

RESULTS OF ANALYSIS OF IRRIGATION WATER LOCATED MAINLY IN COUNTY BACS-KISKUN

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ABSTRACT

Ground water samples, collected mainly in Kecskemét and its outskirts, were analysed in the laboratory of Faculty of Horticulture (Kecskemét College). Depending on the depth three categories of the sprinkling water samples were formed: 10-30, 31-70 and 71-275 m, respectively. Chemical analysis of 103 water samples showed the decrease in the salt content with deepness (conductivity (EC) decreased from 1116 to 682 $\mu\text{S}\cdot\text{cm}^{-1}$ in the deepest groundwater samples). It was the result of the decrease primarily in sodium, hydro-carbonate and chloride contents in the samples. Acidity and alkalinity of the samples didn't change with deepness considerably in our samples. The levels of nitrogenous and phosphorous ions were low in almost all water samples. Ferrous, manganese and arsenic content was the highest in the middle deep water region (31-70 m depth). These results may reveal problems in the application of these water sources in agriculture, mainly in growing and irrigation because of high salt concentration, principally thanks to hydro carbonate and metallic ions. Acidic pre-treatment of these irrigation waters seems to be crucial.

Keywords: sprinkling water, chemical analysis, groundwater, salt content

INTRODUCTION

Throughout the world, irrigation (water for agriculture or growing crops) is probably the most important use of water (almost 60 percent of all the world's freshwater withdrawals go towards irrigation uses). Irrigation water of crop fields may originate from rivers, lakes, reservoirs, and wells. Similarly to other Southern European countries, irrigation is essential for agricultural production in the south plane region of Hungary. The region of our experiments, mainly county Bács-Kiskun, is one of the most productive areas of the country. Sandy soils located here have low moisture-holding capacities, so irrigation significantly increases crop yields and quality. Water sources are often used for liquid fertilizer application, as well.

In our study irrigation water samples from ground origin were analysed. Groundwater, under most conditions, is safer and more reliable for use than surface water. However, groundwater can be contaminated through natural origin and by chemicals that are easily soluble and penetrate the soil layers. These pollutants can reach aquifer system and in the end private wells. The water quality used for irrigation is essential for the yield and quantity of crops, maintenance of soil productivity, and protection of the environment. For example, the physical and mechanical properties of the soil, soil structure and permeability, are very sensitive to the type of ions present in irrigation waters (BAUDER AND BROCK, 2001; PEREIRA ET AL., 2002).

The excess of salt content is one of the major concerns with water used for irrigation. A high salt concentration present in the water and soil will negatively affect the crop yields, degrade the land and pollute groundwater. High carbonate and hydro-carbonate ions (CO_3^{2-} , HCO_3^-) increase SAR index.

Natural nitrate levels in groundwater are generally very low (typically less than 10 mg/l NO_3), and it is the case with phosphate forms, as well. Metallic and semi-metallic ions,

such as iron, manganese and arsenic may be present in natural rural groundwater supplies, causing a common problem: its concentration may be many times larger than the allowed level. Iron may occur naturally in the aquifer but the level in groundwater can be increased by dissolution of some ferrous mechanic pumping components. Inorganic arsenic can occur in the environment in several forms in natural waters, and thus in irrigation water, it is mostly found in trivalent arsenite (As(III) form (GRAFE ET AL., 2002).

MATERIAL AND METHOD

Groundwater samples were collected in two times rinsed plastic containers after running out water for some minutes, bags or bottles were totally filled, reclosed and refrigerated, and transported to laboratory analysis as soon as possible (within 24 hours of sampling). Correct sampling, storage and transportation are critical to the accuracy of analysis. Measurements were carried out in Soil and Plant Analysing Testing Laboratory of Faculty of Horticulture, Kecskemét College.

Avoiding precipitation, 100 ml water samples were acidified slightly with HNO₃ for (semi)metallic ion measurements. Instrumental analysis were carried out as soon as possible, whereas pH and electrical conductivity (EC) measurement were made immediately. EC and pH of tempered samples were measured using laboratory EC and pH-meter, Ca²⁺, Mg²⁺, Na⁺, K⁺, Fe, Mn, As and PO₄³⁻ content were analysed by ICP-OES spectrometry (Horiba JY). Hydro-carbonate and chloride (HCO₃⁻ and Cl⁻ ions were measured volumetrically. Nitrate and ammonium in samples were determined by flow FIA analysis and spectrometric detection (FiaStar Analyzer). Standard analytic methods were used in the case of all parameters.

103 groundwater samples were collected from private founts in the south-east region of Hungary, primarily county Bács-Kiskun. Samples were distributed into three categories with deepness of the source of water: 5-30 m, 31-70 m and 71-275 m, respectively. Analytic results were compared and statistically valued.

RESULTS

As shown in *Table 1*, acidity of water samples didn't change with deepness considerably. The spread of acidity/alkalinity decreased in samples. Decreasing tendency of EC in the deepest water source region, reflecting dissolved saline content, was also shown (*Table 1*).

