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S. B. Kenenbaev[1], R. Yelnazarkyzy[1], P. A. Kalashnikov[2], S. V. Didorenko[3]

[1]Non-Profit Joint-Stock Company "Kazakh National Agrarian University", Almaty, Kazakhstan,
[2]LLP "Kazakh research Institute of water management", Taraz, Kazakhstan,
[3]LLP "Kazakh Research Institute of Agriculture and Crop Production",
Almalybak village, Karasai district, Almaty region, Kazakhstan.
E-mail: serikkenenbayev@mail.ru, rahia@mail.ru, kalashnikov_81@inbox.ru svetl_did@mail.ru

THE EFFECT OF IRRIGATION REGIME ON THE YIELD OF SOYBEAN IN THE SOUTH AND SOUTH-EAST OF KAZAKHSTAN

Abstract. The quantitative indicators of irrigation norms depend on soil-hydrological features and climatic conditions of the region.

The highest yields in both zones were obtained with drip irrigation and wide range of two-line sowing, it is 51.6 c/ha in the conditions of the Kyrgyz Alatau, and it is 54.6 c/ha in the conditions of the Ili Alatau. The lowest yields were obtained with furrow irrigation in a wide range of single-line sowing.

Key words: irrigated agriculture, drip irrigation, soybean, total water consumption, irrigation norm.

Introduction. Cultivated crops require moisture, the bulk of which they are extracted from the soil, for the normal growth and development. According to many authors, soil moisture has the greatest availability for plants, close to the lowest moisture content. Moisture, as noted by many researchers, is one of the main and indispensable factors of plant life [1].

The irrigation regime of agricultural crops is a set of norms, number and terms of irrigation of each crop in the irrigated crop rotation in accordance with climatic, soil, agrotechnical, hydrogeological conditions of the geographical zone. It should meet the needs of plants in water during all periods of growth and development, taking into account the requirements of agricultural culture; to carry out optimal regulation of water and related nutrient, salt and thermal regimes of the soil; to promote soil fertility; to be linked with the technique and technology of irrigation [2].

Irrigation rationing and timing of irrigation are the main stages of resource-saving technology of cultivation, allowing obtaining the planned grain yields of soybeans, and are also a positive impact on irrigated areas [3].

Obtaining high yields of soybeans is complicated by unstable provision of the territory with atmospheric precipitation. In these conditions [4], irrigation plays a crucial role in the complex of agricultural activities for the cultivation of this crop. Irrigation regime is zonal in nature and it depends on soil-hydrological and weather conditions, method and technique of irrigation [5].

Materials and results. Zhambyl region is a part of the Shu-Talas water basin (WB), which consists of: Shui WMD (code 08.01.14) with three water management areas (codes 08.01.14.01, 08.01.14.02 and 08.01.14.03), Talas WMD (code 08.02.15) with two WMA (codes 08.02.15.01 and 08.02.15.02).

Placement of water management areas and sites, administrative areas and areas of the Shu-Talas WB on natural zones of moisture are given in table 1 and in figure 1.

Total water consumption and irrigation norm. Total water consumption is the total water consumption by the field for evaporation from the soil surface and transpiration of plants during the growing season. Water consumption consists of the moisture reserve of their soil used by plants, atmospheric

Table 1 – Location of WMD and WMA, administrative regions and districts
by natural and corresponding agro-climatic zones of moisture in the Shu-Talas water basin

The name of the water management districts, the code	Code of water management areas	Natural areas and coefficient of moisture (CM)	Administrative areas and districts
08 Shu-Talas water basin			
Shuy 08.01.14	08.01.14.01	Foothill semidesert – FSD, CM=0,25-0,20	Zhambyl region: Korday
	08.01.14.02	Foothill semidesert – FSD, CM =0,25-0,20	Merke, named after T. Ryskulov
		South desert – SD, CM=0.15-0.10	Shusky
	08.01.14.03	Foothill semidesert – FSD, CM=0,25-0,20	The Western part of the district T. Ryskulov
		South desert – SD, CM=0.15-0.10	Moyinkum, Shuy, the southern part of Merke the district after T. Ryskulov
		South desert – SD, CM=0.15-0.10	South Kazakhstan region: Sozak
Talas 08.02.15	08.02.15.01	Foothill semidesert – FSD, CM =0,25-0,20	Zhambyl region: Bayzak
		South desert – PU, Ku=0.15-0.10	Talas, South of Baizak, Zhambyl and Zhualy districts
	08.02.15.02	Foothill steppe – FS, CM=0,30-0,35	Zhualy
		Foothill semidesert – FSD, CM =0,25-0,20	Zhambyl, Zhualy, Sarysu
		South desert – SD, CM=0.15-0.10	Sarysu, Talas

