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Influence of The Improvement of Water-salt Regime on the Yield

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The article examines land-reclamation of irrigated lands of the Shieli array through analysis of the volume of salts coming into soil together with irrigation water and the volume of salts exiting soil with collector waters. Water was supplied to crops on the experimental field through a specially prepared biofield sown with thick rush. It produced positive results of the soil water-salt regime.

Key words: Salinization, Experimental plot, Agriculture, Checks, Biofield, Rush, Collector, Water regime, Salt regime.

In the Shiely area of the Kyzylordinsky region, the irrigated area amounted to 31,118 hectares. Including the area of irrigated lands set in the engineering system, it made up 25,801 hectares, while the total area of fields was 22,736 hectares[1].

Weather conditions of the Shiely area is characterized by hot summers and very cold winters. Favourable period for crops lasts from April to mid-October. The hottest month is July, the coldest time of the year – January and February.

Within the area, precipitation is in very small quantities except for some years. Atmospheric precipitation occurs during winter and summer months.

According to the data of the Shiely weather station, this year, the amount of precipitation amounted to 168.4 mm. The highest temperature is +27^{0}C, and the lowest temperature – 4,8^{0}C, the average temperature made up 13.3^{0}C[2, 3].

The main source of water for crop irrigation in the Shiely region is the Syr Darya River. The main water intake part of the river originates in the town of Tomenaryk through the main canal New Shiely. Agricultural lands of the Akmaya, Kodamanov, Begezhanov, Zhuantobe, Bestam farms, etc. are irrigated through this canal. Farms of the villages Bidaikol and Zhahaev are irrigated through the Kamystykak canal.

In the area, water supply to the canals starts with the third week of April, while water supply to the field begins in May and lasts until August 25.

Hydrogeological-reclamation conditions of irrigated land are a complex system, i.e. they depend on the salinity of the crop soil and the level of groundwater[4, 5].

The groundwater level and salinity index were identified through pipes located in irrigated land. Reclamation condition of irrigated lands in the farms was unsatisfactory, only in some farm lands we observed a change in the mechanical composition of soils due to their high and low-land position.

Index of soil salinity depends on the mineralization of irrigation water and groundwater.

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A rapid drop in groundwater levels was seen this autumn. The reason for this was that the water level the Syr Darya river was below and the groundwater level of all irrigated land quickly decreased.

Methodology

During the experiments, the chemical composition of water and soil, and soil moisture were determined in a special laboratory (Kyzylorda hydrogeological-reclamation expedition). During this different methods were used.

Colorimetric methods are used when determining phosphorous. With the gravimetric method phosphorus determination is carried out by subsidence in a solution with the addition of $(NH_4)_2MoO_4$ or magnesium. By the Lorentz method determination of the phosphorus of molybdenum sulfate is based on the formation of a solution, which absorbs light and changes to a specific colour, if some substances ($SnCI_2$, NH_4VO_3, $NaCO_3$) are introduced into the reaction ($(NH_4)_2MoO_4$, Na_2MoO_4) with molybdate additives[6-9].

All methods for determining total nitrogen are based on the combustion of organic substances, on the conversion of nitrogen to ammonia, the conversion of ammonia to a solution of the theralene vinegar.

The chemical composition of soil and water (pH), total nitrogen (N), ammonium nitrogen and nitrate nitrogen, sulphate (SO_4), chloride (Cl) were determined by the method of Lure Y.Y. and Rybnikova A.I., calcium (Ca) and magnesium (Mg) – by the complex-metric method, potassium (K) and sodium (Na) – with the photometer, chemical oxygen demand was determined by the bichromate method[10-12].

In order to determine soil moisture the following equation was used:

$$W=P_1/P100$$

where: W – soil moisture, in percent (%) by weight of soil;

P1– mass of evaporated water, grams;

P – absolute mass of dry soil, grams.

In production conditions regular irrigation norm was determined in complenace with the adopted methodology, depending on the pre-irrigation moisture of the soil according to the following equation of the academician Kostyakov:

$$m=100H\,\theta\,(\beta_{EC}-\beta)$$

m – estimated irrigation norm, m^3/ha;

H – calculated soil layer, m;

α – volume weight of soil, t/m^3;

β_{EC} – free soil water-intensive, as a percentage of the dry soil weight,%;

β – preirrigation soil moisture as a percentage of the dry soil weight, %.

