Bulgarian Journal of Agricultural Science, 25 (No 2) 2019, 337–344

Cultivation of agricultural crops with irrigation in Amur region

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Abstract

Makannikova, M. V., Lapshakova, L. A., & Belmach, N. V. (2019). Cultivation of agricultural crops with irrigation in Amur region. *Bulgarian Journal of Agricultural Science*, *25*(2), 337–344

The following article examines the importance of rice and oats cultivation in the light of current food balance in Russia. One of the problems of their low yield that the authors consider is climatic conditions in the region. They go on to prove the importance of research which is related to the need of developing effective water regimes for the cultivation of grain crops while observing current principles of water conservation and environmental safety requirements of production. Experimental studies that were conducted during the research period have proved the regularity of formation of production process and yield of adapted rice and oats varieties and their dependence on the irrigation and mineral nutrition regimes. The authors have proved that it is possible to obtain the yield of oats at the level of 5.4 t/ha under the irrigation regime of 80% of minimum moisture capacity (MMC) and the dose of mineral fertilizers of $N_{45}P_{45}K_{45}$.

Keywords: rise; oats; irrigation; fertilizers; Amur region; Russia

Introduction

Rice plays an important role in Russia's current food balance. It occupies a leading position in the amount of sowing areas, yield, and gross harvest among all cereal crops. The demand for rice among the population increases every year. A necessity to meet the population's need for rice appears to push this matter forward by relying only on the country's domestic resources because of the limited imports of cereals due to their low quality. The increase and stabilization of grain production in Amur region can help solving this problem by expanding crop varieties composition. Given the climatic features of Amur region in its southern areas, the amount of heat and light will be sufficient for cultivating such a dietary culture as rice. Currently it is being cultivated only in Primorsky region within Far Eastern Federal District. However, its present production volumes are insufficient to meet the local population's growing food need. The relevance of the present research is determined by the need to develop efficient water regimes for rice cultivation in compliance with the principles of water conservation and environmental safety requirements of production. Reducing water spending for irrigation of rice is of great economic, social and environmental importance. Solving these issues will help to use irrigated land and water resources more effectively, as well as to increase the plant yield.

There is an opinion that it is possible to reduce the rice irrigation rate to the volume of water consumption for transpiration and evaporation off the soil surface. This can be implemented by replenishing soil moisture of a rice field by periodical watering (Makannikova and Lapshakova, 2015). In this connection, the idea of using agricultural waste for irrigation and fertilization of crops is also interesting (Kovshov and Skamyin, 2017; Kovshov and Iconnicov, 2017). According to many scientists the methods of periodic watering are connected, in the first place, with soil moisture level (Makannikova and Belmach, 2014). In the situation of periodic watering, the soil moisture content prior to seed germination phase should be at least 65-70% of minimum moisture capacity; and starting from the tillering phase – no less than 75-80% of minimum moisture capacity. A very important point is the choice of an efficient irrigation regime, considering rice's biological need in soil moisture. The number of watering sessions during vegetation period can vary from 2 to 15, depending on the cultivation region. Water consumption can be reduced by 2-3 times compared to traditional technologies of rice cultivation. Periodic watering can be applied in cultivating upland or moisturized rice varieties (Ali and Talukder, 2008; Rahman and Singh, 2014).

Among other cereal crops oats is an advantageous forage crop for Amur region. Currently oats yield remains low with moisture being one of the main causes of this, namely, its lack in the beginning of vegetation, and, on the contrary, its excess in the phase of plant's complete ripeness. The present development of agricultural production is based on the growth of oats gross output due to the increase and stabilization of its yield, by improving soil water and supply regimes. Livestock production development pushes forward the need to increase the fodder base and, as a result, to expand grain crops own areas. Oats, in comparison with other grain crops, is the most valuable energy culture for horse breeding.

The purpose of the research: a development of efficient crops sprinkling irrigation regimes and rational use of water resources in the southern agricultural zone of Amur region.