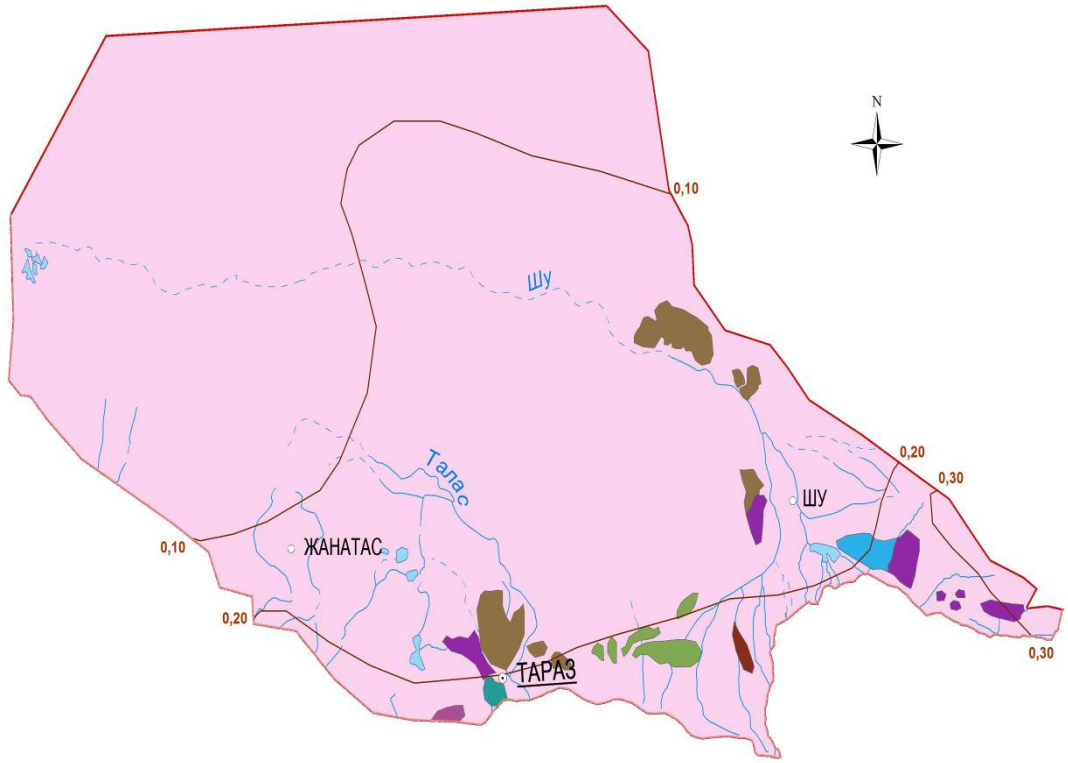

Figure 1 – Shu-Talas water basin

precipitation of the vegetation period, capillary recharge of groundwater (with their close occurrence) and irrigation water.

Evapotranspiration (total water consumption) is established by bioclimatic method according to the dependence of:

$$ET_{crop}=K_oK_v\ ET_o, \quad (1)$$

where ET_{crop} – crop evapotranspiration in m^3/ha; K_o – microclimatic coefficient; K_v – biological coefficient characterizing the role of plants; ET_0 – evaporation over monthly time intervals, determined by the formula N. N. Ivanova:

$$E=0.018(25+t)\ 2\ (100-a),\ m^3/ha, \quad (2)$$

where, t is air temperature, °C; a is relative humidity, %.

Irrigation norm is defined as the difference between evapotranspiration (total water consumption) of agricultural crop and its natural moisture supply. In irrigated areas with deep groundwater tables (>3 m) non-saline soils and its value were set according to:

$$M= ET_{crop} - W_a - P_{ef}, \quad (3)$$

where M is irrigation norm (net) on non-saline soils at deep (>3 m) groundwater table, m^3/ha; ET_{crop} is the evapotranspiration of agricultural crops, m^3/ha; W_a is productive reserves of soil moisture used by plants, m^3/ha; P_{ef} is precipitation during the growing season, m^3/ha.

