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WATER-SAVING TECHNOLOGY OF IRRIGATION OF CORN

Abstract. Annually increasing deficit of irrigation water in the Republic of Kazakhstan under market conditions dictates the need for rational and economical use of it. In this regard, the development and implementation of irrigation methods and techniques that ensure a uniform water distribution over the irrigated field, automation of the irrigation process, increase in labor productivity and reduction of water loss for filtration are relevant in the zone of irrigated agriculture. Creation of perfect irrigation systems with reliable technical means and progressive irrigation technology allows toensure highly efficient use of irrigated lands and increase the yield of cultivated agricultural crops.

The article suggests a new method for watering a plant, allowing to switch from watering to watering the plant and providing irrigation water saving up to 80-86%.Given the materials of field research on its use for irrigation of tomatoes and corn in the conditions of Kazakhstan [1].

Keywords: injection watering, xylem, driver unit, osmotic pressure, low pressure, suction, evaporation, transpiration, injection needle, injection, drip irrigation, refueling tank.

Introduction. The decisive factor for obtaining a stable and high yield of agricultural crops in the arid zone of Kazakhstan is irrigation water. In many agricultural formations, due to a shortage of irrigation water during the intensive phase development of plants, a large number of products are not received.

At present, to maintain the normal life of plants, depending on the weather conditions of the growing season, for each hectare of sowing by irrigation is supplied from 3000 to 10,000 cubic m of water.

Of these irrigation norms, only 10–20% areused by plants to form the crop, the rest isspent on physical evaporation from the soil surface, descends into the underlying layers or remains in the same soil layer.

Different plants consume water in unequal quantities, it varies both during the day and during the growing season. By the end of the vegetation, the need for water decreases.

In the dry and hot period plants use 2-3 times more water for vegetation than in temperate climates. Therefore, in order to obtain high yields, it is very important that the plants are supplied with water in the required quantity. It is necessary to maintain a constant turgor pressure in the leaf cells.

For this purpose, the soil is humidified artificially. Analysis of the development trend of irrigation technology in all countries of the world in recent years convincingly testifies to the intensive development of perfect irrigation systems of a new type, based on the continuous supply of plants with water during the growing season in accordance with the course of their water consumption.

Proceeding from the physiological features of the aboveground and underground plant organs, we found it necessary to put them on the very watering, that is, water must be supplied directly to the xylemBased on the physiological characteristics of the aboveground and underground plant organs,we found it necessary to put them on self-watering, that is, water must be supplied directly to the xylem.

Methodology. The experience was carried out in the conditions of the Almaty region, in Zhambyl district at peasant farm "Bereke". Crop seeding according to the options of the experiment was carried out on May 19, when the average moisture of the meter layer was 93% of the lowest moisture capacity. The first watering in the general options of the experiment was carried out when the moisture of a meter layer of soil was at the level of 70,6% of the lowest moisture capacity i.e. 15,15% of the weight of the dry soil (table 1). The first watering on both options was carried out on June 23 at 12 noon [2].

Table 1 – Dynamics of soil moisture from sowing untilfirst watering

19 May		31 May		10 June		31 June		15 July		22 July	
%	$м^3$/га	%	$м^3$/га	%	$м^3$/га	%	$м^3$/га	%	$м^3$/га	%	$м^3$/га
18,75	264,4	17,0	239,7	17,01	239,7	16,92	238,8	14,80	208,7	14,80	208,7
21,22	299,2	17,33	244,4	17,01	239,7	16,94	238,8	15,05	212,2	15,0	211,5
19,74	278,3	18,20	256,6	17,23	241,2	17,15	241,8	15,06	212,4	15,1	212,9
18,84	265,6	18,30	258,0	17,35	244,6	17,07	240,7	15,77	222,4	15,4	217,1
19,69	555,7	18,84	531,3	17,37	481,8	17,08	481,4	16,01	454,1	15,01	423,3
23,60	665,6	18,35	517,5	17,39	490,4	16,93	477,4	16,41	462,8	15,35	432,9
19,85	559,8	18,53	522,5	17,38	490,2	17,02	479,5	17,0	479,4	15,30	433,2
20,24	2888,1	18,15	2570	17,65	2435,6	17,01	2398	15,74	2251,9	15,15	2139,6

Account of the supplied water to the furrows (option 1) was performed by using triangular weirs and under injection irrigation (option 2), on a scale.

