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# Utilisation of subsurface waters for soilless vegetable forcing in the Southern Great Plain region of Hungary

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***Summary:*** For soilless vegetable production of the Southern Great Plain region in Hungary, there is enough water available, however, the origin and chemical composition of it are decisive from the point of view of practicability. The ground water is everywhere accessible, although its sodium and chloride content is almost always significant, moreover, human pollution may occur (e.g. nitrates and phosphates). A further unfavourable moment is the seasonal variation observed within the area of the same community. The abundant supply of water in the Quaternary strata are located in more than half of the cases within the upper 50 m region. As by the expected changes of the climate, a strategic increment of the importance of subsurface waters is anticipated. Their composition is relatively stable, and the prognoses are reliable for the same settlement. Salt content of the majority of water resources bearing hydrocarbonates is low, however, streaming of the subsurface waters tend to increase their sodium content and to diminish their calcium and magnesium, whereas the pH increases (mainly by ion-exchange). Water quality is decisive not only because of the interaction with the plants but also from the point of view of the distribution of water. Some micro-elements, mainly iron and secondarily manganese may cause problems, therefore, irrigation water ought to be prepared carefully. Production technology should be completed by a technical equipment using aeration for the elimination of ironinfluence of yields on rate of return of investment; (3) the role of increasing of added value content of products. Importance of the utilisation of alternative channels of distribution and the formation of producers' cooperatives are underlined, being based on calculation of return of investment.

***Key words:*** subsurface water resources, soil less cultivation, water quality, nutritive solution.

## Introduction

Since the political changes of 1989, forced culture of vegetables received more attention, and competition of growers became more severe. Also criteria of food safety and ecological compatibility received more attention. Vegetable forcing enjoys of traditions over several generations in the Southern Great Plain region of Hungary. Monoculture caused a gradual decline of soil conditions, nematodes and salt accumulation stimulated the growers to choose alternative practices as soil less cultures, which proved their value in Western Europe. (*Szőri*, 1997). Exact statistics are lacking, but estimates deal with approximately 300-400 hectares of vegetable forcing on rock wool, whereas other substrates of soilless culture may multiply this number. Real perspectives are attributed to the forced production of pepper, tomato and cucumber (*Balázs* et al., 2003).

In the soilless system of forcing, the supporting substances have a low capacity of nutrient-retention (*Sonneveld*, 2000), therefore, the provision of nutrient solutions ought to be continuous, consequently much water is required. In production, the volume of the solution applied depends on water quality, i.e. the lower quality of water, the more of it is required for a unit of crop (*Terbe,* 1997). Excessive volumes of water mean increasing volumes of overflow, which cause an increasing environmental burden in open systems of production (*Tüzel* et al., 2002). Environmentally safe, closed production systems cannot be work without water of excellent quality because the overflow is reutilised. In soilless cultures, water quality is decisive in determining the chemical conditions of the rooting zone (*De Kreij* et al., 1999). The chemical conditions of water are managed more or less uniformly in soilless cultures, because the interaction is minimal between the substrate and the roots. Therefore, success of soilless cultures depends largely on the quality of local water resources.

An abundant bulk of international literature deals with the technological elements of water (soilless) culture, however, questions related to water quality were treated scarcely. On the other hand, Hungarian publications on this topic are rather few, and new technologies are often adapted and introduced without previous experimental approach. A thorough survey of water resources utilised for soilless cultures is still wanted. Therefore, studies have been initiated to reveal the conditions of water resources from the point of view of their suitability for plant nutrition and irrigation during the last ten years (*Ráczné*, 2001). Results obtained may help to utilise the water reserves of the Southern Great Plain region for the purpose of "ecologically conscientious" soilless plant production.

## Materials and methods

The present scientific research aimed to survey and map the water resources of the Southern Great Plain region from the point of view of chemical composition. Samples are taken from three counties (Békés, Csongrád, Bács-Kiskun) as shown in *Table 1*. The same sources have been sampled repeatedly in order to follow up the temporary changes too not only the spatial ones. The collection and processing of water samples ensued between 2000 and 2004.

***Table 1*** A survey of water samples taken in the Southern Great Plain region

| Water resources | Number of samples |
|---|---|
| Ground waters (37 settlements) | 81 |
| Layer waters as for their suitability for soil less cultures (in 9 model settlements) | 126 |
| Micro-element content of layer waters (in 32 settlements) | 87 |

- the chemical parameters of suitability for soilless plant cultivation: *pH, EC, $NO_3$-N, P, K, Ca, Mg, Na, Cl, $HCO_3$*
- micro-elements examined for the preparation of layer waters of the Southern Great Plain region: *Fe, Cu, Zn, Mn, B, $SO_4$-S*

Samples of water collected by producers were analysed in the Laboratory of Chemical and Soil Department of Tessedik S. College. In the analysis of samples, classical and instrumental procedures have been applied. The suitability of layer waters for the purpose of soilless cultures, the highest values obtained were accepted on the P=5% level of confidence. The qualification is based on the system of *Göhler & Drews* (1989).

