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Examination of Secondary Salinization in Simple Drainage Lysimeters

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Summary

Irrigation from drilled wells is very characteristic in the small hobby gardens located around Karcag, Hungary during the frequently droughty summers. Mainly vegetables and fruits with high water demand are grown in these gardens, hence quite a large amount of subsurface waters are used for irrigation. The quality of these waters is not checked, the chemical composition hence the suitability of the water for irrigation is not known. Our hypothesis was that these waters are salty and irrigation with them involves the risk of secondary salinization. Water samples were taken from 46 drilled wells located in the hobby gardens around the town of Karcag and the samples were analysed. On the base of the results it can be concluded that the waters used for irrigation in the hobby gardens are involves high risk of secondary salinization. All the parameters indicating the salinization effect of irrigation waters were above the thresholds in most of the cases, so it can be established that none of the investigated wells supply water that is suitable for irrigation. In order to quantify the secondary salinization effect an experiment was set in 12 simple drainage lysimeters at the lysimeter station of the Karcag Research Institute. Green pepper was irrigated with 3 different waters with high salt content simulating secondary salinization in comparison with lysimeters irrigated with deionised water. High risk of secondary salinization could be established though the high amount of rainfall moderated the process.

Keywords: secondary salinization, soil preservation, simple drainage lysimeter

Introduction

Horticultural activities have been characteristic in the hobby gardens located in the northern and western areas around the town of Karcag for more than 300 years. The narrow and relatively long plots of the gardens look totally different from the large plots of the large-scale farming that also characteristic for the region. Most of the hobby gardens lay on meadow chernozem soil, while a smaller rate on meadow solonetz turning into steppe formation. Both soil types are characteristic only the areas with higher elevation and can be considered the best soils of the region. Nevertheless both soil types are endangered by secondary salinization due to their susceptibility.

The increase of the level of salty groundwater or the application of poor quality (salty) irrigation water can cause secondary salinization. Alkaline salts, mainly sodium, are accumulated in these soils either naturally or this process can be human induced. The latter case is called secondary salinization and mainly related to improper irrigation. Intensively irrigated areas are endangered by secondary salinization worldwide (LETEY 1984, MANTEL et al. 1985, RHOADES and LOVEDAY 1990). In the Great Hungarian Plain approximately 400,000 ha is the area where secondary salinization has occurred, mainly due to the rise of the level of salty groundwater. This was studied and proved by several scientists (ARANY 1956, SZABOLCS 1965, VÁRALLYAY 1968, BACSÓ and FEKETE 1969, FEKETE 1969, RÓNAI 1985, KUTI et al. 1999). BLASKÓ (2005) monitored the salt- and water balance of irrigated areas and found the increase of salt content of the soil in several cases. During the 1980ies and 1990ies on 30% of the studied area increasing soil salt content could be detected, especially on the susceptible areas where the soil can be only potentially irrigated due to the high salt content in their deeper layers.

Irrigation from drilled wells is very characteristic in the small hobby gardens located around Karcag during the frequently droughty summers. Mainly vegetables and fruits with high water demand are grown in these gardens, hence quite a large amount of subsurface waters are used for irrigation. The quality of these waters is not checked by the owners of the gardens, the chemical composition, hence the suitability of the water for irrigation is not known. Furthermore most of these wells are illegal, not registered, therefore the central monitoring or control of irrigation cannot be solved in the gardens. Our hypothesis was that these waters are salty and irrigation with them involves the risk of secondary salinization.

Material and methods

In our study started in 2009 water samples were taken from 46 drilled wells located in the hobby gardens around the town of Karcag (*Table 1*). In order to get information on the quality of the irrigation water the samples were analysed according to the relevant Hungarian standards and - among others - the total salt content of them was determined for the assessment of the salinization effect of the irrigation waters.

In order to quantify the secondary salinization effect an experiment (*Figure 1*) was set in 12 simple drainage lysimeters at the lysimeter station of the Karcag Research Institute of RISF CAAES University of Debrecen.

Green pepper was irrigated with groundwater (from a shallow well) and the water of a drilled well of high salt

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Table 1: **Designations of drilled wells of the tested area and tap water**

Garden	Drilled wells	Garden	Drilled wells	Karcag town	Drilled wells
Kisvén	1-9	Völgyes	27-34	wells in the town	43-46
Zug	10-19	Koldus	35-37	tap water	47
Rokkant	20-24	Nagyvén	42		
Partos	25-26	Agyagos	43-46		

Figure 1: **Irrigation experiment on simple drainage lysimeters at Karcag**

content simulating secondary salinization in comparison with lysimeters irrigated with deionised and tap water in 4 replications.

