

Soil Thermophysics In Comb Growing Of Cotton With Targeted And Uniform Moistening Of The Root System

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Abstract – The article presents the results of research on the development of technology for growing cotton on the ridge of the bed with targeted and uniform moistening of the root system of plants, which together contributed to the creation of optimal conditions for machine harvesting of raw cotton by ensuring early maturation (for 2-3 weeks) and high yield.

Keywords – Soil Thermophysics, Comb Growing Of Cotton, Targeted, Uniform Moistening , Root System.

I. INTRODUCTION

In the conditions of irrigated agriculture in Central Asia, in the spring, due to low air temperatures and often precipitation, the warming of the soil is always insufficient, as a result of which the germination of cotton seeds is significantly delayed. Therefore, agricultural techniques that contribute to at least some increase in soil temperature in the spring are very appropriate and deserve attention.

Research has established [1, 2, 3, 4-8], that when cultivating cotton on the ridge of the bed, in accordance with the theoretical foundations of tillage, a favorable condition is provided for the addition of the arable layer for a long growing season of cotton. This contributes to the production of friendly shoots, good plant development and a high yield of raw cotton with early maturation.

The differences in the soil temperature observed on the smooth floor and on the crops on the ridges show that in all periods of observations the temperature is higher on the ridges. Studies have found that the soil temperature at a depth of 5 cm on the ridges is always higher than when sowing on a smooth field by 1.5-4 ° C. The same thing was observed at a depth of 10 and 15 cm. In recent years, the so-called "drip irrigation system" has become widespread [5, 6, 9-16], which allows you to provide plants with water and fertilizers where necessary, at the right time and in the right amount. The use of "drip irrigation" guarantees higher yields, as well as provides savings in labor, water and energy resources [17-20].

With changing weather conditions, it is possible to harvest raw cotton with more than 90 % of the opening of the boxes [4]. Knowing the technologies of comb cultivation of cotton with targeted and uniform moistening of the root system of the plant, it is possible to create an even more favorable microclimate of the root system of cotton and conditions for machine harvesting of raw cotton by ensuring early maturation (for 2-3 weeks) and high yield and technical means for their implementation [13]. When using a drip irrigation system [7, 8], cotton seeds are sown along the comb by laying perforated tapes on the comb (Fig. 1, a).

It is very important to establish reasonable parameters of ridges, conditions of pre-sowing and post-sowing treatment, schemes and norms of irrigation; to develop on their basis agrotechnical requirements for the designed machines and tools [21-25].

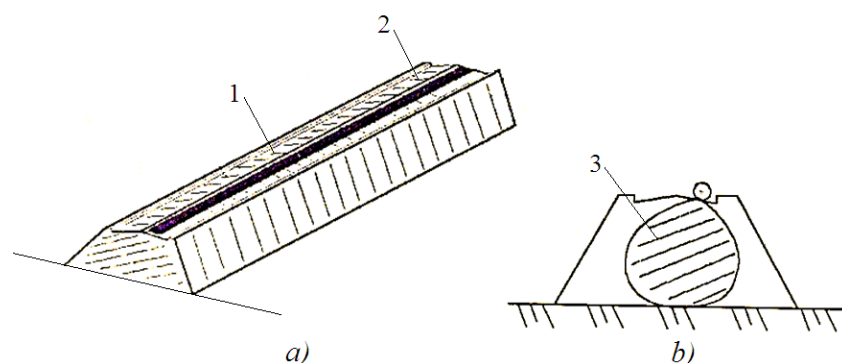


Figure 1. Arrangement of irrigation hoses on the ridges:

a) the type of location of the irrigation hose on the ridge; b) the cross-section of the ridge: 1-irrigation hose; 2-ridge; 3-the bow-shaped shape of the wet soil layer

Mehods. For the growth and development of plants, the most important among the physical factors of the environment are water, air, solar energy and heat. Including soil heat, soil temperature. In connection with the importance of the physical properties of soil soils in relation to the formation of the temperature of the soil layer, we will focus in detail on the main mechanisms and thermophysical properties of soils.

