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PROVISION OF REMOTE SENSING METHODS FOR SOIL SALINITY ASSESSMENT ON RECLAIMED LAND

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ABSTRACT

The main goal of the study is to develop methods for assessing soil salinity in reclamation lands, based on the amount of salt ions in the leaves of cotton in the Amu Darya basin. In this research work, an analysis based on the hypothesis of a long-term continuation of the development of climate impacts has been made to date.
Keywords: cotton leaf; irrigated fields; saline soils; mathematical model; nutrients; salts; water; plant; root; soil moisture; soil-reclamation conditions.

ANNOTATSIYA

Tadqiqotning asosiy maqsadi Amudaryo havzasidagi g'o'za bargidagi tuz ionlari miqdoridan kelib chiqib, meliorativ yerlarda tuproq sho'rlanishini baholash usullarini ishlab chiqishdan iborat. Ushbu tadqiqot ishida hozirgi kunga qadar iqlim ta'sirining rivojlanishining uzoq muddatli davom etishi gipotezasiga asoslangan tahlil o'tkazilgan.
Kalit so'zlar: paxta bargi; sug'oriladigan dalalar; sho'rlangan tuproqlar; matematik model; ozuqa moddalari; tuzlar; suv; o'simlik; ildiz; tuproq namligi; tuproq-meliorativ sharoitlar.

АННОТАЦИЯ

Основная цель исследования – разработка методов оценки засоленности почв мелиоративных земель по количеству ионов солей в листьях хлопчатника в бассейне Амударьи. В данной исследовательской работе к настоящему времени проведен анализ, основанный на гипотезе долгосрочного продолжения развития климатических воздействий.
Ключевые слова: хлопковый лист; орошаемые поля; засоленные почвы; математическая модель; питательные вещества; соли; вода; растение; корень; влажность почвы; почвенно-мелиоративные условия.

1. Introduction

Agricultural production is the main source of sustainable development of the agro-industrial complex and the entire economy. However, a range of conditions such as climate change, a decrease in water resources, deterioration of their quality, and other conditions lead to soil degradation and a decrease in its fertility. Changing climatic conditions is a powerful factor that changes not only the soil cover and reclamation indicators (salinity, waterlogging, etc.), but also the productivity of the environment: vegetation cover, ecological balance of the region, crop yields, etc. [1]

In this regard, for irrigated farming, it is necessary to regularly obtain objective and reliable information about the variability of soil and vegetation cover: their features, the distribution of degraded areas, salinity spotting and the assessment of the yield of a particular field. Without timely objective information, it is impossible to assess, manage and forecast the further development of reclamation indicators (salinity and soil fertility). Moreover, a scientifically based assessment of the effectiveness of the use of irrigated lands and the further development of water-reclamation measures to improve them are also impossible. [2]

Highly knowledge-intensive, laborious and time-consuming method of acquiring information on the state of soils in the time interval, combined with low reliability of land information by existing traditional methods does not allow to quickly evaluate the efficiency of use and degradation processes of irrigated lands.[4]

2. Materials and Methods

2.1 Reclamation classification of saline soils.

Research methodology. Proceeding from the set goal, the general methodology of work is based on theoretical and experimental studies using the methods of probability theory and mathematical statistics to study the effect of spotting salinity of fields on crop yields (cotton).

The study was conducted on a new zone of the Hungry Steppe, (cotton variety "Sultan") farms in the Khorezm region. Collection and analysis of fund materials:To increase the reliability of assessing the degree of soil salinity from aerospace photographs at the first stage of research, the natural reclamation conditions of the area under study and data on the agricultural use of irrigated lands are studied in detail, based on:

- soil and agricultural maps;
- maps of salt surveys performed in previous years;
- all points of salt sampling and salt content at the time of shooting (the sum of toxic salts, prevailing anions and cations) should be shown on these maps;
- cartograms for nutrients;
- information about the reclamation state of the studied objects, the species composition and productivity of the main crops.

When forming a model, we take at the beginning that the intake of nutrients, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, salt ions, chlorine and sodium.