After watering, the moisture content of the soil reached the value of the lowest moisture capacity. The second irrigation time for option 1 (furrow watering) came on 12 August with an irrigation rate of 950 cubic m/ha (table 2).

Table 2 – Accounting of the supplied water to the furrows (option 1)

Beginning and ending of watering	Durationofwatering		Water discharge, l/s	Water supply, l	Irrigation rate	Note
	minutes	seconds				
10^{00}-12^{40}	90	5400	0,5	2700	m=650 cubic m/ha m_1=2,70 cubic m/ha	Totalof corn
11^{00}-12^{51}	111	6700	0,6	4000	m =950 cubic m/ha m_1=3,990 cubic m/ha	
	Total			6700	or 6,7 cubic mfor 42 sq.m area	

At the first watering it was possible to supply 2,7 cubic m of water and in the second watering - 4 cubic m of water. During vegetation of corn plant in the plot with area (42 sq.m) consumed 6,7 cubic m: 300 = 22,3 liters of water.

At the same time, the total water consumption of corn was 4726 cubic m/ ha (table 3).

During the vegetation period in the more humid year the corn silage, under furrow watering used moisture from soil reserves in the range of 1296 cubic m/ha, atmospheric precipitation – 1830 cubic m/ha and irrigation water - 1600 cubic m/ha. Before the injection irrigation of corn silage used 2396 cubic m/ha of water from the soil [3-7].

In the second option, where watering was carried out by injection method, during the corn silage growing period on experimental crops were used 342,5 liters of water from soil (for one plant 1,2 liters of water), while the irrigation rate was 84 cubic m/ ha at the rate of 71thousand grew in the first (table 4).

Irrigation water savings was 91% compared with furrow watering. Under furrow watering, the irrigation rate in the external water was 1600 cubic m/ha and under injection method – 300 cubic m/ha.

Table 3 – Total water consumption of corn silage under furrow watering, cubic m/ha

Dates of irrigation (2002)	Initial moisture reserve, cubic m/ha	Inflow			Total water consumption
		precipitation	fromsoil	fromwatering	
19.05 31.05	2888 2570	- 650	- +318	- -	- 968
10.06 30.06	2436 2398	450 450	+134 +48	- -	584 498
15.07 22.07 31.07	2252 2140 2470	200 -	+146 +112 +330	- 650 -	346 650 112
10.08 31.08	220 2170	- 80	+278 -30	950	1228 80 30
Total		1830	1296	1600	4726

Table 4 – Water accounting for injection irrigation (option 2, experimental plot No. 1)

Period of observations	Horizon of water in the tank, cm	Difference, cm	Water discharge per 100 plants in liters	Water discharge per 100 plants in liters/day	Note
17 VI 30 VI	20 12	- 8	- 40	- 0.038	Full filling 1 cm - 5 liters of water
5 VII 5 VII 15 VII 15 VII 20 VII 20 VII 31 VII	4 20 4 20 13 20 6	8 - 16 - 7 - 14	40 - 80 - 35 - 70	0.08 0.08 0.07 0.07	Refilled 80 liters of water and the level is brought to 20 cm Refilled 80 liters of water Refilled 35 liters of water and the level is brought to 20 cm
31 VII 10 VIII 10 VIII 15 VIII 28 VIII	20 6 20 13 7	- 14 - 7 6	- 70 - 35 30	0.07 0.07 0.03	Refilled 70 liters of water Refilled 70 liters of water
Total water discharge for vegetation 400 liters.					

Results. For the period from June 17 to August 28 per 100 pieces of corn silage spent under injection 400 liters of water, and per plant 400: = 4 liters of water. In the translation of 1 hectarethe irrigation rate of corn silage under injection method of irrigation was 300 cubic m/ha and under furrow irrigation method it was 1600 cubic m/ha. Water saving was 81% [8-10].

