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Influence of Water-Physical Properties of the Soil on the Root System of Cotton at Drop Irrigation

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Abstract: The article presents the results of scientific research on selection of regionalized, new and promising varieties of cotton suitable for drip irrigation (DS) root system and their resource-saving maintenance technology in the conditions of old irrigated typical gray soils of Tashkent region. Cotton S-6524 (control), S-6570, S-8298, Porloq-4 and Surkhan-104 varieties were compared in TS and under irrigation. During the season, cotton development, soil and irrigation observations were used to obtain information on the quality of cotton. In the researches, cotton cultivars were irrigated in two different moisture regimes 65-70-65 and 70-75-65% relative to the limited field moisture capacity of the soil (ChDNS). The average thickness of plants in the field was 90-95 thousand bushes per hectare. Cotton was irrigated 11 times in the 1st order, with an average of 303-388 m3/ha, and 13 times in the 2nd relatively high order, with an average of 270-380 m3/ha, during the season, a total of 3840 and 4117 m3/ha of water was used proportionally. In this case, it was found that the water consumption was 35% and 38% higher in the irrigated control with an average total of 5950 m3/ha or 35% and 38% more water compared to the options irrigated regularly through TS. Among the varieties tested, S-8298 cotton was the most productive, and the least 146.9 m3 of water was used to grow 1 ts of cotton under direct irrigation, and 37.1 t/ha yield was achieved. Compared to ChDNS, a higher yield was obtained from the S-8298 variety in the case of soil moisture content of 65-70-65% in TS, or relatively little 89.9 m3 of water was used to grow 1 ts of crop, and a yield of 39.1 ts/ha was obtained, irrigation method 70 In the 75-65% variant, 95.6 m3 of water was used to grow 1 t of cotton, and the highest yield was 43.5 t/ha.

Keywords: typical gray soil, cotton drip irrigation technology, irrigation rate, soil moisture, settlement layer, water permeability, boll number, water efficiency, cotton yield.

1. Introduction

Meeting the demand of the country's growing population for agricultural products and the textile industry for valuable raw materials, providing sufficient irrigation water for crops, including cotton fields, plays a major role. Taking into account that this problem is increasing year by year, efficient use of existing water resources, application of water and resource-saving technologies is one of the urgent tasks.

By applying new innovative technologies in the irrigation and feeding of cotton in Jakhan cotton cultivation, it is possible to evenly moisten the active layer in the soil where plant roots are spread and to increase the coefficient of use of mineral fertilizers. When the optimal moisture, air, heat and nutrition regime is created for the plant, its growth and development accelerates, and a high and quality harvest is obtained. Effective use of land, water and other available natural resources, as well as wide use of modern innovative developments that ensure high productivity, are of great importance in cotton growing, which is the main branch of the agricultural sector in the republic. In this regard, agrotechnologies based on the use of effective, water-saving complex methods of new and promising cotton varieties created by local scientists, suitable for the soil and climate conditions of the regions, and scientifically based measures have not fully found their place in the agriculture of the country. Also, in TS technology, which is used in large areas today, the uniqueness of the soil moistening process, its possibilities are limited, and the selection of cotton varieties suitable for this situation is not paid much attention.

The relevance and necessity of this research is defined in paragraph 11 of the decision of the President of the Republic of Uzbekistan dated December 27, 2018 "On urgent measures to create favorable conditions for the widespread use of drip irrigation technologies in the cultivation of cotton raw materials" No. PQ-4087. Effectively using the best achievements of local and global science and practice together with the Academy of Sciences of the Republic of Uzbekistan, the Ministry of Water Management and the Ministry of Agriculture