To achieve this goal, the following tasks were set:

– to develop efficient irrigation regimes considering soil and climatic conditions of Amur region;

– to determine the structure of total water consumption under different water regimes of soils under grain crops;

– to determine an optimal mineral fertilizers dose for stable oats yields;

– to study the influence of key factors on growth, development, productivity and quality of grain of the crops under consideration.

Methods

Research studies were carried out at the experimental field base of Far Eastern State Agrarian University, located in Gribskoye irrigation system (Blagoveschensk district, Amur region).

The minimum water capacity, water permeability and filtration properties of soil at the experimental plot were determined by using the method of small flooded areas with two 0.25×0.25 and 0.5×0.5 meter frames.

The moisture content of soil was determined by using the weight (thermostatic-weight) method before sowing, throughout the vegetation season, two days before watering, two days after watering and after rice harvesting. Soil samples were selected three times in layers of 0 to 1 meter on the experimental field base. Soil moisture levels were determined by using the organoleptic analysis. Soil sampling selection periods, probe repeatability, size and location of observation sites and drilling well placements were determined according to Rode's method (Rode, 1960).

Phenological observations were carried out according to the generally accepted methodology of state variety testing of agricultural crops on specially designated dynamic areas.

After a mass sprouting of rice and oat, field germination record was conducted. The percentage of grown plants was counted on an area of 0.25 m^2 scaling it to 1 m^2. The plant density and height were measured by the sample plot method, the records were taken during growth and development phases of rice. Twenty sample plants were selected with a 3-fold repetition from each dynamic sample plot. The accumulation of dry plant mass was calculated by drying the plants.

Main photosynthetic indices were determined by the methods of Nichiporovich et al. (1961). A correction coefficient of 0.789 was used when calculating leaf surface area. Calculation of crops infestation during full standing period and before harvesting was carried out using the marking method – 0.25 m^2 in a 10-fold repetition.

The biological yield was measured by selecting sheaves from 1 m^2 of sample plot in a 3-fold repetition during full ripeness of grain. The economic yield was measured by continuous harvesting. With all gathered data of crop yield at hand, a mathematical data processing was done using a variance analysis according to Dospekhov's method (Dospekhov, 1985) with the help of MS Excel and Statistika-6 software.

The soil composition of the sample plot for rice cultivation consists of meadow-brown soils. The density of soil composition in the designed layers (0.4 m and 0.6 m) was 1.27 and 1.33 t/m^3; the lowest soil moisture capacity – 23.17-22.50%; porosity – 50.42% and 49.18%. The content of decomposed organic matter in the designed soil layers was low (2.53% and 2.13%); easy hydrolyzable nitrogen – 3.5 and 2.7 mg/100 g; the content of mobile phosphorus – 48.7 and 37.8 mg/kg; the content of exchange potassium was 138 and 122.5 mg/kg.

The soil composition of the sample plot for cultivating oats is represented by meadow chernozem (black earth) soils. The density of soil composition in the designed layer (0.4 m) was – 1.05-1.37 t/m^3; the lowest soil moisture capacity was 33.5-30.9%; the porosity was 58.8-49.2%. The content of decomposed organic matter in the arable horizon was 3.42-3.86%; the easy hydrolyzable nitrogen – 1.5-4.6 mg/kg; the content of mobile phosphorus was 64%; the exchange potassium was 184 mg/kg of soil.

Experimental studies on the validation of rice sprinkling irrigation regimes were conducted with early-ripening rice varieties in bifactorial test.

Factor A. Impact assessment of different levels of water supply on the formation of production process and yields of rice varieties during sprinkling.