The phenomenon of thermal conductivity of soils has several internal mechanisms. Conduction – heat transfer in direct contact of soil particles with each other. Since soil particles are almost always in contact with each other, this mechanism prevails in all mineral soils [23-25].

The transfer of "latent heat" (heat – heat transfer) is the transfer of heat together with water vapors formed (with heat loss) at one point of the soil and condensed (with heat release) at another. The expression "latent heat" is related to the term "latent heat of vaporization", which is 585 cal/g. If there is a temperature gradient in the soil, then water vapor moves from a point with a higher temperature to a point with a lower temperature. Therefore, if 1 g of water evaporates in the warm part of the soil pore (Fig. 1), then in this part the soil will cool by 585 cal. This gram of vaporous water, condensing in the cold part, will emit the same 585 cal. Due to this heat transfer with water vapor, temperature equality is also achieved.

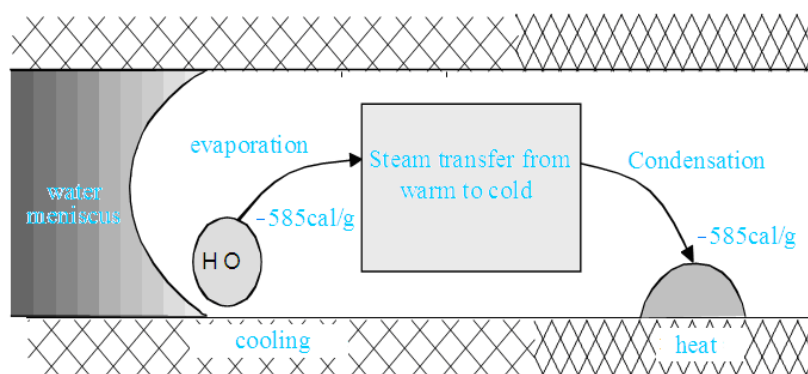


Figure 1. Latent heat transfer – heat and steam transfer.

Convection-warming up due to the jet mixing of the liquid and gaseous phases. In soils, the manifestation of this mechanism is noticeable only at high humidity, rapid mixing of free water.

Heat transfer due to direct infrared radiation. In soils, it is represented to a small extent.

If there are several mechanisms of heat transfer in the soil, it is possible that when its humidity changes, these mechanisms will form the thermal conductivity of the soil as a whole in different ways. Initially, in dry soil, the particles lie freely relative to each other (Fig. 2, Stage 1).