The data in table 5 show that the maximum water demand of corn silage during the injection was observed from June 20 to July 10 in the period of throwing out the panicle and the beginning of flowering. At this time, one corn silage per day sucked from the injection needle an average of 0,08 liters of water [11, 12].

During injection method of watering, the plant does not stop consuming water from the soil by roots. In total, the total water consumption of corn was 4,073 cubic m/ha (table 5).

When the irrigation method was injection, the total water consumption of corn silage was 4073 cubic m/ha, while under furrow irrigation it was 4726 cubic m/ha.

In wet years, the main part of the total water consumption constitutes atmospheric precipitation and the use of a reserve of moisture from the soil (table 6).

Observation of the growth and development of corn was carried out every 15 days during the growing season.

They are presented in table 7. There is no significant difference in the growth and development of corn silage this year. However, there was a tendency for a certain increase in the leaf area and plant in the options where the watering was conducted by injection method.

Table 5 – Total water consumption of corn silage under injection method of irrigation (option 2), cubic m/ha

Period of observations	Initial moisture reserve in the soil	Inflow of moisture			Total water consumption
		precipitation	fromsoil	fromwatering	
19 V	2888	-	-	-	
20 V	2613	570	275	-	845
31 V	2570	80	43	-	123
Start of plant injection					
17 VI	2196	450	374	120	944
30 VI	1779	450	417		867
15 VII	1557	200	222	100	522
31 VII	1404	-	153		153
15 VIII	1195	80	209	80	289
28 VIII	945	1830	1943	300	4073

Table 6 – Components of the total water consumption (experimental plot No. 1)

Experimentoptions	Total water consumption, cubic m/ha	Ofthem					
		precipitation		fromwatering		fromsoilreserves	
		cubic m/ha	%	cubic m/ha	%	cubic m/ha	%
1. Furrow watering (control)	4726	1830	35	1600	30	1219	25
2. Injection watering	4073	1830	45	300	8	1943	46

Table 7 – Growth and development of corn silage in 2011

Period of observations	1 option (furrow watering)		2 option (injection watering)	
	height, cm	area of leaves, sq.cm	height, cm	area of leaves, sq.cm
	-	-	-	-
31V	5,1	9	5,10	9,23
15 VI	27	115,5	27,15	116,18
30 VI	115	1209	115	1228,5
15 VII	190	2657	191	2592
20VII	220	2722	230	2755
15VIII	230	3690	238	3735
31VIII	250	3960	250	3776

In experimental crops, the growth and development of corn silage, depending on the method of irrigation, have their own peculiarity. Under watering by furrows, there was some inhibition in growth and in development of corn, due to a decrease in moisture supply at the beginning of the next irrigation. Under injection method of watering corn silage during the vegetation, the water was evenly supplied to the cells of the leaf, which positively influenced the growth of plants [13, 14].

The intensive growth of the leaf in the second option is probably due to the fact that irrigation water, supplied directly to the xylem of the plant, quickly and easily advances to the leaf cells and the plant was constantly in the conditions of self-watering.

At continuous supply of water to the plants in the cells of the leaves, the turgor will be constant, and the cells will be saturated with water. Under furrow irrigation is not always possible to accurately determine the watering time and any delay with watering can have a negative effect on the turgor of the leaf cells. Thus, under injection water supply, plants do not suffer from a lack of moisture. Plants take water as much as it needs for normal growth and development. All this contributes, ultimately, to the formation of yields. Under injection irrigation, the yield of green mass of corn silage to 80 t/ ha was greater than in the control variant.

The largest yield of corn was noted in the second variant (456 c/ha), where irrigations were carried out by injection method (table 8).