The test design in water regime provided for three variants (options) of water supply for crops:

A1 is a soil water regime, differentiated during the interphase periods of rice ripening: maintaining pre-watering moisture of at least 75% of the minimum moisture capacity (MMC) in 0.4-meter layer during the sowing-tillering period; in 0.6-meter layer – maintaining the pre-watering moisture of at least 85% of MMC during tillering-grain yellow ripeness period;

A2 – maintaining pre-watering moisture of no less than 80% of MMC during sowing-tillering period in 0.4-meter layer; then further during tillering-grain yellow ripeness period – maintenance of pre-watering moisture of no less than 80% of MMC in 0.6-meter layer;

A3 (control) – maintaining the pre-watering moisture of no less than 80% of MMC in 0.6-meter layer throughout rice vegetation period.

According to factor B (variety), the tests included B1 – classified as "Khankaisky 429" variety; B2 – "Rassvet" variety.

The test variations were conducted in a standard manner in a fourfold replication. Agrotechnics of rice cultivation in field experiments were carried out based on zonal recommendations, supplemented by its variants of studied methods. Total water consumption was calculated by Kostyakov's method (Kostyakov, 1960).

Studies for irrigated cultivation of oats were carried out in a bifactorial field experiment:

Factor A. Water regime. The experiment design provided for three options of crops water supply:

A0 – control (without watering);

A1 – maintaining pre-watering moisture of at least 70% of MMC in 0.4-m layer throughout the entire oats vegetation period;

A2 – maintaining pre-watering moisture of at least 80% of MMC in 0.4-m layer throughout the entire oats vegetation period;

A3 – maintaining the pre-watering moisture of at least 90% of MMC in 0.4-m layer throughout the entire oats vegetation period.

Factor B. Fertilizer doses were studied: B0 – control (no fertilizers); B1 – $N_{30}P_{30}K_{30}$; B2 – $N_{45}P_{45}K_{45}$; B3 – $N_{60}P_{60}K_{60}$.

Crops watering was done by a sprinkling machine "Rosa-3" using a two-nozzle mid-jet nozzle of circular action (with watering distance of 10-15 m and flow speed of 4 l/s).

While analyzing Amur region's climatic parameters, an irregular distribution of precipitation during grain crops vegetation period was noted, which, in return, negatively affects their development.

Rice will grow on different soils and in different climatic conditions with a well-regulated water supply (Agareov and Kharitonov, 2007). The key factor to rice's high yields is a suitable watering regime observation on the field. Rice watering regimes may vary depending on the degree of soil salinity, weed control methods and other parameters (Zueva et al., 2008; Dubenok et al., 2015).

Scientists of Amur State Experimental Agricultural Laboratory have proved that oats require more moisture during its initial period of vegetation (T. M. Slobodyanik, V. M. Sayapina). The questions of oat cultivation were studied by G. A. Batalova, A. S. Mitrofanov, N. M. Stepkin, V. I. Rafalsky, P. P. Chalkin (Batalova, 2000; Belmach, 2014). A huge contribution to the development of watering regimes for agricultural crops was made by S. M. Alpatiev, M. I. Bagrov (Kruzhilin, 2004a, b). The issues of plants' mineral nutrition were studied (Technology of spring grain, 2001; Shuravilin and Kibeka, 2006). Synthesizing of scientific research and practical experience allowed formulating a certain goal and objectives of the research. Its solution is aimed at increasing the efficiency of grain crops cultivation in Amur region, ensuring a sustainable functioning of agricultural land-improvement landscapes.

Results and Discussion

For the first time in the southern zone of Amur region, the basic patterns of production process formation and yield capacity of adapted varieties of rice and oats, depending on irrigation and mineral nutrition regimes were determined.

