Höhere Bundeslehr- und Forschungsanstalt für Landwirtschaft
Raumberg-Gumpenstein

18. Gumpensteiner Lysimetertagung 2019, 171 – 174
ISBN: 978-3-902849-64-9

Simulation of the irrigation practice applied in the hobby gardens of Karcag in simple drainage lysimeters

Lúcia Sinka[1*], A.R. Garcia[1], Krisztina Czellér[2], Géza Tuba[2] and József Zsembeli[2]

Summary

Most of the vegetables have high water demand hence their production with irrigation is generally justified. Nevertheless improper irrigation may induce unfavourable processes in the soil (e.g. secondary salinization). An irrigation experiment was set in 12 simple drainage lysimeters at the lysimeter station of the Research Institute of Karcag with the basic goal to quantify the effect of the irrigation frequency and water quality on the soil and green bean. Two approaches were applied: all the lysimeters were irrigated with the same weekly amount of water, 6 with saline water, 6 with deionised water. Within both treatments 3 lysimeters were irrigated 5 times, while the other 3 two times a week. We examined the effect of irrigation on the moisture content of the soil layers at 0-10 and 20-30 cm. The soil moisture content data measured in the soil columns irrigated once a week with a higher dose showed more favourable soil moisture profile for the plants. Irrigation with saline water had negative effect on each investigated plant parameter.

Schlagwörter: irrigation frequency, soil moisture, vegetables

Introduction

In Hungary climate change severely affect agricultural production recently as the damages caused by drought are more and more frequent especially in the case of the crops that have the most important role in human nutrition. The Mediterranean character is strengthening in the Great Hungarian Plain, the frequency of weather extremes is increasing, therefore irrigation is essential for the effective production of vegetables with high water demand.

In contrast of primary salinization, secondary salinization is induced by human activities like the development of large-scale irrigation projects (Lambert et al. 2002). The effects are large changes in the natural water and salt balances of entire hydrogeological systems (Daliakopoulos et al. 2016).

The soil salinity cause by human activities is becoming a land degradation issue when soil and environmental conditions allow the concentration in soil layers to rise above a level that impacts on agricultural production, environmental health, and economic welfare, eventually evolving into a sociocultural and human health issue (Rengasamy 2006). In fact the main cause of secondary salinization is the irrigation practice often coupled with poor drainage conditions (Ghassemi et al. 1991). However this type of salinization is restricted to irrigation in the semiarid zone, generally when the rainfall is below 700 mm, and about 110 million ha is located in this zone (Geeson et al. 2003). The impact of irrigation often extends beyond of the immediate irrigated area. Furthermore the cases of secondary salinization are spread all around the world and each case is different (Smedema 2000).

In plant production in sodic soil plant growth problems can occur including drought, compaction, nutrient deficiency, mineral toxicity, salinity, and submergence (Kemo et al. 2017). As mention previously sodic soils are generated by the accumulation of salts in the soil (Na, K, Mg, and Ca). However these physical conditions and the excess of salts delay seed germination and reduce the rate of plant growth. The plant growth can be affected by osmotic effects, specific ion effects, toxic ion effect and foliar absorption of salt constituents (Qadir & Oster 2004, Shainberg &Letey 1984).

Material and Methods

Our research work was started on the preliminary knowledge that the risk of secondary salinization is high in the hobby gardens around Karcag as the water of the aquifers used for irrigation is saline, nevertheless irrigation in the droughty periods is essential for vegetable production. We examined the possibility of a "soil friendly" optimization of irrigation if we take all these conditions given. For the scientific establishment of our examinations, we set up a complex experiment in 12 simple drainage lysimeters in the lysimeter station of the Research Institute of Karcag, Institutes for Agricultural Research and Educational Farm, University of Debrecen (RIK). The lysimeters are filled with a slightly sodic (0.06% salt content) meadow solonetz soil. The lysimeters are 150 cm deep with a drain tube at 120 cm and have a surface area of 0.8 m². Simple drainage lysimeters are very suitable to quantify the amount of salts leached from the soil column.

As the main goal of our study is the optimization of irrigation under unfavourable soil conditions (heavy textured clay soil susceptible to secondary salinization) and hydrological circumstances (saline irrigation water, high climatic water shortage), we have chosen beans (*Phaseolus vulgaris* L. var. *nanus*) as an indicator crop, which is commonly grown in the hobby gardens and has high water demand.

