19. Gumpensteiner Lysimetertagung 2021, 133 – 138
ISBN: 978-3-902849-83-0

Water use of lawns determined in weighing lysimeters

József Zsembeli[1*], Lúcia Sinka[1,2], Géza Tuba[1], Arzu Rivera-García[1,2] and Györgyi Kovács[1]

Summary

The main goal of the research was to determine the water balance and water use efficiency of lawn in the case of different water inputs in weighing lysimeters. Two grass-covered lysimeters were irrigated with different doses of water representing deficit and sufficient irrigation. Irrigation was applied only when the soil moisture contents decreased down to these lower thresholds. Therefore, the irrigation frequency was determined by the natural conditions influencing the actual soil moisture content of the topsoil of the lawns. Soil moisture contents were measured on a daily basis. The biomass of the lawns were cut when exceeded the height of 10 cm. Beyond the water balance and its components, the water use efficiency index was calculated from the rate of total water input and the biomass for each treatment. The lawns, with different water supplies, transpirated almost the same amount of water, but the water utilization of the more intensively irrigated lawn was more favourable.

Keywords: weighing lysimeters, water balance, evapotranspiration, lawn, irrigation

Introduction

Lawns provide numerous aesthetic and functional benefits to various environmental setups, creating opportunities for recreation; essential component of urban vegetation (De 2017, Haydu et al. 2008, Ignatieva et al. 2017) and they are regularly irrigated (Milesi et al. 2005). Lawns are mainly established from the grassland species and comprise of a relatively high percentage of natural environment of the local vegetation within the vicinity (Pal et al. 2013). Weighing lysimeters are suitable tolls to understand the water balance (WB) of a lawn system measuring the actual evapotranspiration (ET) directly through the changes in mass and quantify over a short period of time interval (Beeson 2011). Weighing lysimeters are the most valuable instruments used for accurate monitoring of the crop ET, water seepage and WB studies as they give reliable data in terms of quantity and quality over short intervals (Jancsó et al. 2019). Hence, water inflow and outflow are measured based on the changes in weight of the lysimeter; ET is depicted from the decrease in weight due to water loss while an increase in weight is realised in the case of precipitation or irrigation (water input) (Zsembeli et al. 2018). The main goal of the research was to determine the WB and water use efficiency of lawn in the case of different water inputs in weighing lysimeters.

Material and Methods

The experiment was carried out in 3 weighing lysimeters at the lysimeter station of the Research Institute of Karcag (Czellér et al. 2019). Seepage water was weekly collected at a bottom outlet and quantified. The amount of precipitation was measured by a rain gauge at a meteorological station close to the lysimeters. Two lysimeters were grass-covered and one was with bare soil without irrigation. The two grass-covered

[1] Research Institute of Karcag, IAREF, University of Debrecen, Kisújszállási út 166, H-5300 Karcag
[2] FAFSEM University of Debrecen, Kisújszállási út 166, H-5300 Karcag
* Ansprechpartner: Dr. József Zsembeli, email: zsembeli@gmail.com

lysimeters were irrigated with different doses of water. In lysimeter Lawn 1 (L1) the soil moisture content of the upper 10 cm soil layer was maintained above 15 v/v% representing sufficient irrigation, while in lysimeter Lawn 2 (L2) above 10 v/v% representing deficit irrigation, respectively. The soil moisture content was regularly measured with an SMT-100 probe. Irrigation of 10 mm dose was applied only when the soil moisture contents decreased down to these lower thresholds. Therefore, the irrigation frequency was determined by the natural conditions influencing the actual soil moisture content of the topsoil of the lawns. From May to September in 2020, L1 received 310 mm, L2 210 mm water by irrigation. The investigation period lasted from May to December of 2020, when 504.6 mm precipitation was detected, which corresponds to an average annual quantity in Karcag.

The biomass of the lawns were cut when the grass exceeded the height of 10 cm. Beyond the WB and its components, indexes characterizing the water use efficiency were calculated. Total Water Input (TWI) includes the amount of precipitation and irrigation water; Daily Biomass Production (DBP) describes how much plant biomass (B) was generated each day; Water Use Efficiency Index (WUEI) was calculated from the rate of Total Water Input (TWI) and ET according to ET/TWI*100 (%). The total lawn biomass production in the function of ET describes how much plant biomass was built up using 1 mm of water through ET during the investigated period (Zsembeli et al. 2011).