"In 2019-2020, conduct scientific research in the field of creating agrotechnology for growing cotton varieties with a root system adapted for drip irrigation" aimed at ensuring the implementation of the task.
Today, high results are achieved by applying resource-efficient technologies in cotton irrigation in our republic. In particular, in recent years, drip irrigation of cotton fields and laying polyethylene film between the rows and application of mineral fertilizers dissolved in water (fertigation) and distribution of water during irrigation through artificial flexible pipes create an opportunity not only to save water, but also to use fertilizers effectively. According to the decree of the President of the Republic of Uzbekistan of June 17, 2019 "On measures for the effective use of land and water resources in agriculture" No. PF-5742, the forecast indicators for the introduction of water-saving technologies on 253,381 hectares of cropland during 2019-2022 have been approved. Also, the tasks related to the issue are defined in the decision of the President of the Republic of March 1, 2022 No. PQ-144 "On measures to further improve the introduction of water-saving technologies in agriculture" and other regulatory legal documents related to this activity.
Based on the above-mentioned decrees, decisions and regulatory documents, this practical project was implemented in cooperation with the scientific research institutes of Cotton Selection, Seeding and Cultivation Agrotechnologies (PSUEAITI) and Irrigation and Water Problems (ISMITI).

2. Materials And Methods

Akademik S.N.Ryjov [9] In order for cotton to grow well, develop and give a high yield, the pre-irrigation soil moisture should be maintained at 65-70% relative to ChDNS under any conditions, and in order to reduce the concentration of soil solution in areas prone to salinity, the moisture ChDNS recommended that 75% should be kept.
According to B. Dospehov [5], cotton varieties with different ripening speed require different soil moisture depending on the development periods in different soil and climate conditions. Therefore, it is advisable to develop an optimal soil moisture regime for each cotton variety. Usually, the minimum amount of soil moisture before irrigation in relation to ChDNS is 65-65-60 (65)%, 65-70-60(65)%, 70-70-60(65)%, 70-75- 60(65)%, 75-75-60(65)% and even higher 80-80-60(65)% is recommended to give water to cotton. In this case, the first of the three conditions is represented by the soil moisture before the cotton combing period, the second by the flowering-harvest period, and the third by the opening of the bolls. In areas where the level of saline seepage water is close, setting the soil moisture in the order of 70-70-65%, 70-80-65% and 80-80-65% according to ChDNS gives a high effect. The scientist noted that the difference between the moisture accumulated in the soil and the moisture determined by ChDNS when watering the plant does not exceed 1-2 percent.
In recent years, in the research conducted by N.Kh. Durdiev [8], the hydrophysical and agrophysical properties of typical gray soil were analyzed, and the field moisture capacity was proportionally 21.1-21.6 and 21.2 in the 0-70, 0-100 cm layers. -21.8%. At the end of the cotton season, when irrigation was carried out in the regime of 70-70-60% of the soil compared to ChDNS, the volume mass increased by 0.02-0.04 g/cm3 in the 0-30.0-50.0-70 and 0-100cm layers, respectively, compared to ChDNS At 70-75-65%, these indicators were 0.03-0.06 g/cm3. By the end of the application period, the water permeability of the soil was found to decrease by 49 and 95 m3/h respectively in the 70-70-60% and 70-75-65% irrigation regimes compared to ChDNS. The author concluded that these soils are structurally impermeable to water, disperse as a result of irrigation, and lead to a decrease in water permeability.
According to the data of G. Bezborodov, B. Kamilov, M. Esanbekov [4] on the tests of drip irrigation technology in cotton, plants consumed an average of 5,673 m3/ha during the season during irrigation, while drip irrigation consumed 3,663 m3/ha and 1,810 per hectare. m3 or 31.9% water saving was achieved.
In the scientific research carried out by M.Avliyakulov and B.Matyakubov [3] on the application of TS to cotton, nitrogen fertilizers up to 35-40%, irrigation water saving up to 40-55%, labor consumption reduced to 1.5-2 maratoba and finally it was determined that the cotton yield will increase by 8-10 centners per hectare.
T. Duysenov, B. Kamilov [7] stated that in the conditions of medium and light sandy meadow-gray soils of Mirzachol, high efficiency was achieved when cotton was irrigated in an area with a length of 100 m by interlacing the intercalation before flowering, and during the subsequent period, when each interlacing was carried out.
Applying mineral fertilizers to cotton in TS together with water saves up to 50% compared to spraying on the soil, optimal nutrition system is created and cotton yield is higher by 5.6-7.1 t/ha.
The essence of the recommendations of the above-mentioned scientists is that the water flow and the length of the egate change depending on the water-physical properties of the soil, the slope of the place and the leveling of the area.