The development of efficient watering parameters for rice during sprinkling allowed to obtain optimal irrigation value rates, while the efficiency of water use is largely determined by irrigation regimes and meteorological conditions. As field research has shown, the most favorable in terms of moisture accumulation for rice cultivation was year 2013, when the amount of precipitation during vegetation period exceeded perennial standard values by 166 mm. In differentiated moisturizing test, conducted in 2013, it was necessary to have 2 vegetative waterings of irrigation standard for "Khankaisky 429" variety – 560 cubic meters per hectare (m^3/ha); for "Rassvet" variety – 530 m^3/ha. During the same test in 2011, it took 8 watering procedures of 2060 m^3/ha for "Khankaisky 429" variety; and 6 watering procedures of 1560 m^3/ha for "Rassvet" variety; in 2012 the watering standard for "Khankaisky 429" variety was 1810 m^3/ha, and 1560 m^3/ha for "Rassvet" variety. The atmospheric moisture percentage in rice's total water consumption under different watering regimes was 54.5-72.1% in 2011; 62.8-74.6% in 2012 and 87.5-97.9% in 2013.

The field test results revealed that soil moisture is used in rice development only during the initial period of plant development and accounts for about 1% of total water consumption. The percentage of irrigation water in the structure of rice crops total water consumption varied from 10.0-15.1% (in 2013) to 50.9-57.1%, based on irrigation water supplies (Table 1).

It should be noted that water consumption of rice has been changing throughout the vegetation period according to plant growth phases. It increased along with plant growth and root system development and peaked by the interphase period of "booting-ear formation". It was 1952.1 m^3/ha for "Khankaisky 429" variety; and 1705.6 m^3/ha for "Rassvet" variety in the first variant of the test with 75%-85% of MMC (0.4 and 0.6 m). In the third test variant with 80% of MMC (0.6 m), by the interfacial period of "booting-ear formation", water consumption for "Khankaisky 429" variety amounted 2256.6 m^3/ha and 2032.2 m^3/ ha for "Rassvet" variety. The lowest water consumption level of rice falls on "sowing-sprouting" period with 127.8 m^3/ha and "yellow ripeness-complete ripeness" period with 99 m^3/ha while maintaining a pre-watering moisture threshold of at least 75%-85% of MMC (0.4 and 0.6 m). The obtained data allows to determine the irrigation timing periods, as well as to give a characteristic of rice plants' requirements in moisture.

Table 1. Structure of rice's total water consumption

Pre-watering moisture, % of MMC	Year of research	Total water consumption (E), m^3/ha	Irrigation rate		Amount of moisture from precipitation		Use of natural soil moisture reserves	
			m^3/ha	% of E	m^3/ha	% of E	m^3/ha	% of E
Option 1: 75%-85% MMC, 0,4 m and 0,6 m	Khankaisky 429 rice variety							
	2011	3750	2060	54,9	2410	64,3	-720	-19,2
	2012	4830	1810	37,5	3520	72,9	-500	-10,4
	2013	5598	560	10,0	5460	97,5	-422	-7,5
	average	4726	1476	31,3	3797	80,3	-547	-11,6
	Rassvet rice variety							
	2011	3010	1560	51,8	2170	72,1	-720	-23,9
	2012	4180	1560	37,3	3120	74,6	-500	-11,9
	2013	5198	530	10,2	5090	97,9	-422	-8,1
	average	4129	1216	29,4	3460	83,8	-547	-13,2
Option 2: 80% of MMC, 0.4 m and 0.6 m	Khankaisky 429 rice variety							
	2011	3780	2160	57,1	2410	63,8	-790	-20,9
	2012	5040	2160	42,8	3520	69,8	-640	-12,6
	2013	5646	690	12,2	5460	96,7	-504	-8,9
	average	4822	1670	34,6	3797	78,7	-645	-13,3
	Rassvet rice variety							
	2011	3200	1820	56,9	2170	67,8	-790	-24,7
	2012	4300	1820	42,3	3120	72,5	-640	-14,8
	2013	5306	800	15,1	5010	94,4	-504	-9,5
	average	4269	1480	34,7	3434	80,4	-645	-15,1
Option 3: 80% of MMC, 0.6 m (control)	Khankaisky 429 rice variety							
	2011	4420	2380	53,8	2410	54,5	-370	-8,3
	2012	5780	2380	41,1	3630	62,8	-230	-3,9
	2013	6190	680	11,0	5460	88,2	50	0,8
	average	5463	1813	33,2	3833	70,1	-183	-3,3
	Rassvet rice variety							
	2011	4010	2040	50,9	2340	58,3	-370	-9,2
	2012	4930	2040	41,4	3120	63,2	-230	-4,6
	2013	5820	680	11,7	5090	87,5	50	0,8
	average	4920	1587	32,3	3516	71,4	-183	-3,7

