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THE QUALITY OF IRRIGATION WATER OF SOUTH BUG AND KAMIANSKA IRRIGATION SYSTEMS

A large part of Ukraine is located in areas of insufficient and unstable moisture, and therefore the food security of the population and the export potential of the state largely depend on the availability, condition and efficiency of irrigation land use. A factor limiting the development of irrigation in the South of Ukraine is the lack of quality irrigation water.

Agronomic quality of irrigation water according to FAO and other authors - is determined by several parameters (Ayers, Westcot 1994; Zaman et al. 2018; Bortolini et al. 2018): (1) content of water-soluble salts, the high concentration of which leads to salinization of soils, reducing the availability of water and nutrients to plants; (2) content of sodium cations, which leads to the degradation of the physical properties of soils, which, in particular, impairs their infiltration properties; (3) content of other ions that can accumulate in concentrations toxic to crops, which leads to a decrease in yield and product quality; (4) pH value.

The aim of our research was to study a set of agronomic criteria for irrigation water in the process of transporting it from the South Bug River to take to the lands of the South Bug and Kamianska irrigation systems. This assessment allows developing a system of reclamation and agro-technical measures aiming to improve the condition of irrigation water and soil. It also may help to improve the structure of sown areas, growing more salt-tolerant crops if necessary.

Soil salinization is dangerous because the aqueous solution supersaturated with salts has a high osmotic pressure, which prevents the absorption of water and nutrients by the roots, and this significantly reduces crop yields. A side negative effect of the presence of a high concentration of salts in the soil solution is the inhibition of photosynthesis. At the same time, more recent FAO estimates attribute such irrigation water to the average risk of soil salinization (EC_w (electrical conductivity) = 0.7−3.0 mS/cm). Such irrigation water has certain restrictions on use and may lead to reduced yields individual non-salt-tolerant crops (Ayers, Westcot 1994; Zaman et al, 2018; Nikolau 2020 etc).

Deterioration of physical properties of soil during watering is associated with the presence of sodium cations in the soil-absorbing complex. To assess the risk of deterioration of the physical condition of the soil, according to (Ayers, Westcot 1994; Zaman et al, 2018 etc.), the most informative is the SAR (Sodium Adsorption Ratio), which is calculated as follows

$$SAR = \frac{Na}{\sqrt{Ca + Mg/2}},$$

where Na, Ca, Mg - values of sodium, calcium and magnesium cations in irrigation water, mg-eq/cm^3.

FAO experts and other authors (Ayers, Westcot 1994; Zaman et al, 2018 etc.) assess the risk of degradation of physical properties of soils, including the rate of water infiltration into the soil, depending on the salt content, which, in turn, is a function of electrical conductivity. In such estimates, the risk of degradation of physical properties of soils and reduction of soil infiltration capacity during watering and precipitation will be greatest in conditions of relatively low total salt content in water and small values of EC_w accordingly. Conversely, when irrigated with highly mineralized irrigation water, the risk of deterioration of the physical properties of soils will be minimal even at high SAR values. From these positions, irrigation water with SAR values=3,2-4,8 and EC_w=0,9-1,1 mS/sm have medium risks of degradation of physical properties of soil.

The content of sodium cations does not exceed 2,0 mg-eq/cm^3 in the water of the Southern Bug. In the process of transportation after the passage of water through a number of reservoirs, the sodium content increases several times, reaching values of 5,4-6,6 mg-eq/cm^3. The main reason for this phenomenon is temperature changes of irrigation water. In the presence of excess carbonates during the evaporation of the solution, the process of formation of insoluble calcium carbonates ($CaCO_3$) and magnesium carbonates ($MgCO^3$), which precipitate from the solution. At the same time, increasing water temperature in reservoirs, especially in summer, increases the solubility of salts such as Na_2SO_4 and NaCl. As a result, the relative and absolute content of sodium cations increases, and with it the SAR value increases to toxic values for plants. According to studies of water quality indicators, no toxic effects of sodium were observed in May (SAR<3).September studies showed that the average risk of toxic effects of sodium cations (SAR=3-9). In the case of irrigation by sprinkling, the content of sodium cations exceeds 3,0 mg-eq/cm^3 for all observation sites, which is dangerous for all agricultural plants.Chlorides are almost always found in water used for irrigation. But the initial content of chlorine anions in the Southern Bug River and even a small increase in the content of this ion during transportation does not exceed the threshold value of 3,0 mg-eq/cm^3. This indicates the absence of a negative effect of this anion on crop yields.

