ISSN 2181-9408



Scientific and technical journal



## Sustainable Agriculture

**SPECIAL ISSUE.2022** 







ECONOMY. ECONOMIC SCIENCE. OTHER BRANCHES OF THE ECONOMY.
N.Abdurazakova, M.Inoyatova, G.Attakhanov  Export potential of the republic of Uzbekistan48
O.A.Shermatov  New innovations in increasing the economic efficiency of rice growing52
Z.Khamidova  Experiences of foreign countries in financial support of the agricultural sector56
A.Maksumkhanova, Kh.Khujamkulova, Z.Toshtemirova  Forecasting the sustainable development of the agricultural network of the republic  of Uzbekistan using econometric models
A.Maksumkhanova  Important aspects of ensuring food safety in the republic of Uzbekistan64
M.Kholikulov  Analysis of the share of farming forms in the growing of fruit and vegetable products68
J.B.Hasanov  Directions for improving the efficiency of using modern information systems in small business and entrepreneurial activities70
I.M.Kamoliddinov  Methodological aspects of assessment of the efficient use of production resources in the activity of business subjects
M.Inoyatova  The reforms to reconciliate the regulatory relationships in agriculture: effects and results76
ORGANIZATION AND MANAGEMENT.
S.A.Bahodurova, G.A.Yusupova, M.R. Li, A.B.Makhsumkhonov  Teacher ranking as a tool of the university quality management system78
I.I.Ergashev, Y.A.Sobirova  Priorities for improving the information and staffing of the agricultural management system82
POWER ENGINEERING, ELECTRICAL ENGINEERING, AUTOMATICS.
Sh. Abduganieva, Z.Abduganiev, A.Musurmonov, K.Shavazov, J.Abduganiev  Convective mass and heat exchange during the drying of vegetable skins in a helio-dryer86
Andriy Verlan, B.A.Khudayarov, F.Zh.Turaev  Modeling of supersonic flutter of a viscoelastic plates90
B.Kh.Norov, Kh.N.Kholmatova, Sh.B.Mirnigmatov  Organizations of technical service of ameliorative and construction machines94
B.A.Khudayarov, F.Zh.Turaev  Bending-torsional vibrations of aircraft wing98

A.A. Bokiev, N.A. Nuraliyeva, A.N. Botirov, S.S.Sultonov  Methods of charging electrical vehicles102
A.U.Djalilov , O.A.Nazarov  Features of the use of hall sensors in devices for measuring water flow106
Sh.Khudainazarov, T.Mavlanov  Dynamics of shell structures considering rheological properties110
J. Z. Ulashov, N. A. Maxmudov, K.A.Shavazov  The role of physical and mathematical laws in diagnosing electrical equipment of military vehicles
Sh.R.Rakhmanov, A.M. Nigmatov  Development of an algorithm for optimization of continuous technological process of cultivation of microorganisms
M.Ibragimov, O.Matchonov, D.Akbarov  The basis of the optimal parameters of the process of reducing the moisture content of cotton technical sheets by electric contact
A.Mukhammadiev, T.M. Bayzakov  Pre-harvesting electrical processing of cotton: the state of the prospects for the development of research
B.B.Utepov  Determination of the speed of the air disc atomizer with air flow131
ENVIRONMENTAL PROTECTION. WATER MANAGEMENT, HYDROLOGY.
A.Abduvaliev, A.Abdulkhayzoda  Vibration protection of an underground cylindrical structure using a dynamic damper133
A.A. Khojiyev  Moisture and salt transfer in the initial period of plant development136
M.Akhmedov, E.Toshmatov  Analysis and assessment of the technical condition of earth dams and dammed lakes of the republic of Uzbekistan
S.Turaeva, M.Li, S.Shoba, R.Romashkin, A.Zokhidov  Negative impacts of climate change for Uzbekistan and the countries of Central Asia143
P.U.Islomov  Monitoring of irrigated soils and their fertility. (on the example of Navoi region)147

