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IMPROVING THE METHODS OF CALCULATING THE MAIN HYDRAULIC PARAMETERS OF THE IRRIGATION NETWORK DELIVERING WATER TO THE DRIP IRRIGATION SYSTEM

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Abstract

When designing and using irrigation networks, it is necessary to know the second water consumption for agricultural crops. That is, the use of a hydromodule gives a good result in the comparative assessment of water consumption in the system.

We will perform a general analysis of the size of the hydromodule used in the calculation of the main parameters of irrigation networks. For this we use formula (1).

$$q(x,y,t) = \frac{x \cdot y \cdot k}{86{,}4 \cdot t} \qquad (1)$$

where: x is the share of the area where the drip irrigation system is introduced in the total cultivated areas of the massif, %; u – irrigation rate, m3/ha; k is the reclamation loading coefficient. Depending on the different mechanical properties of the soil, the value of the coefficient: 0.3; Takes values 0.4 and 0.5 t – duration of irrigation, milk.

The size of the hydromodule calculated by the formula (1) makes it possible to estimate the water demand of the irrigation array where the drip irrigation technology is introduced, and to determine the excess value of the hydromodule of irrigation networks.

Now consider formula (1) as a function of several variables. It is known that the value of irrigation standards of different crops changes depending on the water supply of the year. Therefore, crop area and time can be considered as variables, then q(x,y,t) can be considered as a function of three variables. For clarity, we express the graph of q(x,y,t) as a superposition of several variables:

$$q \cdot 86{,}4 \cdot t = x \cdot y \cdot k \qquad (2)$$

We introduce the following definitions:

$$\left.\begin{aligned} r &= 86{,}4 \cdot \frac{q \cdot t}{\sin\varphi} \\ \varphi &= \arccos\left(\frac{x \cdot y}{r}\right) \end{aligned}\right\}$$

The graph of r and φ planes in space will look like this (Fig. 1).

Projecting the resulting linear function onto a plane, we have a family of curves at different values of K. Through these curves, the hydromodule can be expressed geometrically depending on the crop area and irrigation rate. Moreover, r and φ are functions of two variables.

Thus, it is possible to find hydromodulus values at different values of irrigation rate, crop area and time. By connecting them, we get the approximate function graph.

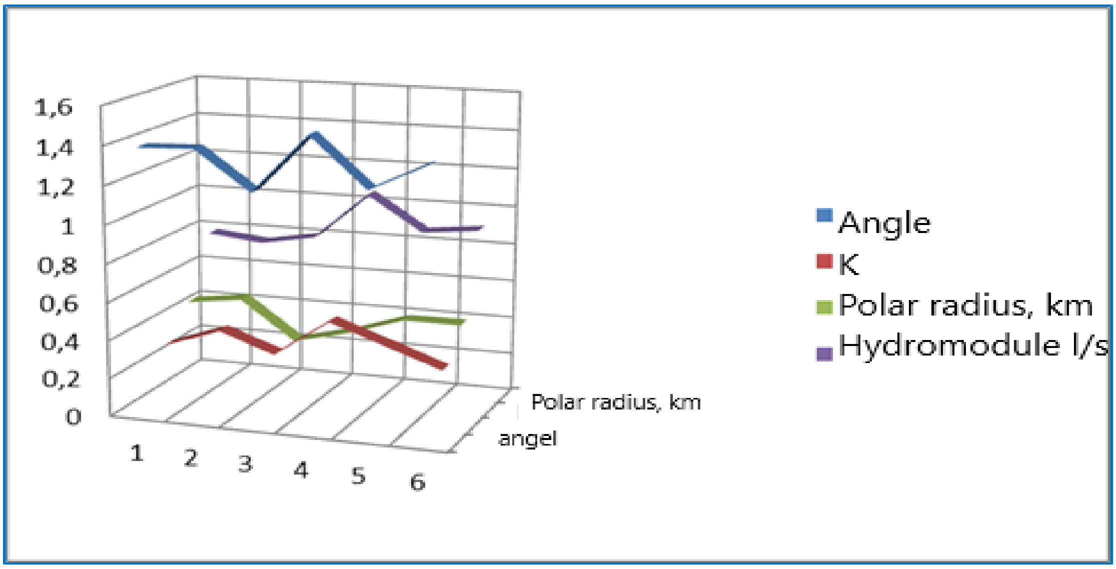

Figure 1. The dynamics of changes depending on the irrigation duration, irrigation rate and area of the hydromodule.

We find the conditional extremum of this function. For this, we assume the following, that is, the values of variables such as the irrigation rate, the percentage of the area where the drip irrigation system is introduced in the array, and the duration of irrigation are equal to or less than the value of the function Φ:

$$ax+by+ct \leq \Phi \qquad (4)$$

Here: a, b, c are empirical coefficients.