Regarding frequency, two typical irrigation practices are characteristic in the hobby gardens around Karcag: some hobby farmers has time to irrigate their gardens every day, while others are typical weekend farmers, they use higher

[1] Faculty of Agricultural and Food Sciences and Environmental Management, University of Debrecen

[2] Research Institute of Karcag, Institutes for Agricultural Research and Educational Farm, University of Debrecen, Kisújszállási út 166, H-5300 KARCAG

[*] Ansprechpartner: Lucia Sinka, sinkalucia@gmail.com

dosage of irrigation water, generally at the weekends only. In order to simulate these two typical irrigation practices, all the lysimeters were irrigated with the same weekly amount of water (15 litres per week), 6 with saline water (1,600 mg/l salt content), 6 with deionised water. Within both treatments 3 lysimeters were irrigated 5 times (3 litres per day), while the other 3 two times (7.5 litres per day) a week. Taking the surface area of the lysimeters into account, 1 litre of irrigation water equals 1.25 mm.

We wanted to determine the effect of the irrigation frequency and the water quality on the soil moisture profile, and through that, on the water supply of the indicator plant that can be manifested in the morphological parameters and the yields of the plants. SMT 100 sensors by Umwelt-Geräte-Technik GmbH inserted in the soil layers of 0-10 and 20-30 cm measured the soil moisture content (v/v%) and temperature (°C) with the measurement frequency of one hour. The soil moisture data were illustrated by ranking them to four water supply categories (dry, sufficient, good and wet) determined on the base of the water holding capacity of the investigated soil. Among the plant parameters average plant height (cm), average aboveground mass (g/plant), average root mass (g/plant), the number and mass of pods plant (g) were determined.

Results and Discussion

The soil moisture content values published here are the means of 6 replications as we could not figure out any differences in the water qualities: salinity have not influenced the infiltration and percolation processes. The irrigation period in the year of 2018 started on 20th April, at the same time of the sowing of the green beans. In *Figure 1* it can be seen very well that before the start of the irrigation, the soil moisture content of all lysimeters was quite similar, the fluctuation was due to only the natural precipitation and evaporation. After starting irrigation, though all lysimeters were irrigated with the same weekly amount of water, the soil moisture content of the top soil layer (0-10 cm) was generally higher in the lysimeters irrigated 2 times a week contrary to those which were irrigated on every weekday. Taking the water supply into consideration, sufficient water supply was characteristic before the irrigation period, while by means of irrigation, good water supply category could be achieved in the summer months, especially if 2 times a week irrigation frequency was applied.

In the spring-summer period of 2018, the soil moisture stocks of the lysimeters at the depth of 20-30 cm are shown in *Figure 2*. Significant difference between the two irrigation could be figured out regarding the soil moisture content in the investigated period. Due to the fact that the same irrigation frequencies were applied in the previous year (green beans were grown as a secondary (catch) crop after sweet corn. We found that the differences between the two irrigation frequencies endured to the beginning of the next irrigation season in the deeper soil layer. Therefore the average soil moisture content was higher in the lysimeters previously irrigated 2 times a week even at the beginning of the irrigation season and remained higher at the end as well. This soil layer has more important role in the water