## Results and discussion

Water resources to be utilised are first scrutinized for their origin as a preliminary information related to its utility.

### *Ground waters*

All relevant chemical properties of waters varied on a broad scale (*Figure 1*). Electric conductivity (EC) values are found between 0.79 and 4.2 mS/cm, which means approximately 500–3000 mg/l salt content. The groundwater of the settlements was influenced essentially by the excessive use of chemical fertilisers as well as by the respective communal sewage system. For water cultures, the presence of the following ions are really decisive: Na, Cl, hydrocarbonates. The utility of groundwater are often impaired by more than one prohibitive values above the limit.

For the origin of water samples, it is of special interest that from some settlements several samples were taken at different sites at the same time (e.g. Nagyszénás), or at different dates at the same site (e.g. Orosháza). Both cases indicate that the parameters are continuously subject to spatial and temporal variation, therefore regular checks are necessary.

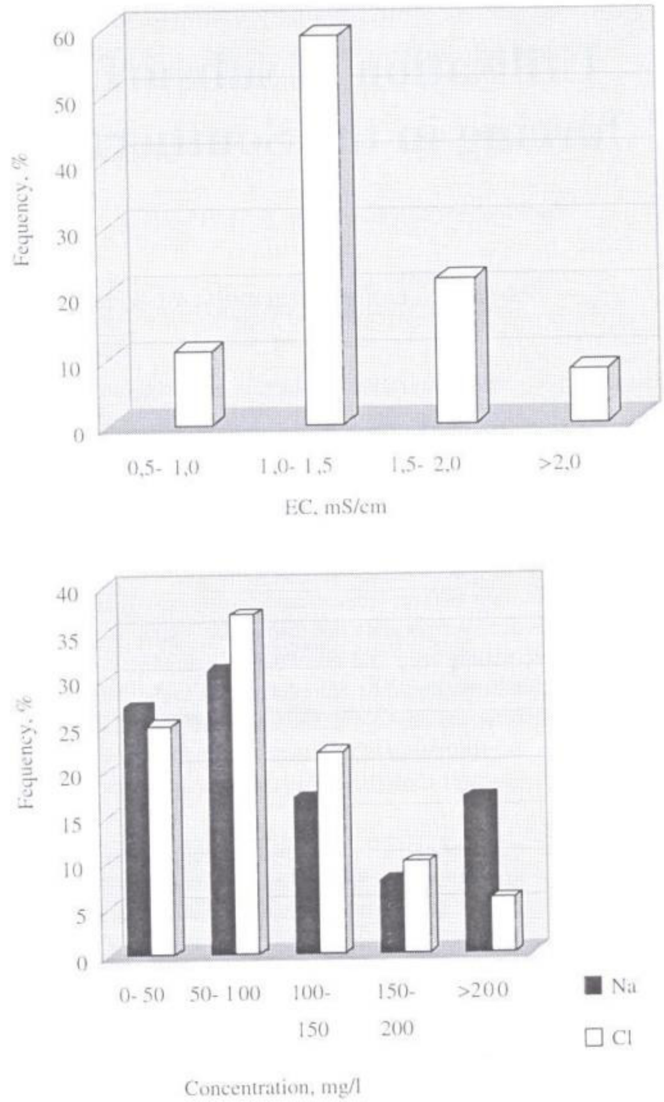


***Figure 1*** The frequency of concentrations, Na and Cl, as well as of electric conductivity (EC) in groundwater samples

### *Layer waters*

The layerwater samples of model settlements displayed a more uniform picture of chemical properties. Electric conductivity varied: EC=0.34–0.8 mS/cm (*Figure 2*). As the most decisive anion, hydrocarbonate, has been recognised. Cations are more variable. With declining calcium content the sodium content increases. Higher sodium concentration is associated with lower magnesium content most likely as a consequence of precipitation. The chemical character of layer waters is attributed to the influence of regional subsurface streams, which is convincingly expressed by the gradual softening of water streams.

As for the content of nutritive elements, nitrates are found in traces, phosphorus and potassium are scarce as expected (P: 0–2.4 mg/l; K: 0.3–6.0 mg/l).

In hard waters, the limiting factor is the hydrocarbonate content, in soft waters, the sodium content limited their use for hydroculture. Essentially, layer waters are characterised by predictable parameters on the long run.