With differentiated moisturizing the water consumption coefficient averaged 985.4 cubic meters per ton (m^3/t) for “Rassvet” variety over the years of research, and 1078.9 m^3/t for “Khankaisky 429” variety, which is 111.7-149.9 m^3/t less, compared with 80% of MMC variant in “sowing-tillering” period in 0.4-m layer; further in “tillering-wax ripeness” period in 0.6-m with 80% of MMC and 405.6-412.3 m^3/t less than control. The correlation analysis established a strong inverse dependence (r = 0.92 and – 0.94) that can be traced between yield and water consumption coefficient.

Consequently, the research results revealed that the most efficient parameters of rice sprinkling irrigation regime are achieved by using differentiated moisturizing: 75% of MMC in 0.4-m layer during “sowing-tillering” period, in 0.6-m layer – 85% of MMC in “tillering-wax ripeness”, which contributes to considerable decrease of water used for obtaining planned yields of grain.

Our researchers showed that 75-85% of MMC (of 0.4 and 0.6-m) variant is the best sprinkling irrigation regime for rice, while the grain yield in this regime estimated to 3.58-5.37 t/ha for “Rassvet” and 3,36-5,75 t/ha for “Khankaisky 429” variety (Table 2).

Our study showed that during the initial periods of rice development the leaf surface index was insignificant and varied from 0.26 to 0.45 in the test variants. During flowering period the leaf square area reached the maximum values and amounted, according to the test variants: with sprinkling irrigation of “Khankaisky 429” – 38.45-44.04 thousand m^2/ha; of “Rassvet” – 29,85-36,30 thousand m^2/ha; at surface flooding, respectively, 44.78-47.08 and 38.45-47.61 thousand m^2/ha.

As the studies have shown, the dependence of grain yield on photosynthesis net productivity (PNP) and photosynthetic potential (PP) is characterized by a high degree of convergence, as indicated by the correlation coefficients, correspondingly for “Khankaisky 429”, r = 0.79-0.98 and r = 0.83-0.91; and for “Rassvet”, r = 0.86-0.99 and r = 0.97-0.99.

As the correlation analysis showed, there was a linear regression relationship between the height of rice plants and its yield. The correlation coefficient (r) varied in the test variants from 0.85 to 0.99 for “Khankaisky 429” variety and from 0.54 to 0.99 for “Rassvet” variety.

When rice was cultivated in the first test variant, the content of protein in grain was 8.2%-8.5%, the content of starch was 55.7%-54.8%, the content of raw fat was 0.9-1.0% and the content of fiber was 0.5% in both rice varieties. For the second and third tests of 80% MMC (0.4 and 0.6 m) and 80% MMC (0.6 m) quality indicators for “Khankaisky 429” variety were the following: protein 8.1%-8.3%; starch 51.4%-52.4%; raw fat 0.8%; fiber 0.4%. For “Rassvet” variety quality indicator values were the following: protein 7.5%-7.9%; starch 52.8%-54.1%; raw fat 0.8%; fiber 0.4%-0.5% (Yasonidi, 2004).

In 2009 and 2010 in the test version of 70% of MMC for oat cultivation each time a single irrigation procedure was made. In 2011 two irrigation procedures of 450 m^3/ha of an irrigation rate value were made. An average irrigation rate value was estimated at 600 m^3/ha. An increase of pre-watering humidity threshold up to 80% of MMC involved an increase of irrigation procedures: 2 in 2009 and 2010, 3 in 2011, with an irrigation rate value of 300 m^3/ha. The irrigation rate value increased to 700 m^3/ha. The 90% of MMC regime was supported by the largest number of irrigation procedures: 5 in 2009, 6 in 2010, 7 in 2011 with a rate value of 150 m^3/ha. The irrigation rate value was estimated as 900 m^3/ha.