Table 8 – Corn silage yield andwater consumption coefficient

Experimen toptions	Method of watering	Yield, centner/ha	Total water consumption, cubic m/ha	Water consumption coefficient, cubic m/centner
1	Furrow watering (control)	419	4726	11,2
2	Injection watering	456	4073	8,9

Conclusion. During injection method of irrigation to produce one centner of the crop was used 8,9 cubic m of water and under watering by furrows was used 11,2 cubic m of water. The productivity of irrigation water under injection method is very high, 1 cubic m, gives 1,5 centners of production, while irrigation by furrows gives 0,25 centners (table 9). Consequently, with traditional irrigation, our farmers now spend a huge amount of water, moistening the entire territory, whereas the plant uses a meager part of it. Therefore, in the conditions of water resources shortage (it increases every year) the use of some types of crops for irrigation, in small areas the water-resource-saving irrigation technology is of great importance [15-18].

Table 9 – Irrigationwaterproductivity

Experimen toptions	Yield, centner/ha	Irrigation rate, cubic m/ha	Irrigation rate productivity, cubic m/centner
1. Furrow watering (control)	419	1600	3,85
2. Injection watering	456	300	0,66

Observations of the growth of the corn root system showed that during furrow irrigation the roots penetrated to a depth of 74 cm, and when the irrigation method was injection, the roots spread to a depth of 36 cm.

It can be noted that corn silage before the first irrigation succeeds in extending the root system to a depth of 35-40 cm. Further growth of the root system with the injection irrigation method is not significantly noticeable. In our opinion, this is due to the fact that after the injection the plants are not needed in the roots, because water is supplied to the zone of differentiation of the root hairs directly into the xylem. At this time, the roots terminate their function of supplying plants with soil moisture.

Table 10 – Dynamics of soil moisture change
in the experimental plot No.2 in the numerator - %, in the denominator – cubic m/ha

Experiment options	May		June		July		August		Moisture consumption, cubic m/ha
	15	31	15	30	15	31	15	28	
Option1 (open)	19,2 2669	18,0 2500	16 2224	13,8 1918	11,8 1640	10,8 500	9,1 1265	7,6 1060	1609
Option2 (closed)	19,2 2669	-	-	-	-	-	-	13,9 1932	737
Option3 (openinjectionwatering)	-	-	15,8 2196	12,8 1779	11,2 557	10,1 1404	8,6 1195	6,8 945	1724

These data show that in conditions without irrigation from May 15 to August 28, the total moisture consumption from the soil was 2669-1060 = 1609 cubic m/ha, whereas the closed area by film (the soil is closed between plants), the moisture consumption was 2669-1932 = 737 m^3/ha (table 10).

Findings. At a rough calculation, the moisture transpiration through the corn silage leaf organ was 737 cubic m/ha, and the physical evaporation from the soil was 1609-737 = 872 cubic m/ha. Consequently, of the total water discharge of the non-irrigated fields, about 46% is transpiration and 54% physical evaporation. When the irrigation method was injection, the total water discharge in the field was 2669-975 = 1724 cubic m/ha, of which 1724·0.46 = 793 cubic m/ ha for transpiration and 931 cubic m/ha for physical evaporation. In this third option, observations were made over supplied water by injection. On the option there were 20 corn plants, on which 80 liters of water were used for injection irrigation, which translates for 1 ha that is 300 cubic m/ha. This volume of water (300 cubic m/ha) completely goes to the transpiration of plants, it is fed into the interior of the plant. If we take into account that the water consumption for transpiration according to rough estimates was 793 cubic m/ ha from May 15 to August 28, then it can be assumed that corn plants for silage from the moment of entrance to harvesting during the injection irrigation, in addition to the injection water from the soil, are sucked 793-300 cubic m/ha of water [19-21].

The preliminary economic effect is based on an estimate of the costs of irrigation water (the main factor) and the variants of the experiment, using the results of table 11.

Table11 – Economic efficiency on irrigation water costs

Options	Irrigation rate, cubic, m/ha	Cost of 1 cubic m of water in tenge	Cost of irrigation water in tenge	Savings compared to the final option. tenge
1- furrow watering	4570	0,2	917	
2 - injection watering	330	0,2	66	848

Cost of irrigation water on control (furrow irrigation) at a price of 1 cubic m of water in Almaty region cost 0,2 tenge and an irrigation rate of 4570 cubic m/ha is 917 tenge/ha. When injectionwatering (irrigation rate 300 cubic m/ha) water costs do not exceed 66 tenge/ha (table 11).

