The Assessment of the Reservoir Water Phytotoxicity

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Abstract. Oil production often leads to territory contamination by reservoir water. Often during the recultivation of oil fields land and water bodies oil pollution is considered more important than negative impacts of reservoir water. Meanwhile spills high salty reservoir oil waters have a greater negative impact on the environment than oil sometimes. In this regard the important task is to determine the extent of their toxic effects for the biological objects. This article provides a comparative assessment of the toxicity of the reservoir waters of the deposit and model waters prepared in accordance to the chemical composition of the produced water. The test-objects were the Lepidium sativum seeds of two species - "Zabava" and "Krupnolistovoi". To determine the toxicity of the environment such parameters as seed germination, length and average dry weight of seedlings were considered. The conducted experiments show good responsiveness of both species of Lepidium sativum and usability to the toxicity assess of produced oil waters. The obtained data testify to the acute toxicity of the produced water. The study results analysis shows the need to take into account the toxic properties of the reservoir waters that can get into the water and soil with oil during the development of water resources and land restore measures.

1. Introduction
There is a new basic version of the forecast of the Ministry of Economic Development of Russian Federation which tells that oil production will increase to 553 million tons per year in 2018-2020 [1]. Such forecast is economically advantageous but there are serious environmental consequences [2, 3]. Recently the negative effect of oil production and transportation is in large-scale environmental pollution [4-7]. There are a great number of publications about analysis of such pollution and about the remediation of contaminated soils [8-13]. It is important to consider not only oil contamination, but also pollution by reservoir water which has high mineralization and can change environment [14].

2. Practical part
The aim of the work was to study the phytotoxicity of reservoir waters and model waters, prepared in accordance with their chemical composition. The test-object was the Lepidium sativum of species "Zabava" and "Krupnolistovoi". Lepidium sativum is unpretentious and sensitive to many toxicants [15, 16].

The composition of the model water is given in the Table 1.
Table 1. The composition of model water.

| Components           | Quantity (mg/kg) |
|----------------------|------------------|
| Sodium chloride      | 86000            |
| Calcium chloride     | 10500            |
| Magnesium chloride   | 5200             |
| Sodium sulphate      | 4000             |
| Sodium bicarbonate   | 400              |

For the comparative assessment of phytotoxicity of reservoir waters the certified method PND F T 14.1: 2: 4.19-2013 [17] was used. The experiment was carried in the laboratory conditions. 30 seeds of Lepidium sativum were placed on the filter paper in the Petri dishes. Then a number of the following dilutions of reservoir water were prepared: 1:2, 1:4, 1:8, 1:16 and 1:32. Distilled water was used for dilution and as a control medium. Each dilution and control medium were made in three replicates.

The experimental medium with a model salt solution corresponding to the composition of the reservoir waters were prepared analogously. The equal amount of native medium and prepared dilutions were added to each dish. Seed germination (%), average length (mm) and average dry weight (mg) of seedling were measured on the seventh day after sowing.

The statistical analysis of data was carried out using the program "Statistica 5.0 for Windows" [17].

3. The experimental results

Seeds of both species of Lepidium sativum began to rise at the eightfold dilution. This indicates acute toxicity of the analyzed medium. The seed germination in the model water exceeds the value of germination in the reservoir water of the oil deposit and varies between 85-98.9% and 53-91% for the species "Zabava", as well as 94-99% and 87.8-95.6% for the species "Krupnolistovoi", respectively.

The values of the average length of the seedling are shown in Table 2. The length of the seedlings of both species increases with the decrease of the concentration of reservoir waters in the medium.

Table 2. Average length of the seedlings (mm).

| Dilution        | «Zabava» |                  | «Krupnolistovoi» |                  |
|-----------------|----------|------------------|------------------|------------------|
|                 | Model water | Water from oil field | Model water | Water from oil field |
| Undiluted medium| 0        | 0                | 0                | 0                |
| 1:2             | 0        | 0                | 0                | 0                |
| 1:4             | 0        | 0                | 0                | 0                |
| 1:8             | 20.9     | 13.26            | 38.76            | 35.95            |
| 1:16            | 75.1     | 68.3             | 67.38            | 88.41            |
| 1:32            | 81.93    | 84.8             | 80.71            | 107.4            |
| Control         | 91.9     |                  | 104.6            |                  |

The total length of seedlings of Lepidium sativum "Zabava" in 8-fold and 16-fold dilution exceeds the total length of seedlings in water from oil production by 7.3% and 6.8%, respectively. The length of seedlings in the reservoir water exceed the length in the model water by 2.87% in 32-fold dilution. For the "Krupnolistovoi" the length of seedlings in the reservoir water exceeds the length in the model water by 23-24% for 4, 16, 32-fold dilution. This dependence can be explained by the different adaptability of varieties to environmental factors.

The values of the average weight of the dry seedlings are shown in Table 3.
Table 3. Average weight of dry seedlings (mg).

| Dilution | «Zabava» | «Krupnolistovoi» |
|----------|----------|-----------------|
|          | Model water | Water from oil field | Model water | Water from oil field |
| Undiluted medium | 0 | 0 | 0 | 0 |
| 1:2      | 0 | 0 | 0 | 0 |
| 1:4      | 0 | 0 | 0 | 0 |
| 1:8      | 1.08 | 1.22 | 1.40 | 1.55 |
| 1:16     | 1.49 | 1.38 | 1.75 | 1.48 |
| 1:32     | 1.72 | 0.90 | 1.57 | 1.44 |
| Control  | 1.39 | 1.41 |

The average weight of dry seedlings of the species "Zabava" in 16-fold dilution and in 32-fold dilution in model water is greater than in water from oil production, in 8-fold dilution the results are reversed. The average weight of the dry seedlings of the species "Krupnolistovoi" with model water is less than in the medium with water from oil production in 8-fold dilution. In other cases the dependence is inverse.