Results and discussion

The salinization effect of the investigated well waters was assessed according to the four indexes described in the Material and Methods chapter. In the case of soils sensitive for salinization, the upper threshold of the total salt content (*Figure 2*) of the water is 500 mg l^{-1}, above this value the water is not suitable for irrigation. The total salt content of the investigated well waters varied in quite a wide range, but most of them were in the range of 550-600 mEq l^{-1}, the mean value was 689.1 mEq l^{-1}. Only 1 of the 47 samples had a value below the threshold, while 7 of them exceeded even the value of 1,000 mEq l^{-1}. The highest value was 1356.8 mEq l^{-1}. We tried to find correlation between the total salt content value of the water and the depth of the wells, but significant correlation could not be figured out. Nevertheless the waters with the highest values originated from shallow wells affected by the salty groundwater.

In *Figure 3* the total salt content values of the irrigation waters of 4 different sources and of the drain waters flowing out from the lysimeters irrigated with these waters are indicated. It could be established that there is considerable difference between the salt content of the input and output

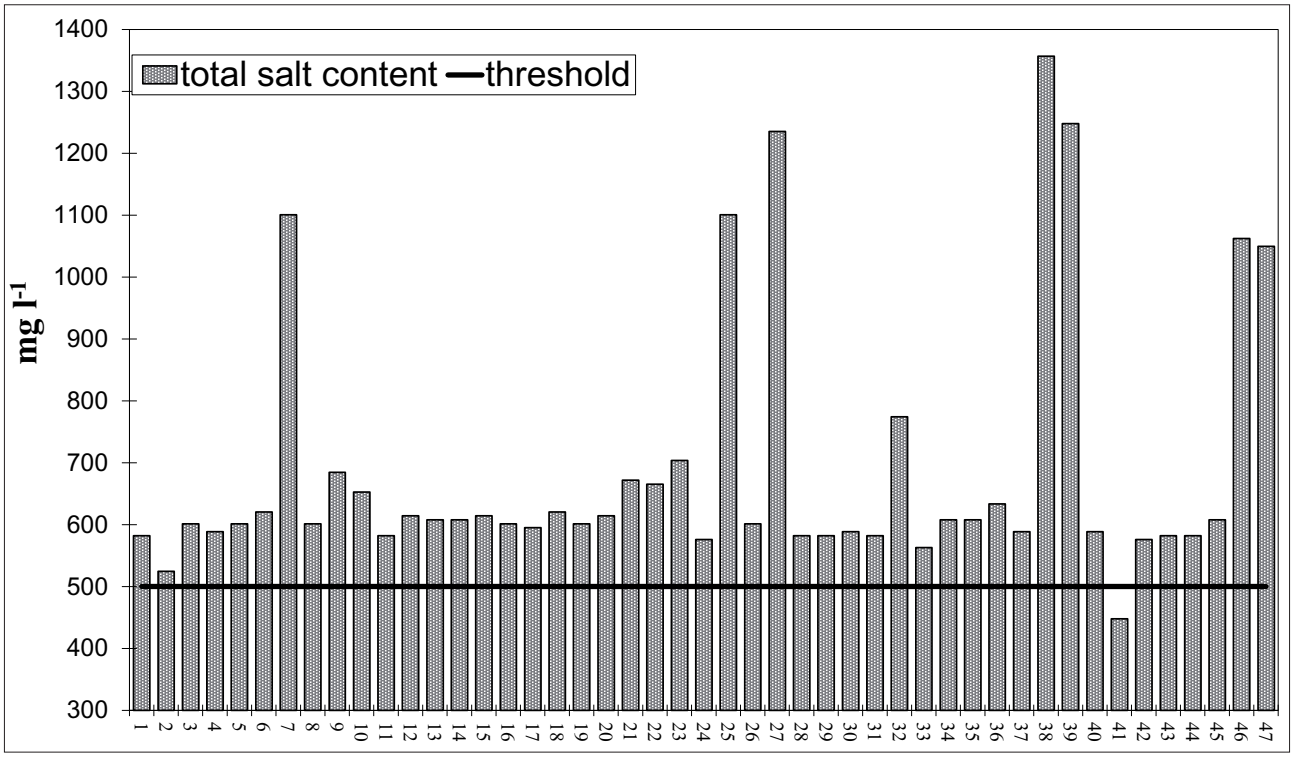

Figure 2: **The total salt content values of the drilled well waters (***Table 1***)**