In the research of A.Shamsiev [10], it was observed that cotton has a positive effect on the agrophysical and agrochemical properties of the soil mulched between the rows, as well as on the heat, air, microbiological regime, plant growth, development, and harvest. It was determined that 30-40% of water is saved when cotton is irrigated in 65-70-60%, and the yield of cotton increases by 6-8 centners per hectare.
Thus, based on the information, scientific conclusions and practical recommendations collected by potential scientists in the irrigation of agricultural crops, as a result of many years of experience, and implementation is the basis of irrigated agriculture. Because the rational use of available land and water resources ensures the cultivation of cheap, high-quality and environmentally friendly products.
The research was conducted in the fields of the Central Experimental Farm of PSUEAITI based on the materials of the practical project number A-KX-2019-40. The experimental area is covered with automorphic, old irrigated, medium and heavy sandy loam, typical gray soils. In scientific studies, soil moisture before irrigation of cotton varieties "S-6524", "S-6570", "S-8298", "Porloq-4" and "Surkhan-104" was 70-75-65 and 65-70- Field studies were conducted on the development of the root system in drip irrigation at 65 percent and pre-irrigation soil moisture at 70-70-60 percent in comparison to ChDNS. In the experiment, all observations, calculations on cotton varieties, soil and water were carried out in strict accordance with the guidelines and scientific-practical recommendations and methods adopted by PSUEAITI. Among them, in the field experiments, biometric measurements, soil, and plant sample analyzes were conducted on the cotton plant according to "Metodika polevyx opytov s xlopchatnikom" (1981), "Methods of conducting field experiments" (2007).

3. Results And Discussion

It is important that agro-physical and water-physical indicators of soils are at an acceptable level in order to obtain abundant and high-quality crops from agricultural crops, including cotton. It is necessary to maintain this feature of the soil in an optimal order, especially when developing economical irrigation technology for various cotton varieties.
S.N.Rijov, N.I.Zimina (1969), V.P.Kondratyuk (1972), M.Mukhammadjanov and S.S. Suleymanov (1973), A.E. Avliyokulov (1985), and other local scientists studied. For the region of cultivated and old irrigated gray soils, they accepted 1.2-1.3 g/cm3 as an acceptable indicator of bulk density. Also, these scientists have shown that the highest index of volume mass of soil driving layer can reach 1.5 g/cm3 observed in heavy mechanical soils.
According to the scientific project, the volume mass and porosity of the soil were determined in the fields where the field experiments were conducted. These indicators are one of the most important agro-physical properties and have an effect on the spread of the plant's root system in the soil layer, the uniform growth of the above-ground part, the formation of crop elements and the increase in productivity. In the research, in early spring, before placing the experimental options, sections were dug from three diagonal points of the field, and the volume mass of the soil was determined in every 10 cm layers from 0-100 cm depth, and the porosity was calculated based on the specific gravity (2.70 g/cm3). The results of the determinations and their analysis are presented in Table 1. It can be seen from the data that in early spring, at the beginning of the cotton season, the volume mass and porosity of the soil in the 0-30 cm tillage layer is 1.27 g/cm3 and 52.9%, in the 0-50 cm layer it is 1.32 g/cm3 and 51.2%. , in the lower 0-70 cm and 0-100 cm layers, it was observed that the average was 1.35-1.36 g/cm3, 50.0-49.6 percent, respectively.
It is also possible to see the following regularity, that is, from spring to late autumn and with the deepening from the surface of the soil to genetic layers, the volume mass increases (up to 1.44 g/cm3) and the porosity decreases to a certain extent (46.6%). As a result of detailed analysis, it can be seen that despite the fact that cotton is grown in different soil conditions, the parameters of bulk mass and porosity are not affected by plant varieties.