The highest value of the total water consumption of 4071 m^3/ha was in the 90% of MMC test variant; its lowest value of 3818 m^3/ha was in the test variant of 70% of MMC, and the most appropriate 3923 m^3/ha was obtained in the irrigation regime of 80% of MMC. Atmosphere precipitation moisture takes the biggest portion in the structure of total water consumption: 81.5% for 70% of MMC; 79.2% for 80% of MMC and 75.5% for 90% of MMC. The share of

Table 2. Grain yield of early ripening rice varieties, t/ha

Irrigation regime	Variety							
	Rassvet				Khankaisky 429			
	2011	2012	2013	average	2011	2012	2013	average
Method of irrigation: sprinkling								
Option 1: 75-85% of MMC (0.4 m and 0.6 m)	3,58	3,61	5,37	4,19	3,36	4,03	5,75	4,38
Option 2: 80% of MMC (0.4 m and 0.6 m)	3,12	3,54	4,61	3,76	2,85	3,79	5,51	4,05
Option 3: 80% of MMC (0.6 m), (control)	2,97	3,49	4,09	3,52	2,64	3,45	4,94	3,68
MED* 05 (2011) = 0,16; MED05A = 0,120; MED05B = 0,098 MED 05 (2012) = 0,200; MED05A = 0,142; MED05B = 0,116 MED 05 (2013) = 0,16; MED05A = 0,116; MED05B = 0,095								

* MED – minimum essential difference

irrigation water in oats water consumption was estimated 15.6%, 17.8% and 22.1% for the irrigation regimes of 70% of MMC, 80% and 90% of MMC, respectively. The use of soil moisture reserves was insignificant: 2.8-3.0% (Fig. 1).

Correlation analysis showed that the dependence of the total water consumption of oats on different moisture conditions is expressed by a strong ordinal relation (R = 0.99). A weak correlation was observed between total water consumption and oats yield (R = 0.96).

