11th Alps-Adria Scientific Workshop

Opatija – Croatia, 2013

SPECTRAL EVALUATION OF THREE ACIDIFICATED CHERNOZEM SOIL SAMPLES

Imre T. TOLNER [1], László TOLNER[2], Kornél D. SZALAY [3], László FENYVESI [4], Miklós NEMÉNYI [1]

[1] University of West Hungary, Faculty of Agricultural and Food Science, H-9200 Vár 2, Mosonmagyaróvár , Hungary

tolner.imre@mtk.nyme.hu

[2]Szent István University, Faculty of Agricultural and Environmental Sciences, Department of Soil Science and Agrochemistry

[3] Hungarian Institute of Agricultural Engineering, Outer Agricultural Technical Department of Szent István University

[4] Hungarian Institute of Agricultural Engineering

Gábor Baross programme

Established by the support of the National Office for Research and Technology

NKTH

Introduction: It's important to develop remote sensing test methods for precision agriculture. The wavelength of infrared spectroradiometers used in remote sensing is from 350 to 2500 nm range. The determining information of the mineral composition of the soil can be found in the upper part of the wavelength interval (Kardeván et al., 2000, Kardeván, 2007).

Most of the Hungarian soils are acidic soils. It's important to estimate the extent of acidification because of the appropriate melioration and soil conservation (Várallyay et al., 1980; Várallyay, 2006; Husti, 2006). Beside the pH examination, the total acidity of the soil can be identified even with direct titration method (Czinkota et al., 2002; Simon et al., 2006; Vágó et al., 2010) which is extremely essential for calculation of liming (Tolner et al., 2008; Vágó et al., 2008).

Determining the pH value of the soil with remote sensing can be a problem because the effects can be combined with the effects caused by the organic matter and clay content of the soil (Chang et al. 2001). Chang et al. (2005) examined the correlations based on 400 soil samples. Calibrations were based on partial least-squares regression (PLSR), using the first differentials of log ($1.R^{-1}$) for the 1100 to 2500-nm spectral range. Based on experiments Seilera et al. (2007) proved that pH change causes change in the concentration of OH group. Acidic soils can contain $CaCl_2$. In these cases there are significant absorption differences in the interval of 1900-2000 nm if the humidity of the soil is different (Tolner et al., 2012).

The water content of the soil samples strongly influences the reflection spectrum (Neményi, 2008; Milics, 2004), so we paid great attention to the drying of the samples.

Materials and methods: We have carried out experiments with three types of chernozem soils from Mosonmagyaróvár. The most important features of the soils are in Table 1.

Table 1. ***The most important features of the soils***

Code	$CaCO_3$%	pH(KCl)
T01	14.9	6.36
T05	28.3	7.01
T08	30.4	6.71

We applied hydrochloric-acid on five different levels. The solutions were completed with distillated water to 300 cm^3 in every case. To 500 g soil we used hydrochloric acid whose concentration was 6 $mol.dm^{-3}$ (Table 2)

Table 2. ***The quantities of the treatments by hydrochloric acid (6 mol.dm^{-3}) on 500 g soil.***

Treatment	T01 soil		T05 soil		T08 soil	
code	HCl cm^3	HCl/$CaCO_3$ %	HCl cm^3	HCl/$CaCO_3$ %	HCl cm^3	HCl/$CaCO_3$ %
1	0	0	0	0	0	0
2	61.8	50	61.8	26	61.8	24
3	111.2	90	111.2	47	111.2	44
4	123.6	100	234.9	100	252.5	100
5	136.0	110	258.3	110	277.8	110

After intensive mixing we dried the samples on 110°C and we prepared them with 2 mm sieve. We examined pH(KCl) values in KCl (6 $mol.dm^{-3}$) dilutions. The soil solution rate was 1:2.5. We repeated the spectrum recordings for half an hour, meanwhile we checked the mass increasing caused by increasing humidity with scales. The spectra were taken with a portable hyperspectral spectroradiometer ASD FieldSpec®3 Max. This device belongs to the Hungarian Institute of Agriculture Engineering. We applied continuum removal at data processing.

