IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

Analysis of heat and moisture content inside the ridge in ridge cotton growing

To cite this article: B P Shaimardanov 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1076** 012064

Analysis of heat and moisture content inside the ridge in ridge cotton growing

B P Shaimardanov

National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers", Kari Niyazov street 39, Tashkent, 10008, Uzbekistan

E-mail: shaymardanovvb@mail.ru

Abstract. On the basis of theoretical developments of recent years it was established that there is a certain dependence between soil density and productivity of agricultural crops and that for different biological groups of plants there is a certain value of soil, under which the best conditions for their growth and development are created. In this connection it was recommended to pay special attention to identification of relation between soil density and its water-air, biological and nutritive regimes. Results of researches showed that the best water-physical parameters, good biological and nutritious regime in typical sierozem and meadow non-saline medium-loamy soils is at volume weight equal to 1.1-1.34 g/cm3, and for light sierozem medium-loamy, medium saline - 1.2-1.4 g/cm3, etc. In order to create and maintain optimum compaction of arable soil during long period of vegetation it is necessary to change technology of ridge cultivation of cotton. The change consists in making ridging in spring and sowing cotton seeds on them without early spring and pre-sowing tillage. With sowing of seeds by seeders, drip irrigation hose is laid immediately on the ridge and after sowing, soaking water is supplied to the seeds. In article results of researches on development of cotton cultivation technology on a ridge with addressed and uniform moistening of root system of plants are given.

1. Introduction

The developed new technology of cotton cultivation by ridges consists in the following:

- In autumn after harvesting cotton stalks, winter plowing with a two-tiered plow when the soil is ripe is carried out;
- in autumn after harvesting of stalks of cotton, in autumn after under-winter plowing by a two-tiered plow with a ripe state of soil;
- In springtime the plowing of ridges with a height of 25-28 cm is carried out;
- In spring without preliminary early spring and pre-sowing tillage cotton seeds are sown simultaneously with making ridges by precise sowing of seeds to the depth of 4-5 cm
- laying of irrigation hose by drip irrigation is carried out by a seeder behind sowing of seeds;
- absorption irrigation is carried out immediately after sowing;
- vegetation irrigation is carried out on top of the ridge, where the wetting of the soil occurs by capillary flow from top to bottom, which allows you to maintain optimum density of soil compaction almost the entire period of vegetation.

In the Republic of Uzbekistan, cotton is sown with 60 and 90 cm row spacing. In order to create and maintain optimum compaction of ridges, it is necessary to have ridges of 20-25 cm in height. This height of ridges can be obtained with row spacing of 60, 80 and 90 cm. Table 1 shows data on ridge height at different row spacing and natural angle of soil slope. On the studied soils the angle of natural slope is 36-370.

Volumetric mass on ridges when sowing cotton on them and drip irrigation of root system on top of ridge during long period of vegetation is kept in favorable limits while on sowing by smooth sowing after first deep furrows density of formation in layer 10-30 cm reaches initial value.

Table 1. Ridge height depending on row spacing and angle of natural slope at C=18 cm. Table 1.

U_1,	B = 60		B = 70		B = 80		B = 90	
	H	h	H	h	H	h	H	h
30	17.2	11.9	21.0	14.2	24.9	16.5	28.7	18.7
35	18.5	12.5	22.7	15.0	26.9	17.4	31.1	19.7
40	19.7	13.1	24.3	15.7	28.9	18.2	33.5	20.7
45	21.0	13.6	26.0	16.3	31.0	19.0	36.0	21.6

where: C - width of the ridge on top; U1 - angle of natural slope of the soil; B - width of the inter-row; H - height of the ridge; h - depth of tillage of the inter-row.

The ridges made in spring are subjected to the variable factors of the ridge packer, as a result of which the top layer of soil acquires a favorable structure, which well resists the erosive action of water. Therefore, if precipitation occurs after sowing, no heavy soil crust is formed on the surface of the ridges, which makes it unnecessary to fight it and helps to maintain good germination. The thickness of crust on ridges is 2,0-3,0 times less than on sowing on a smooth field and the most important indicator - its density is 2,0-3,0 times less than on the sowing on a smooth field.

The temperature factor becomes very important in the sowing period. Not only sowing dates, but also seed germination, growth, development of seedlings, etc. depend on it.

Due to ridged surface of soil, temperature on ridges is higher by 1,0-3,4 0C at cotton row crops. This allows us to sow cotton a few days earlier than normally accepted dates and get seedlings 2-4 days earlier. At drip irrigation on top of the ridge downward the moistened soil layers accumulate more heat than on a smooth field.