Irrigation norms, that take into account soil-reclamation and hydrogeological conditions of the irrigated field, were established according to the following dependence:

$$M_{(n.м.)} = \frac{M - ET_{crop} \cdot K_г}{K_м}, \quad (4)$$

where M (p. m.) is the ecological irrigation rules providing for reclamation prosperity on irrigated land, m^3/ha; M is the irrigation net norm, for non-saline soils with deep (>3.0 m) the occurrence of groundwater, m^3/ha; ET_{crop} is total water consumption (evapotranspiration) of crops, m^3/ha; Kg is coefficient of permissible use of groundwater for subirrigation.

2. Water consumption norms of agricultural crops are adopted according to table 40 of "Integrated water consumption and sanitation norms in agriculture" and are given in table 2.

Table 2 – Aggregated norms of water consumption of soybean under drip and surface irrigation in Shuy water area 08.01.14, water sector 08.01.14.02

Cu, natural areas	Irrigated crops	Water consumption norms, m^3/ha								
		Soil-hydrogeological areas								
		automorphic, Groundwater>3 m			semihydromorphic, UHF=2-3 m			hydromorphous, UHF=1-2 m		
		Probability of exceedance, %								
		50	75	95	50	75	95	50	75	95
0,25-0,20, FSD	*Surface irrigation*									
	Soybean	4300	4950	6100	3050	3700	4850	2150	2800	3900
	Drip irrigation									
	Soybean	3400	3900	4850	2400	2950	3850	1700	2200	3100

Thus, the water consumption (m^3/ha) of soybean under drip and surface irrigation in Shuy water management region depends on the features of soil-hydrogeological state, i.e. in both cases the norms decrease with increasing hydromorphism. At the same time, the water consumption rate for drip irrigation is 900-1250 m^3/ha less than for surface irrigation.

Almaty oblast is part of the Balkhash-Alakol water basin (code 02) include water chemistry Ili (code 02.01.07) with seven water stations (codes with 02.01.02.01 for 02.01.02.07), Karatal-Aksu water

chemistry (code 02.02.03) two VAS (codes 02.02.03.01 and 02.02.03.02), Alakol-Sarykolsky water chemistry (code 02.03.00) two VAS (codes 02.03.00.01 and 02.03.00.02) and North Pribalkhashsky water chemistry (code 02.04.00) with one of VAS (code 02.04.00.00).

The location of the water chemistry and VAS, administrative regions and districts by natural zones of moisture are shown in table 3 and figure 2 (contour, Well built according to the SMS, not more than 1000 m above sea level).

Table 3 – Location of WCR and HCU, administrative regions and districts by natural and corresponding agro-climatic zones of moisture in the Balkash-Alakol water basin

The name of the water management districts, the code	Code of water management areas	Natural areas and coefficient of moisture (CM)	Administrative areas and districts
02 Balkash-Alakol water basin			
Ili 02.01.02	02.01.02.01	Mountain steppe – MS, CM=0,55-0,60	Almaty region: Raiymbek, river basin Tekes
	02.01.02.02	Foothill steppe – FS, CM=0,35-0,40	Uighur, southern part
		Foothill semidesert – FSD, CM=0.20 to 0.25	The Uighur, a central part
		South desert - SD, CM=0.10-0.15	Uighur, Northern part
	02.01.02.03	Foothill steppe – FS, CM=0,35-0,40	Panfilov, Northern part
		Foothill semidesert – FSD CM=0.20 to 0.25	Panfilov Central part
		South desert - SD, CM=0.10-0.15	Panfilov, southern, Kerbulak, southern Talgar, Shengeldy array
	02.01.02.04	Mountain steppe – MS, CM=0,55-0,60	Raiymbek, the basin of the river Kegen
	02.01.02.05	Foothill steppe – FS, CM=0,35-0,40	Southern parts of Enbekshikazakh, Talgar, Karasay districts
		Foothill semidesert – FSD CM=0.20 to 0.25	Central parts of Enbekshikazakh, Talgar, Karasay districts
		South desert - SD, CM=0.10-0.15	Northern parts of Enbekshikazakh, Talgar, Karasay districts
	02.01.02.06	South desert - SD, CM=0.10-0.15	Balkhash, the North-Western part of the Karasai district
	02.01.02.07	Foothill semidesert – FSD CM=0.20 to 0.25	Zhambyl, southern part
		South desert - PU, Ku=0.10-0.15	Ili, Zhambyl, Northern part
		South desert - SD, CM=0.10-0.15	Zhambyl oblast: Moyinkum and Shuy districts
Karatal-Aksu 02.02.03	02.02.03.01	South desert - SD, CM=0,15-0,20	Almaty region: Karatal district
		Foothill semidesert – FSD CM=0.20 to 0.25	Koksu, Eskeldy, Kerbulak, the Northern part
	02.02.03.02	South desert - SD, CM=0,15-0,20	Aksu, Sarkand
		Foothill semidesert – FSD CM=0.20 to 0.25	
Alakol- Sasykkol 02.03.00	02.03.00.01	Foothill semidesert – FSD CM=0.20 to 0.25	Almaty region: the Eastern part of the Alakol district
		South desert - SD, CM=0,15-0,20	
		Northern desert - ND, CM=0,15-0,20	East Kazakhstan region: Eastern part of Urzhar district
		Foothill semidesert – FSD CM=0.20 to 0.25	
	02.03.00.02	Foothill semidesert – FSD CM=0.20 to 0.25	Almaty region:Western part of Alakol district
		South desert - SD, CM=0,15-0,20	
		Northern desert – ND, CM=0,15-0,20	East Kazakhstan region: Western part of Urzhar district
		Foothill semidesert – FSD CM=0.20 to 0.25	
North Balkash 02.04.00	02.04.00.00	South desert - SD, CM=0.10-0.15	Zhambyl region: North-Eastern part of Moyinkum district
		North desert – ND, CM=0.10-0.15	Karaganda region: southern part of Aktogay district
		Northern desert – ND, CM=0,15-0,20	Almaty region: North-Western part of Alakol district
		Semi-desert – SD, CM=0,25-0,20	East Kazakhstan region: Ayagoz district