TABLE 1. Volumetric mass and porosity of experimental field soil

Layers, cm	**0-30**	**0-50**	**0-70**	**0-100**
At the beginning of the operating period (General background)				
Bulk mass, g/cm ^{3}	1,27	1,32	1,35	1,36
Porosity, %	52,9	51,2	50,0	49,6
At the end of the validity period (according to the options)				
Drip irrigation 70-70-60%	1,35	1,41	1,43	1,44
Porosity, %	50	47,7	47,0	46,6
TC 65-70-60 %	1,29	1,33	1,37	

Porosity, %	52,2	50,7	49,2
TC 70-75-65%	1,30	1,34	1,38
Porosity, %	51,8	50,3	48,8

Because, it has been emphasized by many scientists that the agrophysical properties of soils hardly change in a short period of time (2-3 years).

The water permeability of the soil varies depending on the mechanical composition, structural structure, the period of absorption, seasonal irrigation, the level of tillage between the rows, the level of seepage water and other factors. At the same time, this feature of the soil, especially under the influence of the number and standards of irrigation, changes and a sharp decrease is observed from the beginning to the end of the application period.

Table 2 shows the results of observations made in the field to determine the water permeability of the soil. According to them, in early spring, the general background water conductivity was 882 m^3/ha or 0.24 mm per minute on average for a total of 6 hours. Towards the end of the cotton vegetation, in late autumn, the water permeability in all variants is significantly reduced due to seasonal agrotechnical measures, including irrigation.

In fall, it was observed that water was broken down by 657 m^3/ha or 25.5% less than in spring. It can be seen that in the TS variants of the experiment, this indicator did not exceed 9.5% in the 65-70-65% mode, and 12% in the 70-75-65% mode, compared to ChDNS without a sharp decrease.

TABLE 2. Soil permeability, m^3/ha

Options	**Indicators**	**Hours**						**6 hours**
		1	**2**	**3**	**4**	**5**	**6**	
At the beginning of the period (March)								
In the general background	m^3/ha	423	177	100	72	62	48	882
	mm/min	0,71	0,29	0,16	0,11	0,10	0,07	0,24
At the end of the validity period (November)								
Egatlab irrigation (70-70-60%)	m^3/ha	208,7	152,8	117,0	76,2	60,9	51,4	657,0
	mm/min	0,34	0,25	0,18	0,11	0,08	0,07	0,17
TC (65-70-60%)	m^3/ha	253,0	159,9	134,6	102,2	94,9	73,8	818,4
	mm/min	0,42	0,27	0,22	0,18	0,16	0,12	0,23
TC (70-75-65%)	m^3/ha	228,7	165,5	121,7	102,4	91,3	66,0	775.6
	mm/min	0,38	0,28	0,28	0,18	0,15	0,11	0,23

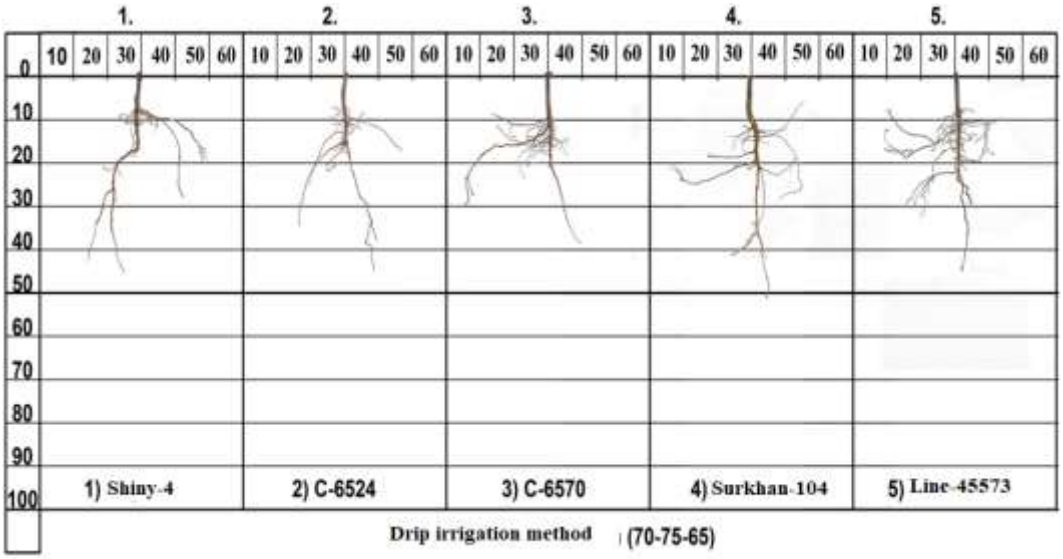

FIGURE 1. Development of the root system of cotton varieties in TS compared to ChDNS (70-75-65%)