Table 1. pH and electrical conductivity of water samples according to deepness in the three categories

| | 5-30 m | | 31-70 m | | 71-275 m | | threshold limit |
|-----------|---------|------|---------|------|----------|------|-----------------|
| | average | SD | average | SD | average | SD | |
| pH | 7.25 | 0.44 | 7.32 | 0.39 | 7.30 | 0.25 | 6.5-7.8 |
| EC, µS/cm | 1116 | 887 | 978 | 847 | 682 | 267 | 1000 |

Major ions present in groundwater samples are shown in *Figure 1*. Main anion in samples was bicarbonate, which is a natural characteristic ion in this pH range in our region. The level of the contaminant chloride ion decreased considerably with deepness.

According to major cations, the average of ion concentrations didn't succeed the threshold limit in all deepness. Potassium levels were extremely low (falling from 11.4 to 2.49 mg/l).

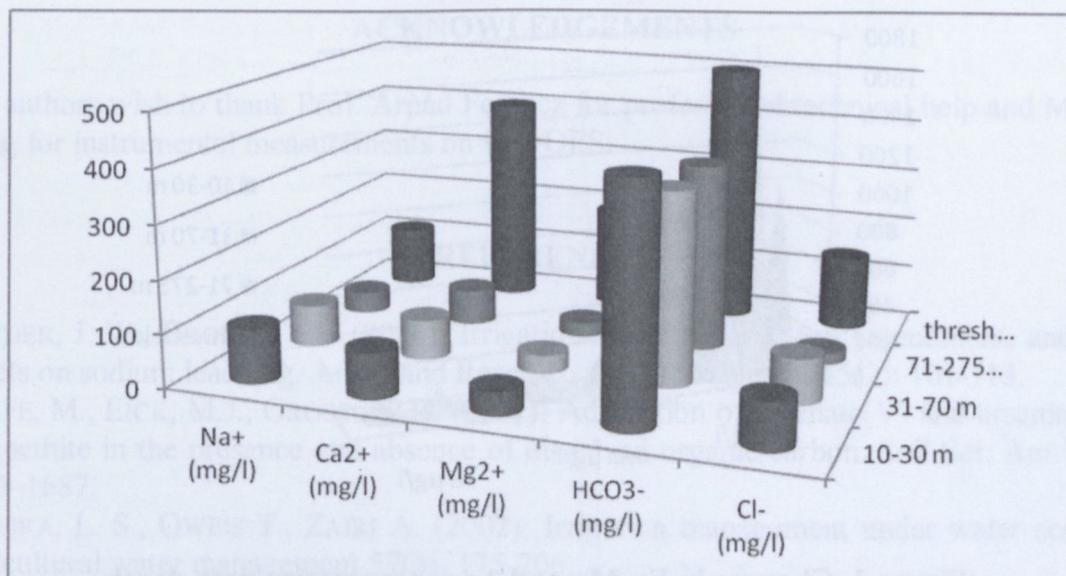


Figure 1. Sodium, calcium, magnesium, bicarbonate and chloride concentration in groundwater samples

Levels of contaminant nitrogenous and phosphorous forms were also determined, concentration of NH_4^+ , NO_3^- and PO_4^{3-} were the lowest in irrigation water samples came from the deepest layer region (Figure 2).

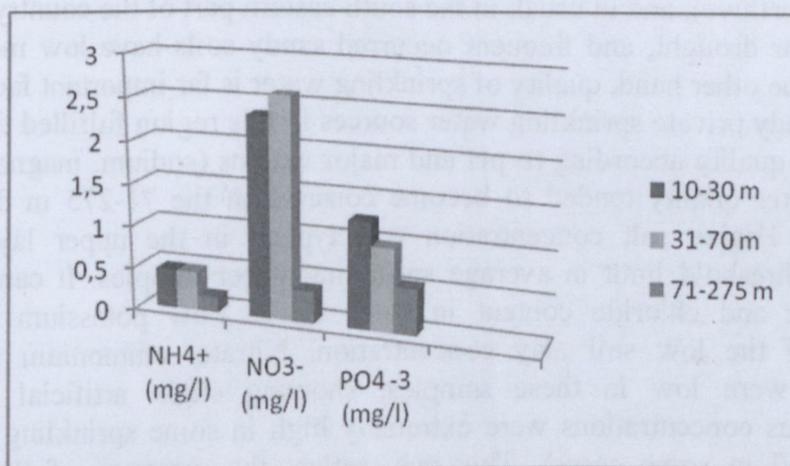


Figure 2. Ammonium, nitrate and phosphate concentration in water samples

Concentration of ferrous, manganese and arsenic are shown in Figure 3. The level of Fe transcended the threshold limit in the upper layer waters. All examined (semi)metallic ion concentrations were the highest in the middle deep region.