Figure 2 – Balkash-Alakol water basin

Water consumption norms of agricultural crops are adopted according to table 40 of "Integrated water consumption and sanitation norms in agriculture" and are given in table 4.

Table 4 – Aggregated norms of water consumption of soybean under drip and surface irrigation water management in the Ili district water area 02.01.02, water sector 02.01.02.05

CM, natural zone	Irrigated crops	Water consumption norms, m^3/ha								
		Soil-hydrogeological areas								
		automorphic, Groundwater>3 m			semihydromorphic, UHF=2-3 m			hydromorphous, UHF=1-2 m		
		Probability of exceedance, %								
		50	75	95	50	75	95	50	75	95
0,25-0,20, FSD	*Surface irrigation*									
	Soybean	4050	4700	5800	2600	3200	4200	1550	2000	3000
	Drip irrigation									
	Soybean	3200	3700	4600	2050	2550	3350	1250	1600	2350

Quantitative indicators of water consumption (m^3/ha) also depend on the characteristics of the soil-hydrological state, the greater the hydromorphism, the less irrigation norms in the Balkhash-Alakol basin in the Ili water management region. At the same time, the water consumption rate in the Shuy water management region as a whole is 200-300 m^3/ha higher than in the Ili water management region due to the arid climatic conditions of the region.

Table 5 – Comparative assessment of the elements of productivity, yield and quality of soybean seeds of the Lastochka variety depending on the methods of sowing and irrigation

Irrigation method	Method of sowing, aisles, cm	Yield, c/ha	Protein, %	Fat, %
Kyrgyz Alatau				
Drip irrigation	45	49,6	40,2	19,8
	50x20	51,6	39,8	19,5
Furrow irrigation	45	41,5	40,1	20,1
	50x20	43,6	40,6	20,4
Ili, hospital (Kaz NIACP)				
Drip irrigation	45	52,6	39,1	19,2
	50x20	54,6	39,6	19,5
Furrow irrigation	45	44,5	39,4	19,8
	50x20	46,6	39,8	19,2

The results of studies to assess the elements of productivity and quality of soybean seeds cultivated with drip and surface irrigation in the areas of Kyrgyz Alatau of Zhambyl region and Ili Alatau of Almaty region showed that these indicators were more aligned and were within their genetic limits.

At the same time, there is a fairly high stability despite the conditions of their cultivation both in terms of large-scale and quality. The level of protein in the variety Lastochka was within 39.1-40.6% and fat was 19.2-20.4%.

It is known that the integral indicator is the productivity of cultures. This figure varies depending on the conditions of cultivation. The highest yields in both areas of the experiments were obtained by drip irrigation on a wide range two-line sowing. It is 51.6 c/ha in the conditions of the Kyrgyz Alatau, and 54.6 c/ha in the conditions of the Ili Alatau. The lowest yields were obtained by furrow irrigation on a wide range two-line sowing.

