Influence of Various Concentration of Aral Sea Salt on Germination of Seeds and Morphometric Characteristics of Agricultural Groups

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Abstract*— *This article presents the results of studies of the chemical composition of the salt of the Small Aral Sea and their phytotoxicity for agricultural crops. The high toxicity of salts with a high content of chloride ions is established. They cause changes in the morphometric parameters of plants. The tested plant species differ in their response to the action of high concentrations of salts.
Keywords*— *sea salt, phytotoxicity, morphometric parameters, chloride ions.

I. INTRODUCTION

The ecological disaster of the Aral Sea remains the main negative factor for the ecosystems of Central Asia. At the bottom of the dried sea formed a new desert that is called Aralkum. It consist a mixture of sand and salt. Intensive dust storms carry this mixture to the depth of the mainland to 300 km and lead to gradual degradation of historically formed phytocenoses [1]. Already irretrievably destroyed many natural plant communities and more than 2 million hectares of arable land have become unsuitable for agricultural purposes. The reason for this process is a gradual increase in soil salinity in the coastal zone of the Aral Sea. Sea salt is heterogeneous in its chemical composition in various parts of the dried bottom. Its main part is represented by chloride and sulphide compounds, which also contain other toxic substances and pesticides. These toxicants came to the sea with surface wastewater from the vast agricultural lands of the Central Asian republics of the former Soviet Union. Therefore, large reserves of sea salt remain a source of environmental pollution on a hugeterritory.

At present, the dried up Aral Sea is divided into northern and southern parts. The Northern Aral is located on the territory of the Republic of Kazakhstan. Therefore, the salvation of the Northern Aral Sea and restoration of phytocenoses of coastal areas is the main task of the Republic of Kazakhstan [2,3].Restoring the plant communities of the shoreline will serve as a natural barrier to the onset of sand, and help reduce the spread of salt. Many research projects of recent years are devoted to solving this problem. Scientists are carrying out studies to study the salt tolerance of both traditional and completely new crops and wild-growing species for the region. Using the salt-tolerant crops can facilitate the return of lost land to agricultural use and improve the socio-economic situation in the region. And the identification of salt-tolerant species of wild vegetation makes it possible to hope to restore a degraded terrestrial ecosystem. In this regard, the study of the reaction of some crops on the effect of different samples of the salt of the Aral Sea has become the goal of our studies.

II. MATERIALS AND METHODS OF RESEARCH

The materials of the study were 13 samples of the salt of the dried bottom of the Small Aral Sea, which differ from each other in the specific gravity of the chloride ions. The tested plant species were *Medicago sativa* L., Amaranthus tricolor L. and *Festucapratensis* Huds. In case of successful results, these species can be used in forage production. A substrate for experiments used vermiculite. The experiment was carried out at a temperature of 22-23 oC.and with an illumination of 2500 lux. Plant seeds were sown to a depth of 2-3 cm. 1%, 5%, 10% saline solutions of 13 test salt samples were used as irrigation. Observations started from the 5th day of the experiments.

During the experiments we took the counts of influence of the concentration of salts on the germination of seeds and the morphometric indices of the plants.

In determining the chemical composition of salt were used standard methods of chemical analysis of sea water (Manual on methods for the chemical analysis of sea water, 1977) [4]. In addition to analytical methods for determining the main components of the salt composition, control measurements were made on an ion chromatograph. The concentrations of potassium and sodium ions were determined by ion-selective and chromatographic methods, as well as by the method of flame photometry [5-7].

Definitions of the relative electrical conductivity were carried out on a high-precision salt generator of the 601 MK III model produced by the Japanese company WATANABE KEIKI MFG. CO., LTD (an analogue of the Australian salt maker from YEO-KAL ELECTRONICS PTY LTD). For thermo stating the samples, a water precision thermostat TVP-6 from the Alma-Ata Experimental Factory "Etalon" was used with a working temperature range of -10 to 95 ° C. The measurements were carried out at temperatures of 15, 20, 25, 30, and 34 ° C.