Results and discussion : During the half an hour measuring the change of soil mass is less than 0.03% due to the humidity from the air. That is why we did not analyze the effect of moisture during the test. The average spectra after continuum removing are shown in Figure 1. (T01 soil), Figure 2 (T05 soil), Figure 3 (T08 soil)

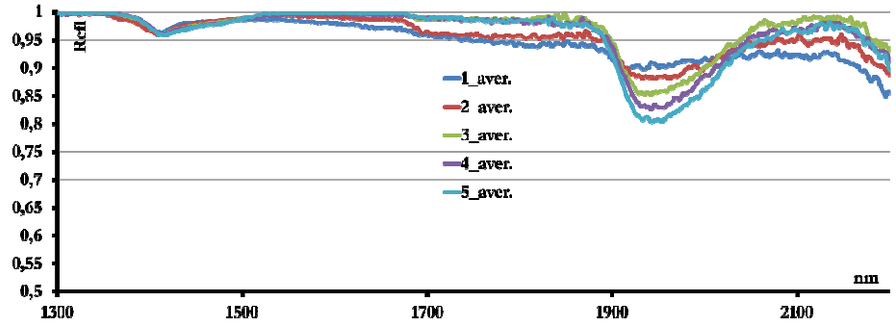

Figure 1. The average T01 soil spectra after continuum removing

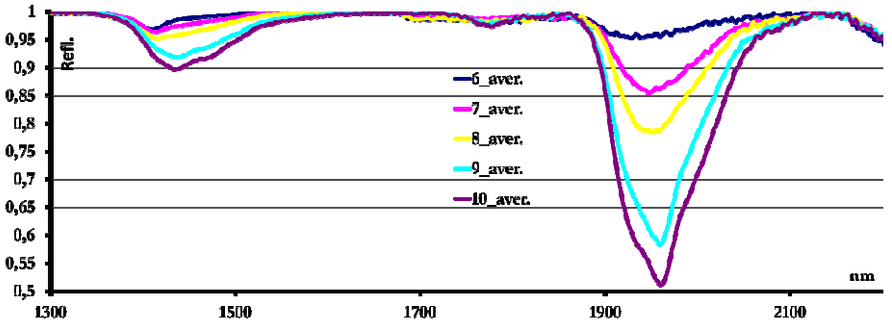

Figure 2. The average T05 soil spectra after continuum removing

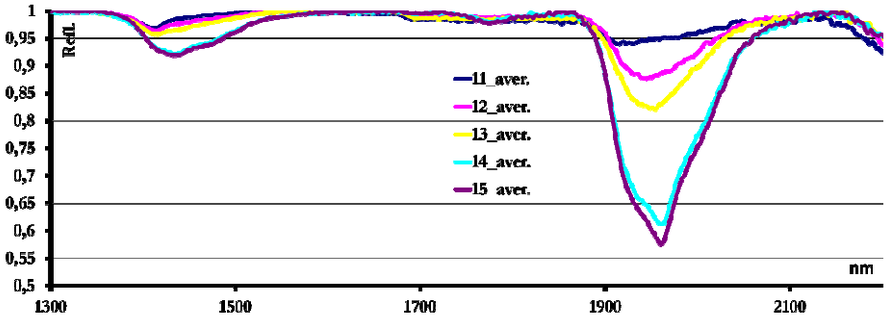

Figure 3. The average T08 soil spectra after continuum removing

We found increasing absorption in range 1900-2000 nm due to increasing acid treatments. We have examined the correlation between absorption maximum values and pH(KCl). We got the following linear function (Figure 2.a).

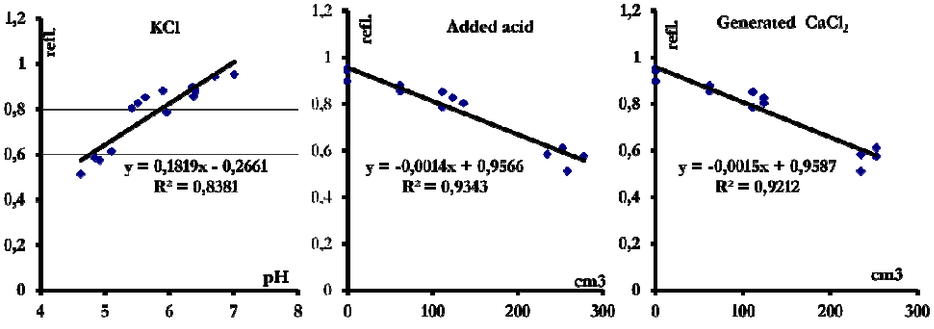

Figure 2. **The correlation between absorption maximum values and the examined factors. The 3 examined factors are pH(KCl) (a), added acid (b), and the resulted $CaCl_2$ (c) quantities**

The connection with pH is strong (R^2=0,8381) but the effect is due to indirect effects of other factors. The studied range of wavelength features an absorption peak characteristic for the water content of the sample. Studying the correlation between the absorption maxima and the additional acid or the quantity of $CaCl_2$ formed a stronger correlation (R^2=0.9343, R^2=0,9212) was established than that with the pH(KCl). (Figure 2.b, 2.c)

Conclusions : The moisture-preserving ability of the soil can be influenced by acid treatment. IR absorption can be utilized to study the water content of the soil, and from the data obtained we can draw conclusions about the pH of the soil.

Acknowledgements : This work was supported by Baros Gábor and TÁMOP 4.2.2.B-10/1-2010-0018 (TALENTUM) grants