

DEVELOPMENT AND EXTENSION OF CO₂-EMISSION MEASUREMENTS FOR DIFFERENT SOIL SURFACES

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Introduction

Soil is the main source and at the same time the potential sink of greenhouse gases (e.g. CO₂, CH₄). These gases can originate both from the deeper horizons and from the layers close to the soil surface. The scale and degree of the gas production of these sources have not quantified yet. It is already determined that soil emits the most CO₂ into the atmosphere, hence from the point of view of global climate change and the rearrangement of water funds it is of great importance to gain information based on measured data about the gas emission of soils. Studying the seasonal dynamics of gas emission from soils under field conditions can provide information on gas immission and emission processes.

Both from the point of view of management and environmental protection it is very important that the humus enriching and decomposing processes can be influenced consciously by controlling the microbiological activities in the soil, so the favourable physical and chemical state of the soil can be maintained (BIRKÁS, 2002; ZSIGRAI, 2001). In the case of non-ploughing soil cultivation systems the decomposition of crop residues remaining on the soil surface is a considerable factor (QUEMADA and CABRERA, 1995). By means of soil conservation tillage systems replacing the conventional cultivation methods the chemical, physical and biological status of the soil can be significantly improved (LÁSZLÓ and GYURICZA, 2004). This fact was experienced in many places all over the world (DORAN, 1980; BEARE *et al.*, 1994). Contrary to undisturbed soils, higher rate – approximately 2/3 - of the carbon content of the organic matter getting into cultivated soils is oxidised and emitted into the air (ZSEMBELI *et al.*, 2005).

Methods

The measurements were carried out in two experimental sites of the Karcag Research Institute of University of Debrecen, Centre for Agricultural Sciences (KRI). One of the two is a complex soil tillage experiment (H-1) that was set on 15.8 ha in 1997 with conventionally cultivated (plough based) plots, with reduced tillage and direct seeding treatments respectively. The soil type of the site is meadow chernozem salty in the deeper horizons. The other site, called Rainer, is an extensive pasture utilised by grazing sheep, the soil type is medium meadow solonetz, the main characteristic grass species cover the area are *Festuca pseudovina*, *Festuca rupicola*, *Alopecurus pratensis*, *Trifolium repens* and *Bromus inermis*. The experiment carried out on that area is about the use of different grass treating rollers (rollers with knives of different size and layout) in order to examine the effects of them on the soil state and the grass life and composition. In the framework of that experiment we made CO₂-emission measurements to gain information if the different rollers have effect on this parameter.

The in situ CO₂-emission of soil was measured by means of an ANAGAS 98 infrared gas analyser in plastic (PVC) chambers (Fig. 1.) of 950 cm³ each in the case of experiment H-1, but this previously applied method (cylinders) was not suitable for the soil surface covered with grass, hence a new instrument was needed to be invented. In order to measure CO₂-emission on a larger area without deep disturbance of the soil, a special metal frame (Fig. 2.) was created with a matching bowl. The diameter of the frame is 44 cm, the height is 8 cm of

which a 5.5 cm high frame is inserted into the soil. The volume of the bowls is approximately 18.000 cm³ each. In both cases we applied three replications of the measurements.

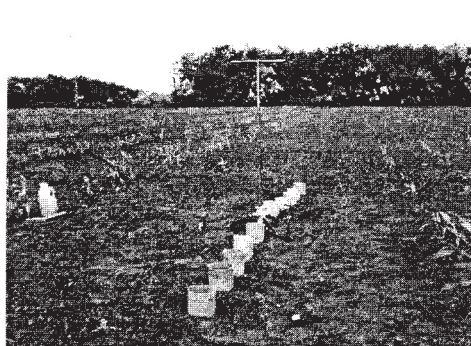


Fig. 1.: The cylinder method

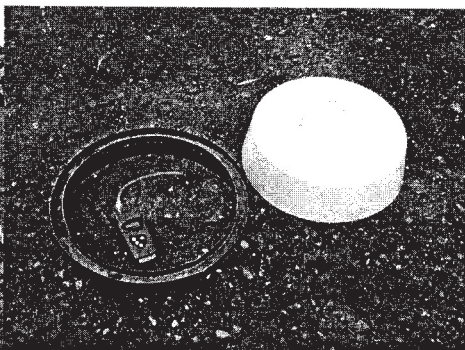


Fig. 2.: The frame+bowl method

Results and discussion

CO₂-emission values measured in the soil tillage experiment

In 2005 we had two opportunities to measure CO₂-emission in the soil tillage experiment. The results we gained are summarised in Fig. 3. We compared the values measured in the conventionally cultivated plots to direct seeding in two different crop vegetations (winter wheat and vetch). Higher emission values were detected in the cultivation system based on direct seeding in the case of both indicator crops at both dates, the difference was more developed for winter wheat. These differences can be explained with the higher rate of CO₂-emission due to the characteristically increased decomposition in autumn originating from the extra crop residues involved in minimum tillage like direct seeding.