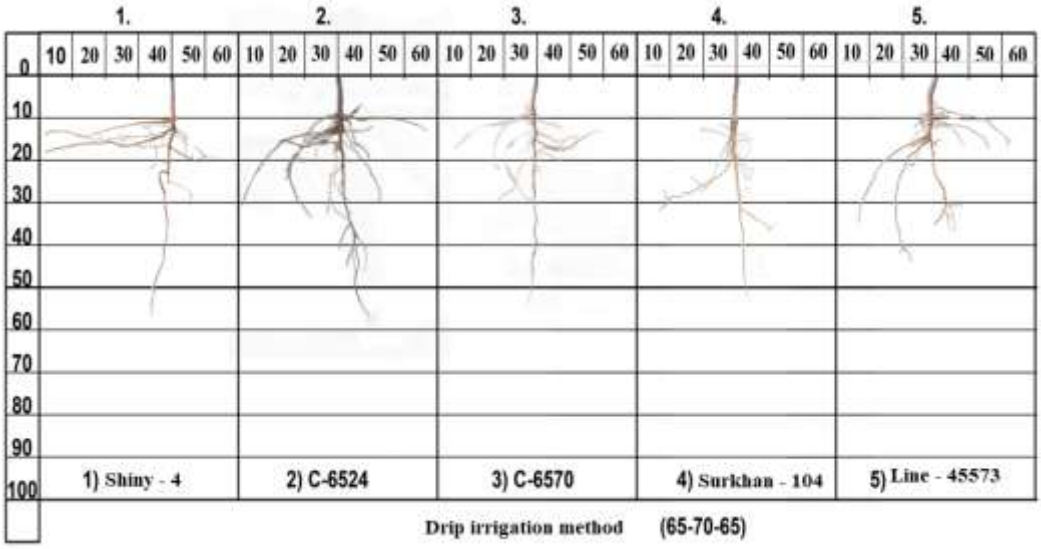

FIGURE 2. Root system development of cotton cultivars in TS compared to ChDNS (65-70-65%)

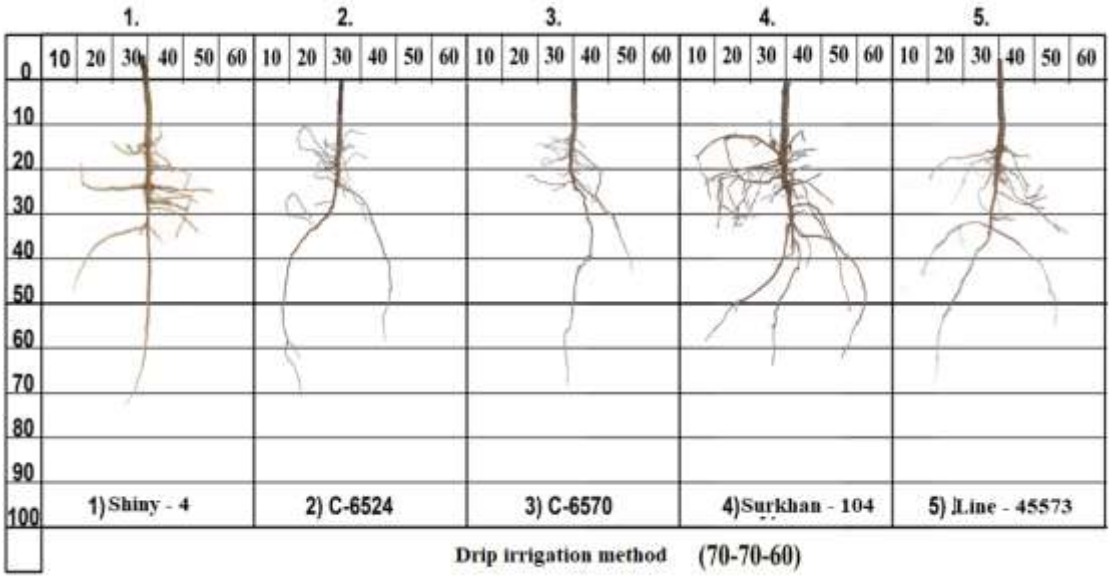

FIGURE 3. Development of the root system of cotton cultivars under partial irrigation, compared to ChDNS (70-70-60%)