Conclusion. The studies done in the Shu-Talas Water basin of Zhambyl region and Balkhash-Alakol basin of Almaty region revealed that the quantitative indicators of the irrigation norm (m^3/ha) depend on the characteristics of the soil-hydrological state (the more hydromorphic, the less than the norm), the agro-climatic conditions of the region (the drier, the more irrigation standards).

The highest yields were obtained by drip irrigation on a wide range two-line sowing in both zones. It is 51.6 c/ha in the conditions of the Kyrgyz Alatau, and 54.6 c/ha in the conditions of the Ili Alatau. The lowest yields were obtained by furrow irrigation on a wide range single-line sowing.

С. Б. Кененбаев[1], Р. Елназаркызы[1], П. А. Калашников[2], С. В. Дидоренко[3]

[1]НАО «Қазақ ұлттық аграрлық университеті», Алматы, Казахстан,
[2]«Қазақ су шаруашылығы ғылыми-зерттеу институты» ЖШС, Тараз, Казахстан,
[3]Қазақ егіншілік және өсімдік шаруашылығы ғылыми зерттеу институты,
Алмалыбак ауылы, Карасай ауданы, Алматы облысы, Қазақстан

ҚАЗАХСТАННЫҢ ОҢТҮСТІК ЖӘНЕ ОҢТҮСТІК-ШЫҒЫС АЙМАҒЫНДА СУ РЕЖИМІНІҢ МАЙБҰРШАҚ ДАҚЫЛЫНЫҢ ӨНІМДІЛІККЕ ӘСЕРІ

Аннотация. Суару жылдамдығының сандық көрсеткіштері аймақтың топырақ-гидрологиялық қасиеттеріне және климаттық жағдайларына байланысты.

Екі аймақта жоғары өнімділік Қырғыз Алатауының 51,6 ц/га жағдайында тамшылап суару және кең жолақты екілік егістік алынды, ал Іле Алатауының жағдайында – 54,6 ц/га Төменгі өнімділік көрсеткіші далалық алқапта қарықпен суару арқылы алынған.

Түйін сөздер: суармалы егіншілік, тамшылатып суару, майбұршақ, жалпы су тұтыну, суару жылдамдығы.

С. Б. Кененбаев[1], Р. Елназаркызы[1], П. А. Калашников[2], С. В. Дидоренко[3]

[1]НАО «Казахский национальный аграрный университет», Алматы, Казахстан,
[2]ТОО «Казахский научно-исследовательский институт водного хозяйства», Тараз, Казахстан,
[3]ТОО «Казахского научно-исследовательского института земледелия и растениеводства»,
пос. Алмалыбак, Карасайский район, Алматинская область, Казахстан,

ВЛИЯНИЕ РЕЖИМА ОРОШЕНИЯ НА УРОЖАЙНОСТЬ СОИ НА ЮГЕ И ЮГО-ВОСТОКЕ КАЗАХСТАНА

Аннотация. Количественные показатели оросительной нормы зависят от почвенно-гидрологических особенностей и климатических условий региона.

Наивысшие показатели урожайности в обеих зонах получены при капельном орошении и широкорядном двустрочном посеве, в условиях Киргизского Алатау 51,6 ц/га, а в условиях Илийского Алатау – 54,6 ц/га. Самые низкие показатели урожайности получены при бороздковом поливе в широкорядном однострочном посеве.

Ключевые слова: орошаемое земледелие, капельное орошение, соя, суммарное водопотребление, оросительная норма.

Kenenbayev Serik Barmanbekovich, Kazakh Professor, Doctor of Agricultural Sciences, National Agrarian University, Almaty, Kazakhsta; serikkenenbayev@mail.ru; https://orcid.org/0000-0003-1745-8475

Yelnazarkyzy Rahiya, PhD student of 3 year- study at the Kazakh National Agrarian University, Almaty, Kazakhsta; Rahia@mail.ru; https://orcid.org/0000-0002-6653-7041

Kalashnikov Pavel Alexandrovich, Candidate of Technical Sciences, “Kazakh research Institute of water management”, Taraz, Kazakhstan; kalashnikov_81@inbox.ru; https://orcid.org/0000-0003-0506-9130

Didorenko Svetlana Vladimirovna, Candidate of Biological Sciences, Head of Leguminous Crops Department, Kazakh Research Institute of Agriculture and Crop Production; svetl_did@mail.ru; https://orcid.org/0000-0002-2223-0718

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