Results and Discussion

We determined the elements of the WB for 3 lysimeters for the period of May-December, 2020 (*Figure 1*). L1 received 854.3 mm water input, L2 754.3 mm, while the bare soil 544.3 mm. On the output side, the ET was 581.4 mm from L1, 568.7 mm from L2, and the evaporation of the bare soil was 348.3 mm. The amount of seepage waters were 212.7 mm (L1), 131.5 mm (L2), while 121 mm for bare soil. The WB for the 2 grass-covered units was nearly the same, 52.6 mm and 46.9 mm, while the bare soil had the most positive (73.5 mm).

Figures 2-3 show the monthly WB and ET values calculated for the 3 lysimeters. May was dry, the bare surface evaporated the total water supply, and its WB was zero. In the case of L1, in addition to the higher ET, there was only little seepage water, so

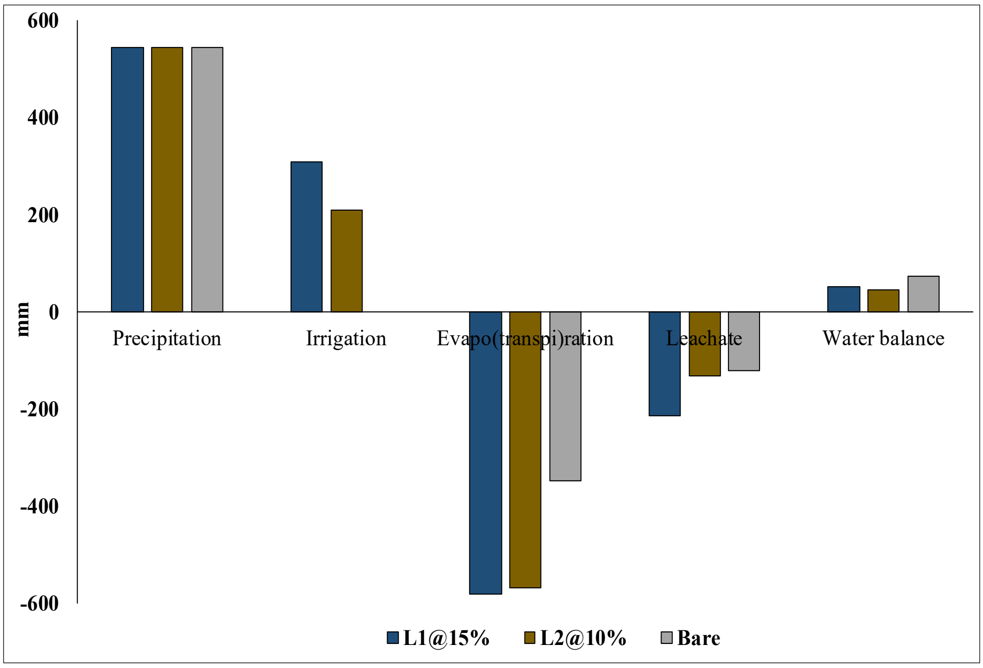

Figure 1: Components of the water balance in the treatments in the investigated period.