Physical qualities of the soil were determined by the following parameters: water conductivity – by the flooding method, the volume weight – by obtaining soil samples in a special glass without disturbing the natural soil structure, free water-intensive – by thermostatic weighing at a temperature of 105°C. Moisture percentage of the weight of absolutely dry soil was determined with the 0.01 percent accuracy[13].

Soil samples were taken in each version from 3 points in a 3-5 fold replicates according to the methodological instructions of Roden A. (1969). Monitoring of groundwater levels formed due to rain and snow, was carried out through the well No. 8, located in the area of research. Determination of their salinity mode was carried out by sampling water from the well. The chemical composition of the soil was determined twice a year in spring and autumn. Soil samples were taken at 3-fold replicates up to the depth of 60 cm – every 10 cm, then up to the depth of 100 cm – every 20 cm.

RESULTS

The experiments were conducted on 71.15 hectares of Bidaikol agricultural land of the Shiely area (Fig. 1). We named these lands B-71-8, i.e. B – Bidaykol, 71 – area of the irrigated plot, respectively 8 – ordinal number of the wells in this irrigated plot. We conducted the experiments in the crops area, located in the south western part of the Bidaykol irrigated sowing farm. The well number 8 is the closest to it. In our experimental arable land 49 hectares of alfalfa and 22 ha of silage corn were sown[1, 2].

The research goal is to form water-salt regimes of cultivated land in optimal conditions. To achieve this goal, the following work was carried out:

a) Determination (by the laboratory method) of the soil chemical composition before the experiment;

b) Determination of the amount of water taken

Table 1. The composition supplied to the biofield and the water composition released from it (average values), mg/l

No.	Ingredients	2012		2013	
		Supplied water	Released water	Supplied water	Released water
1	pH	7.2	6.8	7.2	6.7
2	HCO_3	252.0	208.0	258.0	215.0
3	Cl	220.0	169.0	223.0	171.0
4	SO_4	902.0	806.0	903.0	811.0
5	Ca	231.0	141.0	216.0	136.0
6	Mg	124.0	93.0	120.0	88.0
7	Na+K	331.0	235.0	281.0	214.0
8	nitrogen	24.0	16.0	21.0	12.0
9	phosphorous	8.0	5.0	8.0	5.0
10	oil products	0.603	0.201	0.598	0.292
11	BOD_5, mEq/L	28.0	20.0	29.0	21.0
12	Total salinity	2060.0	1652.0	2001.0	1635.0

for irrigation of crops and determination of its salinity;

c) Determination of the amount collecting water and its salinity;

d) Yield obtained from the irrigated crops;

e) Determination of the chemical composition of soil and water was carried out in a specially equipped laboratory of the Regional Committee of Ecology and Biological Resources[14-16].