The goal is to find the hydromodule extremum. So let's put this issue into standard form:

$$\left.\begin{array}{c} q = \dfrac{x \cdot y \cdot k}{86{,}4 \cdot t} \to \min \\ ax + by + ct \leq \Phi \end{array}\right\} \qquad (5)$$

Now we can construct the Lagrange function:

$$F(x, y, t, \lambda) = \frac{x \cdot y \cdot k}{86{,}4 \cdot t} + \lambda(ax + by + ct - 4802) \qquad (6)$$

(6) After finding the eigenvalues of the Lagrange function in terms of x,y,t and λ variables, setting them to zero, we get the following system of equations:

$$\left.\begin{aligned}
\frac{\partial F}{\partial x} &= \frac{x\cdot k}{86{,}4\cdot t} + a\lambda = 0\\
\frac{\partial F}{\partial y} &= \frac{x\cdot k}{86{,}4\cdot t} + b\lambda = 0\\
\frac{\partial F}{\partial t} &= \frac{x\cdot y\cdot k}{86{,}4\cdot t^2} + c\lambda = 0\\
\frac{\partial F}{\partial \lambda} &= ax + by + ct - 4802 = 0
\end{aligned}\right\} \qquad (7)$$

By performing the appropriate mathematical operations, we obtain the solution of the system of equations (7):

$$\left.\begin{aligned}
\frac{\partial F}{\partial x} &= \frac{x\cdot k}{86{,}4\cdot t} + a\lambda = 0\\
\frac{\partial F}{\partial y} &= \frac{x\cdot k}{86{,}4\cdot t} + b\lambda = 0\\
\frac{\partial F}{\partial t} &= \frac{x\cdot y\cdot k}{86{,}4\cdot t^2} + c\lambda = 0\\
\frac{\partial F}{\partial \lambda} &= ax + by + ct - 4802 = 0
\end{aligned}\right\} \Rightarrow \left|\begin{matrix} a = 480{,}2\\ b = 1{,}1\\ c = 2825\\ \lambda = 0{,}019 \end{matrix}\right| \Rightarrow \begin{matrix} x = 10\\ y = 4365{,}5\\ t = 1{,}7\\ q = 0{,}88 \end{matrix} \qquad (8)$$

Based on the method of Lagrange multipliers and the values of irrigation rate, crop area and duration of irrigation, the optimal value of the hydromodule of the irrigation network was found.

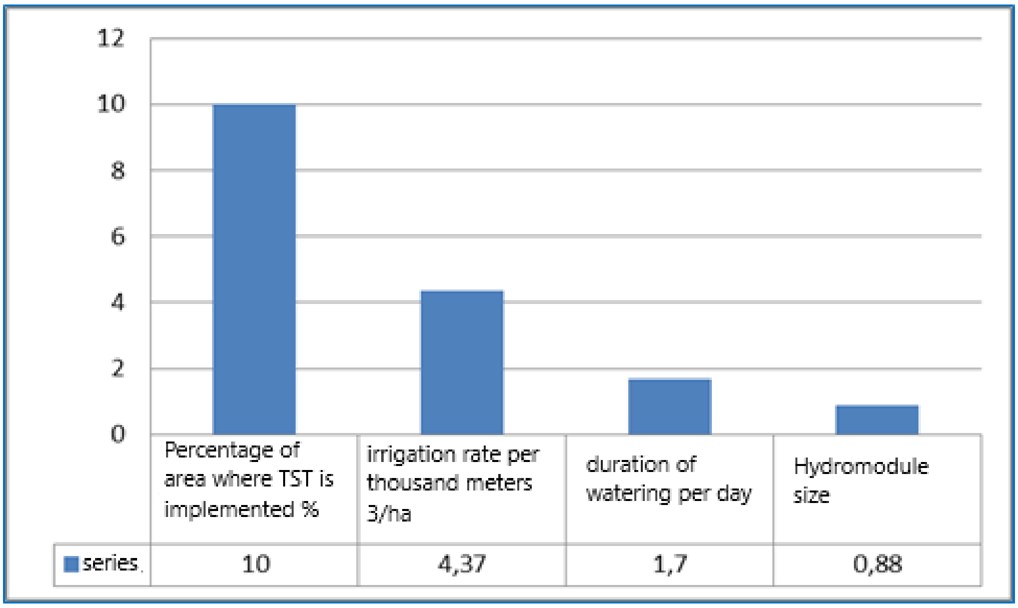

Figure 2 Optimal value of irrigation hydromodule

The dynamics of the water level in the irrigation network, the drip irrigation technology, the water consumption of the drippers of the irrigation tapes, the radius of the soil-soil wetting surface and the hydromodule were developed.

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