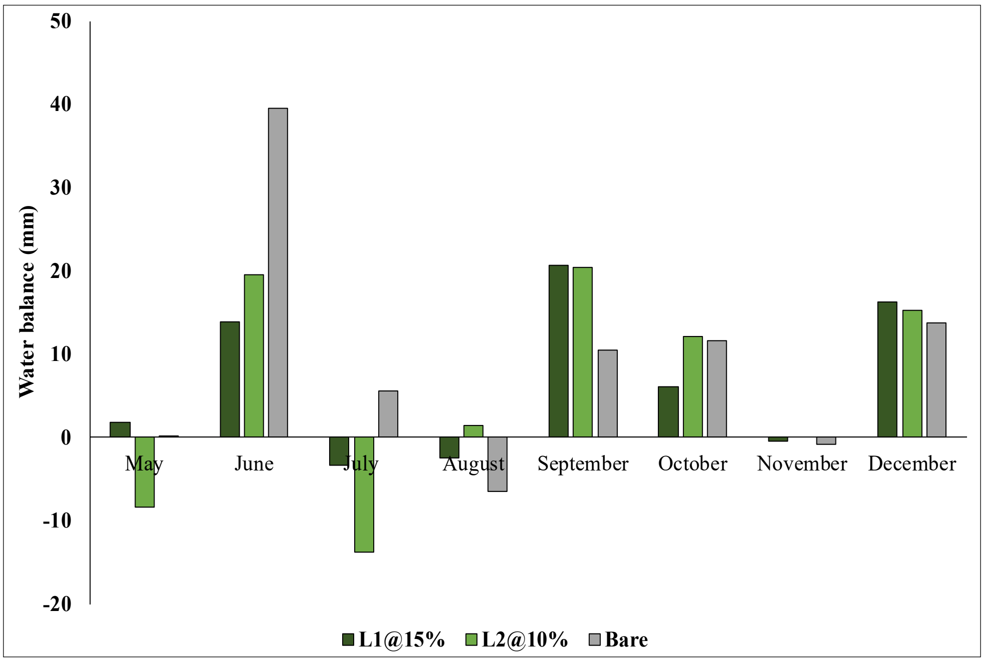

Figure 2: The monthly water balances in the lysimeters.

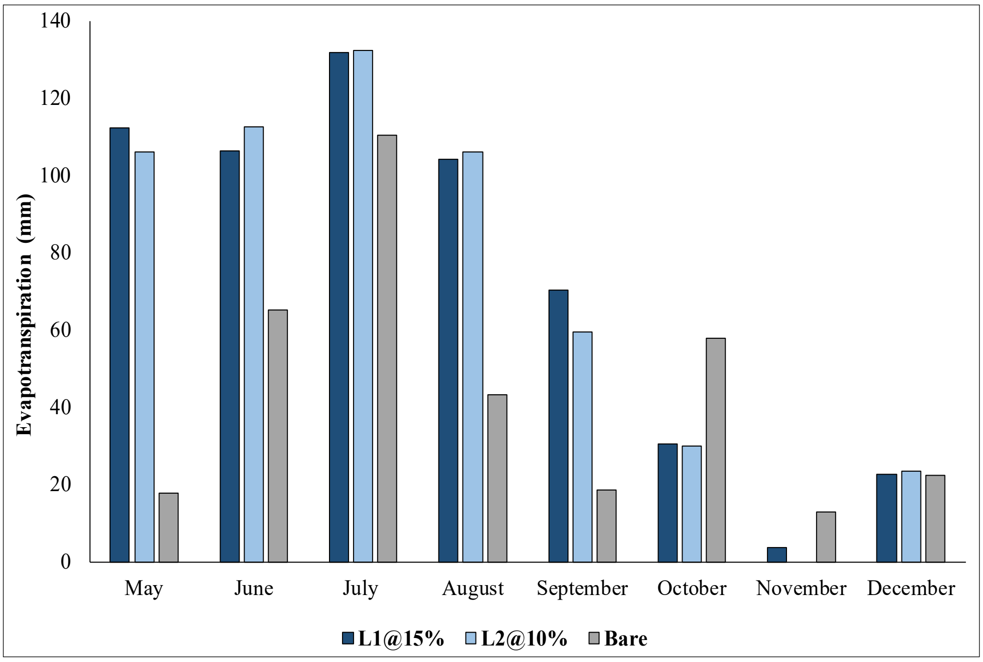

Figure 3: The monthly evapotranspirations in the lysimeters.

its WB was slightly positive. 20 mm less irrigation resulted in less ET and a negative WB for L2. The 3 summer months were rainy, so less irrigation water was needed to maintain the desired moisture content of the topsoil. In June, all the three units closed with a positive WB. Due to the warm July, ET was higher, so the WB of the 2 lawns was negative. In September, the weather was warm with little rainfall, so the more intensively irrigated lawn transpirated more with a positive WB. We stopped irrigation in October, because the soil moisture content was always above the desired value due to the natural precipitation. In October and December, the WB of all the three units was positive, but in November, it was around zero due to the low amount of precipitation.