It was also observed that when hoses (tapes) were laid between the rows in TS, the root system of cotton grew towards the moistened rows. In the research conducted by M. Mukhamedjanov and S. Suleymanov (1973), it was noted that the root system developed mainly in the direction of unirrigated rows due to the creation of the most favorable microbiological and nutrient environment during irrigation.

As a result of our research, it was observed that the main root system of cotton is spread in the 10-70 cm layer of the soil in the irrigated field, while in TS it is located in the 10-40 cm deep layer. The root system of cotton in the irrigated options is 70-70-60% relative to ChDN, the root system of cotton is 10-67 cm in the "Porloq-4" variety, 10-75 cm in the "S-6524" variety, and 10-70 cm in the "S-6570" variety. In "Surkhan-104" cultivar, it was observed that the main root system developed in 10-80 cm, and in "S-8298" in 10-73 cm soil layer.

When soil moisture before irrigation is 65-70-65% compared to ChDNS, in TS options, the main root system of the cotton variety "Porloq-4" is in the 10-48 cm layer, in the "S-6524" variety in 10-49 cm, in the "S-6570" variety in 10 It was observed that the main root system of "Surkhan-104" variety was developed in 10-52 cm, and the main root system of "S-8298" variety was developed in 10-41 cm soil layer. When soil moisture in TS is 70-75-65% compared to ChDNS, the main root system of cotton variety "Porloq-4" is 10-43 cm, "S-6524"

variety is 10-49 cm, and "S-6570" variety is 10-46 cm. In "Surkhan-104" variety, it was found to be spread in 10-50 cm, and in "S-8298" variety in 10-41 cm layer of soil.
As a result, when irrigation is carried out at 70-70-60 percent of soil moisture in relation to ChDNS, the main root system of cotton is 10-67 cm in the "Porloq-4" variety, 10-75 cm in the "S-6524" variety, and 10-75 cm in the "S-6570" variety. It was observed that it spread in 10-70 cm, in "Surkhan-104" variety in 10-80 cm, and in "S-8298" variety in 10-73 cm soil layer.
Also, at soil moisture 70-75-65 percent, cotton TS variants have their main root system in the layer "Porloq-4" 10-43 cm, in the variety "S-6524" 10-49 cm, in the variety "S-6570" 10-46 cm In "Surkhan-104" variety, it was found that it developed in 10-50 cm, and in "S-8298" variety in 10-41 cm soil layer.

4. Conclusion

As mentioned above, the role of irrigation in acquiring valuable morphological and economic characteristics and a well-developed root system of the cotton variety is incomparable. In the researches, cotton varieties were studied in 2 different regimes (65-70-65 and 70-75-65%) compared to progressive, resourcative TS. In order 1, cotton was irrigated 11 times, with an average of 303-388 m3/ha, and in order 2, relatively high, 13 times, with an average of 270-380 m3/ha, or a total of 3840 and 4117 m3/ha of water was used proportionally during the season. In this case, it was found that in the control option with direct irrigation, an average of 5950 m3/ha or 35 and 38% more water was consumed compared to the options that were regularly irrigated through TS.
As a result, the highest productivity was obtained from the medium fiber variety of cotton "S-8298". At the same time, the least 146.9 m^3 of water was used for the cultivation of 1 ts of cotton crop in total irrigation compared to other varieties, and 37.1 t/ha yield was achieved.
The highest yield was also obtained from cotton variety "S-8298" in variants with soil moisture content of 65-70-65% in drip irrigation. 89.9 m^3 of water is used for the cultivation of 1 ts of cotton of this variety, 39.1 t/ha, and in the 70-75-65% irrigation method, the least 95.6 m^3 of water is used for the cultivation of 1 t of cotton, the highest -43.5 ts/ha yield was achieved.

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