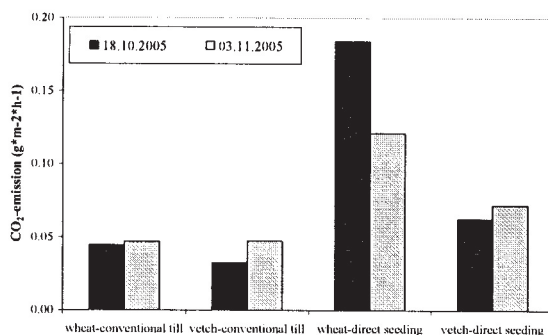


Fig. 3.: CO₂-emission in the soil tillage experiment

CO₂-emission values measured in grassland treating experiment

In the case of this experiment we wondered if there is any effect of different grassland treating rollers on the CO₂-emission of the soil. The Grassland Management Department of KRI started an inventory research to develop a roller that is suitable for the improvement of pasture quality through improving the water- and air-regime of the soil and the development of the grass, hence for the increase of the yields. We considered CO₂-emission a suitable parameter to characterise and quantify the favourable changes in the soil texture after the application of the rollers. According to the relevant literature, the duration of the increased CO₂-emission of the soil after an impact like cultivation or water input is 2-6 days. So we measured CO₂-emission four days after the application of them, and of course also on an untreated plot, three roller prototypes were involved. We repeated the measurements another two days later. The values we detected are summarised in Fig. 4. As the figure shows increased (four times higher) CO₂-emission was characteristic to the treated plots, which shows increased root respiration and/or microbiological activity. There were some differences among the rollers, roller 2, which makes deeper but shorter cuts, did not result in so high CO₂-emission like the other two prototypes. It is obvious that several more measurements are needed to gain clearer correlation, but the *frame+bowl* method was found suitable for the determination of CO₂-emission from grasslands.

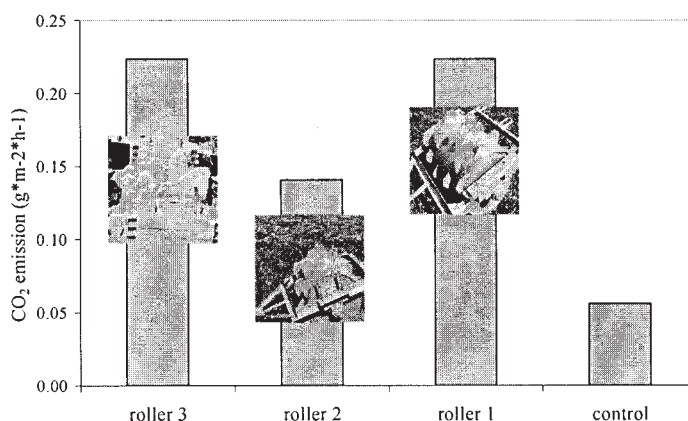


Fig. 4.: A CO₂-emission in the grassland treating experiment

Conclusion

There are several methods to measure the CO₂-emission of the soil, but none of them is universal, and can be used in any circumstances. The most problematic part is the spatial delimitation of the measurement area as the surface of the soil can be very various and proper isolation is a must. We consider the *frame+bowl* method we developed suitable for measuring CO₂-emission of pastures and suggest it to researchers interested in this topic.

References

- BEARE, M.H. - HENDRIX, P.F. - COLEMAN, D.C.: 1994. Water-stable aggregates and organic matter fractions in conventional- and no-tillage soils. *Soil Sci. Soc. Am. J.* 58:777-786.
- BIRKÁS M.: 2002. Környezetkímélő és energiatakarékos talajművelés. Szent István Egyetem, Gödöllő.
- DORAN, J.W.: 1980. Soil microbial and biochemical changes associated with reduced tillage. *Soil Sci. Soc. Am. J.* 44:765-771.
- LÁSZLÓ P. – GYURICZA Cs: 2004. Effect of the ridge tillage system on some selected soil physical properties in a maize monoculture *Acta Agronomica Hungarica*. Akadémiai Kiadó. DOI: 10.1556/AAgr.52.2004.3.1 pp. 211 - 220
- QUEMADA, M. - CABRERA, M.L.: 1995. Carbon and nitrogen mineralized from leaves and stems of four cover crops. *Soil Sci. Soc. Am. J.* 59:471-477.
- ZSEMBELI J. – TUBA G – JUHÁSZ Cs – NAGY I: 2005. CO₂-measurements in a soil tillage experiment. *Cereal Research Communications*. Vol. 33. No. 1. 137-140.
- ZSIGRAI, GY.: /2001/ The Effect of Artificial Fertilization on Some Chemical Properties of The Soil and on The Yield of Maize in Long-Term Experiments. (In. Ed. LAZÁNYI, J.: Sustainable Agriculture and Rural Developement. Vider Plus Bt., Debrecen. 91-117.)
- Kádár, I. (2004): Szennyvíziszap-adagok hatása a növény (*Triticum vulgare* L.)-talaj rendszer néhány mikrobiológiai és biokémiai tulajdonságára (Impact of sludge treatments on some microbiological and biochemical properties of plant (*Triticum vulgare* L.)-soil system. – in *Hungarian*). *Agrokémia és Talajtan*. 53. 3-4. 331-342 pp
- Svetková, K.; Henselová, M.; Morvová, M. (2005): Effects of a carbonization product as additive on the germination, growth and yield parameters of agricultural crops. *Acta Agron. Hun.* 53. (3). 241-250 pp
- Tanács, L., Matuz, J., Gerő, L., Petróczi, I.M. (2005): Effect of NPK Fertilizers and Fungicides on the Quality of Bread Wheat in Different Years. *Cereal Res. Commun.* 33 (2-3): 627-634 pp