Influence of water of the small river of Western Siberia – Ulu-Yul on sprouts of wheat and tomato

A V Kurovsky¹,a, K A Petrochenko¹,b, Yu V Andreeva¹,c, A Yu. Godymchuk²,d, V N Kurovskiy³, E N Burnashova¹, Yu E Yakimov¹, A E Starodubtsev¹, A S Sheptor¹, D V Breit¹

¹Tomsk State University, pr. Lenina 36, Tomsk, 634050, Russia
²Tomsk Polytechnic University, pr. Lenina 30, Tomsk, 634050, Russia
³Tomsk State Pedagogical University, ul. Kievskaya, 60, 634061, Russia

a a.kurovskii@yandex.ru; b charlie9008@yandex.ru; c andreeva_Y@mail2000.ru; d godymchuk@mail.ru

Abstract. The some hydro chemical peculiarities of the Uly-Yul River’s water (basin Ob) sampled during the spring flood has been demonstrated. In samples of river’s water was fixed high level of humic substances concentration: about 23 mg/L humic acids and about 30 mg/L fulvic acids. Ca²⁺ was a predominant inorganic cation with concentration 0.3 mEq/L. Electrical conductivity of researched water was about 30 μS × cm⁻¹. The sum length of wheat shoots was statistically significantly lower for plants cultivated on Ulu-Yul River’s water (experimental group) in comparison with plants cultivated on low concentrated Hewitt nutrition solution (control group). The sum length of tomato roots was statistically significantly bigger for plants cultivated on Ulu-Yul River’s water in comparison with plants cultivated on low concentrated Hewitt nutrition solution. Both for wheat and for tomato an increasing of quantity roots/shoots ratio for experimental groups has been demonstrated.

1. Introduction
Humic substances continue to attract the attention of researchers from various fields of sciences [1]. The reason for this is the high biological activity and diversity of action of these compounds. The stimulating and regulatory action of humates is now well known for both plants and animals[2]. Research on the properties of humates in Western Siberia has two main aspects. The practical aspect is connected with the study of the possibility of using the resources of humic substances as fertilizers. The theoretical aspect concerns the formation, under the influence of humates of morpho-physiological adaptations in plants to the conditions of oligotrophic nutrition and to other extreme factors of the ecosystems of Western Siberia. The goal of this work was study the effect of the Ulu-Yul River’s water on root- and shoot formation of wheat and tomatoes grown under aquatic culture.

2. Materials and methods
In general, the area of our research belongs to the typical taiga areas of the east of the Tomsk region, basin Ob. In right coast Ulu-Yul River, the dominant territorial and biocenotic importance belongs to the watershed oligotrophic bogs. Water samples from the Ulu-Yul River were taken in 2015–2018,
during the spring flood (May 1–10). The coordinates of Sampling Point: 57°44′24″ N, 85°45′38″ E. During this period, there is a maximum runoff from raised oligotrophic bogs to the riverbed. River water becomes brown. This is due to the high content of humic substances in the water. The pH, concentration of potassium and nitrate, electrical conductivity and concentration of calcium and magnesium in samples of river’s water were monitored by potentiometric, conductometric and titrimetric methods, described in [3–7]. Concentration of humic substances was determined by method [8].

In the work we studied the effect of Ulu-Yul river’s water on the root- and shoot development of wheat (Triticum aestivum L.) and tomato (Lycopersicon esculentum Mill.). Root formation indicators are widely used in plant growth stimulators studies [9].

Ural scientific research institute of agriculture (Ekaterinburg, Russia) developed the Iren variety of wheat. Ripening time of this variety is 70–80 days, height of plants is 65–80 cm, and productivity is 2–4 tones/ha. Russian research institute of vegetables growing (Moscow-region, Russia) developed the Dachnik variety of tomato. It is an early, ecologically resilient variety with a high yield in different climatic conditions. Both varieties described were used as models in our research.