The bicarbonate content is an important indicator of irrigation water quality. Their excess leads to the formation of insoluble calcium and magnesium carbonates and to relative sodium cations content increase in the water, which leads to an increase of this cation toxic effect on plants, especially in hot days, and the spread of physical soil degradation. The water of the South Bug contains 5,0 mg-eq/cm^3 of bicarbonate, so they dominate among all anions. The high content of bicarbonates is explained by the processes of chemical weathering as a result of dissolution of carbonate rocks such as limestone, marl, dolomite. In addition, a sufficient amount of precipitation in the upper and middle parts of the Southern Bug basin creates periodic leaching of soils in this area, which stimulates the ingress of HCO_3^- anions into groundwater and the formation of specific

ionic runoff of the river. Determination of irrigation water quality indicators showed that the HCO_3^- bicarbonate content ranges from 4,6 to 8,0 mg-eq/cm^3, which in some cases indicates the average risk of adverse effects of this anion on the soil solution and the plant.

The value of the hydrogen index (pH) in surface waters is usually formed within the carbonate-calcium system in the form of several components − calcium cations, carbonate and bicarbonate ions and carbon dioxide. This balance state of the system is determined by the temperature regime of water bodies, on which the solubility of CO_2 and the intensity of hydro biological processes depend. The pH value in surface waters increases with decreasing CO_2 content due to increasing water temperature or intensive photosynthesis of aquatic organisms, in particular blue-green algae, and decreases with increasing CO_2 content. In our case, the pH value is relatively stable both on the transport route and during the irrigation season, due to the presence of a large number of bicarbonate ions, which compensate for the reduction of CO_2 when heating water. The formation of carbonic acid, which determines the value of the hydrogen index, in this case is almost independent of the concentration of carbon dioxide, and therefore the pH value does not change. Thus, the range of 6,5-8,6, which was observed in water quality studies, according to regulatory values and data of other authors can be defined as safe for most crops**.**

References

1. **Ayers R.S., Westcot D.W.** 1994. Water Quality for Agriculture.FAO irrigation and drainage paper. Vol. 29. Rome: FAO, 174 p. URL: http://www.fao.org/3/t0234e/t0234E00.htm.

2. **Bortolini L., Maucieri C., Borin M.** 2018. A Tool for the Evaluation of Irrigation Water Quality in the Arid and Semi-Arid Regions. Agronomy, 8, 23. doi:10.3390/agronomy8020023.

3. **Nikolaou G., Neocleous D., Christophi C., Heracleous T., Markou M.** 2020. Irrigation Ground water Quality Characteristics: A Case Study of Cyprus Atmosphere 11, 302. doi: 10.3390/atmos11030302 www.mdpi.com/journal/atmosphere.

4. **Zaman M., Shahid S.A., Heng L.** 2018. Irrigation Water Quality. In Guideline for Salinity Assessment, Mitigation and Adaptation Using Nuclear and Related Technique; Springer: Cham, Switzerland, pp. 113-131.

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REQUIREMENTS FOR THE SIZE OF QUARTERS OF INDUSTRIAL WALNUT PLANTATIONS AND CALCULATION OF THE WORKING CYCLE TIME OF THE MACHINE-TRACTOR UNIT

Ukraine has significant natural advantages compared to neighboring countries for the highly efficient cultivation of walnuts, on its territory 424 thousand hectares of vacant land are suitable for growing this crop. At the same time, the level of domestic production does not reach a third of a