Application of Weighing Lysimeters in Soil Tillage Research

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Abstract

In Hungary the investigation of water regime of the soil by means of lysimeters is not a widely applied method, nevertheless as it can provide very detailed information on the components of water balance, agricultural research can not dispense it. In the Research Institute of University of Debrecen Centre for Agricultural Sciences located in Karcag, Hungary a weighing lysimeter system of six units was constructed in 1992 with the main goal of the investigation of the effects of different agrotechnical factors on the water regime of the soil. Our investigations carried out so far proved that weighing lysimeters - completed with instruments suitable for the determination of moisture- and temperature profile - are suitable and effective tools to reveal the water regime effects of the new soil tillage methods prospectively replacing soil destructive conventional tillage.

Introduction

The research of soil cultivation, which has been in the focus of the institute's profile for 50 years, fits into the lysimeter studies very well. Under the ecological (soil- and climatic) circumstances of the Great Hungarian Plain soil tillage is of great importance. It is obvious that moderation of drying out of cultivated soils to the deeper layers is of great importance, especially in the case of arid climatic conditions or during droughty periods. The moisture content of the topsoil is mainly determined by the surface type influencing the water input (infiltration) and output (evaporation) processes. As the physical state of soil surface can be modified by soil cultivation, it is one of the major tools of the moderation of soil moisture losses due to evaporation. In 1997 a long-term soil cultivation experiment on large plots was set in the Institute with the aim of the adaptation of conservation tillage systems. Although these systems were not developed to control the moisture regime of the soil, their effects of this kind are also very considerable.

Material and method

At the lysimeter station of the Karcag Research Institute of Centre for Agricultural Sciences of University of Debrecen we set the following treatments simulating surface formations characteristic for various tillage practices in the six weighing lysimeter units:

2002:

❶ straw mulch of 0.5 kg (2.5 t/ha) between rows, no plant;

❷ tarping with black polyethylene between rows , no plant;

❸ bare soil surface, no plant;

❹ straw mulch of 0.5 kg (2.5 t/ha) between rows with plant;

❺ tarping with black polyethylene between rows with plant;

❻ bare soil surface with plant.

2003:

❶ mulching with corn residues mixed into the top 10 cm soil layer, 2 kg (10 t/ha);

❷ soil covering with corn residues, 2 kg (10 t/ha);

❸ mulching with wheat-straw mixed into the top 10 cm soil layer, 1 kg (5 t/ha);

❹ soil covering with wheat-straw, 1 kg (5 t/ha);

❺ no cover, regular shallow cultivation;

❻ control.

In 2002 we used pritamin red pepper as an indicator plant, in 50x25 cm spacing, which means 22 plants in 3 rows in each unit. In 2003 sweet corn was applied in two rows in each lysimeter unit with 70x27 cm spacing.

Results

Effect of mulching and tarping on evapo(transpi)ration in lysimeters

Evaporation and evapotranspiration values were calculated for the whole vegetation period on the base of the relevant water balance equation. Nevertheless the most remarkable differences were detected in the period of July-August, hence only these results are given in this paper (*Table 1-2*). On the base of the data obtained in 2002, it can be figured out that the highest amount of moisture can be preserved in the soil with the application of tarping, somewhat less with mulching, and bare soil surface resulted in the highest evaporation loss. In the in-

Table 1: **The components of the water balance of the lysimeter units (mm, 2002. July-August)**

	mulch	tarp	bare surface	mulch +plant	tarp +plant	bare surface +plant
input water (P+I*)	160.9	160.9	160.9	183.9	189.9	209.9
evaporation/ evapotranspiration	116.9	104.9	130.8	229.0	203.8	285.7
percolate	40.1	13.5	10.2	0.3	3.9	0.1
balance	3.9	42.5	19.9	-45.4	-17.8	-75.9
input/day	2.7	2.7	2.7	3.1	3.2	3.5
evap./day	1.9	1.7	2.2	3.8	3.4	4.8
evap./input (%)	72.7	65.2	81.3	124.5	107.3	136.1

*P = natural precipitation. I = irrigation

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Table 2: **The components of the water balance of the lysimeter units (mm, 2003. July)**

	corn mulch	corn residue cover	wheat mulch	straw cover	shallow cultivation	control
input water (P+I*)	25.2	25.2	25.2	25.2	25.2	25.2
evaporation/ evapotranspiration	32.6	33.0	32.4	32.8	38.7	40.0
balance	-7.4	-7.8	-7.2	-7.6	-13.5	-14.8
evap./day	1.05	1.06	1.04	1.06	1.25	1.29
evap./input (%)	129	131	129	130	154	159

*P = natural precipitation. I = irrigation

vestigated period positive water balance was characteristic to the treatments without indicator plants, but negative water balance to the units with plants. During these two months the water demand of red pepper is approximately 200 mm according to the literature data. As the results show by means of polyethylene tarping evapotranspiration does not exceed this amount of input water considerably, but in the case of bare soil surface significant evaporation loss must be calculated. Water efficiency of mulching was 7.5 %, with tarping 16.1 % better compared to bare soil in case of the treatments without plants; these values were 17.2 and 28.8 % with plants respectively. The less favourable efficiency of mulching can be explained with the gradual mixing of crop residues into the soil. This is proved by the evaporation curves as well: at the beginning no difference could be figured out between the two treatments. In 2003 all the water balances were negative due to the very droughty weather. Nevertheless the absolute values of evaporation were quite low (1.04-1.29 mm/day) as the soil moisture contents were low as well. Even under these circumstances mulching and surface covering provided measurable decrease of evaporation loss.

Conclusions

The positive effects of the isolation layer close to the soil surface, a very important element of conservation tillage, on the moisture-, heat- and air regime of the soil is indisputable. This isolation layer can be created in several ways: by shallow cultivation, with crop residues left on the surface and also by means of artificially added materials like transparent or non-transparent polyethylene. By means of mulching and tarping evaporation loss can be considerably moderated, which is of great importance in case of the production of plants with high water demand.