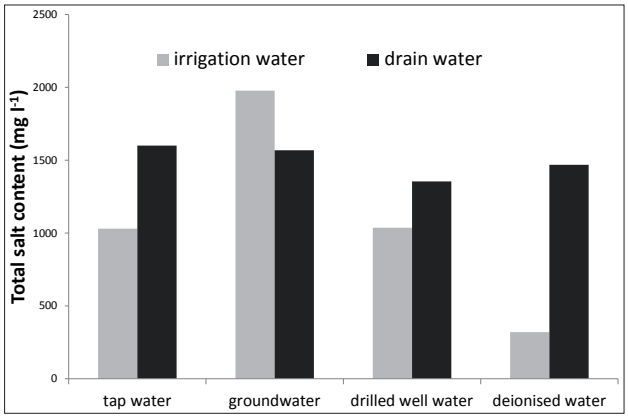

Figure 3: **The total salt content of the waters got into and out from the lysimeters irrigated with various waters**

waters. In 3 cases, when the lysimeters were irrigated with tap water, drilled well water or deionised water, leaching was characteristic as the total salt content of the input (irrigation) waters was lower than of the output (drain) waters. Though the investigated soil was originally salt affected with relatively high salt content (>0.1%), leaching was due to the high amount of rainfall taking place during the investigated period (572.2 mm from June to December). A pot-experiment carried out later proved the risk of secondary salinization as salt accumulation was detected if these waters were used for irrigation. Nevertheless, contrary to the high amount of rainfall, its extremely high salt content resulted in salt accumulation in the soil of the lysimeters irrigated with groundwater. No significant difference was detected among the total salt content of the drain waters.

Conclusions

On the base of the results we gained it can be concluded that the waters used for irrigation in the hobby gardens around Karcag are involves high risk of secondary salinization. All the indexes indicating the salinization effect of irrigation waters were above the thresholds in most of the cases, so it can be established that none of the investigated wells supply water that is suitable for irrigation without improvement. The data gained by means of the simple drainage lysimeters proved that irrigation with waters with extremely high salt content results in salt accumulation in the soil even under extremely wet years letting us to conclude that in drier years considerable amount of salts load the soil by irrigation saline subsurface waters characteristic for the region. Simple drainage lysimeters are good tools to quantify this phenomenon of great practical importance.

Literature

ARANY, S., 1956: A szikes talaj és javítása. Mezőgazdasági Kiadó. Bp. 408.

BACSÓ, A. and J. FEKETE, 1969: Role of ground Water in the secondary salinization of meadow-chernozem soils in the Hajdúság area. Agrokémia és Talajtan. 18. (Suppl) 339-350.

BLASKÓ, L., 2005: Talajromlási folyamatok és mérséklési lehetőségeik a Tiszántúl kötött talajain. MTA doktori értekezés.

FEKETE, J., 1969: Salt Circulation in Irrigated Meadow-Chernozem Soils of the Hajdúság Area of Hungary. Agrokémia és Talajtan Tom.18. Suppl. 341-344.

KUTI, L., T. TÓTH, L. PÁSZTOR and U. FÜGEDI, 1999: Az agroökológiai térképek és a szikesek elterjedésének kapcsolata az Alföldön. Agrokémia és Talajtan. 48. 501-516.

LETEY, J., 1984: Impact of salinity on the development of soil science. p. 1-9. In. I. Shainberg and J. Shalhevet (ed.) Soil salinity under irrigation. Processes and management. Ecological Studies 51. Springer-Verlag, New York.

MANTELL, A., H. FRENKEL and A. MEIRI, 1985: Drip irrigation of cotton with saline sodic water. Irrig. Sci. 6. 95-106.

RHOADES, J.D. and J. LOVEDAY, 1990: Salinity in irrigated agriculture. P. 1089-1142. In B. A. Steward and D. R. Nielsen (ed.) Irrigation of agricultural crops. Agron. Monogr. 30. ASA, CSSA, and SSSA, Madison, WI.

RÓNAI, A., 1985: Az Alföld negyedidőszaki földtana. Geologica Hungarica Series Geologica 21. MÁFI Budapest.

SZABOLCS, I., 1965: Salt-Affected Soils in Hungary. Agrokémia és Talajtan. Suppl. 14. 275-290.

VÁRALLYAY, G.Y., 1968: Salt accumulation processes in the Hungarian Danube Valley, Trans. 9th Int. Congr. Soil Sci. 1. 371-380.