CARBON-DIOXIDE EMISSION MEASUREMENTS IN A TILLAGE EXPERIMENT ON CHERNOZEM SOIL

Eszter TÓTH – Sándor KOÓS

Research Institute of Soil Science and Agricultural Chemistry, Budapest

Introductions

The terrestrial ecosystems are the biggest carbon reservoirs on the earth and soils, as part of these ecosystems, play a very important role in the global carbon cycle. Globally, in the upper one meter of minerals soils 1300-1500 Gt carbon is stored, which is twice more than the amount stored in terrestrial vegetation (Neill et al. 1998). Therefore a considerable part of the atmospheric carbon pool came from the terrestrial ecosystems, especially from soils (Lal, R et al. 1998).

The atmospheric carbon dioxide concentration was approximately 280 mg/kg in 1850 and 365mg/kg in 1996, so it has been increasing at a rate of 0.5 % per year. Now, this rate has reached the 1.5% per year, so if this trend does not change, the CO_2 concentration of the atmosphere can be about 600mg/kg during the 21st century. (Lal R. et al. 1999)

Globally, the agricultural originated carbon getting into the atmosphere is estimated at $2.5x10^{15}$g. This loss has an effect not only on the global warming, but plays an important role in the long-term quality of soils (Bloodworth and Uri, 2002).

The balance must be found between the highly disturbed and the non-tillage cropping systems applied in agriculture to ensure the least possible carbon losses from soils. (Németh et al. 1998)

Materials and Methods

Site description

In 2002 a tillage treatment experiment was set up in the Józsefmajor experimental site of the Szent István University near Hatvan. There is a calcareous chernozem soil on the plots, with a clay loam texture. The experiment was set up with the following six different tillage treatments in four replications:

- No-till
- Cultivator (12-16cm)
- Cultivator (16-20cm)
- Disking (16-20cm)
- Ploughing (26-30cm)
- Disking with deep loosening (40-45cm) (Farkas, 2004)

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The humus content is 2.84% in the upper 40cm and 3.17% in the upper 20cm layer. In that layer the total N content is 0.13-0.15%, the Al-P_2O_5 is between 240 and 320mg/kg and the Al-K_2O is 80-140mg/kg. The average yearly precipitation is 580mm, from that 323mm falls in the growing season (Birkás and Gyuricza, 2004).

Measurements methods

The carbon-dioxide emission measurements started in the tillage treatment experiment in 2005 on three different treatments: on the no till, the ploughing and the disking completed with loosening plots. In that way we can study the less disturbed, the most conventional and most disturbed tillage treatments. In situ measurements with a portable gas analyzer and air sampling were also carried out. In this article the results of the air sampling can be read.

To control the in situ measurements we also take air samples, which are analyzed with gas chromatograph. For this type of measurement 3 cylinders – 40 cm in diameter – were established on every examined plot. During the one hour long measurement period three sampling are carried out, the first is at the beginning, the second is half hour after covering the cylinder and the last one after one hour. The cylinders can be closed with plastic caps, with a hole clogged with a permeable septum on it, so the air sampling easily can be done with needle. From the syringe, the air samples can be transposed into vacuumed tubes.

Beside the emission measurements, the soil temperature is determined before and after each CO_2 measurement with digital soil thermometer and installed probes also record the soil temperature and soil moisture content four times a day. Soil samples are also taken in every sampling day from the examined plots. From the samples NO_4 and NO_3, Al-P and Al-K and total N content is also determined.

1. Results and discussion

The CO_2 fluxes were calculated on the base of the following equation:

$$F=d*(V/A)*(C2-C1)/t*273/(273+T)$$

Where: CO_2 flux [kg/m^2*s]

d: density of CO2 [kg/m^3]

V: volume of the cylinder [m^3]

A: area of the cylinder [m^2]

C1: CO_2 concentration at time of start [m^3/m^3]

C2: CO_2 concentration at time of end [m^3/m^3]

t: duration of the measument [s]

T: air temperature inside the cylinder [C^o]

The initial CO_2 concentration measured on the different treatment plots are shown in Figure 1. It is well seen, that the initial emission data are not diverse considerably in the different plots. In fact these initial concentration values – although they were measure in the opened cylinders – are in accordance with the atmospheric CO_2 concentration, and are better influenced by the actual meteorological circumstances than by the effect of the treatment.

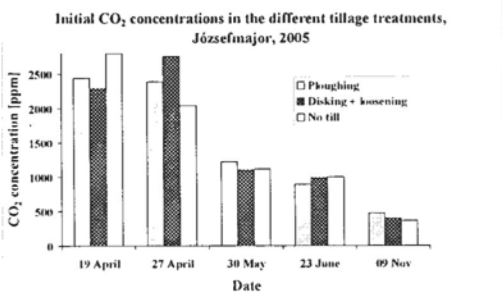

Figure 1. Initial CO_2 concentration in the different treatments (Józsefmajor, 2005)

In Figure 2. and Figure 3. the concentration changes are shown in the first and the second half hour. In both cases the highest values were measured in April, which corresponds with the literature results (Lal R et al, 1999; Tóth et al, 2005). From the figures it can be seen that the values of fluxes – aside from some exception – are always higher in the first half hour than in the second half of the measurement period.

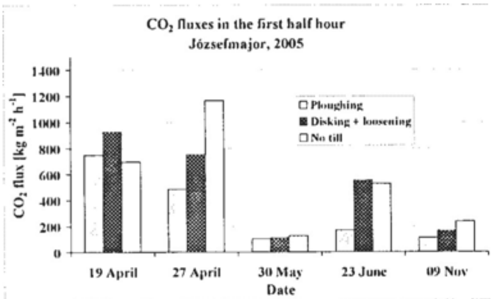

Figure 2. CO2 fluxes in the first half hour (Józsefmajor, 2005)

In the first half hour the highest fluxes were measured in the disking with loosening and the direct drilling treatment. The high fluxes of the disking with loosening treatment can be explained with the intensive soil management, which stimulates the aerobe microbiological activities and results soil organic carbon decomposition and higher CO_2 emission. Although the less disturbed treatment is the direct drilling; even so high emission values were measured. Since the direct drilling treatment is the less disturbed, there are favorable circumstances for animals – especially for rodents – living in the soil. Their respiration can significantly influence the soil respiration data, so in the future we have to emphasize to exclude these effects.

In the second half hour the differences between the fluxes of ploughing and the other two ones are hard expressed. Although the ploughing treatment is more disturbed than the direct drilling, even so in the second half of the measurement period, the flux values are rather low. On the base of the post hoc comparisons of the annual summed CO_2 emission values there is no significant differences between the three treatments, but the p values between ploughing and the other two treatments vary between 0,07 and 0,09. The three replications per plots are likely not enough to show the statistical differences so during the further samplings, more replications must be done.

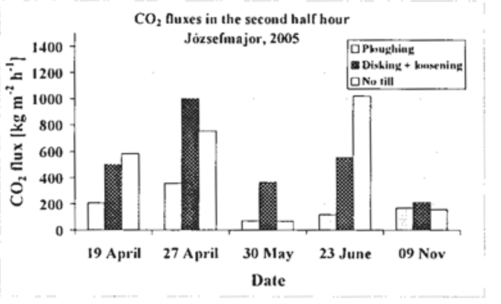

Figure 3. CO2 fluxes in the second half hour (Józsefmajor, 2005)

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