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Совершенствование водосберегающей технологии орошения в предгорных районах на юге республики Узбекистан

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Аннотация. В статье представлены результаты исследований, направленных на совершенствование водосберегающей технологии полива на крутых склонах. Уточнены элементы техники полива при контурном поливе и дискретном поливе на юге Узбекистана. Разработана технология полива мутной (неочищенной) водой для капельного орошения садов. Показано, что внедрение технологии капельного орошения в интенсивных садах позволило снизить расход воды на пашне на 20-60%, минеральных удобрений до 50%, горюче-смазочных материалов до 30%. Также уровень грунтовых вод не повышается из-за поливной потребности растения в воде и избыточной водоподачи, малой испаряемости воды из почвы, а также равномерного увлажнения по всему периметру поля.

Ключевые слова: водосберегающая технология, капельное орошение, водоподача, увлажнение, испаряемость воды.

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Water-saving irrigation technology in the foothill areas in the south of the Republic of Uzbekistan

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Abstract. The article presents the results of research that are devoted to water-saving irrigation technology on steep slopes and clarified the elements of irrigation techniques at contour irrigation and discrete irrigation in the south of Uzbekistan. The technology of muddy water irrigation for drip irrigation of gardens has been developed. The implementation of drip irrigation technology in intensive gardens has resulted in a 20-60% reduction in water consumption on arable land, up to 50% on mineral fertilizers and up to 30% on fuel and lubricants. Also, the level of ground water does not rise due to the irrigation water requirements of the plant and excessive water supply, low water evaporation from the soil, as well as uniform moisture throughout the field.

Keywords: water saving technology, drip irrigation, water supply, humidification, water evaporation.

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INTRODUCTION

As it is known, water saving system includes a wide range of issues: optimization of reclamation regimes against drainage and irrigation technique, agrotechnical methods that increase fertility, etc. In other words, they are mainly reduced to management of the main elements of the field water balance: evaporation, filtration, unproductive water releases from the field, reduction of water supply time from the irrigation network, elimination of soil erosion and subsidence, etc.

The well-known range of water-saving technologies used includes drip irrigation, frontal sprinkling, laser field leveling, etc. They are covered in the works of several authors [1-11].

Certain studies are devoted to the improvement of furrow irrigation [2-4,12]. At furrow irrigation in the form of erosion control measures a number of authors recommend irrigation by a variable stream. At the beginning of irrigation (air-dry soil) the minimum stream is submitted in a furrow, which after passing 1/3 of length of a furrow (in 3-7 hours) is increased twice, then after reaching the end of a furrow the flow rate is reduced to the initial, minimum value. Another noteworthy agricultural technique to prevent irrigation erosion is a change in furrow design. The author suggested that instead of conventional irrigation furrows to make micro-furrows with special rollers, hinged behind the cultivating bodies [4]. Micro-furrow has a width of 3-6 cm, a depth of 3-4 cm and a live cross-section area of 2-10 cm^2. Water flow rate in it can vary from 0.050 to 0.2 l/s. Also, one of the important agrotechnical methods to prevent irrigation erosion is artificial soil structuring along the bottom of furrows by polymeric preparations of K and PGP series synthesized in Uzbekistan. Use of preparations at irrigation are devoted to researches, in particular, as practical recommendations it is noted that at gradients 0.01-0.04 it is necessary to compact the initial part of furrows and fix them with polymer-structural formers with norm to 80 kg/ha, and at steep slopes (0.1-0.22) at irrigation along the highest gradient it is necessary to apply preparations K-4, K-7, K-9, K-17 with norm to 180 kg/ha [13].

According to with slopes 0.1 and more should switch to contour farming system, and with slopes over 0.3 produce construction of bench terraces [3].

Authors recommend to irrigate typical sierozem with 0.04-0.15 gradient to irrigate maize by contour furrows, and in the range of gradients from 0.15 to 0.25 - by jowl furrows. It is also noted that in the conditions of highly rugged terrain, where there is no possibility to irrigate by contour and joist furrows, irrigation by the highest slope is effective, but with the use of polymers K-4 and K-9 with a dose of 180 kg/ha [13].

Surin V.A. notes the possibility of applying furrow irrigation along the highest slope with flexible hoses on slopes even up to 0.3 and above this value to switch to terraced irrigation [2].

METHODS

Methods of field experiments, determination of water-physical, agrochemical properties of soil and the amount of salts in the Research Institute of Cotton Breeding, Seed Production and Agro-technology, and the accuracy and reliability of the data obtained were analyzed mathematically in the method of dispersion analysis in the source of B.A. Dospexov's "Methods of Field Experiments" [14].

RESULTS AND DISCUSSION

Contour irrigation

Use of the same irrigation jets as at irrigation on the greatest gradient of 0.098 l/sec on contour furrows has shown time of irrigation: 10, 33, 64 hours for the same norms of irrigation at the same efficiency of irrigation technique on the greatest gradient. Length of contour furrows due to increase of water absorption became shorter – 65, 100, 110 m, i.e. reduced more than 2 times. Thus, the direction of irrigation across the slope can significantly change the parameters of water absorption by loosening compared with the field without loosening indicates that the contour furrows, cut across the slope on low permeable soils, increase water absorption into the soil, compared with the control – irrigation on the highest slope, respectively, the irrigation parameters change.

Corn yield under irrigation by contour furrows

In contour furrows with inter-row 0.7 m with soil loosening at 90 cm water permeability increased and therefore irrigation jets were higher in comparison with the variant without soil loosening. Irrigation jets less than 0.105 l/s decrease furrow length, above 0.185 l/s cause soil washing away along contour furrows slope 0.02-0.02. On the background without loosening irrigation jets appeared 0.04-0.10 l/s.