## MOISTURE AND SALT TRANSFER IN THE INITIAL PERIOD OF PLANT DEVELOPMENT

A.A. Khojiyev Associate Professor - Tashkent Institute of Irrigation and Agricultural Mechanization Engineers National Research University

## Abstract

In Uzbekistan, the use of groundwater in agriculture is 3-5 km3 per year. This creates the basis for achieving high yields of agricultural crops in conditions of low water. Water - as moisture, has essential role in all biochemical processes of plants, all vital processes, occurring in a vegetative organism, can proceed normally only under condition of sufficient saturation of cages by a moisture. The article presents the results of scientific research on the impact of groundwater level, salinity, amount and rate of irrigation on the yield of winter wheat in the Syrdarya region, on an area with a groundwater level of 1-3 m and a mineralization of 1-3 g/l. Results of theoretical researches on dynamics of ground humidity have shown: (1) similarity of physical processes of change of humidity of soil on different irrigated areas. (2) hysteresis of the nature of humidity at an irrigation and drainage. (3) sharp recession of humidity of soil in the root zone.

**Keywords:** mathematical model, water stress factor, salinity, irrigation, mechanical composition of soil, hydromodular areas.

Introduction. Among the main factors in the arid zone, an important role is played by the water and thermal regimes of soils, which mainly determine the fate of the crop of irrigated crops. This is explained by the fact that the subsoil processes are closely related to weather conditions and, depending on their behavior, the need for appropriate ameliorative impacts on the agricultural field is established.

The conducted studies to date have proved the inconsistency of the interpretations of the management of the productivity of agroecosystems, when only a few isolated indicators were taken into account or the informativeness of the integral indicators was usually judged from the data of correlation and regression analyzes that do not always reflect the actual processes taking place in the soil- plant". In the methodology for assessing soils as an object of intensive agricultural use, a new stage has come-the transition from bathing assessments, studies of individual optimal parameters to the analysis of the productivity of agroecosystems on the basis of their mathematical modeling[3; 4; 5].

Methodology study. The spatial-temporal dynamics of soil moisture were investigated in several Water Consumers Association.

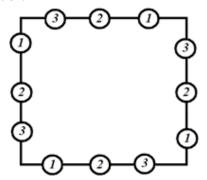


Fig 1. Sampling arrangement with fourfold replication of moisture determination.

On the demonstration sites cotton was grown; space between the rows was 90 cm. Five sampling sites (four under cotton grown area and one at non-vegetated area – control) with four replications of each were selected randomly. Soil samples were collected annually during 2019-2020.

The experiment consists of two parts: The first is the analysis of the dynamics of soil moisture based on the irrigation frequency. The soil moisture was measured right before and after the irrigation, the next were as well as 1, 2, 3 and 5 days before and after the irrigation. The sampling was replicated four times. Moisture is determined from 10-cm layers, and in the root and top soil - from 0.5 and 5-10 cm layers. The sampling arrangement is shown in Fig. 2.

In the initial period of plant development under steadystate conditions, when transpiration of Em can be neglected, the following mathematical model will be used for a two-layer medium consisting of arable and subarable layers [1; 2;8;9].

With soluble salts and small content in the solid phase (for example, chlorine), the equation of salt transfer satisfactorily describes the distribution of salts observed in nature and experiments without the last term  $y(c_s - c)$ , ie:

We note that in this case D takes into account the peculiarities of the motion of solutions in a nonsolvent medium (the so-called longitudinal and transverse effects) and is not equal to the usual diffusion coefficient in a resting solution[4; 5;6].