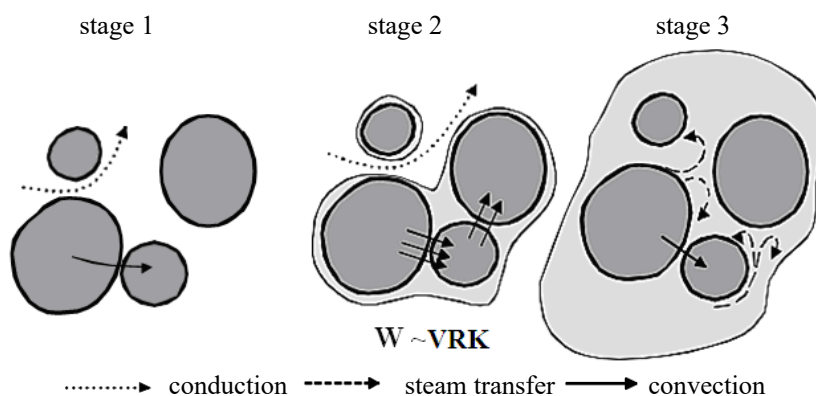


Figure 2. Scheme of heat transfer at different soil humidity

And the heat transfer will be due to only a few individual contacts (conduction). As the water film forms, the particles approach each other. The number of contacts increases, although the free pore space is still significant, and water "plugs", water-filled capillaries, do not interfere with thermal transfer (stage 2). At the moment, the two main mechanisms of steam transfer are fully presented. The thermal conductivity reaches its maximum values. This occurs when the soil reaches a moisture content close to the moisture content of the capillary bond break (RCC) - soil moisture, at which the hydraulic connection of the capillary network is interrupted, and the mobility of moisture in the drying process decreases sharply. It is located in the humidity range between the lowest moisture capacity and the humidity of the stable wilting of plants in the region. The lowest moisture content of HB is the greatest amount of moisture that the soil in the natural occurrence can hold in a stationary or almost stationary state after abundant or artificial moistening and runoff of moisture in the deep occurrence of groundwater ("capillary-suspended moisture").

With further increase in humidity, the conductivity will increase already weak, mainly due to the mechanism of convection circulation of fluids (stage 3, Fig. 2).

Therefore, the dependence of conductivity on moisture is in the nature close to exponential, when humidity values close to the WRC, the curve approaches the maximum value [25].

II. RESULTS AND DISCUSSION

The physical basis of temperature regulation is the following processes based on changes in the components of the thermal balance and the thermophysical properties of the soil: - change in the albedo of the soil surface; - decrease in heat loss of the soil; - increase in the thermal conductivity of the soil.

Covering the surface with dark substances (peat) leads to a significant decrease in the albedo, and, accordingly, to an increase in the absorption of energy by the soil. Remember, the albedo is the ratio of the reflected short-wave energy to the received one. To reduce the albedo means to reduce, first of all, the reflection of radiation by the soil, to increase the flow of heat into it. These are traditional techniques that are often referred to as surface mulching. Mulching of the surface in warm periods leads to a decrease in the temperature of the soil, to its shading. Thus, in the broadest sense, mulching reduces the amplitude of the temperature of the soil surface, "smooths" its dynamics. Another technique, based on a change in the balance components, is associated with a decrease in the amount of heating of the surface layer of air. More precisely, using the heat radiation of the soil to heat the soil itself. It sounds paradoxical, but this is a very effective technique: combing the surface of the soil. This technique leads to the fact that the soil from the side surfaces receives solar radiation and with the same side surfaces of the ridges radiates heat to the side surfaces of nearby ridges. This radiated by the lateral surface of the ridge is not lost, but is acquired by those adjacent to it. In total, the soil loses less heat and accumulates less. And, in addition, when combing the surface of the soil increases, it again consumes more total solar radiation energy than the leveled surface of the soil. This is shown schematically in Figure 3.

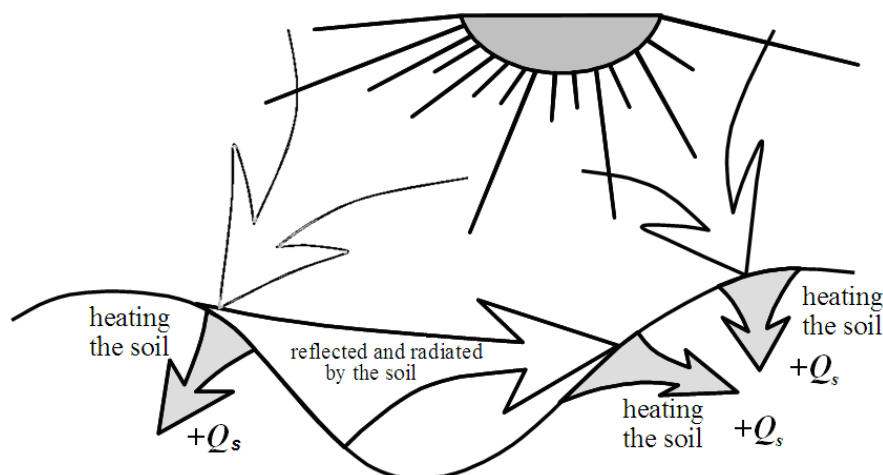


Figure 3. Distribution of heat fluxes on the soil surface during combing

It should not be forgotten, however, that if the surface is given such a wavy mesorelief, there will also be an increase in evaporation. Such beds will dry faster, being physical analogues of small "wicks" that evaporate moisture much faster than the leveled surface of the soil.