Thus, in comparison with furrow irrigation, under injecting irrigation by reducing irrigation water costs ensured saving of 848 tenge/ha.

REFERENCES

[1] Zubairov O.Z., Tattibaev A.A., Konstantinov V. System of injection irrigation of plants. Pre-patent №10256, Bulletin No. 6 from 15.06.2001.

[2] Zubairov O.Z., Ismailova G.K. Injection irrigation system. Collection of works of KazNAU. Research, results. Almaty, 2002, №47. P. 13-15.

[3] Zubairov O.Z., Kumashuly A. Injection method of the basis of water-saving irrigation technology. J. "Scientific Research in Land Reclamation and Water Management". Proceedings of KazNIIVH, issue 1. 2002.

[4] Zubairov O.Z., Nusipbekov M.Z., Anuarbekov K.K., Nabiollina M.S. Makhambetova R.K. Injection irrigation method and its use for watering. Biosciences Biotechnology Research Asia. 2015. December 2015, Vol. 12(3), 2657-2664.

[5] Anuarbekov K.K., Zubairov O.Z., Nusipbekov M.Z. Influence of the improvement of water-salt regime on the yield. Biosciences Biotechnology Research Asia. April 2015, Vol. 12(1), 999-1006.

[6] Anuarbekov K., Zubairov O., Nusipbekov M. Improving water-salt regime in irrigated agriculture. Life Science Journal 2014; 11(5):459-464] (ISSN:1097-8135). http://www.lifesciencesite.com.65

[7] Alimbayev Y.N., Anuarbekov K.K., Kalybekova E.M., Sagaev A.A., Zhailaubaeva M.M. Improvement of the ecological and meliorative state of the irrigated lands in the lower course of the Syr Darya. International Journal of Pharmacy & Technology. Dec-2016. Vol.8. Issue No.4, 27143-27157.

[8] Kozykeeva A.T., Mustafayev Z.S., Dauletbai S.D. Ecological feasibility of the arrangement of river watersheds in the reclamation of agricultural lands. World Applied Sciences Journal 29 (1): 62-67, 2014.

[9] Mustafayev Z.S., Kozykeeva A.T., Tursynbaev N.A. Methodological basis of estimation of the limiting land of the land of results from the environmental services of water resources of transboundary river basins. News of the National Academy of Sciences of the Republic of Kazakhstan. Series of Geology and Technical Sciences. Vol. 5, N 425(2017), 156 – 170.

[10] Diietrich W., Ulrich P. ZurEntwicklungg von Unberboden nach Gefugemeliration //Archiv furAckeu und Piianbau und Bodenkunde. 1979. Vol. 23, N 12. P. 721-732.

[11] Scharff E. Erfa hrungen mit der jandwir tchafteichen Ab // Wasservtung in Braun Schweigwasser and Boden. 1980. Vol. 32, N 1. P. 22-26.

[12] Verma A.K., Gupta S.K., Isaac R.K.Use of saline water for irrigation in monsoon climate and deep water table regions: Simulation modeling with SWAP // Original Research ArticleAgricultural Water Management. 2012. Vol. 115, N 2. P. 186-193.

[13] Duke G.V. Comparative Eperiments With Flield Crops. London, 1974. 211 p.

[14] Kutch H., Schuh H. Versuschder mathematischen Darstellungg derWasserbedafsh-ocffisient for bewasserte. Kulturen-Zeitschut for Bewasserung swirtshaft. 1980. P. 183-191.

[15] David LeBlanc. Molten salt reactors: A new beginning for an old idea. Original Research Article. Nuclear Engineering and Design. Vol. 240, Issue 6, June 2010. P. 1644-1656.

[16] Christian Zörb, Christoph-Martin Geilfus, Karl H. Mühling, Jutta Ludwig-Müller. The influence of salt stress on ABA and auxin concentrations in two maizecultivars differing in salt resistance. Journal of Plant Physiology. Vol. 170, Issue 2, 15 January 2013. P. 220-224.

