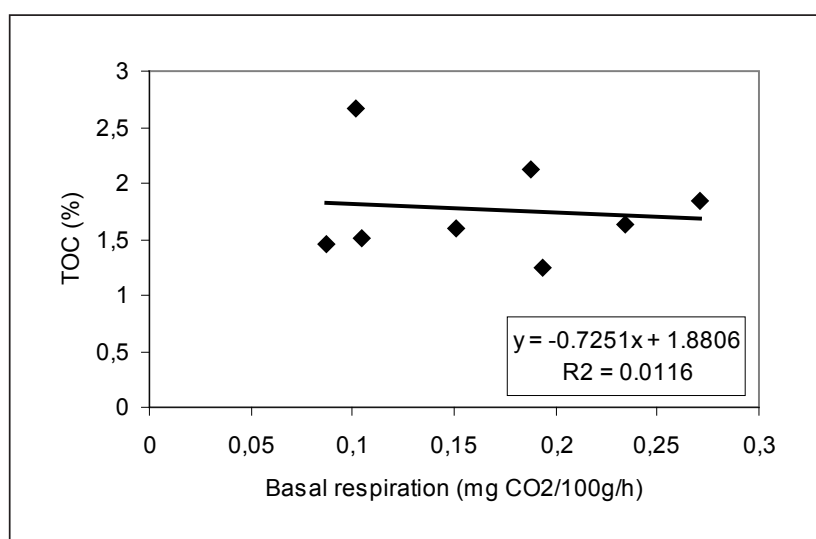
2: Fractional composition of humus (Sum of humic substances (HS) and humic acids (HAs))

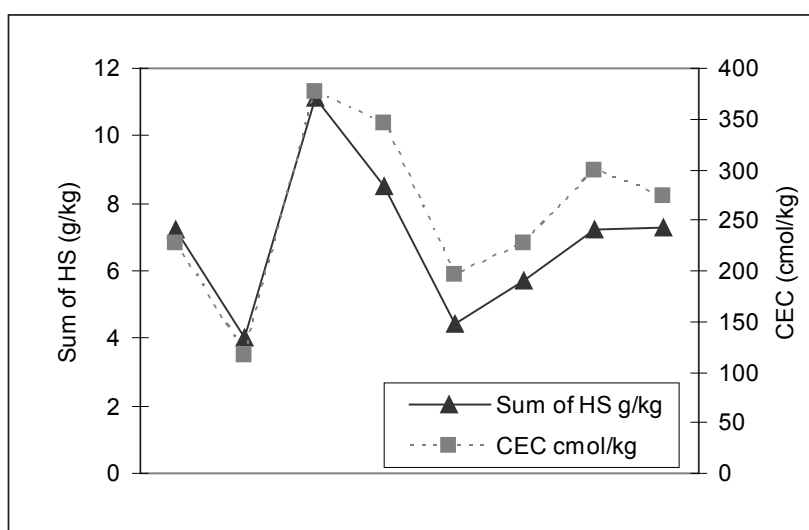


3: Comparison of basal respiration (mg CO₂/100g/h) and humification degree (%) in selected chernozems subtypes