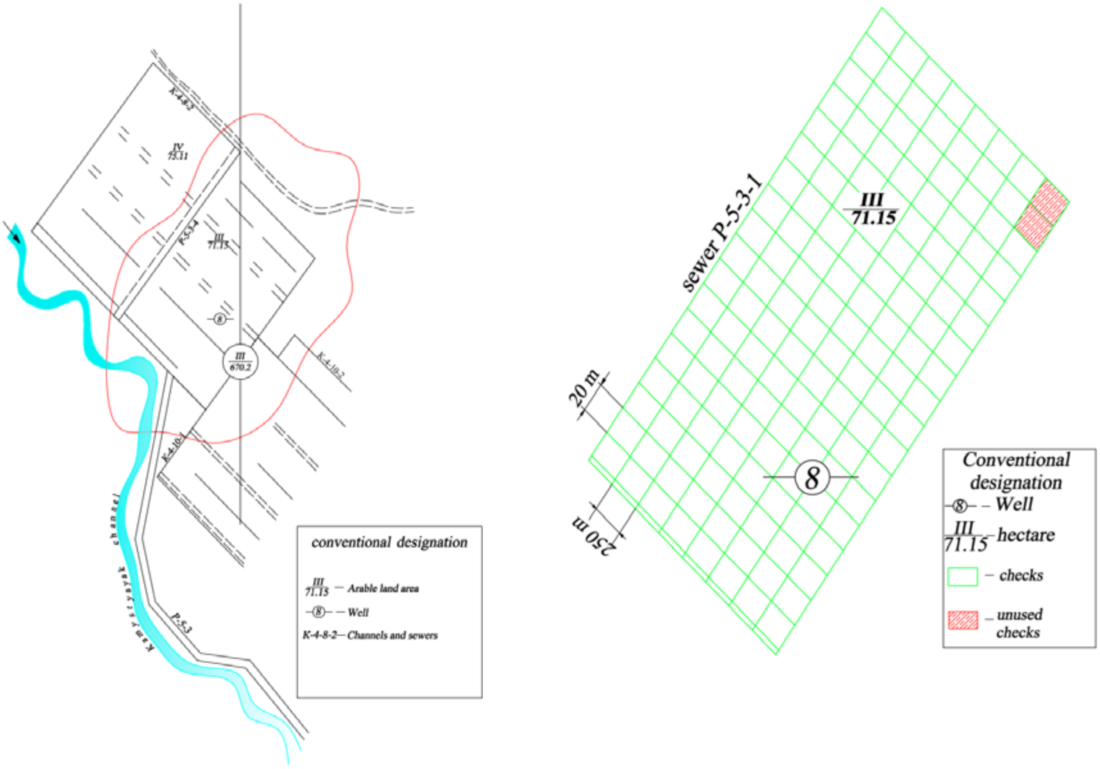

Fig. 1. Hydrogeological-reclamation conditions of the experimental plot B-71-8 (Bidaycol irrigated farming)

Table 2. Watering of corn and alfalfa by the proposed method

Crop	Frequency of watering	Watering norm m, m^3/ha	Watering norm M, m^3/ha	Duration of watering	Amount of water supplied to the field, m^3	Salinity of supplied water, g/L	Amount of salt received by soil, tonnes	Amount of water released from the collector, m^3	Salinity of Supplied water, g/L	Amount released from the collector, m^3
2012										
Corn	1	850	4,350	8/VI	34,800	1.65	57.4	9,048	1.99	18
W=8 ha	2	850		23/VI						
	3	900		9/VII						
	4	900		24/VII						
	5	850		13/VIII						
Alfalfa	1	1,000	5,200	11/VI	83,200	1.65	137.3	21,632	1.99	43
W=16 h0	2	1,000		29/VI						
	3	1,100		14/VII						
	4	1,100		31/VII						
	5	1,000		19/VIII						
					“118,000		“194.7	“30,680		“61.0
2013										
Corn	1	800	4,100	11/VI	32,800	1.63	53.4	8,528	1.95	16.6
W=8 h0	2	800		27/VI						
	3	850		13/VII						
	4	850		29/VII						
	5	800		15/VIII						
Alfalfa	1	950	5,000	12/VI	80,000	1.63	130.4	20,800	1.95	40.5
W=16 h0	2	1,000		30/VI						
	3	1,100		15/VII						
	4	1,000		28/VII						
	5	950		17/VIII						
					Σ112,800		Σ183.8	Σ29,328		Σ57.1

Water was supplied to crops on the experimental field through a specially prepared biofield sown with thick rush (Fig. 2).

When conducting tests we determined the water-salt regime received by the biofield and water released from it, as well as the quantity and salinity of the water released from the crops.

Biofield area was divided into five parts

Table 3. Yield of corn in the experimental fields

Variants	Indexes	15.06	01±07	15.07	01±08	25±08
2012						
Regular watering	H, cm	38.0	104.0	135.0	152.0	160.0
	S, cm^2	92.0	1,109.0	2,600.0	4,100.0	4,300.0
Purified with the biofield	H, cm	52.0	128.0	155.0	175.0	210.0
	S, cm^2	106.0	2,001.0	3,020.0	5,800.0	7,200.0
2013						
Regular watering	H, cm	41.0	110.0	138.0	158.0	162.0
	S, cm^2	102.0	1,200.0	2,630.0	4,300.0	4,401.0
Purified with the biofield	H, cm	56.0	135.0	162.0	181.0	220.0
	S, cm^2	123.0	2,200.0	3,140.0	6,310.0	7,600.0

