Environmental condition of saline compact soils of the Central Pre-Caucasian region and its sanitation

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Abstract. The main factors determining the change of the ecological situation in the zone of salinized compact chernozems distribution are the hydrological state, waterlogging, water erosion and the use of chemical crop products. In order to prevent further progress in the degradation of these lands, a number of activities are required. The most important task is to ensure the expanded reproduction of soil fertility. Its solution suggests the systematic application of fertilizers. A great advantage on saline soils should be given to organic fertilizers in order to maintain stocks of humus. The value of humus in their composition increases even more due to the fact that it reduces the possible negative impact on plants of some components of the mineral part of the soil, improves its water-physical properties. Humus limits the leaching of nitrogen caused by uncontrolled mineralization, increases the filtering and buffering effect of the soil and groundwater. In the intensive farming system, a deficit-free humus balance can be observed by combining the use of organic and mineral fertilizers. At the same time, the use of higher doses of them leads to pollution of the soil, plants and the environment. Therefore, the use of fertilizers should be carried out taking into account the biological needs of plants and specific soil conditions. On saline soils, due to a significant reduction in plant growth parameters and the biomass formed by them, the removal of nutrients in the composition of the primary and secondary crop significantly decreases. In addition, they are characterized by relatively high osmotic potential, which may further increase due to the application of higher doses of fertilizers. Therefore, in these conditions, moderate and small doses of mineral fertilizers are effective, and they meet the needs of plants and the interests of the soil ecology.

1. Introduction
Salinization is a property that limits soil fertility and determines their ecological condition. Saline, including saline-halophytic soils occupy about 20% of the agricultural land of Russia. Currently, the process of salinization is considered as one of the main degradation processes that limit soil fertility in drylands in different countries of the world, including Russia.

The accumulation of nutrients in plants decreases during soil salination, that is also the cause of growth inhibition and productivity. Improving the food regime of the soil by applying nitrogen-phosphate fertilizer to saline soil reduces the accumulation of salting ions in plants and stimulates the formation of their growth parameters.
2. Place, program, research method

In the Central Ciscaucasia chernozems are widespread, characterized by high salinity and solonetzicity. They have very unfavorable properties for the growth of cultivated plants. According to the particle size distribution, they are represented by clay soils and the content of the clay fraction in them is more than 65%. These soils are characterized by a high density of $1.40-1.58\text{ g/cm}^3$ at $1.20\text{ g/cm}^3$ for zonal chernozems. They have a high adsorption capacity, which determines the maximum hygroscopicity (13-15%). The amount of moisture inaccessible to plants, leading to a steady wilting in solonetsous soils, ranges from 15 to 19%, whereas on typical chernozem it is 12-13% [1].

The humus content ranges from 4.52 to 7.08%. The reaction environment of the soil is from 6.6 to 8.2. In the food regime, there is also a large variegation - from 13-15 to 38-40 mg/kg of the soil of mobile phosphorus and from 204-222 to 433-484 mg/kg of exchangeable potassium.

The type of salinization in saline soils is represented by chloride-sulphate. The amount of water-soluble salts in various varieties of saline soils at a depth of 0-30 cm reaches 0.08-0.21%, and as a part of the solonchak soil - up to 0.34%.

On these soils there is a slowdown in plant growth, a significant decrease in the quantity of the crop and a deterioration in its quality.

According to the data, one of the methods of increasing the productivity of these soils is the selection and widespread cultivation of salt-resistant crops.

When diagnosing the degree of salt tolerance of cultivated plants, researchers take into account the accumulation of salts from a saline substrate as one of the criteria. Such an approach is of particular interest from the point of view of assessing the possibility of using individual crops in the implementation of phytomelioration of saline lands and the need to develop reclamation crop rotations.

In our studies performed in vegetation experiments, it was found that sunflower (18.8%) and sorghum (19.9%) are characterized by rather high content of mineral salts in the aerial parts during soil salination. At the same time, sunflower plants differed in a higher content of sulfate ion (1.73%), chlorine (0.14%) and sodium (0.86%). The remaining cultures studied by us (winter wheat, winter barley, oats, and corn) did not differ in the accumulation of ash and individual ions, but a noticeable dependence of their concentrations on the degree of salt tolerance of the plants was not observed. The ash content of their tissues ranged from 13.35 to 15.64% at concentrations of sulfate-ion 0.36-0.84%, chlorine - 0.09-0.11%, sodium - 0.22-0.89%.

Comparison of the mineral part of individual crops during their growth on weakly and strongly saline soils showed that in sunflower and sorghum, an increase in the level of salinity is associated with an increase in the total ash content of the tissues by 0.96-3.08%. Such a link was not found in other cultures, and this gives reason to believe that their biological absorption of mineral salts, in comparison with their reserves in the soil, is insignificant and they cannot play a significant role in the phytomelioration of saline lands. At the same time, the accumulation of salting ions is one of the reasons for the inhibition of plant growth on saline soil.

In the zone of distribution of saline compacted chernozem, the main factors determining the change in the ecological situation are the hydrological state of the land, the processes of secondary salinization, waterlogging, water erosion, as well as the use of means of agricultural chemicalization.

In recent years, the rise of the groundwater level is very common here, which is accompanied by the saturation of the upper soil horizons with plant harmful salts, waterlogging and other negative phenomena. They were the result of the introduction into the irrigation of unsuitable lands in salt relations and violations in their operation.