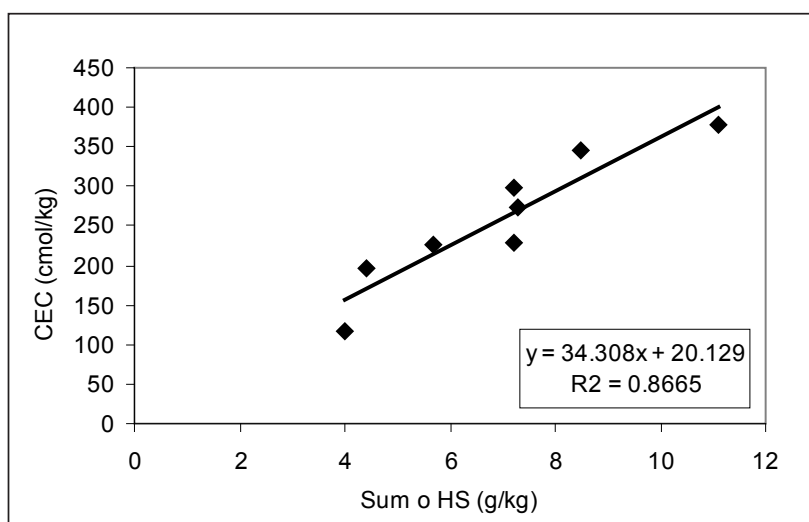


4: Correlation between basal respiration and humification degree

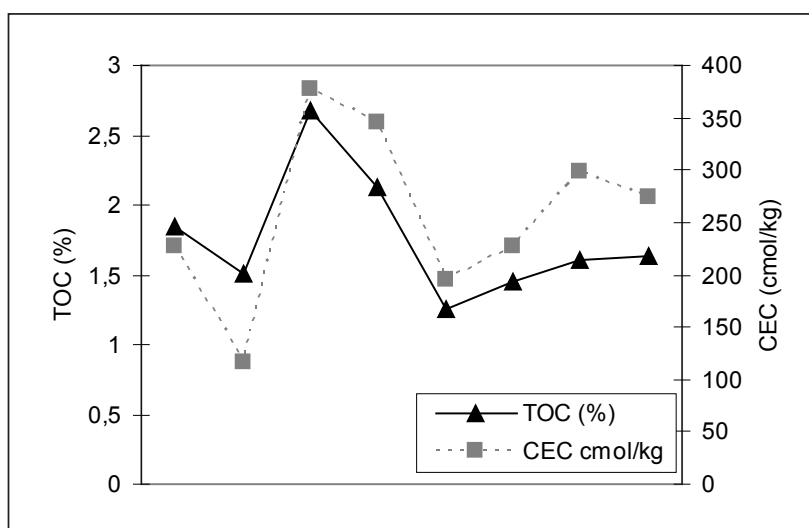
5: Comparison between TOC (%) and basal respiration (mg CO₂/100g/h)6: Correlation between TOC (%) and basal respiration (mg CO₂/100g/h)



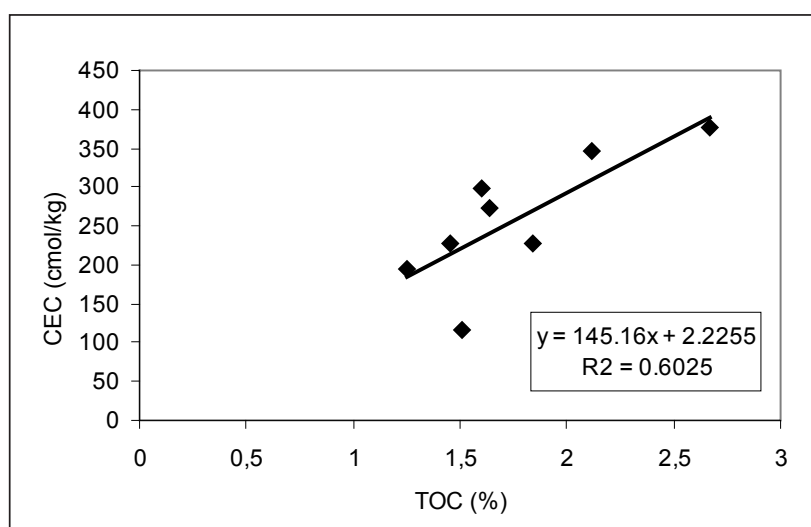
7: Comparison between sum of HS and cation exchange capacity (CEC)



8: Correlation between sum of HS and cation exchange capacity (CEC)



9: Comparison between TOC content and cation exchange capacity (CEC)



10: Correlation between TOC content and cation exchange capacity (CEC)

SOUHRN

Vztahy mezi respirací, kvalitou humusu a kationtovou výměnnou kapacitou u vybraných subtypů černozemí jižní Moravy

Změny biologických a chemických vlastností půdy jsou způsobeny jak vlivy vnějšího prostředí, tak i vnitropůdními činiteli. Každý půdní typ má vlastní dynamickou rovnováhu mezi obsahem minerální a organické části, mezi stabilizací a aktivací organických a minerálních látek. Při stanovení souboru ukazatelů pro hodnocení uvedených vlastností vycházíme ze skutečnosti, že každý půdní typ má v procesu pedogeneze dány charakteristické vlastnosti půdního sorpčního komplexu (PSK), zásobu humusu i jeho specifické složení a rozdělení v profilu. Vzorky byly odebrány z ornice na následujících lokalitách jižní Moravy: černozem modální (lokalita Bořetice), černozem karbonátová (Březí), černozem lužní (Dubany), černozem degradovaná (Kašenec), černozem modální (Ostrožská Lhota), černozem modální (Prace), černozem modální (Syrovice) a černozem modální (Želeč). Měření bazální respirace čerstvě odebraných vzorků probíhalo v laboratorních podmínkách, kde mohou být podmínky vnějšího prostředí přesně kontrolovány a stanovení probíhalo na základě odečítání hodnot z přístroje Vaisala GMT220. Podrobný postup měření je uveden (Foukalová and Pokorný, 2006). Celkový obsah uhlíku v půdě byl zjištěn oxidimetrickou titrací (Nelson and Sommers, 1982). Frakční složení humusu bylo stanoveno krátkou frakcionací podle Kononové-Bělčikové (in Podlešáková et al., 1992). Parametry půdního sorpčního komplexu byly stanoveny podle Mehlicha (BaCl_2 , pufovaný trietanolaminem, $\text{pH} = 8,1$) in Hraško (1962). Výsledky ukazují, že přímý vliv na bazální respiraci měla kvalita humusu a stupeň humifikace organických látek (obr. 3, 4). Lineární korelace mezi obsahem humusu a bazální respirací nebyla zjištěna (obr. 5, 6). Kvalita humusu a jeho frakční složení bylo ovlivněno charakterem půdního koloidního komplexu. Byla zjištěna lineární korelace mezi obsahem organického uhlíku a kationtovou výměnnou kapacitou (obr. 7, 8) a mezi obsahem humusových látek a kationtovou výměnnou kapacitou (obr. 9, 10). Uvedené výsledky korespondovaly s literaturou Kahl et al. (1993) and Gao et al., Chang (1996).

bazální respirace, frakcionace humusu, kationtová výměnná kapacita, černozem

ACKNOWLEDGEMENTS

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