2. Materials and methods

The goal is achieved by using proven technology and methods of comb cultivation of cotton with the creation of a microclimate for the root system of the plant; using the possibility to regulate the parameters inside the comb by the ratio between heat + moisture + fertilizer of the soil with targeted and uniform moisture both for absorption of seeds with fertilizer and the root system during vegetation; ensuring full opening of bolls for machine harvest with desiccation by irrigation hoses. *Ridge machining* (ridge tillage). In this case the soil is not tilled before sowing. Simultaneously with sowing, 1/3 of soil surface is cultivated with lancet tines or row cleaners forming ridges. Sowing of cotton seeds is carried out on ridges 15-20 cm high; to control weeds, herbicides are used in combination with cultivation.

Sowing is the most important technological operation in the cultivation of crops. Its quality directly affects the yield. In turn, the quality of sowing depends on the technical serviceability of sowing machines and how perfect their design is.

Thermal engineering calculation of heat and mass exchange of soil layers of the root system of plants in the ridges allows substantiating the parameters of the ridge shape and location of irrigation hoses on the top of the ridge.

3. Results and discussion

3.1. Soil temperature control [5,6,7]

In most cases, we are interested in how quickly the soil warms, how the temperature of its layers increases (or decreases). Ultimately, what matters most for the entire floor and intra-soil biont is how soil temperature changes over time. Temperature dynamics, like salt dynamics, will be determined by the temperature gradient over distance:

$$\frac{\partial \mathrm{T}}{\partial \mathrm{t}} = \mathrm{k} \cdot \frac{\partial^2 \mathrm{T}}{\partial^2 \mathrm{z}} = \frac{\lambda_\mathrm{T}}{\mathrm{C_m \rho_b}} \cdot \frac{\partial^2 \mathrm{T}}{\partial^2 \mathrm{z}}$$

A new coefficient will appear, consisting of the parameters we know:

$$K = \lambda_T / C_m \cdot \rho_b$$

which is called the thermal conductivity ***K*** [cm^2/day]. It reflects the ability of the soil to conduct a temperature wave. Note that the dimensionality of thermal conductivity [cm^2/day, cm^2/s] coincides with the diffusion coefficient for salts. Therefore, it is not uncommon for the value of ***K*** is called thermodiffusivity. It is clear that the higher the thermal diffusivity of the soil, the faster it will conduct the temperature flow, the temperature of the lower layers will rise faster, the faster the "temperature wave" will penetrate downwards. That is, the soil will warm up faster. Temperature conductivity of soil, as well as thermal conductivity, significantly depends on its moisture content. The nature of these relationships is determined by the interaction of the solid, liquid, and gaseous phases of the soil (Fig. 1).

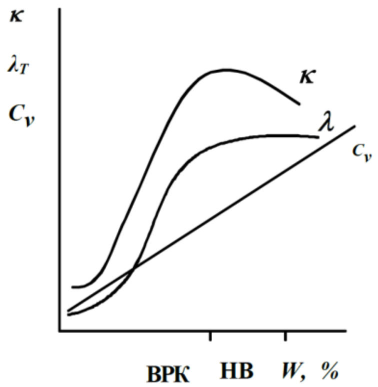

Figure 1. Dependencies of thermophysical parameters on humidity.

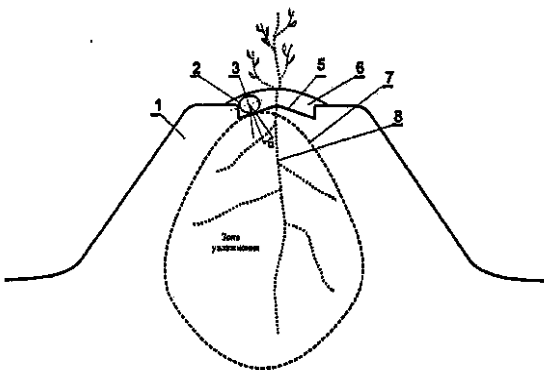

Figure 2. Irrigation hose for drip irrigation and method of its laying (Patent UZ IAP 06314. 14.10.2020): 1 - ridge; drip irrigation hose; 3 - water outlet; 5 - trace of compacting roller to planter; 6 - top of ridge; 7 - moisture contour; 8 - root system.

3.2. Analytical study of targeted and uniform wetting of the root system of plants inside the ridge [5,7,8,9]

On moist soil layers more heat is accumulated, its volume expands, loosened layer is created and favorable microclimate for cotton root system is created. It allows earlier and even sprouting, intensive development of the root system of the plant during the growing season. With the proposed drip irrigation there is no moisture infiltration on the sides of the ridge, then there is no need for repeated cultivation between the rows. Only after rainy weather at the beginning of the sowing period, crusts and weeds are eliminated, perhaps using a razor cultivator set at 1350 relative to the sides of the ridge or with active working tools like a milling machine.