2.2 Conducting field experiments

Field experiments were carried out in accordance with the methods of “Methodology of State variety testing of agricultural crops”, “Methods of agrochemical, agrophysical and microbiological studies in irrigated cotton areas”, “Methodology of field experiments with cotton”. Statistical processing of experimental data was conducted according to the method of B. D.Dospekhov [4; 3] using MicrosoftExcel.

We assume that the absorption of nutrients by plant roots follows the Michaelis-Menten law, which relates concentration to the flow inside the root - this is the movement of nutrients through the soil and roots in the convective flow of water caused by the absorption of water by the plant, i.e. evapotranspiration with a leaf of a plant.[9]

Reconnaissance survey of the territory of the studied object and selection of key sites: The task of reconnaissance surveys is to visually assess the degree of soil salinity by indirect signs: the state of crops, the presence of plant fallout spots, salt efflorescence, etc.

The area of each crop rotation field is taken as the main unit for a reconnaissance survey, if the territory of several farms, district or region is subject to reconnaissance survey, then a route reconnaissance survey of the territory is given, while only the crop rotation field is taken as a survey unit.

When conducting reconnaissance surveys, plans of the territory of the economy and agricultural maps on a scale of 1: 10000 or 1: 25000 are used as a basis.

A reconnaissance survey is carried out in the fall (August-September) for remote shooting next year.

The results of the reconnaissance survey are recorded in the field book.

Based on the materials of the reconnaissance survey, a salinity cartogram is compiled, highlighting the saline contours; slightly saline, moderately saline and highly saline lands.

Based on the analysis of reconnaissance survey materials with the involvement of other available materials on the characteristics of the soil cover, the number and location of key areas is determined for identifying deciphering signs of soil salinity.[5]

However, the Michaelis-Menten law considers the simultaneous effect of diffusion and mass flow, supplying nutrients to the root surface. This is described by the following equation:

$$J_y = D_e \frac{\partial C_s}{J y} + V_0 C_i \quad (1)$$

where J_y flow to the root; D_e effective diffusion coefficient; y radial distance from the axis of the cylinder i.e. to the root hair; C_s the concentration of ions in the solid phase of the soil, which, during irrigation, is easily balanced with the concentration of ions in the pore solution (C_i); V_0 water flow rate to the root. [9]

To preserve the solute and due to the decrease in area with a drop

$$\frac{\partial 2\pi r J_r}{\partial r} = \frac{\partial 2\pi r \partial C_s}{\partial t} \quad (2)$$

Adding equations 1 and 2, we obtain:

$$\frac{\partial(\frac{rD_e \partial C_s}{\partial r} + r v_0 C_l)}{\partial r} = \frac{r \partial C_s}{\partial t} \quad (3)$$

Using dependency of ∂Cs = dClb (т. е. b = dCs/dC_l) and $r_0 v_0 = r\upsilon$ as r_0 to convert Cs and C_l we obtain:

$$\frac{1}{r}\frac{\partial}{\partial r}\left(\frac{\partial 2\pi r \partial C_s}{\partial t} + r_0 v_0 C_l\right) = \frac{\partial C_l b}{\partial t} \quad (4)$$

This dependence can be simplified to

$$\frac{\partial C_l}{\partial t} = \frac{1}{r}\frac{\partial}{\partial r}\left(rD_e \frac{\partial C_l b}{\partial r} + \frac{r_0 v_0 C_l}{b}\right), \quad (5)$$

where r_0 is the root radius.

Given certain boundary conditions, this continuity equation can be used to calculate the temporal changes in the concentration gradient in the radial direction from the root. In turn, this makes it possible to calculate the changes in time of C_l and the concentration in the vapor solution at the root surface.

2.3 Atmosphere of ions in the process of absorption by plant roots

If more than one nutrient is present in the pore solution, the uptake rate of one ion is determined by direct crosslinking of anions and cations for common uptake sites, or other second ion processes may be uptake dependent. Ion competition was studied in experiments with detached roots. Absorption of many ions increased in the presence of calcium. When studying ion competition, based on the hypothesis that ions are transported through the plasma using separate carriers, it is possible to determine which ions are absorbed by the same carrier and which ions do not compete in the same areas. The results of such studies show that H, K, NH4, Rb and Cs compete for the same carrier. Among divalent cations, competition for the same carrier is observed between Ca, Sr, and Ba.