III. RESULTS AND DISCUSSION

The results of analyzes of the chemical composition of the salts showed that all 13 samples from the Lesser Aral Sea belong to chloride salts. In 11 of these samples (samples No. 2,3,4,5,6,8,9,10,11,12,13), the specific total NaCl is 77.9 ± 4.4%, sodium sulfate (Na_2SO_4) 1 , 7500 ± 0.002%, insoluble residues 0.11 ± 0.001%. Other macro- and microelements is 20.24 ± 0.3%. The chemical composition of the other two samples (No.1 and No.7) turned out to be slightly different: NaCl - 97.9 ± 1.5%, sodium sulfate (Na_2SO_4) -0.7800 ± 0.001%, insoluble residues - 0.12 ± 0.001% and the share of other macro- and microelements is 1.2 ± 0.001%.A study of the toxicity of these salt samples for the tested plant species showed that the first 11 of them, with a lower content of chloride ions, are less aggressive than the last two. Their 1% concentration had a stimulating effect on the germination of plant seeds, the seed germination of all three plant species was within 85.5 ± 2.6% -96.52.8% (control parameter: 81.5 ± 3.1% - 94.3 ± 3.3%). However, an increase in the salt concentration to 5% led to a sharp decrease in the germination of seeds. In addition, inhibition of growth processes led to an extension of the plant germination period by 15 days compared to control and trial versions with 1% salt concentration. The seed germination rate was 18.9 ± 0.65% -32.4 ± 1.11%. At 10% concentration of seedlings, the test cultures were not observed. The results of other experiments showed that samples of salt No.1 and No.7 differ the most potent phytotoxicity. In our experiments, their 1% concentration strongly inhibited the growth processes of the seeds of *F. pratensis* Huds. Seed germination was only 15.5 ± 0.01%, while the control variant was 83.6 ± 3.8%. With an increase in the salt concentration to 5%, seed germination decreased to 1.3 ± 0.01%, and at 10% concentration the seed germination was completely absent. It should be noted that *M. sativa* L. and *A. tricolor* L. compare to *F. Pratensis* Huds. were the most sensitive. In this experiment the seed germination of these species at 1% salt concentration did not exceed 1.5 ± 0.001%, and at 2% concentration was absent completely. In general, analysis of the results of these experiments showed that the most phytotoxic samples are salts with an increased content of chloride ions, which is consistent with the results of early studies. From literature sources it is known that chloride salts are more aggressive ions in the composition of sea salt, while sulfate is less harmful [8].The lesser toxicity of sulphate salinity is in particular due to the fact that unlike the Cl ion, the $S0_4$ ion is required in small amounts for normal mineral nutrition of plants, and only its excess is harmful [8]. The effect of salinization on plant organisms is associated with two causes: a deterioration of the water balance and a toxic effect of high concentrations. Salinization leads to the creation in the soil of low water potential, while the flow of water into the plant is difficult. Under the influence of salts, the functions of all ultra-structural elements of cells occur. This is particularly pronounced in chloride salinity [9]. All chloride ions are toxic. Cl- ions are bound to hypothetical salts in the sequence: NaCl, $MgCl_2$, $CaCl_2$. They also have the greatest migration capacity, which is explained by their good solubility, poorly expressed ability to sorption on suspensions and consumption by aquatic organisms, which explains the nature of their phytotoxicity. Due to the fact that in our experiments the test salt concentrations were close to extreme, the study of the effect of salt toxic effects on the morphometric parameters of plants was carried out only in variants of the experiment with a reduced content of chloride ions and only at 5% concentration. Table 1 shows the results of morphometric studies of plants of F. pratensis Huds., M. sativa L. and A. tricolor L., grown in an experiment with a 5% salt content of the specific gravity of the substrate. In this experiment the salts of sample No. 5 were used. It was found that the 5% salt concentration of this sample affects the variability of the morphometric parameters of the studied plant species in different ways. The least changes in comparison with the control variant were found in F. pratensis Huds. His morphometric indicators were practically at the level of the control variant. While M. sativa L. and A. tricolor L., the length of the roots, stems, number and area of the leaves, compared to the control variant, underwent significant changes. Thus, the root length of M. sativa L. and A. tricolor L. was 8.9 ± 0.34 cm -12.3 ± 0.54 cm, and the length of the stems was 14.6 ± 1.0 cm -17.3 ± 1.1cm shorter than the control. Similar changes in the direction of decrease were established for the number of leaves and the total area of leaf blades on the plant.