The *Lepidium sativum* of the species "Zabava" showed the greatest responsiveness in model water, which is confirmed by a reliable correlation coefficient of all analyzed parameters (Table 4).

Table 4. The dependence of the analyzed parameters on the dilution multiplicity.

| Analyzed parameters | «Zabava» | «Krupnolistovoi» |
|---------------------|----------|-----------------|
| Germination of seeds (%) | Y=85.017+0.486X | Y=51.133+1.389X |
| Average length of seedlings (mm) | Y=17.471+2.241X | Y=4.999+2.702X |
| Average dry weight of seedlings (mg) | Y=0.968+0.025X |

* Values of correlation coefficients are reliable for P> 0.95

Y - is the analyzed parameter;
X - is the dilution multiplicity.

The most sensitive parameter is the average length of the seedlings for both species of *Lepidium sativum* (Table 4). So it is recommended to use this parameter for the toxicity analysis.

The safe dilution multiplicity was calculated to compare the toxicity of model water and reservoir water. This is the dilution multiplicity in which the analyzed parameter is equal to the value of the control medium.

4. Summary

Comparison of the safe dilution multiplicity of model water and water from oil field which were made by the regression analysis showed that the model medium is more toxic than water taken from the oil field for both varieties of *Lepidium sativum*. This can be explained by the presence of organic substances (petroleum hydrocarbons) contained in the reservoir water of oil deposits. Small quantities of petroleum hydrocarbons are the source of nutrients for plants [18].
The experiments show the good responsiveness of the watercress of both varieties and its suitability for the toxicity analysis of the reservoir waters. The obtained results tell about acute toxicity of reservoir waters. It is important to analyze the toxic properties of reservoir waters that can pollute the environment during ecological monitoring and remediation of water and soil resources.

5. References

[1] Letter of the Ministry of Economic Development of the Russian Federation 26 of April, 2017 D14i-917 About the forecast of the social and economic development of the Russian Federation for 2018 and for the planning period 2019 and 2020

[2] Shulaeve N S, Bykovsky N A, Pryanichnikova V V and Kadyrov R R 2015 Fundamental and Applied Research in the Technical Sciences in Conditions of Transition of Enterprises to Import Substitution: Problems and Solutions: works of the All-Russian Scientific and Technical Conf. with Intern Participation (Sterlitamak: USPTU) 453-455

[3] Gritsenko A I, Akopov G S, Maksimov V M 2007 Ecology. Oil and gas (Moscow: Science) 598

[4] Pryanichnikova V V, Shulaeve N S, Kadyrov R R and Bykovsky N A 2016 Modern technologies in oil and gas business: Collection of proceedings of the Int. Scientific and Conf. on the 60th anniversary of the branch (Oktyabrska: USPTU) 275-278

[5] Seifert D V and Gamerova L M 2013 The Bashkirskiy chemical J. Vol. 20 1 79-83

[6] Ovsyannikova I V 2016 Education and science in modern conditions: Collection of materials of the Intra-University Scientific and Practical Conf. (Sterlitamak: USPTU) 85-88

[7] Daminiev R R, Asfandiyarova L R, Yunusova G V, Panchenko A A and Ovsyannikova I V 2017 Oil and Gas vol 15 1 236-240

[8] Ovsyannikova I V 2016 Education and science in modern conditions: materials of the Intra-University scientific-practical conf. (Sterlitamak: USPTU) 82-85

[9] Pryanichnikova V V, Shulaeve N S, Bykovsky N A and Kadyrov R R 2016 Successes of modern natural science 2 193-197

[10] Ovsyannikova I V 2016 Education and science in modern conditions: materials of the Intra-University Scientific and Practical Conf. (Sterlitamak: USPTU) 85-88

[11] Grigoriadi A S, Kireeva N A, Gareeva A R, Shchemelinina T N and Atepaeva O S 2011 Vestnik of the Bashkir University vol 16 4 1214-1218

[12] Gareeva E F 2018 Gas Industry 2 66-72

[13] Shulaeve N S, Pryanichnikova V V, Kadyrov R R, Bykovsky N A 2016 Butlerov Communications Vol. 47 8 133-138

[14] Boguslavskaya N V 2009 Environmental safety in the agroindustrial complex. Abstract J. 2 377

[15] Seifert D V, Khairullin R M, Oparina F R and Ovsyannikova I V 2015 Ecology and safety of vital activity of industrial-transport complexes: Works of the Fifth Int. Ecological Congress (the 7th Int. Scientific and Technical Conf.) (Samara: Samara Science Center of the RSA) 174-178

[16] Ovsyannikova I V, Khayrullin R M 2015 Protection of the environment from ecotoxicants: Collection of proceedings of the II Int. Scientific and Technical Conf. (Ufa: USPTU) 49-51

[17] PND F T 14.1: 2: 4.19-2013 Methods for determining the toxicity of drinking, ground, surface and sewage, chemical solutions by measuring the germination, average length and average dry weight of seedlings of cress-salad seeds (Lepidium sativum)

[18] Pryanichnikova V V, Shulaeve N S, Kadyrov R R and Fanakova N N 2017 Safety in the technosphere Vol. 6 1 25-30

[19] Pryanichnikova V V, Shulaeve N S, Bykovsky N A and Kadyrov R R 2016 Butlerov Communications Vol. 47 7 47-51

[20] Pryanichnikova V V, Shulaeve N S, Bykovsky N A and Kadyrov R R 2017 Key Engineering Materials 743 314-318