In 2020, 218 days elapsed from the sowing of the lawn to the last cut, during this time, there were 7 cuts (*Table 1*), so the investigated period was divided into seven grass growing stages. During the whole season, there was 100 mm difference in the TWI. The

	Duration day	TWI mm		WUEI %		DBP g/day		B/ET g/mm	
		Lawn 1	Lawn 2	Lawn 1	Lawn 2	Lawn 1	Lawn 2	Lawn 1	Lawn 2
1st cut	29	80.9	70.9	94.8	112.0	1.0	0.8	0.4	0.3
2nd cut	19	77.5	57.5	100.0	100.1	4.0	4.3	1.0	1.4
3rd cut	14	78.1	78.1	50.1	67.1	3.4	3.7	1.2	1.0
4th cut	21	128.6	118.6	64.8	67.0	7.2	6.2	1.8	1.7
5th cut	34	184.0	144.0	64.0	85.2	3.4	3.5	1.0	1.0
6th cut	36	108.3	88.3	88.1	96.2	8.8	6.5	3.3	2.8
7th cut	65	157.2	157.2	27.6	25.3	0.4	0.5	0.5	0.9
Total or average:	218	814.6	714.6	65.4	72.2	3.5	3.1	1.4	1.3

Table 1. Water use efficiency indexes in terms of the rate of total water input and the biomass.

WUEI shows whether the water supply was sufficient or the cultivated crop decreased the moisture stocks of the soil. During the first two grass growing stages, the water consumed by ET in L2 was not appropriately replaced by irrigation, but L1 was more effective in the whole investigated period. DBP was higher on average in L1 which evaporated more water resulting in higher biomass production, so its efficiency (B/ET) proved to be more favourable.

Conclusions

We found that even in a rainy season, it is necessary to irrigate to achieve a nice lawn. Partly because to ensure surviving the dry periods, and partly to achieve a higher biomass production. We figured out that 32% more irrigation water resulted in a 12.5% increase in biomass production comparing sufficient to deficit irrigation. The lawns, with different water supplies, transpirated almost the same amount of water, but the water utilization of the more intensively irrigated lawn was more favourable. The bare soil had 40% lower ET, but only slightly more positive WB compared to the lawns.

Literature

Beeson Jr., R.C. (2011) Weighing lysimeter systems for quantifying water use and studies of controlled water stress for crops grown in low bulk density substrates. Agricultural Water Management, 98(6), 967-976. pp.

Czellér K., Tuba G., Kovács Gy., Sinka L., Zsembeli J., Percze A. (2019) Water use efficiency of Miscanthus giganteus under different irrigation doses. 18. Gumpensteiner Lysimetertagung, Austria; 175-178. pp.

De, L. (2017) Lawn grasses-a review. International Journal of Horticulture, 7.

Haydu J.J., Hodges A.W., Hall C.R. (2008) Estimating the economic impact of the US golf course industry: challenges and solutions. HortScience 43, 759–763. pp.

Ignatieva M., Eriksson F., Eriksson T., Berg P., Hedblom M. (2017) The lawn as a social and cultural phenomenon in Sweden. Urban Forestry & Urban Greening, 21, 213-223. pp.

Jancsó M., Kun Á., Székely Á., Szalóki T., Ibadzade M., Bozán Cs. (2019) New developments at the Lysimeter Station in Szarvas. 18. Gumpensteiner Lysimetertagung, Austria, 155 – 156. pp.

Milesi C., Elvidge C.D., Dietz J.B., Tuttle B.T., Nemani R.R., Running S.W. (2005) A strategy for mapping and modeling the ecological effects of US lawns. J. Turfgrass Manage, 1(1), 83-97. pp.

Pal R.W., Csete S., Botta-Dukát Z., Pinke, G. (2013) Composition and diversity of lawn flora in differently managed village yards–a case study from southwestern Hungary. Folia Geobotanica, 48(2), 209-227.

Zsembeli J., Kovács Gy., Mándoki A. (2011) Water use efficiency of maize and different sorghum hybrids under lysimeter conditions. 14. Gumpensteiner Lysimetertagung, Austria, 227-229. pp.

Zsembeli J., Czellér K., Sinka L., Kovács G., Tuba G. (2018) Application of lysimeters in agricultural water management. Creating A Platform To Address The Techniques Used In Creation And Protection Of Environment And In Economic Management Of Water In The Soil., 5.