e-ISSN 2795-3248
p-ISSN 2795-3222

Research Article | Vol. 06 Issue 08 August - 2023 | Manuscript ID: #1071

OPERATIONAL OPTIMIZATION OF THE IRRIGATION REGIME FOR AGRICULTURAL CROPS TO SOLVE THE PROBLEM OF PRODUCTION OF ENVIRONMENTALLY FRIENDLY PRODUCTS IN THE CONDITIONS OF AZERBAIJAN

Dr. Prof. Z.H. Aliyev; Dr.S.Xh.Shukyurov
Institute of Soil Science and Agrochemistry of NAS of Azerbaijan
Email-: zakirakademik@mail.ru

ABSTRACT

The effective hydro meteorological provision of agriculture, the effective development of the neighborhood in general, in particular, depends on the accuracy of agro-ameliorative information, which in turn is determined by the measurement of acceptable agro-ameliorative parameters: in general, the moisture level in the soil and the air layer above the soil, the temperature of the soil and air, from the soil layer and plant evaporation, solar radiation, water silt level of irrigation water, irrigation rate, absolute resistance of plant tissue, etc. It is very dependent on the accuracy and agro melioration forecasts. A special mathematical apparatus for operative determination of agro-ameliorative parameters is described in the article. Thus, our hypothesis proves that it is possible to achieve the highest economic and ecological efficiency through the application of agro-ameliorative recommendations, and this can only be achieved when these parameters are calculated for individual households. It should be taken into account for making a specific decision in the cultivation of agricultural plants and the development of environmentally safe technologies used in order to achieve maximum productivity. In this regard, the value of information obtained with accuracy from various means is of great importance in the optimization of agro meliorating parameters.

KEYWORDS:

Starting humidity, total water consumption, volume of irrigation norm; amount of under watering; amount of overwatering; vegetation phase; frequency of watering; productivity; averaged data on wind speed and, based on long-term data, a meteorological forecast of precipitation, temperature and soil moisture.

INTRODUCTION:

Operational management of the process of irrigation of agricultural crops becomes necessary when, during the growing season of plants, deviations from the planned development occur, primarily when the meteorological situation - precipitation, soil temperature and humidity, air temperature and humidity, wind conditions, solar radiation, water inflow and infiltration, etc. deviate from previously planned based on long-term average conditions in the region. Thus, a problem arises that has solutions in two aspects:

1. Technical equipment of the irrigation management system;
2. Development of an algorithm for adjusting the irrigation plan drawn up at the beginning of the process based on average long-term data, which naturally may deviate from the reality of each period.

In this case, deviations from the required irrigation regime that occurred in the past period should also be taken into account, since they affect the subsequent development of plants and their water availability.

An analysis of numerous studies by a number of scientists proves that the main mathematical apparatus for solving the optimal multi-stage irrigation control problem is the dynamic programming method. It is believed that the main differences here from the alternative solution to the long-term forecasting problem are:

1.Operation of the irrigation optimization system in real time;
2.Use of sensors for monitoring water and temperature conditions of soil and air;
3.Use of the reference plant development sensor.
4. Adaptation of the soil moisture model to changes in water consumption regime.
5. Adaptation of the vegetation model to deviations in the vegetation process;
6.Use of short-term and long-term weather forecasts.

Consequently, here, as sensors for monitoring the regime of an agricultural field, sensors of the following parameters should be used: incl.

- soil moisture at various depths;
-soil temperatures at different depths;
- atmospheric temperature;
- atmospheric humidity;
- intensity of solar radiation;
- wind speed
- Direction of the wind;
- irrigation consumption;
- amount of precipitation;
- evaporation of moisture;
- degree of turbidity of irrigation water;

- the value of resistivity of plant trunks, etc.

It is supposed to be noted that as resistance sensors of its stem, which allow monitoring the growth of the plant, the thickness of the stem and the condition of the plant.

In addition, to monitor the operational parameters of technological equipment (filters for water purification, sprinkler systems, pumping equipment, irrigation and irrigation pipeline networks) and water distribution, it is proposed to use sensors of the following parameters:

- turbidity of water supplied to sprinkler systems (the amount of mechanical impurities in irrigation water should not exceed 3 mg/l);
- consumption of water supplied to the agricultural field;
- water pressure in the pipeline network;
- operability of pumping equipment and irrigation equipment and irrigation installations.

In this case, the following parameters should be taken as a basis for control variables:

1. Irrigation intensity;
2. Irrigation timing, which is determined as a result of solving the problem “Operational optimization of crop irrigation regime”

It must be assumed that in the general case, the moisture model of an agricultural field has the general form:

$$\frac{dW}{dt} = -Ef - ET \quad (1)$$

Here ET is the water consumption for transpiration;

Ef - water consumption for physical evaporation.