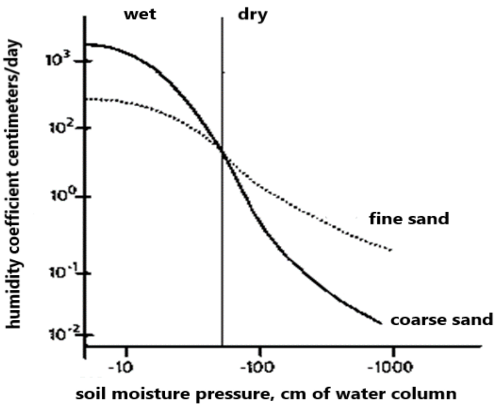

Figure 3. Dependence of moisture transfer coefficient on soil moisture pressure for coarse and fine sand.

This is explained by the general phenomenological law: the transfer of substances and energy occurs in the direction opposite to the gradient of the driving force (the gradient is directed from a smaller value to a larger one). In this case, the driving force is the gradient of soil moisture pressure. However, not only he is responsible for the formation of flow, but also the so-called coefficient of moisture conductivity - the ability of the soil to conduct moisture. This coefficient is not constant for each soil but depends on moisture pressure of soil. It serves not only as a characteristic of material composition and composition of soil but also its saturation with moisture, i.e. moisture pressure. And this dependence is quite complicated and non-linear. For coarse and fine sand these are two different in form dependences (Fig.2). Moisture absorption was determined primarily by the moisture conductivity coefficient, i.e., the ability of sand to conduct flow. In dry soil, in the area of higher moisture pressure (taking into account the sign, because pressure is a negative value), the conductivity of fine sand is higher than that of coarse sand. At the same pressure coefficient of moisture conductivity for fine sand is higher than for coarse sand. So the downward flow of moisture in the fine sand was several times greater. It turns out that water wetted the fine sand faster while slowly moving down the coarse sand. This dependence for fine and coarse sand is basically identical for dense and loose soil. Consequently, moisture conductivity is higher for dry compacted soils than for loosened soils on the sides of the ridge. Suppose the soil is pre-wetted (a bow-shaped moistened zone within the ridge). Then the conductivity of coarse sand would be higher than that of fine sand, because in the region of high (given the sign) pressures, in wetted sands, the moisture conductivity of coarse sand is higher than that of fine sand.

Thus, the specific dependence of soil moisture conductivity on water pressure for different natural objects often leads to specific soil effects, which are very difficult to predict and explain without knowing the patterns of moisture transport in unsaturated soils. These effects have not only cognitive, but also important practical value, for example, at various methods of irrigation [5,6,7].

4. Conclusions

Targeted and uniform moistening of the root system of the plant inside the ridge is that directly to the trunk of the plant at the base is led a thin tube, from which very slowly, by drops, water flows into the soil. As it spreads, the water forms a moistened contour, shaped like a wet bulb.

Development of technology and technical means of ridge-cropping cotton growing with targeted and uniform moistening of plant root system is allowed to crest dry and loose sides, reducing heat and moisture losses from inner layers.

References

[1] Pogosov Yu A, Sharipov N Sh and Kunduzov A M 1982 *Recommendations for cotton cultivation on ridges* (M: TSNIITI)
[2] Mukhamedzhanov M and Suleymanov S 1978 *Root system and cotton yield* (Tashkent: Uzbekistan Publishing House)
[3] Mukhamedzhanov M and Suleymanov S 1978 *Root system and cotton yield* (Tashkent: Uzbekistan Publishing House)
[4] Shaimardanov B P, Matchanov R D *et al* 2017 *AGRO ILM*. **6(50 SON)** 13
[5] Shaimardanov B P, Berdimuratov P T and Kalimbetov B Ye 2021 Development of technical means for laying a drip irrigation hose for comb cultivation of cotton *Industrial Technologies and Engineering – ICITE-2021* **226** pp 327-332
[6] Shein E V and Goncharov V M 2006 *Agrophysics of soil* (M.: Publishing House: Phoenix)
[7] Shein E V 2002 Soil paradoxes *Nature* **10**
[8] Umurzoqov U P and Akhmedov A K 2015 Suv tanqischilligi sharoitida qishloq xujalik ishlab chiqarishini rivojlantirish istiqbollari *Irrigftsiya va Melioratsiya* **1** pp 94-96
[9] Khamidov M H and Suvanov B U 2018 Guzani sugorishda tomchilatib sugorish texnologiyasini qullash *Irrigftsiya va Melioratsiya* **4(14)** 9-11