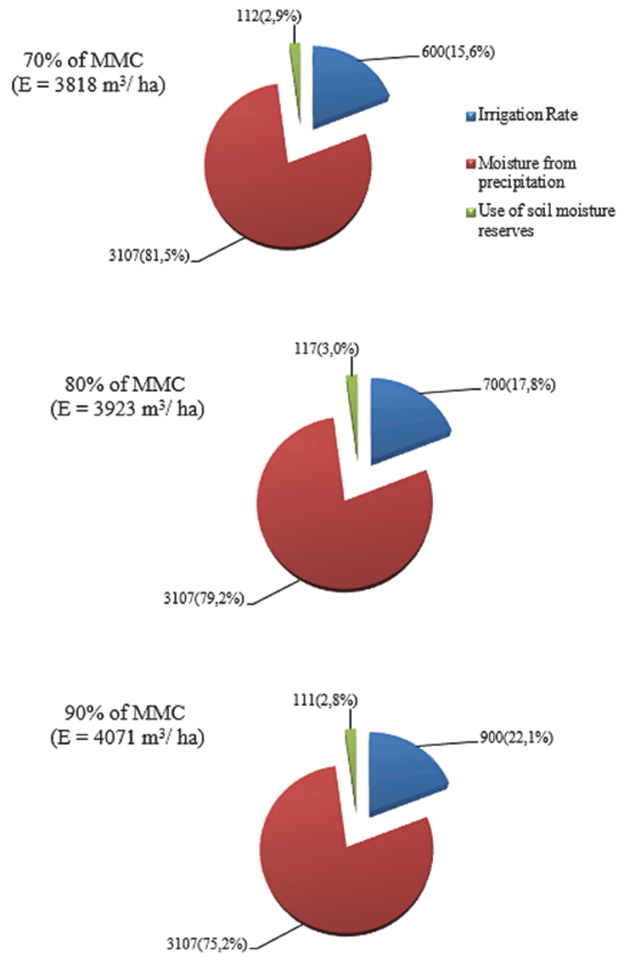

Figure 1. Structure of total water consumption of oats during sprinkling, m³/ha

During "booting-tasseling" period the average daily water consumption was the highest and amounted to 79.9 m³/ha, 76.2 and 79.1 m³/ha in 70% of MMC, 80 and 90% of MMC, respectively. Subsequently, it gradually reduced to 14.0 m³/ha, 13.3 and 12.8 m³/ha per day during "yellow ripeness-complete ripeness" period.

Research tests have revealed that natural moisture and irrigation water were consumed in the most efficient way while maintaining soil moisture level at 80% of MMC. The water consumption multiplying factor (coefficient) there was 780 m³/t, and the amount of irrigation water for obtaining 1 ton of oats grain estimated to 140 m³/t. In the test variants of 70% of MMC and 90% of MMC, natural moisture and irrigation water were consumed less efficiently – 898 and 141 m³/t; 905 and 200 m³/t, respectively (Table 3).

With the prevailing conditions during the research period, the duration of oats vegetative development phases varied from 79 to 87 days. It was determined that in all test variants square area of oat leaves reached its largest values during booting phase and varied from 34.4 to 42.0 thousand square meters per hectare. The biggest growth of the leaf surface was observed in the irrigation regime of 90% of MMC (2.6-42.0 thousand m³/ha). Introduction of fertilizers contributed to the increase of developing leaf surface. The highest values of this indicator were obtained in $N_{45}P_{45}K_{4}5$ and $N_{60}P_{60}K_{60}$ variant.

The analysis of the correlation dependence of "leaf surface square area-grain yield" indicators has revealed a compound relationship. The correlation multiplying factor (coefficient) made up to 0.26-0.75, depending on the development phase.

Introduction of fertilizers during all irrigation regimes led to an increase of photosynthetic potential, with its highest values obtained in the 90% of MMC regime against a background of mineral nutrition $N_{60}P_{60}K_{60}$ (1,729,400 m²/ha).

Oats has a great plasticity and combining ability in the yield forming. The best indicators of the crop yield structure were obtained with the moisture content of the designed soil layer at the level of no less than 80% of MMC. Introduction

Table 3. Water consumption multiplying factor (coefficient) and irrigation water amounts in different oat irrigation regimes (fertilizer dose: $N_{45}P_{45}K_{45}$)

Pre-irrigation soil moisture, % of MMC	Total water consumption, m³/ha	Grain yield, t/ha	Irrigation rate value, m³/ha	Water consumption multiplying factor, m³/t	Amount of irrigation water per ton of oat, m³/t
70	3818	4.2	600	898	141
80	3923	5.0	700	780	140
90	4071	4.5	900	905	200