The 3-day sprouts of wheat and tomato in number 10 items were placed in hydroponic vessels with volume 300 ml. In experimental vessels was poured river's water. In control vessels was poured Hewitt nutrition solution [10], which was diluted by distilled water to electroconductivity same as in river's water. The hydroponic vessels was placed in phytotron with period change day/night 16:8 and power of lighting 30 w/m². The cultivation of tomatoes and wheat was carried at 20 ± 1 ºC for 14 days. After cultivation was conducted an estimation of sum length of shoots and sum length of roots for each plant. This procedure was performed with using of digital photo of sprouts laid out on dark fabric and ImageJ program [11]. For calibration of images we used metal ruler with an accuracy of 0.5 mm.

All experiments were performed in three replicates. The data are presented as mean arithmetic values and their errors. Student’s t-test for independent samples was used for comparing two means.

### 3. Results and discussion

Table 1 presents some indicators of the chemical composition of the studied water.

| Parameter | Value       |
|-----------|-------------|
| pH        | 6.11 ± 0.11 |
| EC, [μS × cm⁻¹] | 33.01 ± 4.06 |
| Water hardness (Ca²⁺+Mg²⁺), [mEq/L] | 0.37 ± 0.04 |
| Ca²⁺, [mEq/L] | 0.31 ± 0.04 |
| K⁺, [mEq/L] | 0.033 ± 0.01 |
| NO₃⁻, [mEq/L] | < DL |
| Humic acids, [mg/L] | 23.29±1.75 |
| Fulvic acids, [mg/L] | 30.6±2.31 |

**Notes:** mEq, milliequivalent; EC, electric conductivity; DL – detection limit.

As is evident from Table 1, the water of the Ulu-Yul River collected during the spring flood was weakly acidic. The conductivity was very low that corresponding to the total electrolyte content of
approximately 0.2–0.5 mEq/L. Potassium concentration also was very low. Nitrate concentration was below detection limit by potentiometric methods (10^{-4} \text{ mol/L}). The only predominant cation was Ca^{2+}. If we consider this water as a source of mineral nutrition for plants, then it can be characterized as very oligotrophic. In general, our results corresponding data about hydro-chemical peculiarities of Siberian rivers [12,13]. In data presented in table 1 relative high concentration of humic matters could deserve attention.

Table 2 present the data of morphometric measurements of plant-objects for experimental and control variants.

| Parameter                        | Object                  | Wheat                              | Tomato                              |
|----------------------------------|-------------------------|------------------------------------|-------------------------------------|
|                                  | River’s water           | Hewitt                             | River’s water                       | Hewitt                             |
| Sum length of shoots, [cm]       | 22.9 ± 2.1\*            | 30.1 ± 2.0                         | 4.7 ± 0.3                           | 5.5 ± 0.4                          |
| Sum length of roots, [cm]        | 61.9 ± 4.8              | 59.3 ± 5.6                         | 16.3 ± 1.5\*                       | 8.4 ± 2.1                          |
| length of roots/length of shoots ratio | 3.0 ± 0.3\*            | 2.1 ± 0.2                          | 3.7 ± 0.4\*                        | 1.5 ± 0.2                          |

Notes: * Significant difference with control (Hewitt) at p < 0.05; Hewitt – Hewitt nutrition solution.

The sum length of wheat roots from the control and experimental vessels on completion of the exposition was fixed practically at same level, approximately 60 cm. However, sum length of shoots was statistically significantly lower for experimental plants. Accordingly, length roots/length shoots ratio also was significantly lower for sprouts cultivated on Ulu-Yul River’s water. We observed expressed difference in sum length of roots between experimental and control groups of tomatoes. This indicator was statistically significantly bigger for tomatoes cultivated on Ulu-Yul River’s water. In addition, the same picture was observed in relationship roots/shoots ratio. We think, that the obtained effects was conditioned specific properties of two main components of researched water. These components are humic substances and quantitatively prevailing cations of calcium. Both factors can provide to increase of adaptation possibilities of plants to oligotrophic conditions by stimulation of root formation [1, 14].

4. Conclusion
Our study has demonstrated that the natural water of small rivers of the Western Siberian can be considered as especially agrochemical and ecological factor which capable to influence on development of plants. Highly likely that these properties are conditioned by high level of humic substances concentration and by predominance Ca^{2+} in inorganic fraction of water. Further studies in this direction may increase understanding of role of humic substances in natural- and agroecosystems.

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