Some ions that have similar sizes (along the atomic radius) and the same charge can be poorly distinguished by plants, and then the competition between such ions in the absorption process will be significant, and selectivity may not be observed. These ions include K+ and Rb+, Ca2+ and Sr2+, Cl‾ and Br‾, SO24‾ and SeO24‾. However, one of the ions in each of these pairs usually does not play an important role in plant nutrition and is present in the soil only in small amounts. Therefore, in these cases, the competing effect is of academic rather than practical interest.

3.Result and Discussion

In order to use Equation 5 to describe a concentration gradient directed perpendicular to the root, it is necessary to determine the initial condition and two boundary conditions. The initial condition is simply C_l i = C_l 0 as t - 0, i.e., a homogenous distribution of the nutrient near the root.

The internal boundary condition on the root surface, when $r = r_0$, can be formulated by assuming that the absorption follows the Michaelis – Menten kinetics, so

$$J_r = \frac{l_{max} \cdot C_l}{K_m + C_l} - E$$

$$r = r_0,\ t > 0 \quad (6)$$

If we now substitute the value of J_r from the equation and use the relation bC_l = Cs, we obtain

$$D_e b \frac{\partial C_l}{\partial r} + v_0 C_l = \frac{k_1 C_l}{1 + k_1 C_1 / 1_{max}} - E, r = r_0, t > 0 \quad (7)$$

In Equation 8, Cl can be replaced with Cl - C_{min}, dropping E, so that C_{min} is used instead of E. Now Equation 8 describes the inner boundary.

Assuming that the roots do not compete for nutrients, the outer boundary, r_l becomes constant:

$$C_l = C_l \text{ t } r = r_l, t > 0 \quad (8)$$

If the concentration gradients directed from neighboring roots really overlap, the external boundary condition is Jr = 0 for $r = r_l$ t> 0.

Barber and Cushman described a method for solving this equation in the form of finite differences using the numerical Crank-Nicolson method.[6]

The solution of this equation allows us to describe the time variation of the inward flow on the root surface. When part of the nutrients comes from diffusion, the basal concentration decreases as they are absorbed. In turn, a decrease in the concentration at r0 leads to a gradual decrease in the flow inside. Under these conditions, the total absorption can be determined by summing the inward flow over time; this approach is valid for a non-growing root. Usually, in the case of annual plants, development begins with seed, and new roots are constantly formed in the plant. The absorption of nutrients by each new root begins at a correspondingly later point in time during the growing season. The initial absorption by the roots of the plant can be described by the expression

$$\int_0^{t_m} J_r(r_0, S) dS$$

$$T = 2\pi r_0 L_0 \quad (9)$$

where T — total absorption over time tm; L_0 — initial root length; Jr (r_0, S) — flow inward on the root surface S.

Inserting a parameter characterizing root growth into this expression, we obtain

$$\int_0^{t_m} J_r(r_0, S) dS + 2\pi r_0 \int_0^{m} \frac{df}{dt} \int_0^{t_m^{-t}} J_r (r_0, S) dS dt, \quad (10)$$

$$T = 2\pi r_0 L_0 \quad (10)$$

where $\frac{df}{dt}$ root growth rate.

The solution of equation 11 allows to calculate the absorption of nutrients by the roots of plants growing in homogeneous soil systems.