[17] Rong-jiang Yao, Jing-song Yang, Tong-juan Zhang, Li-zhou Hong, Mao-wen Wang, Shi-peng Yu, Xiang-ping Wang. Studies on soil water and salt balances and scenarios simulation using SaltMod in a coastal reclaimed farming area of eastern ChinaOriginal ResearchArticle. Agricultural Water Management, Vol. 131, 1 January 2014. P. 115-123.

[18] Mustafayev Zh.S. 2004. Methodological principles and environmental reclamation of agrculturalland. cities. The comprehensive development of the Taraz, pp: 306.
[19] Mustafayev Zh.S., Kozykeeva A.T., Eshmakhanov M.K., Mustafayev K.Zh. 2004. Mathematical modeling and geographic stability of the natural system, Poisk, 4: 126-133.
[20] Golovanov A.I., Sukharev Y.I., Shabanov B.B. Complex arrangement of territories – a further phase of land reclamation. Irrigation and Water Management, 2006. 2: 25-31.
[21] Mustafaev J.C., Mustafaev K.J., Koybagarova K.B. On the environmental andeconomicefficiencyofenvironmental. Actualenvironmental problems of Tatarstan. Kazan, 2007. P. 128-130.

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ЖҮГЕРІНІ СУҒАРУДА СУДЫ ҮНЕМДЕУ ТЕХНОЛОГИЯСЫ

Аннотация. Жыл сайын, нарықтық жағдайда Қазақстан Республикасында суғармалы судың тапшылығына байланысты суды ұтымды және үнемді пайдалану қажет. Осыған байланысты, суғарудың жаңа әдістері мен тәсілдерін енгізу, суғармалы суды біркелкі бөлуді қамтамасыз ету, автоматтандырылған суғару процесі, өнімділікті арттыру және суғару аймағында су шығынын азайту, басқа да шараларды іске асыру ауыл шаруашылығы саласында өзекті болып отыр. Қазіргі таңда суғарудың озық технологияларымен, сенімді техникалық құралдармен жабдықталған суғару жүйесін құру, ауылшаруашылық дақылдарының өнімділігін арттырып, суғармалы жерлерді тиімді пайдалануға мүмкіндік беретіні сөзсіз.

Мақалада суғармалы суды 80-86% дейін үнемдеуга мүмкіндік беретін суғарудың жаңа әдісі қарастырылған. Қазақстанның жағдайында қызанақ пен жүгеріні суғаруға қолдануға арналған далалық зерттеулер материалдары ұсынылған. [1]

Түйін сөздер: инъекциялық суғару, ксилема, алдын-ала орнатылған құрылғы, осмотикалық қысым, төмен қысым, сору, булану, транспирация, инъекциялық ине, инъекция, тамшылатып суғару, құю цистернасы.

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ВОДОСБЕРЕГАЮЩАЯ ТЕХНОЛОГИЯ ОРОШЕНИЯ КУКУРУЗЫ

Аннотация. Ежегодно увеличивающийся дефицит оросительной воды в Республике Казахстан в условиях рынка диктует необходимость рационального и экономного ее использования. В связи с этим, разработка и внедрение способов и техники поливов, обеспечивающих равномерное распределение воды по орошаемому полю, автоматизация процесса полива, повышение производительности труда и снижение потери воды на фильтрацию, являются актуальными в зоне орошаемого земледелия. Создание совершенных оросительных систем с надежными техническими средствами и прогрессивной технологии орошения позволяют обеспечить высокоэффективное использование орошаемых земель и повысить урожайность возделываемых сельскохозяйственных культур.

В статье предлагается новый способ для полива растении, позволяющий переходить от полива к поливу растении и обеспечивающей экономию оросительной воды до 80–86%. Приводятся материалы полевых исследования по использованию его для орошения томатов и кукурузы в условиях Казахстана [1].

Ключевые слова: инъекционный полив, ксилема, задающийся устройства, осмотическое давление, низконапорная, всасывания, испарения, транспирация, инъекционная игла, инъекцирования, капельное орошения, заправочный бак.

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