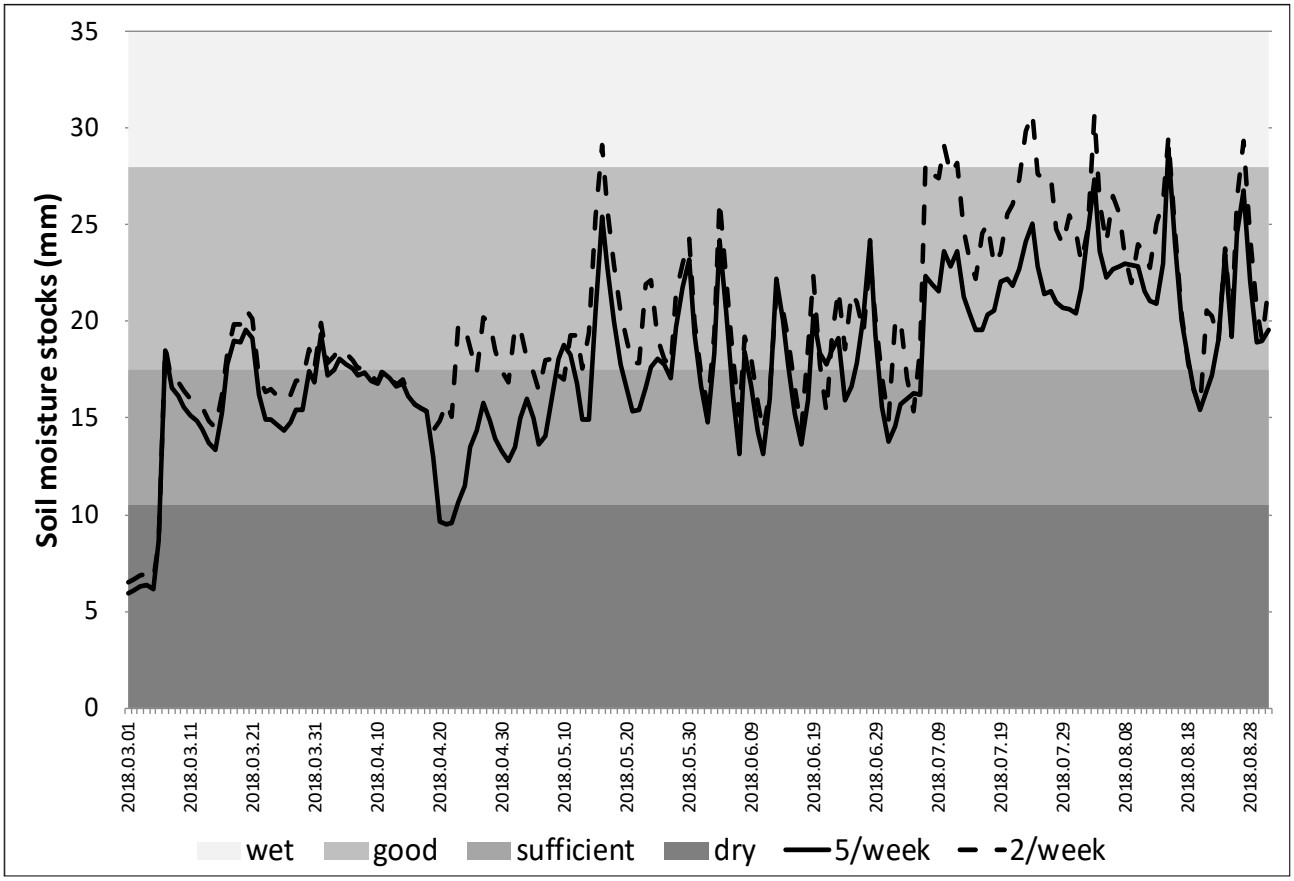

Figure 1. **Effect of irrigation frequency on the soil moisture content at the depth of 0-10 cm.**