$$\begin{cases} 0 \le z \le z_{1} \\ \frac{d}{dz} \left[ D_{1}(W_{1}) \frac{dW_{1}}{dz} \right] - \frac{dK_{1}(W_{1})}{dz} = 0, \\ \frac{d}{dz} \left[ D_{N_{1}}(W_{1}) \frac{dN_{1}(W_{1})}{dz} \right] - \frac{dV_{N_{1}}(W_{1})}{dz} = 0, \\ z_{1} \le z \le L \\ \frac{d}{dz} \left[ D_{2}(W_{2}) \frac{dW_{2}}{dz} \right] - \frac{dK_{2}(W_{2})}{dz} = 0, \\ \frac{d}{dz} \left[ D_{N_{2}}(W_{2}) \frac{dN_{2}(W_{2})}{dz} \right] - \frac{dV_{N_{2}}(W_{2})}{dz} = 0 \end{cases}$$

$$(1)$$

$$W_1(0) = W_{ib} = const,$$
 (2)  
 $N_1(0) = N_{ib} = const$  (3)

$$W_{1}(Z_{1}) = W_{2}(Z_{1}) \tag{4}$$

$$N_1(Z_1) = N_2(Z_1) \tag{5}$$

$$\left[K_{1}(W_{1})-D_{1}(W_{1})\frac{dW_{1}}{dz}\right]_{z=z_{1}} = \left[K_{2}(W_{2})-D_{2}(W_{2})\frac{dW_{2}}{dz}\right]_{z=z_{1}}$$
(6)

$$V_{N_1}(W_1) - D_{N_1}(W_1) \frac{dN_1(W_1)}{dz} \bigg|_{z=Z_1} = V_{N_2}(W_2) - D_{N_2}(W_2) \frac{dN_2(W_2)}{dz} \bigg|_{z=Z_1}$$
(7)

$$W_2(L) = W_{mc}, (8)$$

$$N_2(L) = N_{mc} \tag{9}$$

where the following designations are entered for the arable and sub-plow layers respectively:  $W_1$ ,  $W_2$  – volumetric humidity; coefficients of moisture conductivity are adopted in the form [1; 3]:

$$K_1(W_1) = A_1 e^{A_2 z}, K_2(W_2) = B_1 e^{B_2 z}$$
 (10)

136

the speed of water movement in the ground is taken as [1]:

$$V_{N_1} = R_1 e^{R_2 Z}, \quad V_{N_2} = P_1 e^{P_2 Z}$$
 (11)

In view of the fact that the stationary regime is considered for the diffusivity coefficients, their mean values

$$D_1(W_1) = D_1 = const, \quad D_2(W_2) = D_2 = const$$
 (12)

$$D_{N_1}(W_1) = D_{N_1} = const,$$
  $D_{N_2}(W_2) = D_{N_2} = const,$  (13)

where: L - groundwater depth, m;

 $Z_{1}$ - boundary between arable and subsoil layers, m;

 $W_{ib}$ - some intermediate moisture capacity between wilting moisture  $W_3$  and the maximum moisture capacity  $W_{iib}$ , r.e.

$$W_3 \prec W_{mc} \prec W_{iib}$$
 (14)

where:  $W_{mc}$ - full moisture capacity;

 ${\it Z}$  - vertical coordinate directed down from the earth's surface.

Also  $N_{ic}$  -it is an intermediate concentration of the salts between the concentration of the salts in the wash water  $N_W$  and the concentration of the limiting saturation of water  $N_S$ , i.e.

$$N_W \le N_{ic} \le N_S \tag{15}$$

As a result of these notations, we rewrite the boundary value problem (1) - (9) as follows

$$\begin{cases} D_{1} \frac{d^{2}W_{1}}{dz^{2}} - A_{1}A_{2}e^{A_{2}Z} = 0 \\ D_{N_{1}} \frac{d^{2}N_{1}}{dz^{2}} - R_{1}R_{2}e^{R_{2}Z} = 0 \\ D_{2} \frac{d^{2}W_{2}}{dz^{2}} - B_{1}B_{2}e^{B_{2}Z} = 0 \\ D_{N_{2}} \frac{d^{2}N_{2}}{dz^{2}} - P_{1}P_{2}e^{P_{2}Z} = 0 \end{cases}$$