Table 4. Daily average growth of corn leaf area

Variants	Years	from 15.05 till 30.06	from 01.07 till 15.07	from 16.07 till 31.07	from 01.08 till the harvest
Regular watering	2012	67.8	99.4	100.0	10.0
	2013	73.2	95.33	111.33	5.05
Purified with the biofield	2012	126.33	67.93	185.33	70.0
	2013	138.47	62.67	210.67	65.0

Table 5. Calculation of the corn crops harvest, kg/ha

Variants	First repetition	Second replication	Third replication	Average yield	Changes in comparision with the first variant
2012					
Regular watering	348	380	352	360	
Purified with the biofield	390	410	400	400	+40
2013					
Regular watering	363	366	375	368	
Purified with the biofield	442	460	451	451	+83
HCP_{05} – 27 cwt/hà, P – 3%					

Table 6. Yield of alfalfa, cwt/ha

Variants	First repetition	Second replication	Third replication	Average yield	Changes in comparision with the first variant
2012					
Regular watering	412	424	418	418	
Purified with the biofield	475	490	490	485	+67
2013					
Regular watering	410	414	412	412	
Purified with the biofield	470	482	476	476	+64

Table 7. Water balance, mln m^3

Water balance elements	Regular watering		Purified with the biofield	
	2012	2013	2012	2013
Intake				
Supplied water	0.126	0.120	0.118	0.113
Atmospheric moisture	0.040	0.039	0.040	0.039
Water, absorbed by MC	0.048	0.045	0.045	0.043
Total	0.214	0.204	0.203	0.195
Flow rate				
Amount of evaporated water	0.080	0.080	0.080	0.080
Drainage and collector water	0.033	0.031	0.031	0.029
Vertical absorption	0.010	0.010	0.011	0.011
Total	0.123	0.121	0.122	0.120
Balance	0.091	0.083	0.081	0.075

* MC – main canal

(each was of 1 ha). Each part works taking turns.

Chemical composition supplied to the biofield and chemical composition of water released from is presented in the table 1.

As indicated in the table, we noted the presence of water purification feature of the biofield. The total salinity of supplied water in 2012 amounted to 2,060.0 mg/L, and the salinity of released water – 1,652.0 mg/L. If in 2013 the total salinity of supplied water amounted to 2,001.0 mg/L, the salinity of the released water was 1,635.0 mg/L, i.e. the salinity was reduced by 12-17%.

Such biofield is suggested by Ukrainian scientists as well. According to their data, good growth of rush is observed in the water with the presence of lead nitrate. For example, the 3-5 mg/L of such lead is very dangerous for humans and animals. Each leaf of this plant has 22,500 holes. Through these openings rush sucks in all harmful substances. However, it is known that field tortula and Far Eastern buckwheat absorb metals heavier than water. Planting seedlings in biofield is also considered favourable. They take a variety of substances out of water.

In 2012 during water purification through the biofield, 118,000 m^3 of water was supplied, but the amount of salt received by the soil with supplied water amounted to 194.7 tonnes. Amount of the water supplied by the collector was 30,680 m^3, while the amount released from the collector of salt made up 57.1 tonnes[17].

Water purification through the biofield had a significant impact on the growth and yield of corn.

As it was shown by the results of the study, growth and development of corn during growing season went more intensively when water passed through the biofield in comparison with normal watering (Table 3).

The highest index (7,600 cm^2) of corn leaf area growth was observed in the second year (2013), i.e. during harvest the plant height reached

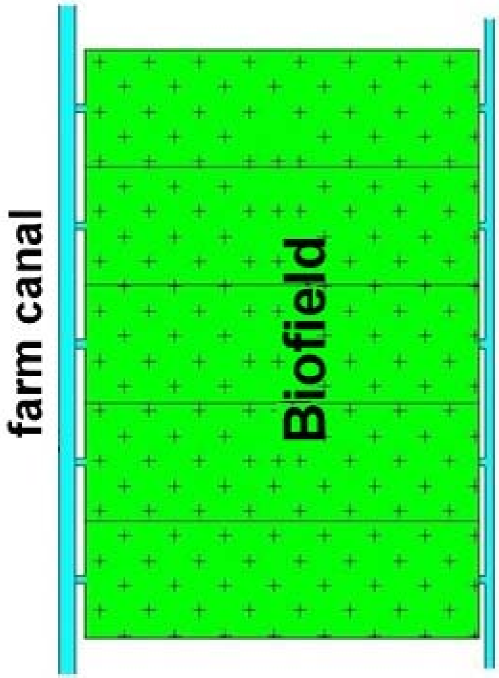

Fig. 2. Scheme of the biofield

220 cm.