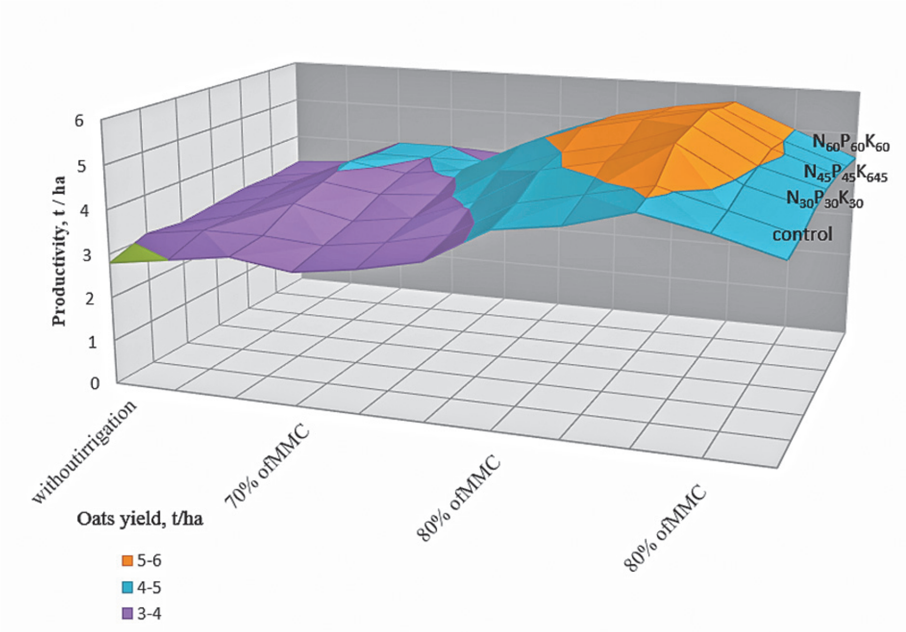

Fig. 2. Influence of irrigation regimes and fertilizer doses on oats yield, t/ha

of mineral fertilizers in various doses increased the structural indicators of oats yield. The indicators "number of productive stems- yield", "number of seeds in a panicle-yield", "1000 seeds' mass-yield" were marked with direct correlation, with their coefficients being r = 0.73; r = 0.56; r = 0.79 and r = 0.71, respectively.

The average oats yield varied within 3.7-4.6 t/ha during research years while keeping soil moisture level at 70% of MMC, and with soil moisture level at 80% of MMC it varied from 4.4 to 5.4 t/ha, depending on the doses of mineral fertilizers (Fig. 2).

The correlation analysis of oat production depending on moisture supply revealed a strong curvilinear relationship (R = 0.78). Dependence of indicators is presented by the following equation: y = –0,0062x2 + 1,0125x – 36. A strong direct relation is traced due to the analysis of productivity and fertilizer doses indicators (R = 0.73).

Oats quality indicators increased with the improvement of water supply of oats crops and mineral nutrition conditions (Belmach, 2014; Makannikova and Belmach, 2014).

Conclusions

Research results have proved the possibility of rice cultivation on meadow brown soils of southern agricultural zone of Amur region with the use of water-saving irrigation technologies and at a significantly lower irrigation rates and high economic efficiency. Differentiation of irrigation regimes during sprinkling has a positive effect on the development of rice plants. The best variant was 75-85% (0.4 and 0.6 m) with the yield of 4.19 t/ha in "Rassvet" variety and 4.38 t/ha in "Khankaisky 429". To obtain a yield of 4.38 t/ha in rice cultivation with sprinkling irrigation it is necessary to maintain a pre-irrigation moisture threshold of at least 75%-85% of MMC (0.4 and 0.6 m) with "Khankaisky 429" variety due to irrigation procedures which are carried out according to the following scheme: in a slightly arid year – 2 irrigation procedures with irrigation norm of 280 m^3/ha during "sprouting-tillering" phase; 6 irrigation procedures with irrigation norm of 250 m^3/ha during "tillering-milky ripeness" phase; in a humid year – 2 irrigation procedures of irrigation norm of 280 m^3/ha during "sprouting-tillering" phase, 5 irrigation procedures of irrigation norm of 250 m^3/ha during "tillering-milky ripeness" phase; in a waterlogged year – 2 irrigation procedures of irrigation norm of 280 m^3/ha during "sprouting-tillering" phase.

The possibility of yielding oats at a level of 5.5 t/ha with an irrigation regime of 80% of MMC and a mineral fertilizer dose $N_{45}P_{45}K_{45}$ due to 3-4 irrigation procedures with irrigation norm of 300 m^3/ha during "tillering-booting-ear formation" phase was proved.

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Received: 13.09.2018; *Accepted*: 25.09.2018