Table-2. Results of phenological observations at the end of the growing season

№ p / p points	The amount of toxic salts,%	Density of standing of cotton, pcs. per running meter	Number of sympodial branches, pcs.	Number of boxes, pcs	Number of flower buds, ovaries	Main stem height, cm	Raw weight of the whole plant, gr.	Fresh weight of leaves, gr.	Raw weight of die cuts, gr.
101	-	12	15	13	4	84	435,72	100,23	2,58
103	0,434	15	13	9	3	82	354,47	82,45	2,87
105	0,323	18	14	6	8	100	282,34	78,99	3,19
107	0,575	17	9	8	1	60	88,74	45,23	2,53
109	-	20	9	4	2	53	136,32	35,78	3,16
111	0,520	16	12	7	2	70	203,59	43,16	2,72
113	0,371	17	14	7	6	112	391,28	108,00	1,91
115	0,371	22	13	11	3	90	356,61	80,26	2,23
117	0,301	22	11	4	2	92	197,18	49,18	2,26
119	0,223	12	13	6	2	91	248,53	60,75	2,01
91	-	25	10	9	3	80	362,07	84,19	2,00
93	-	-	10	6	2	84	251,56	55,19	2,39
95	-	-	10	8	1	77	281,8	48,9	1,79
97	-	-	11	3	5	78	202,52	59,67	2,00
99	-	-	8	7	2	80	261,94	50,74	2,38
072	0,396	26	12	15	3	76	569,28	130,43	2,51

074	0,299	13	14	11	-	112	505,80	161,62	2,40
076	0,154	20	10	3	6	96	265,71	166,71	2,58
078	0,396	4	12	12	-	106	445,89	94,2	2,45
079	0,363	17	10	4	4	104	214,31	148,20	2,18
081	0,344	28	18	20	17	97	991,01	182,50	3,17
083	0,323	33	13	5	3	90	282,23	83,12	2,85
085	0,382	32	15	10	4	95	441,15	102,53	3,16
087	0,485	37	13	11	10	100	657,46	126,30	3,16
089	0,287	30	12	10	6	103	498,39	135,68	3,12
0161	0,567	7	10	12	1	54	226,48	72,08	3,00
0162	0,686	7	9	9	-	50	217,44	62,70	3,16

[Источник] Source: Compiled by the authors.

According to the forecast analysis, in the period up to 2050, low-salinity irrigated lands will account for 54.6%, in 2050-2100 - 53.2%, highly saline soils - 13.6% and 14%, respectively, moderately saline soils. , 31.8% and 32.8%, respectively. Homogeneous test results showed similar changes. In particular, 55.4% of slightly saline soils in 2020-2050, 52.4% in 2050-2100, 13.4% and 15.1% of highly saline irrigated lands, 31.2% of moderately saline soils and 31.2%. , correspondingly 5%. According to the results, the T test showed the largest changes, and according to the forecast results, slightly saline irrigated soils will account for 52.3% in 2020-2050, and 49.4% by 2100. high-salinity irrigated lands are 14.3% and 16%, respectively, and moderately saline soils are 33.4% and 34.6%, respectively. When the measures set out in the State Program to improve the reclamation of irrigated lands are fully implemented, it will be possible to keep 60% of slightly saline irrigated lands unchanged. High salinity irrigated areas are expected to decrease. In particular, the analysis revealed that by 2050 the area of saline soils will be 11.4%, and by 2100 - 10.3%. The average salinity of irrigated land is projected to be 28.5% by 2050 and 26.4% by 2100.

4. Conclusion

Calculations for the management of water, thermal and nutrient regimes in irrigated fields is a very important component in solving practical problems. Such calculations based on statistic or mathematical modeling methods can be applied only if the regularity of the movement of nutrients in salts, water, and heat from the environment to the plant is known. In order to study stated processes in different soil-reclamation conditions, we have laid down field experiments on cotton fields at selected reference sites Khorezm regions. According to the results obtained, the depth of the groundwater level in irrigated areas is 162 cm, and the mineralization per liter is 1.68 g. According to the results of the linear analysis, the groundwater level will drop to 175 cm, and the mineralization will increase to 1.97 g/l. In 2050-2100, according to the forecast, the groundwater level will be 179 cm and the mineralization will be 2.1 g/l. According to the forecast, the forecast changes will be as follows: groundwater level by 2050 will be 176 cm, salinity 1.65 g / l; From 2050 to 2100, the groundwater level will be 175.4 cm and the salinity will be 2.1 g / l. The results of the showed an increase in groundwater levels and a sharp increase in mineralization. In particular, according to the forecast, the groundwater level will rise to 155 cm by 2050 and 140 cm in 2050-2100, and the mineralization will be 2.1 and 2.6 g / l, respectively.

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