According to the scheme, the system contains blocks for polling sensors, assessing physical evaporation and transpiration Eph and ET

Block Ef - processes sensor readings of temperature and soil humidity and solar radiation intensity. The inputs of the soil moisture forecast block are also the transpiration value ET and the irrigation volume specified by the dynamic programming block (through irrigation actuators).

The ET transpiration unit processes the readings of atmospheric humidity and temperature sensors, allowing the air humidity deficit to be calculated based on them. Next, using the bioclimatic curve, productive water consumption E is calculated.

Knowledge of productive water consumption E makes it possible to forecast the growing season using the model

$$\frac{dR}{Dt} = \text{б}_0 + \text{б}_1 E\tau + \text{б}_2 E^2 \tau \quad (2)$$

where, P – stem of the reference plant.

The average daily water consumption deficit for the billing period is determined from the ratio;

DB=E -(P -ΔP)-G, mm (3)

where, E =∑xK

∑d is the sum of the average daily air humidity deficit for the calculation period, which is determined from the ratio:

K is the bioclimatic evaporation coefficient for a given crop in the region under study;

P - precipitation for the calculation period, mm;

ΔP - loss of precipitation due to runoff and filtration;

E is the water consumption of the crop, which can also make it possible to determine the required volume of irrigation.

The air humidity deficit d is determined as follows. But the corresponding measuring instruments determine the air temperature T, determine the elasticity of water vapor UVP and the measured value of relative air humidity β;

$$\beta = Um\text{-}x\ \beta\imath \quad (4)$$

in this case, the air humidity deficit is determined by the formula;

$$d = Um\text{-}\ \beta \quad (5)$$

The required volume of watering is determined taking into account wind speed and air temperature using the expression:

$$m\tau = \frac{ДВ.К_{см}}{100 - И -} \quad (6)$$

Here Kcm = 1.25 is a coefficient that takes into account the cost of wetting the leaf surface of agricultural crops, depending on the crop, its phase of development and the percentage of irrigated area located under the crown or leaf surface of plants.

The influence of atmospheric temperature and wind speed is taken into account using the coefficient:

$$И = т\,(1 - \frac{a}{100})\,(ах В_{п} - г) \quad (7)$$

Where, a is the relative air humidity at the time of sprinkling;

t - atmospheric temperature;

Вп - estimated wind speed at a height of 2 m.

Therefore, K d and g must be adapted here.

At the same time, the need to adapt the soil moisture model to changes in the water supply regime is caused by the following reasons:

- slow trend (monotonous change) in soil properties due to depletion of the fertile layer;
- changes in the properties of irrigation and groundwater.

As a result of these factors, the sensitivity of plants to watering and the application of mineral fertilizers changes and adaptation of the model becomes necessary.

It should be noted that the reasons (factors contributing to them) look somewhat different, causing the need to adapt the vegetation model.

It is believed that when there are deviations in temperature and water supply, the consequences appear in the further process of plant vegetation. In this case, there is a need to adapt the vegetation model.

Adaptation of the soil moisture and vegetation model is carried out in the blocks of adaptation of the soil moisture model (AMVP) and adaptation of the vegetation model (AMV), where the soil moisture forecast is compared with the readings of the plant stem resistance control system. After adaptation, the models are stored in the Soil Moisture Model Bank (SMBM) and the Vegetation Model Bank (VMB).

At the moment of solving the dynamic programming problem, models are extracted from the BMW and BMW.

Adaptation of ontogeny and soil moisture models is necessary due to changes in soil properties, which affect the interaction of the root system with the soil and the intensity of moisture exchange and accumulation. After solving the dynamic programming problem, the currently required irrigation volume is issued to the irrigation actuators (IME). Then, with a time delay, the calculated value of the irrigation volume is also transmitted to the soil moisture forecast block. The effect of time on evaporation after irrigation in the form:

$$E(t)=E1-0.3(t-1) \quad (8)$$

Where t is the time after watering;

E1 - evaporation during the first day.

For the day of humidification t = 0

It should be noted that in this case it is necessary to take into account the use of a formula for assessing the need for irrigation within irrigation cycles, for example, within decades. This model has the disadvantage that it does not take into account temperature and wind conditions.