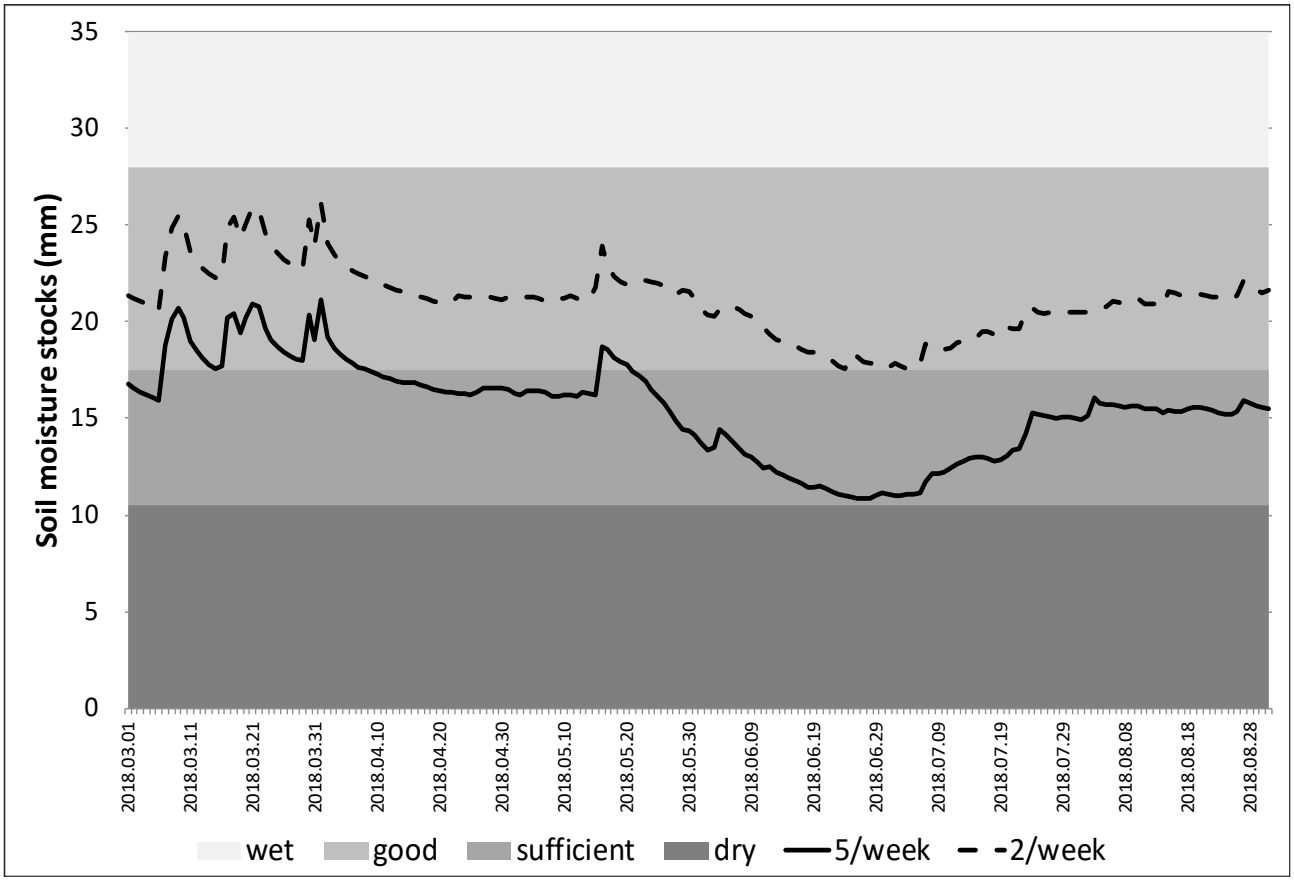

Figure 2. **Effect of irrigation frequency on the soil moisture content at the depth of 20-30 cm.**

supply of beans then of the surface layer as most of the roots can be found in this soil layer. Good water supply category could be maintained by the application of irrigation 2 times a week, while the daily irrigation with smaller doses kept the soil moisture only in the sufficient category.

Analysing the effect of the irrigation quality on the plant height of green beans, it can be established that the plants irrigated with deionised water were averagely 5.3 cm taller than the plants irrigated with saline water. Similar tendencies were characteristic to the average biomass (deionised: 93.5, saline: 62.5 g), the average root mass (deionised: 9.5 g, saline: 8.2 g), the number of pods (deionised: 17.1, saline: 11.9), and the pod yield (deionised: 137.9 g, saline: 85.9 g) values. The difference in neither parameters was significant regarding the irrigation frequency.

Conclusions

The soil moisture content data measured in the soil columns irrigated once a week with a higher dose showed more favourable soil moisture profile for the plants. Irrigation with saline water had negative effect on each investigated plant parameter. Applying irrigation frequency and doses optimised for the soil properties is recommended in areas with unfavourable agroecological conditions.

Acknowledgement

The research was financed by the Higher Education Institutional Excellence Programme (20428-3/2018/FEKUT-STRAT) of the Ministry of Human Capacities in Hungary, within the framework of the 4. thematic programme of the University of Debrecen.

Literature

Daliakopoulos I.N., Tsanis I.K., Koutroulis A., Kourgialas N.N., Varouchakis A.E., Karatzas G.P., Ritsema C.J. (2016) The threat of soil salinity: A European scale review. Science of the Total Environment 573: 727-739.

Geeson N.A., Brandt C.J., Thornes J.B. (2003) Mediterranean Desertification: A Mosaic of Processes and Responses. John Wiley & Sons, Chichester, UK. 441 pp.

Ghassemi F.A.J., Akeman J., Nix H.A. (1991) Human induced salinization and the use of quantitative methods. Environment international. 17: 581-594.

Kemo J., Philip J.W., William R.W., Jianbo S., Lei S. (2017) Shaping an Optimal Soil by Root–Soil Interaction. Trends in Plant Science. 1581: 1-7.

Lambert K., Sedema I., Karim S. (2002) Irrigation and salinity: a perspective review of the salinity hazards of irrigation development in the arid zone. Irrigation and Drainage Systems 16: 161-174.

Qadir M., Oster J.D. (2004) Crop and irrigation management strategies for saline-sodic soils and waters aimed at environmentally sustainable agriculture. Science of the Total Environment 323: 1-19.

Rengasamy P. (2006) World salinization with emphasis on Australia. Journal of Experimental Botany, 57: 1017-1023.

Shaingberg I., Letey J. (1984) Response of soils to Sodic and Saline Conditions. Journal of agricultural science. 52 (2): 1-60.

Smedema L. (2000) Irrigation-induced river salinization: Five major irrigated basins in the arid zone. Colombo, Sri Lanka: International Water Management Institute 95pp.