Table 1. Results of corn irrigation by contour furrows.

Water flow rate in the furrow, l/s	Biometric indicators of plants by the end of the growing season			The number of waterings	Irrigation rate, m3 /ha	Yield, cwt/ha	
	Heigh, cm	Number of leaves, pcs.	Cobs, pcs.			On the grain	On silage
A. On the background with soil loosening at 90 cm							
0.185	217.1	16.0	2.1	4	3400	99.1	342.5
0.145	221.2	16.4	2.2	4	3420	101.0	351.0
0.105	229.5	17.6	2.4	4	3700	106.4	364.2
					S_x=1.6%	S_a=2.3 c	
B. On the background without loosening the soil							
0.10	207.0	15.0	2.0	5	4930	95.2	320.8
0.07	210.2	15.2	2.0	5	4600	96.6	325.5
0.04	218.1	16.1	2.2	5	4580	100.2	337.6
					S_x=0.36 %	S_a=0.5 c	

Advantages of contour irrigation on the slope against the background of loosening the soil were expressed in the following (Table 1):

- irrigation rates decreased (compared to the variant without loosening the soil);
- number of irrigations decreased by one;

- the highest corn yield was obtained in the variant of irrigation at the rate of 0.105 l/s – 374.2 c/ha for silage and 106.4 c/ha for grain at irrigation norm of 3700 m^3/ha.

And also, on an experimental-production plot of steepness 0.077 and length of 150 m the irrigations are made on furrows with the water discharge 0.058 l/s by norm 400 m^3/ha for 3.33 days, and the irrigation norm to 1000 m^3/ha required irrigation to 7 days and more. At a certain combination of them at the irrigation on the largest slope for the irrigation norm: 400, 700, 1000 m^3/ha on the plot with a slope of 0.077, and the jet 0.057 l/s, you need the length of furrows: 145, 175, 210 m watering time was 23, 48, 130 h. at the efficiency of irrigation technique 0.87, 0.92, 0.91. At the fifth irrigation because of the soil compaction at the expense of 0.083 l/sec the same norms have demanded time of irrigation at the same irrigation norms has made 52, 112, 148 h. at length of furrows: 240, 260, 280 m at an efficiency of the irrigation technique 0.80, 0.87, 0.91. This testifies to necessity of regulation of water consumption in a furrow from irrigation to irrigation [15, 16].

Water saving by applying optimal elements of discrete irrigation technique

In areas with water scarcity, in-soil and drip irrigation are recommended, but their high cost is noted. Irrigation technology indicates that the optimum length of furrows at cyclic irrigation and water consumption in the furrow will vary. In this case polymer K-9 reduces soil washing out in 1.6 times. Furrows with K-9 turned out to be more convenient for discrete irrigation, because their carrying capacity increases in 1.5 times. This circumstance directs irrigators on application of water consumption in a furrow in 1.5 times more, than in usual furrows, without soil flushing, and in the subsequent irrigations the consumption in a furrow can be reduced on value of water discharge after runoff of jet. To increase capacity of moisture content in soil application of K-9 soil loosening on depth of 90 cm creates possibility of increase of moisture reserve at application of discrete irrigation [8, 17, 18].

Corn yield at discrete irrigation on furrows cut on the highest gradient

On the background of loosening the soil the discrete watering in furrows was carried out with watering in ordinary furrows on the greatest gradient and in the same furrows with application of K-9. Discrete irrigation equalizes moistening along the length of furrows due to the change of soil absorption capacity at intervals between water supply cycles of 2 hours after reaching the jet. At the expense of soil moistening quality the advantages in water consumption and yield are received in comparison with irrigation on the highest gradient [16, 17, 19-22].

The attempt of water supply by the discrete method without loosening was not successful - the irrigations are strongly delayed in time, evaporation of soil moisture in the intervals between irrigations is more intense than during irrigation without interruption. The peculiarity of the discrete method is that first the water was supplied to the left side of the 100-meter irrigated area for 2 hours, and then to the right side with the flexible hoses. In this case the efficiency of irrigation in terms of irrigation rates and yields increases, but the irrigation time is increased due to breaks and reduction of soil absorption during shrinkage of soil aggregates along the furrow length in subsequent cycles of water supply. However, the advantages of discrete irrigation on equalization of moisture are obvious (Table 2).

Table 2. Results of corn irrigation using the discrete water delivery method in furrows with and without K-9

Polymer	Water flow rate in the furrow, l/s	Biometric indicators of plants by the end of the growing season			The number of waterings	Irrigation rate, cbm /ha	Yield, cwt/ha	
		height cm	number of leaves, pcs.	cobs, pcs			The grains	silage
K-9	0.145	184	14.4	1.9	4	3180	92.6	365.5
without	0.100	170	13.0	1.6	4	2910	78.5	280.0
					S_x=0,56%		S_a=0.68 c	

Note: irrigations were carried out on a slope of 0.068 with pre-watering.

CONCLUSIONS

Principle schemes of using irrigation methods with closed water use inside the field are developed, which allows reducing or excluding water discharge outside the field and losses on filtration inside the soil, in conditions of negative processes: subsidence, suffosion, soil erosion; providing water saving up to 30-48% in comparison with conventional furrow irrigation.

Schemes of perfect furrow irrigation technologies placement on on-farm irrigation system were developed: contour irrigation and discrete irrigation.

In the conditions of the south of Uzbekistan when selecting the basic technological scheme of irrigation, elements of irrigation technique and irrigation methods it is additionally necessary to take into account the following factors:

- high erosion and subsidence of soils;
- low permeability of soils;
- the need to develop and implement relatively inexpensive irrigation methods and techniques with low operating costs.

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