

# Methodological assessment of a weighing lysimeter experiment

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## Abstract

During 10 year operation of a weighing lysimeter experiment several methodological experiences could be gained, especially concerning the possibilities and limitations of the application of the facility. On the base of my experiences it can be concluded that weighing lysimeters with such parameters are not really suitable for the determination of evapotranspiration of field crops, but provide excellent opportunity for the examination on the effect of different soil cultivation operations and methods on the soil moisture regime.

## Introduction

A weighing lysimeter experiment has been carried out at the Karcag Research Institute of the University of Debrecen, Hungary since 1993. During the 10 years of the experiment several methodological experiences could be gained, especially concerning the possibilities and limitations of the application of the facility.

The 6 units of the weighing lysimeter system belong to group of precision mechanical weighing lysimeters. According to their size (2 m<sup>3</sup>) they can be ranged into the medium-size category. The measurement sensitivity (0.05 mm) and the measurement range ( $\pm 150$  mm) range them among the most sensitive lysimeters. As both the outer and the inner tanks are made of plastic, the wall-gap-wall area is as small as possible.

## Results

All the above mentioned characteristics can be considered as the advantages of the facility. Further advantages can be mentioned due to the fully automatic functioning of the built in scales connected to the electronic data loggers (type: DUAL). There is no need to lift the soil filled containers for weighing, unlike the

less up-to-date weighing lysimeters (McILROY and ANGUS, 1963), hence the operation is more simple, cheaper and labour saving. This solution makes the determination of the water balance possible for shorter periods as well (e.g. daily water balances). The measurement sensitivity ensures precise measurements, hence even small differences occurring in the water balance can be detected.

Another question is the application of weighing lysimeters in soil cultivation researches. It is obvious that the moderation of drying out of cultivated soils is of great importance, especially in the case of arid climatic conditions or during droughty periods. The infiltration and evaporation processes are mainly determined by the physical state of the topsoil. As the physical state of topsoil can be modified by soil cultivation, it is one of the major tools of the moderation of soil moisture losses due to evaporation. Investigations carried out with weighing lysimeters provide good opportunity for this kind of research. The majority of the investigations focussing on the determination of the effects of different soil cultivation methods on the soil water regime are not based on continuous measurements, but on the determination of the actual soil moisture content in certain dates (usually at the beginning, in the middle and at the end of the vegetation period). This approach is widely used by soil cultivation experts in Hungary (BERÉNYI et. al., 1959; GYORFFY and SZABÓ, 1969; RUZSÁNYI and PETO, 1988; PETO and HUZSVAI, 1991; FARKAS et. al., 1999; GYURICZA et. al., 1999). On the other hand it must be mentioned that the simulation of field conditions in lysimeters is practically impossible, hence the application of this technique in soil cultivation researches always includes a compromise.

To get the whole picture further disadvantages and application limits must be listed concerning weighing lysimeters with the above mentioned features and parameters.

One of the major disadvantages of weighing lysimeters used for soil cultivation research is that regular soil sampling is hardly executable. This comes from the principle of weighing lysimetry: the soil mass in the tank must be the same. If any soil sample is taken, the original undisturbed soil surface can not be ensured any more.

Another disadvantage originates from the relatively small volume of the tanks. This disadvantage limits the application of these lysimeters for the determination of evapotranspiration of field crops. During the first three years of the experiment I applied indicator crops as treatments (millet, maize, sunflower, Sudan grass) to calculate their evapotranspiration. My experience was that these crops have higher water demand than the water supply capacity of the soil is in dry periods. As the soil columns were dried out by the plants to the wilting point, irrigation of huge doses (50-100 mm) must have been applied several times. These amounts definitely can not correspond to the practice of irrigation in field conditions. The other point was that on the 2 m<sup>2</sup> surface area of the lysimeter units, due their location, the natural vegetation density, which decreases transpiration due to the more favourable microclimate, could not be ensured, hence extremely high evapotranspiration values were detected.

## Conclusions

On the base of the experiences mentioned above it can be concluded that weighing lysimeters with such parameters are not suitable for the determination of evapotranspiration of field crops, but

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**Table 1: The main advantages and disadvantages of the weighing lysimeters operated in Karcag**

<b>Advantages</b>	
◆	high measurement sensitivity (0.05 mm)
◆	relatively big volume (2m <sup>3</sup> )
◆	plastic walls
◆	small wall-gap-wall area
◆	possibility of permanent and automatic measurements
<b>Disadvantages</b>	
◆	conditional suitability for transpiration measurements
◆	the stratification of soil moisture can not be detected
◆	lack of replications
◆	results can not be directly interpreted to other conditions

provide excellent opportunity for the examination the effect of different soil cultivation operations and methods on the soil moisture regime. The main advantages and disadvantages of the facility are listed in *Table 1*.

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