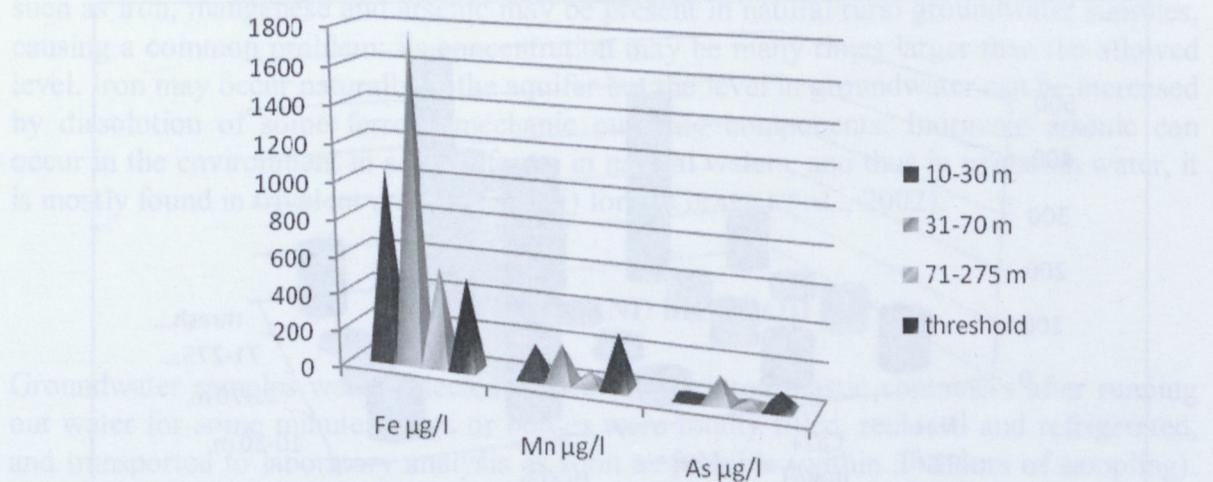


Figure 3. Changes in Fe, Mn and As concentration with depth

CONCLUSIONS

Irrigation in agriculture plays a major role in food production and food security. Future agricultural development strategies may depend on the possibility to maintain, expand and improve irrigated agricultural lands. This is the case specifically in county Bács-Kiskun (Duna-Tisza interfluvium), and in usual, in the south-eastern part of the country. This territory is susceptible for drought, and frequent occurred sandy soils have low moisture-holding capacities. On the other hand, quality of sprinkling water is far important factor. According to our recent study private sprinkling water sources in this region fulfilled the standards of irrigation water quality according to pH and major cations (sodium, magnesium, calcium, potassium). Water quality tended to become constant in the 71-275 m deep sprinkling water samples. Higher salt concentration was typical in the upper layer (10-30 m), exceeding the threshold limit in average sprinkling water samples. It came from higher hydro-carbonate and chloride content in some cases. Low potassium content is the consequence of the low soil clay concentration. Nitrate, ammonium and phosphate concentrations were low in these samples, showing slight artificial contamination. However, ferrous concentrations were extremely high in some sprinkling water samples (3000-4000 mg/l in some cases). This may reflect the presence of fluvial sediments containing high ferrous content, primarily in the middle deep layer samples. Arsenic can be absorbed on the surfaces of Fe-O-OH containing sediments (VARSÁNYI AND KOVÁCS 2006, RAYMAHASHAY AND KHARE, 2003). This is in accordance with our results showing higher As concentration in the 31-70 m depth. However, high ferrous concentration may be resulted from sampling faults. Pre-treatment of these sprinkling waters with nitric acid or phosphoric acid is far suggested avoiding precipitation of ferrous residue in mechanic irrigation components (primarily at trickle irrigation). Acidification is recommended to remove excess bicarbonate as well. Taking account these results may help us in economical use of water resources for agriculture and avoiding threat to the environment.

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REFERENCES

- BAUDER, J. W., BROCK T. A. (2001): Irrigation water quality, soil amendment, and crop effects on sodium leaching. *Arid Land Research and Management* 15(2): 101-113.
- GRAFE, M., EICK, M.J., GROSSL, P.R. (2001): Adsorption of arsenate(V) and arsenite (III) on goethite in the presence and absence of dissolved organic carbon. *Soil Sci. Am. J.* 65: 1680-1687.
- PEREIRA, L. S., OWEIS T., ZAIRI A. (2002): Irrigation management under water scarcity. *Agricultural water management* 57(3): 175-206.
- RAYMAHASHAY, B.C., KHARE, A.S. (2003): The arsenic cycle in Late Quaternary fluvial sediments: Mineralogical considerations. *Current Science* 84: 1102-1104.
- VARSÁNYI, I., KOVÁCS L. O. (2006): Arsenic, iron and organic matter in sediments and groundwater in the Pannonian Basin, Hungary. *Applied Geochemistry* 21: 949-963.