Changing the thermophysical properties of the soil, increasing its thermal conductivity is also a way to regulate the temperature regime. Recall that the thermal conductivity of the soil is the quotient of the division of the thermal conductivity by the heat capacity of the soil. You can increase the thermal conductivity by creating conditions for better heat penetration. And this is the optimum humidity, when all the mechanisms of heat transfer are most pronounced, an increase in contacts between particles (i.e., some compaction), an increase in the proportion of large mineral particles (and this is sanding). A decrease in heat capacity is achieved by reducing humidity, increasing the proportion of mineral components with low heat capacity. This is achieved, as a rule, by adding sand, sanding. In this case, firstly, the proportion of mineral particles that are in good contact with each other increases, and secondly, water is less retained due to its faster flow, i.e., the soil moisture decreases. All this leads to a faster warming of the soil after sanding.

III. CONCLUSIONS

1. Each of the soil phases inside the ridge has a corresponding volumetric heat capacity, based on this, targeted and uniform moistening of the root system of plants accumulates more heat.
2. For the entire ground and subsurface biota, the most important is the soil temperature, the change in soil temperature as a function of time, and the dynamics is determined by the temperature gradient.
3. The physical basis of temperature regulation is the following processes based on changes in the components of the thermal balance and the thermo physical properties of the soil: changes in the albedo of the soil surface; reduction of heat losses of the soil; increase in the thermal conductivity of the soil.

REFERENCES

- [1] Bazarov D.R. Scientific substantiation of new numerical methods for calculating the deformation of river beds composed of eroded soils. Dissertation for the degree of Doctor of Technical Sciences, M. 2000
- [2] Google Earth. Access mode: <https://earthengine.google.com/timelapse/>.
- [3] Umurzakov, U., Mamatov, F., Aldoshin, N., and Mirzaev, B. Exploration of tillage technologies in the Republic of Uzbekistan // ICECAE 2020 IOP Conf. Series: Earth and Environmental Science 614(2020) 012168. IOP Publishing. doi:10.1088/1755-1315/614/1/012168.
- [4] Mamatov, F., Aldoshin, N., Mirzaev, B., Ravshanov, H., Kurbanov, Sh and Rashidov, N. Development of a frontal plow for smooth, furless plowing with cutoffs // IPICSE 2020. IOP Conf. Series: Materials Science and Engineering 1030 (2021) 012135 IOP Publishing. doi:10.1088/1757-899X/1030/1/012135.