Table.1: Mean values ±SD (n-5-6) of root and stem length, leaf number and total leaf area of FestucapratensisHuds.,MedicagosativaL. and AmaranthustricolorL.grown at 5% salt in the soil (salt sample №5).

Plant species	Root length [cm]	Stem length [cm]	Leaf number	Leaf area, [cm^2]
Festuca pratensis Huds.				
Control	38±2,13	59,6±2,81	7,3±0,11	45,9±2,30
5% 5% concentration of salt	36,6±2,11	58,6±2,15	7,2±1,11	44,3±2,10
Medicago sativa L.				
Control	39,8±1,19	45,5±2,2	15,8±1,10	115,8±7,21
5% 5% concentration of salt	30,9±1,70	30,9±2,10	9,8±1,00	74,8±1,11
Amaranthus tricolor L.				
Control	27,9±0,12	34,8±1,14	8,7±0,12	136,7±4,4
5% concentration of salt	15,6±0,12	17,5±0,14	4,9±0,11	65,7±2,4

The analysis of the results of the conducted studies suggests that the salt accumulations of the dried bottom of the Small Aral Sea are not homogeneous in their chemical composition. There are salt reserves with a moderate and high content of chloride ions. For this reason, they have a different degree of phytotoxicity. Within the limits of the 13 salt samples studied by us, the specific gravity of chloride ions varies within the limits of 77.9 ± 4.4% -97.9 ± 1.5%. The most phytotoxic are samples of salt with a high content of chloride ions, 1% of their concentration causes a strong inhibition of growth processes in the studied plant species. The toxic effect of sea salt ions negatively affects the morphometric indices of *F. pratensis* Huds.,*M. sativa* L. and *A. tricolor* L. The last two species of plants studied showed a more sensitive reaction to the effect of 5% salt concentration compared to *F. pratensis* Huds. Identified species of plants with the reaction of resistance and sensitivity in salt stress are of practical interest for studying the molecular mechanisms of salt tolerance in plants.

REFERENCES

[1] Davletov S.R. The problem of the Aral Sea and the Aral Sea region: yesterday and today // Young scientist. — 2014. — №2. — C. 634-636.
[2] .Hydrobiology of the Aral Sea. Edited by Nikolay V. Aladin et al. Dying and Dead Seas: Climatic vs. Anthropic Causes. NATO Science Series IV: Earth and Environmental Sciences. Vol. 36.Kluwer, 2004.
[3] The Aral Sea Disaster. Philip Micklin in Annual Review of Earth and Planetary Sciences.Vol. 35, pages 47–72; 2007.
[4] Sparrows N.I..Application of the conductivity measurement for characterizing the chemical composition of natural waters. - Moscow: 1963. - 144 pp.
[5] Midgley D., Torrence K., "Potentiometric analysis of water", Mir, 1980. -235 p.
[6] Kamman K. "Working with ion-selective electrodes", Mir, 1980. - 180c.
[7] Shapovalova EN, Pirogov AV Chromatographic methods analysis.M .: - 2007. - 109s.
[8] Plant L. Nitrate reductaseactivity of wheat seedlings during exposure to and recovery from water stress and salinity. Physiol, plant., 1974, v.30, N 3, P» 212-217.
[9] Willert D.J. von, Curdts E., Willerfc K. von.Veränderung der PEP-carboxylase währendeinerdurch Na Clgeförderten Ausbildungeines CAM bei Mesembryanthemum crystallinum. -Biochem. and Physiol. Pflanz., 1977, B.171, N 2, 3.101-107.
[10] Kylin A., Quatrano R.S. Metabolie and biochemical aspects of salt tolerance. In: Plants in saline environments. Ecol. Stud., Berlin etc.: Springern 1975, v.15, p. 147-167.