To implement operational optimization, the following information is used:

1) planning period in the form of start and end dates of the period;
2) bioclimatic curves of agricultural crops;
3) meteorological forecast of precipitation, temperature and soil moisture averaged over long-term data;
4) averaged surface runoff data;
5) averaged long-term data on air humidity deficit;
6) planning time step - decade, day;
7) averaged long-term data on ground inflow - recharge;
8) soil type;
9) averaged long-term data on moisture infiltration into the soil;
10) averaged long-term data on the beginning and end of the phenological phases of agricultural crops;
11) data on the initial moisture reserve;
12) averaged wind speed data;
13) averaged long-term data on losses from underwatering in various phases of development of various agricultural crops;
14) averaged long-term data on air temperatures during the growing season;
15) telemechanical information about the above parameters

Operational optimization is carried out on a PC by the appropriate program with subsequent printing of the following results:

- date of;
- volume of irrigation norm;
- amount of underwatering;
- amount of overwatering;
- vegetation phase;
- frequency of watering;
- productivity;
- electricity consumption;
- losses;
- costs;
- irrigation norm;
- number of waterings.

It should be taken into account that the problem is solved from the current date T to T s and not from Tv.

The starting humidity at TV is determined by a sensor or according to laboratory (calculation and analytical) control data. If there are many fields for one user, then

$$\sum gi(t)<G(t) \quad (9)$$

Where, gi – watering of the i-th field at moment t

G(t) – total water consumption at moment t

$\leq P(t)$

$$Vi\ min \leq gi(t) \leq Vi\ max(x) \quad (10)$$

$Wimin(t) \leq Wi(t) \leq Vi\ max(t)$

here P(t) is the paid water resource;

Vi min; Vi mah; - minimum and maximum watering limits (irrigation rates);

Wimin; Wimax; - minimum and maximum humidity limits

Now consider the presence of many users and everyone pays for their water consumption. That is:

$$\sum_{i=1}^{m} R_i(t) < G(t) \quad (11)$$

$\leq P(t)$

$Wimin(t) \leq Wi(t) \leq Vi\ max(t)$

Vi min≤gi(t) ≤ min [Vi max(t), Pъ(t)]

Where, Ri is the maximum permissible irrigation paid for by the i-th consumer at time t on the i-th field.

In this case, the minimum permissible irrigation on the given field is determined by losses when irrigation deviates from that accepted according to the bioclimatic curve.

During the first reverse stroke, the problem of coordinating the irrigation regime based on pre-irrigation moisture for the (t) and (t+1)th grid lines is solved. In addition, the optimal path element between the grid nodes of each field is selected. Note that the grid is divided into MF subgrids, each of which describes processes in a given field.

Here, subsystems represent independent tasks that are combined with each other depending on the conditions and type of task. Thus, if the moisture grid is taken to have mw divisions, and the irrigation grid has mp divisions, then the number of generalized operations will be no less than –(mw, mp mf), each of which in turn is large.

For all this, when choosing the beginning of the path, at the moment the “direct passage” begins, an auxiliary optimization problem is solved after establishing a connection between soil moisture and the starting soil moisture.

In this case, the problem is simplified, and the total losses are determined by the formula:

$$\textbf{min P}= \sum_{i=1}^{m} \text{P1} \quad (12)$$

Since the objective functions of different fields are related to a given condition that was checked earlier.

References:

1.AliyevZ.H.Scientific justification of efficient use of land and water resources in the Republic of Azerbaijan,. J..AUDİT. №3-4.Baku-2007. pp.43-46.

2.Aliev B.H., Aliev Z.H. and others. Equipment and technology of low-intensity irrigation in the mountainous region of Azerbaijan.Publishing house "Elm", Baku, 1999.220 p.

3.Aliev B.H., Aliev Z.H. Agaev N.A. Environmentally safe technology for micro-irrigation of agricultural crops in the conditions of insufficiently humidified zones of Azerbaijan. Publishing house "Zia-Nurlan", Baku, 2002.163 pp.

4.Aliev B.H., Aliev Z.H. - Zoning of the territory of the Azerbaijan Republic by choosing progressive irrigation technology. Monograph, Publishing House “Zia-Nurlan” IPC, Baku, 2001.249 p.

5.Aliev B.H., Aliev Z.H. Research of complex indicators of reliability of micro-irrigation systems for the conditions of mountain-irrigated agriculture in Azerbaijan. NTO.(Recommendation) archive. NPO "Impulse Baku-1997,59 p.

6.Aliyev B.H., Aliyev Z.H. Prerequisites for solving problems of water supply for agricultural production in the mountainous and foothill regions of Azerbaijan. Proceedings of the Research Institute “Erosion and Irrigation”. Baku-1999, pp. 125-129.

7.Aliyev Z.H., AliyevB.H.Tsche studios of tscheomplekh factors to sistem reliability mi'roirrieation for conditions is blazed-irrieatedschusbandries in Azerbaijan. SRI (TscheReommendation), Arashchive. NPO "Pulse", Baku, 1997, p. 59.