There was also a high daily average growth of leaf area (Table 4).

The biggest rate of development of the leaf area is noted in the second half of July. During this period, there is the phase of releasing panicles and corn flowering.

During the harvest of corn crop sampling was carried out in each variant (Tables 5, 6)

As can be seen from the table, when water passed through the biofield corn yield was 40-83 cwt/ha bigger in comparison with regular watering. In 2012 extra 67 cwt/ha of corn yield was obtained, but in 2013 – 64 cwt/ha of the yield [18-20].

DISCUSSION

Water balance elements:

1. The volume of water supplied to the experimental plot – 0.118 million m^3.
2. Expenditures for water absorption from the main canals were calculated in the volume of the produced water amount.

F_k amount of water (water intake) • efficiency (1-efficiency canals) m^3/ s;

$$F_k = 0.118 \,.\, (1-0.62) = 0.045 \text{ mln } m^3.$$

3. According to the the weather station, the amount of atmospheric moisture for 2012-2013 was 168.4 mm [2].

$$168.4 \text{ mm} \,.\, 10 \,.\, 24 \text{ h}\alpha = 0.040 m^3$$

4. According to the "Hydrogeology" Institute, the amount of evaporation "Z is equal to the known index of plants and water movement evaporation

F_{total} – total area 724 h0;
F_{alf} – total alfalfa area 16 h0;
F_{scorn} – total area of silage corn 8 h0;
Z_{alf} – water evaporation from the land surface occupied by 12 hectares of alfalfa;
Z_{scorn} – water evaporation from the silage corn land 0.80 hectares;
(Table 7)

$$\sum Z = \frac{16 \cdot 12 + 8 \cdot 0.80}{24} = 0.08 \text{ thous. } m^3/\text{ha}$$

Drainage and collector water amounted to 0.031 million m^3.

6. Vertical absorption totalled 0.011 million m^3

Salt balance elements

1. Changes in soil salinity reserved were determined by the following formula:

$$\sum Z = (S_{irr} + S_{abs} + S_{atm}) - (S_{col} + S_{harv})$$

S_{irr} – the amount of salt that comes with canal waters 0.118 • 1.65 = 0.195 thousand tonnes;
S_{abs} – the amount of salt that comes with absorbed water 0.045•1.65=0.074 thousand tonnes;
S_{atm} – the amount of salt that comes with atmospheric moisture 0.040•0.85=0.034 thousand tonnes;
S_{col} – the amount of salt that comes with drainage and collector waters 0.031•1.99=0.062 thousand tonnes;
S_{harv} – salt released together with the crop harvest 0.120 thousand tonnes (Table 8).

According to these two tables, the amount of water that supplied the experimental plot with usual watering amounted to 0.204 million m^3 (2013), and water flow made up 0.121 million m^3. The difference of 0.083 million m^3 of water is lost. The water supplied to the experimental plot purified by the biofield was 0.195 million m^3, and the water flow amounted to 0.120 million m^3. The difference of 0.075 million m^3. During regular watering 0.363 thousand tonnes of salt goes to soil, at a salt consumption rate of 0,206 thousand tonnes, the difference of 0.157 thousand tonnes of salt stays in the soil. During watering with water purified by a biofield 0.287 thousand tonnes of salt goes to soil, at a salt consumption rate of 0.176 thousand tonnes, the difference of 0.111 thousand tonnes of salt stays in the soil.

CONCLUSIONS

Nowadays in order to further improve the water-salt regime of soils water should pass through the biofield. For preliminary purification of water biofield, sown with thick rush, should be located in the upper part of the crops. Its area should not be less than 2% of the irrigated area.

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