$$(16)$$

$$A_1 e^{A_2 Z} - D_1 \frac{dW_1}{dz}\bigg|_{z=z_1} = B_1 e^{B_2 Z} - D_2 \frac{dW_2}{dz}\bigg|_{z=z_2}, \quad (17)$$

$$R_1 e^{R_2 Z} - D_{N_1} \frac{dN_1}{dz} \bigg|_{z=z_1} = P_1 e^{P_2 Z} - D_{N_2} \frac{dN_2}{dz} \bigg|_{z=z_1}$$
 (18)

where  $A_1$ ,  $A_2$ ,  $B_1$ ,  $B_2$ ,  $D_1$ ,  $D_2$ ,  $R_1$ ,  $R_2$ ,  $P_1$ ,  $P_2$ ,  $D_{N1}$ ,  $D_{N2}$ - are some constants determined by comparing the analytical solution with the experimental data [1];

Integrating the first equation of system (16) we will successively find

$$\frac{d^2W_1}{dz^2} - \frac{A_1 A_2}{D_1} e^{A_2 Z} = 0$$
$$\frac{dW_1}{dz} = \frac{A_1}{D_1} e^{A_2 Z} + C_1$$

$$W_1 = \frac{A_1}{A_2 D_1} e^{A_2 Z} + C_1 Z + C_2 \tag{19}$$

**Results.** Relation (4) with allowance for (21), (22) and (26) allows us to determine C1 from equality

$$W_{mc} - \frac{B_1}{B_2 D_2} \left[ e^{B_2 L} - e^{B_2 Z_1} \right] - C_1 \frac{D_2}{D_1} \left[ L - Z_1 \right] =$$

$$= W_{IIP} - \frac{A_1}{A_2 D_1} \left[ e^{A_2 Z_1} - 1 \right] + C_1 Z_1$$

From where we find

$$C_{1} = \frac{W_{mc} - W_{ic} - \frac{A_{1}}{A_{2}D_{1}} \left[ e^{A_{2}Z_{1}} - 1 \right] - \frac{B_{1}}{B_{2}D_{2}} \left[ e^{B_{2}L} - e^{B_{2}Z_{1}} \right]}{\frac{D_{2}}{D_{1}} \left[ L - Z_{1} \right] + Z_{1}}$$
(20)

It is possible to establish the value of  $C_3$  from equation (18), (19), and

$$N_{mc} - \frac{P_1}{P_2 D_{N_2}} \left[ e^{P_2 L} - e^{P_2 Z_1} \right] - C_3 \frac{D_{N_2}}{D_{N_1}} \left[ L - Z_1 \right] =$$

$$= N_{ic} - \frac{R_1}{R_2 D_{N_1}} \left[ e^{R_2 Z_1} - 1 \right] + C_3 Z_1$$

Hence we find

$$C_{3} = \frac{N_{mc} - N_{ic} - \frac{R_{1}}{R_{2}D_{N_{1}}} \left[e^{R_{2}Z_{1}} - 1\right] - \frac{P_{1}}{P_{2}D_{N_{2}}} \left[e^{P_{2}L} - e^{P_{2}Z_{1}}\right]}{\frac{D_{N_{2}}}{D_{N_{c}}} \left[L - Z_{1}\right] + Z_{1}}$$
(21)