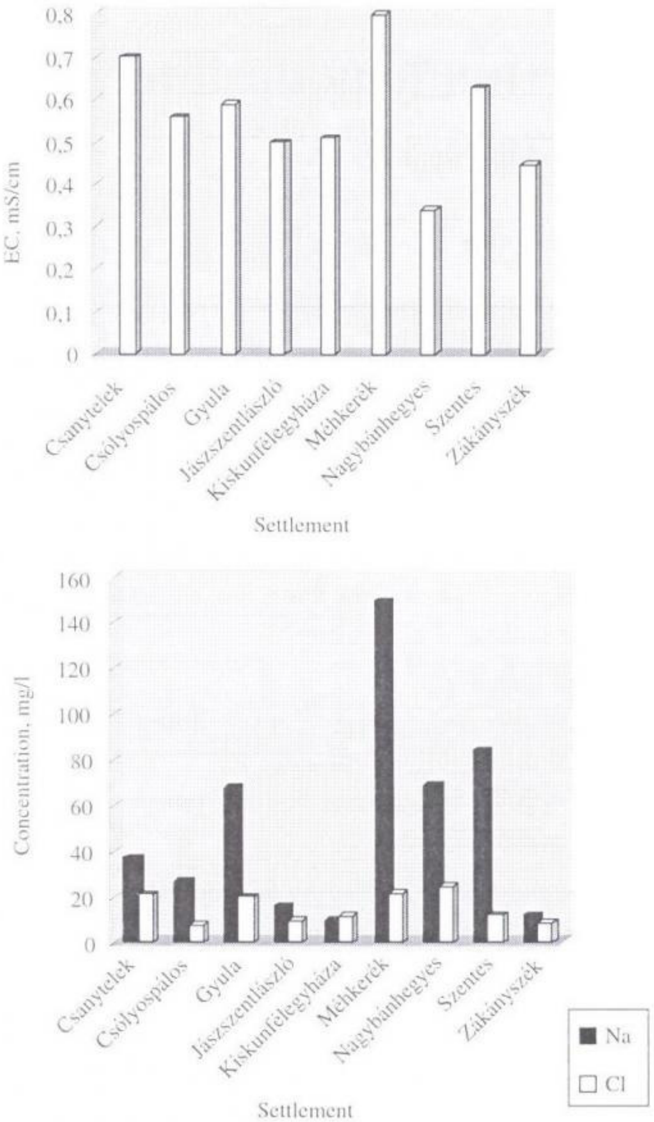


*Figure 2* Salt, sodium and chloride content of layer waters in 9 settlements of the Southern Great Plain region

The ill-proportioned cation composition, salt- and sodium content of waters aggravates the exact preparation of nutritive solutions. Excellent, i.e. low Na-content and EC was found for immediate use at some settlements (Csólyospálos, Jászszentlászló, Kiskunfélegyháza, Zákányszék). The highest salt content was found, mainly due to high sodium content, at Méhkerék, Csanytelek and Szentes. The high hydrocarbonate content alone does not hamper the use of water, although the obligate increment of salt concentration impairs the cultivation of salt intolerant plants.

### *Content of micro-elements*

Results concerning micro-elements in the layer waters of the region are variable but do not exhibit any tendency. Among them, iron and manganese are of outstanding importance. Their

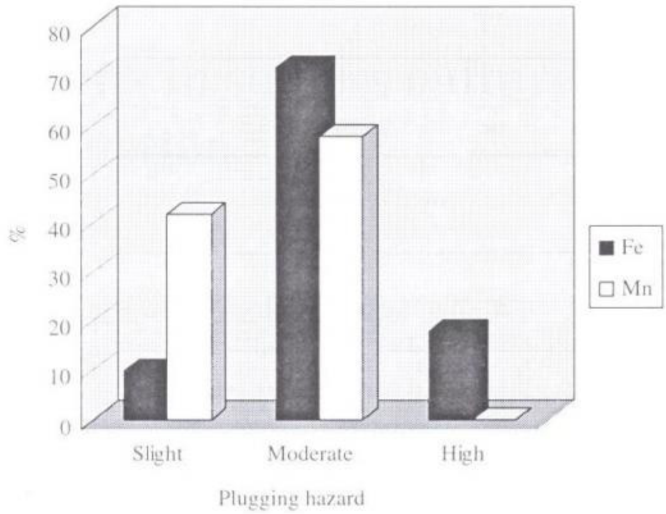


*Figure 3* Distribution of the plugging hazard of micro-irrigation system based on iron and / or manganese concentration of water.

absolute concentration endanger the function of dripping system of irrigation (*Figure 3*). More than 70% of water samples predict the danger of plugging in the distribution of the nutritive solution. First of all iron, less probably manganese is to be blamed.

The production technology should include a technical device, which eliminates the iron content of the solution by aeration.

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