In order to prevent the further progression of the degradation of these lands, a number of activities are required. In places of groundwater rise and already prone to waterlogging, it is advisable to carry out mole plowing followed by deep loosening of the soil. Such land should be subjected to grasslanding by planting perennial grasses (alfalfa, melilot, etc.). Here, as shown by our research, mixed crops of legume-cereal grasses using alfalfa, saline wheatgrass, awnless bromegrass, and others are effective.

On lands with a constant groundwater level and no signs of salinization, irrigation should be such that soil moisture is maintained at the level of optimal natural watering, and irrigation is carried out...
using frontal sprinklers and water consumption rates of more than 350-400 m³ with a soaking depth of 40-50 cm.

The reason for the rise of groundwater with the ensuing consequences in rainfed conditions is the infiltration of water from main canals. Here, cut-off drainage is recommended, as well as anti-filtration lining of the canal bed.

The most important task is to ensure the expanded reproduction of soil fertility. Its solution involves the systematic use of fertilizers. A great advantage on saline soils should be given to organic fertilizers in order to maintain stocks of humus. The value of humus in their composition increases even more due to the fact that it reduces the possible negative impact on plants of some components of the soil mineral part, improves its water-physical properties. Humus limits nitrogen leaching caused by uncontrolled mineralization, increases the filtering and buffering effect of the soil and prevents pollution of the subsoil and groundwater.

In the intensive farming system, a deficit-free humus balance can be observed by combining the use of organic and mineral fertilizers. However, the use of higher doses of them leads to pollution of the soil, plants and the environment. Therefore, the use of fertilizers should be carried out with account of the biological needs of plants and specific soil conditions.

On saline soils, due to a significant reduction in the parameters of plant growth and the biomass they form, the removal of nutrients in the composition of the primary and secondary crops is noticeably reduced. In addition, they are characterized by a relatively high osmotic potential, which may increase further from the introduction of higher doses of fertilizers. Therefore, as shown by the results of our research, moderate and small doses of mineral fertilizers are effective under these conditions and they meet the needs of plants and the soil ecology interests.

High doses of fertilizers here can also cause a greater degree of eutrophication processes, consisting in enriching the water of reservoirs with mineral elements. As a result, there is an increase in non-beneficial productivity of water bodies, the development of coastal thickets and other negative phenomena. This phenomenon can be widely represented in the region due to topographic inequality, poor permeability of the soil, storm character of precipitation and the development of surface runoff.

Due to the specific properties of the compacted soils, which determine the suppression of nitrification processes and the consumption of nitrogen by plants, the doses, methods and timing of nitrogen fertilizers should be based on the content of mineral fertilizers of this element in the soil and the needs of crops in different stages of plant development. In reducing the imbalance of nitrogen in the soil should be more widely practiced cultivation of leguminous crops, carrying out its biological fixation.

The imbalance in phosphorus, which is the most pronounced here, can be reduced not only by fertilizers, but also by adding to the soil residues of plants and manure.

A factor affecting the ecological situation in the region is the widely used phosphogypsum of the soil in the order of their chemical reclamation.

Phosphogypsum, as is known, contains 0.10-0.15% of the element of fluorine, which can be dangerous to humans and animals if it accumulates in the crop. Studies conducted by university staff show that the doses of phosphogypsum used do not lead to the accumulation of fluorine in the crop above the permissible limits. However, this question, as we see it, needs more in-depth research in order to clarify the fluorine cycle in the system soil-plant-animal organism.

In order to prevent possible environmental degradation, phosphogypsum should be carried out no more than once during the crop rotation (8-10 years). With such a use of it with the improver, fluorine may be introduced into the soil many times less than with annually introduced mineral fertilizers.

The preservation of the ecological balance in the soil and crops is achieved by the formation of agrophytocenoses with a certain ratio of biological groups of plants with sufficient salt tolerance.

At present, on the saline soils in the Central Ciscaucasia, in the structure of cropland acres, cereal grains occupy 50% and more, and fodder crops - up to 30%, including perennial grasses within 8-10%.

In connection with the deterioration of the soil cover, it becomes necessary to change the structure of crops.
It is advisable to reduce the seeding of grain crops to 40-45%, with a simultaneous increase in the proportion of salt-resistant crops such as winter barley and oats. It is necessary to increase the seeding of forage crops to 37-40%, including perennial grasses to 20%, mainly due to the grassing down of lands with a deteriorated state. As a result, the total plowing of land will decrease to 50-53%, instead of the current 60-62%.

A prerequisite for environmentally safe farming is the introduction of crop rotations. They must ensure the manufacturing of the necessary plant products, increase soil fertility and environmental safety of production.

Taking into account the proposed changes in the structure of the crop areas, the following crop rotation pattern can be adopted as one of the variants: 1. Fallow; 2. Winter wheat; 3. Winter barley; 4. Pea; 5. Winter wheat; 6. Oat; 7. Corn, sorghum; 8. Winter wheat; 9. Sunflower.

Due to the expansion of intensive crop cultivation technologies, the pesticide load on crops has noticeably increased. Often their use is not justified, due to the fact that they are provided by technology and without taking into account the degree of the pest and diseases spread.

The basis of weed control should be rotations that allow using herbicides with the help of agrotechnical techniques.

3. Conclusions
The technology of individual crops cultivation on saline soils that we offer provides, depending on the specific conditions, a slight increase in the multiplicity of treatments for preparing the soil for planting and caring for plants, which, in combination with other agricultural practices, can reduce or completely eliminate the need to use chemicals. Improving the food regime of the soil by applying nitrogen-phosphate fertilizer to saline soil reduces the accumulation of salting ions in plants and stimulates the formation of their growth parameters.

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