Substituting the values of arbitrary  $C_1$ ,  $C_2$ ,  $C_3$  and  $C_4$  in (19) and (20) we obtain the distribution of volumetric moisture and salt concentration in the arable layer as a function of z

$$W_{1} = W_{1c} + \frac{A_{1}}{A_{2}D_{1}} \left[ e^{A_{2}Z} - 1 \right] + \begin{bmatrix} W_{mc} - W_{1c} - \frac{A_{1}}{A_{2}D_{1}} \left[ e^{A_{2}Z_{1}} - 1 \right] - \frac{B_{1}}{B_{2}D_{2}} \left[ e^{B_{2}Z} - e^{B_{2}Z_{1}} \right] \\ \frac{D_{2}}{D_{1}} \left[ L - Z_{1} \right] + Z_{1} \end{bmatrix} z$$

$$N_{1} = N_{1c} + \frac{R_{1}}{R_{2}D_{N_{1}}} \left[ e^{B_{2}Z} - 1 \right] + \begin{bmatrix} N_{mc} - N_{1c} - \frac{R_{1}}{R_{2}D_{N_{1}}} \left[ e^{B_{2}Z_{1}} - 1 \right] - \frac{P_{1}}{P_{2}D_{N_{2}}} \left[ e^{B_{2}Z} - e^{B_{2}Z_{1}} \right] \\ \frac{D_{N_{2}}}{D_{N_{1}}} \left[ L - Z_{1} \right] + Z_{1} \end{bmatrix} z$$

$$2 \times Z \leq Z Z_{1}$$

The definite values of the constants  $C_5$   $C_6$ ,  $C_7$ , and  $C_8$  in (21) and (22) yield the distribution of the volumetric moisture content and the salt concentration in the subpolar layer as a function of z.

$$W_{2} = W_{mc} - \frac{B_{1}}{B_{2}D_{2}} \left(e^{\beta_{1}L} - e^{\beta_{2}Z}\right) - \left(\frac{W_{mc} - W_{k} - \frac{A_{1}}{A_{2}D_{1}} \left[e^{A_{2}Z_{1}} - 1\right] - \frac{B_{1}}{B_{2}D_{2}} \left[e^{\beta_{1}L} - e^{\beta_{2}Z_{1}}\right]}{\left[L - Z_{1}\right] + Z_{1}}\right) (L - z)$$

$$N_{2} = N_{me} - \frac{P_{1}}{P_{2}D_{N_{1}}} \left( e^{P_{1}L} - e^{P_{2}Z} \right) - \left( \frac{N_{me} - N_{ie} - \frac{R_{1}}{R_{2}D_{N_{1}}} \left[ e^{R_{2}Z_{1}} - 1 \right] - \frac{P_{1}}{P_{2}D_{N_{2}}} \left[ e^{P_{2}L} - e^{P_{2}Z_{1}} \right]}{\left[ L - Z_{1} \right] + Z_{1}} \right) (2.5)$$

The change in moisture content and concentration of salts at various initial surface moisture indices without taking into account the development of the plant root system for the conditions of the Khavast region of the Syrdarya region is shown in Fig. 3.

Determination of the constants was carried out according to the acad. F.B. Abutaliev given in [1].

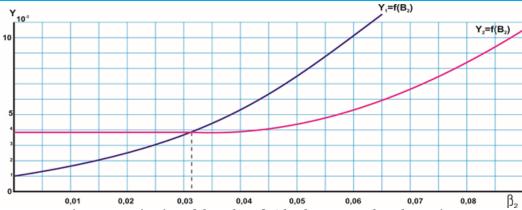


Fig 3. Determination of the value of  $\beta 2$  by the transcendental equation.

Table 1. Coefficients of the mathematical model for determining the parameters of moisture and salt transfer