- [5] Mamatov, F., Mirzaev, B., Mirzahodzhaev, Sh., Uzakov, Z and Choriyeva, D. Development of a front plow with active and passive working bodies // IPICSE 2020. IOP Conf. Series: Materials Science and Engineering 1030 (2021) 012164. IOP Publishing. doi:10.1088/1757-899X/1030/1/012164.
- [6] Mamato, F.M., Eshdavlatov, E., Suyuno, A. Continuous Feed Mixer Performance //Journal of Advanced Research in Dynamical and Control Systems (JARDCS). – Volume-12, 07-Spesial Issue, 2020. DOI: 10.5373/JARDCS/V12SP7/20202343. ISSN 1943-023X.
- [7] Mamatov, F., Ergashev, I., Mirzaev, B., Pardaev, X, Chorieva, D. Research of the Penetration Process of the Frontal Plow // 2nd Bukittinggi International Conference on Education (BICED) 2020. Journal of Physics: Conference Series 1779 (2021) 012002. IOP Publishing. doi:10.1088/1742-6596/1779/1/012002.
- [8] Krutov A.N. Development of the theory and methods of forecasting the spread of pollutants in the surface waters of arid zones. Dissertation for the degree of Doctor of Technical Sciences. M., 1997, 162 p.
- [9] Mamatov, F., Mirzaev, B., Shoumarova, M., Berdimuratov, P., Khodzhaev, D. Comb former parameters for a cotton seeder// International Journal of Engineering and Advanced Technology (IJEAT) Volume-9 Issue1 October/ DOI: 10.35940/ijeat.A2932.109119.
- [10] Mamatov, F., Mirzaev, B., Berdimuratov, P., Turkmenov, Kh., Muratov, L., Eshchanova, G. The stability stroke of cotton seeder moulder // CONMECHYDRO – 2020. IOP Conf. Series: Materials Science and Engineering 883 (2020) 012145 IOP Publishing. doi:10.1088/1757-899X/883/1/012145.
- [11] Militeev, A.N., Bazarov, D.R. A two-dimensional mathematical model of the horizontal deformations of river channels. Water Resources. 1999. 26(1). Pp. 17–21.
- [12] Kwon V.I. About the frictional resistance at unsteady motion of an open fluid flow in the channel. Dissertation for the degree of candidate of physical and mathematical sciences. Novosibirsk., 1967
- [13] Lyatkher V.M., Militeev A.N. Numerical methods in hydraulic studies. Water Resources, 1981, № 3.
- [14] Bazarov, D.R., Vokhidov, O.F., Lutsenko, L.A., Sultanov, S. Restrictions Applied When Solving One-Dimensional Hydrodynamic Equations. Proceedings of EECE 2019, Lecture Notes in Civil Engineering 70. 2019. Pp. 299–305. DOI:10.1007/978-3-030-42351-3_26.
- [15] Lyatkher V.M., Militeev A.N. Study of currents in the downstream of hydraulic structures by numerical methods. Hydraulic Engineering. 1978. No 6. pp. 27 – 32.
- [16] Lyatkher V.M., Prudovskiy A.M. Hydraulic modeling. Energoatomizdat., M., 1984.
- [17] Lyatkher V.M., Shkolnikov S.Ya. Tensor structure of the hydraulic friction coefficient. //Water resources, No 5, 1981
- [18] Bazarov, D., Uralov, B., Matyakubov, B., Vokhidov, O. The effects of morphometric elements of the channel on hydraulic resistance of machine channels of pumping stations. Mater. Sci. Eng. 2020. 869(072014). DOI:10.1088/1757-899X/869/7/072015.
- [19] Meksi A. Prediction of channel dynamics in the headwaters of hydrosystems by numerical methods. Dissertation for the degree of candidate of technical sciences. M., 1987
- [20] Militeyev A.N. Solving problems of hydraulics of shallow reservoirs and hydroelectric facilities using numerical methods. Dissertation for the degree of Doctor of Technical Sciences. M., 1982
- [21] Mukhammedov Ya. S. Operation of the Karshi main canal at water intake from the Amudarya river and ways of its improvement. Access mode: <http://www.cawater-info.net/library/rus/mukhamedov1.pdf>
- [22] Serapinas B.B. Geodetic foundations of maps. Geodetic foundations of maps, theoretical foundations of plane coordinates. Access mode: http://www.geogr.msu.ru/cafedra/karta/docs/GOK/gok_lecture_5.pdf
- [23] Bazarov, D., Markova, I., Norkulov, B., Isabaev, K. Operational efficiency of water damless intake. 2020. DOI:10.1088/1757-899X/869/7/072051.

- [24] Shkolnikov S.Ya. Study of currents in rivers and lakes by numerical methods. Dissertation for the degree of candidate of technical sciences. M., 1980.
- [25] Bazarov, D., Norkulov, B., Vokhidov, O., Uljaev, F., Ishankulov, Z. Two-dimensional flow movement in the area of protective regulatory structures. IOP Conference Series: Materials Science and Engineering. 2020. 890(1). DOI:10.1088/1757-899X/890/1/012162.