of moisture and sait transfer								
Location of the object	Khavast district							
Farms	Baraka	Akhmad Khojayev	Chinor	Khavast simosi	Dariyev Ibodullo	Kushkecik		
Mechanical composition	Heavyloam		Mediumloam		Lightloam			
A <sub>1 X</sub> 10 <sup>-4</sup>	2,18	2,02	5,37	2,30	35,71	32,58		
$\mathbf{A}_2$	1,74	1,57	2,23	2,39	2,30	2,20		
B <sub>1 X</sub> 10 <sup>-4</sup>	3,41	1,67	2,26	1,53	50,71	36,40		
$\mathbf{B}_2$	2,51	2,43	2,42	2,64	1,83	2,09		
D <sub>1 X</sub> 10 <sup>-3</sup>	4,35	5,14	6,75	5,43	3,94	3,08		
D <sub>2 X</sub> 10 <sup>-3</sup>	1,71	2,29	12,19	18,76	6,74	7,70		
R <sub>1 X</sub> 10 <sup>-4</sup>	31,21	32,69	3,23	3,60	5,04	3,70		
$\mathbf{R}_2$	2,07	2,12	2,06	1,88	2,18	1,90		
P <sub>1 X</sub> 10 <sup>-4</sup>	34,87	41,45	1,82	2,97	6,29	1,97		
$\mathbf{P}_2$	1,96	1,84	2,50	2,42	2,38	2,43		
$D_{\rm N1}10^{-3}$	2,91	3,31	5,77	4,98	2,88	5,94		
D <sub>N2</sub> 10 <sup>-3</sup>	7,35	6,88	11,08	6,48	9,12	7,24		

Fig. 3. shows the change in soil moisture during the initial period of plant development (winter wheat). The bend point on the graph indicates the boundary between the arable and sub-plow layers (42 cm).

Conclusions:

- 1. The developed models (24) (25) can be used in the calculation of moisture and salt transfer both in the initial period of plant development and in the calculation of washing of saline lands.
- 2. The use of models and the coefficients of the mathematical model to determine the parameters of moisture and salt transfer make it possible to calculate the reserve of soil moisture and optimize the sowing time at its maximum value.

## **References:**

- 1. F.B. Abutaliev, V.B. Klenov. Some questions of systematization of parameters characterizing the movement of a two-phase fluid in a porous medium. On Sat "Questions of computational mathematics and technology", T. 1965, 3-22 p.
- 2. R. Muradov, Some issues of effective land use in WUA with a shortage of water resources International Scientific and Practical Conference "Agricultural Science for Agriculture" (Barnaul, 2004) pp, 462-468
- 3. A. Khojiyev, M. Avliyakulov, Sh Khojiyeva Influence of irrigation of winter wheat by subirrigation method on the reclamation regime of lands E3S Web of Conferences CONMECHYDRO 264, 04004 (Tashkent, 2021) pp. 7-13
- 4. A. Khojiyev, R. Muradov, Sh. Khojiyeva, Kh. Yakubova, Modeling of water and salt transfer in the initial period of plant development E3S Web of Conferences CONMECHYDRO 264, 04004 (Tashkent, 2021) pp. 28-32
- 5. A. Khojiyev, R Muradov, T. Khaydarov, J. Pulatov, Changes in the exchange of salt and moisture in groundwater management IOP Conf. Series: Materials Science and Engineering CONMECHYDRO (Tashkent, 2020) pp 883
- 6. M. Avliyakulov, N. Durdiev, N. Rajabov, F. Gopporov, A. Mamataliev, The changes of cotton seed-lint yield in parts of furrow length under different irrigation scheduling (Journal of Critical Reviews, Paris, 2020) Issue 5 pp 838-843
- 7. M. Khamidov, S. Isaev, Influence of cotton subirrigation irrigation on cotton yield in hydromorphic soils (Journal of Irrigation and Melioration, Tashkent ,2015) Vol 2, pp. 5
- 8. N. Saidhujaeva, U. Nulloev, Z. Mirkhasilova, B. Mirnigmatov, L. Irmukhamedova Production of Plant Product as a Process of Functioning Biotechnical System (International Journal of Engineering and Advanced Technology, Vena, 2019) Volume-9 Issue-1, pp. 4845-4846
- 9. Z. Mirkhasilova, Ways to improve the water availability of irrigated lands (European Science Review, Vena, 2018) pp. 202-203