

Technology of growing rice without fixed waterflooding in conditions of Danube rice irrigation systems

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The purpose. To justify an opportunity of application of periodic rice watering on existing rice irrigation systems of delta of Danube. **Methods.** Field, comparative analysis. **Results.** It is determined that map-checks of wide front of waterflooding and dump of water have essential advantages before maps-checks of Krasnodar type at periodic rice watering using both sprinkling irrigation, and waterflooding. Waterflooding of such maps-check plots or secure of necessary watering rate of water is carried out on them twice more sweepingly. Due to that the necessary water regime on the whole area of map-check is created. **Conclusions.** Periodic watering at growing rice in Danube conditions of rice irrigation systems allows to diminish consumption of irrigating water in 4 – 4,5 times and to save on its pumping-over up to 2 – 2,5 thousand hrn/hectare.

Key words: *rice irrigation system, fixed waterflooding, rice sprinkling irrigation, water- and power saving measures.*

Since recently, the problem of saving both energy and water resources is becoming more and more important in Ukraine. Due to the fact that the mechanized water supply is used for rice cultivation at Danube rice systems, it requires significant energy resources. According to our research, the cost of water supply in the conditions of the Danube rice systems reaches up to 30% of the cost of rice and it will only grow in future. Apart from saving energy resources in the South of Ukraine, it is also important to save water resources. In 2015, electricity cost for water pumping to Danube irrigation systems exceeded 7 million kWt. Recently, there has been a certain increase in the cost of these resources, so today it is expedient to develop water and energy saving technologies for rice cultivation.

One of the promising ways to save energy and water resources during rice cultivation is introduction of the periodic irrigation of rice instead of shortened flood regime.

Current state of the matter. Rice is grown with usage of periodic irrigation in many countries on virtually all continents. Fundamental justification of cultivation of certain sorts of rice with periodic irrigation was made in the works of E.B Velychko and K.P. Shumakova in the 60's and early 70's of the last century[1,2]. It was discovered that with a seeding rate of 4,5-5,5 million / ha of similar seeds, a yield of 30 to 50 centners / ha can be obtained under condition of periodic irrigation of rice by stripes and sprinkling. In this case, the humidity on the depth of 0,60 ... 0,80 meters should be close to 80% owest moisture content (HB). However, this technology has practically not been used in Ukraine for two main reasons: first, under this technology, it is very difficult to obtain high yields of rice due to active growth of field grass; secondly, the cost of energy was low at that time, and water for agricultural enterprises was almost free of charge.

Since 2000 on the territory of the Russian Federation in the Volgograd region and in the Amur region (Far Eastern Federal District), a study has been conducted to substantiate the possibility of rice cultivation with periodic irrigation. In the Volgograd region, under the supervision of Professor I.P.Kruzhilin, studies were conducted to compare the economic efficiency of rice cultivation with the use of the following irrigation methods: irrigation by sprinkling, surface watering by stripes, on furrows, and also with constant flooding of field checks. It was discovered that the profitability of rice cultivation in all options of periodic irrigation (sprinkling, irrigation by stripes and irrigation along furrows) was significantly higher than under permanent flooding, with the rice yield under all these options, including control, sufficiently high and ranging from 51 to 53,5 centners/ha[2,4].

In the conditions of the Amur region, the possibility of rice cultivation with periodic irrigation was studied on the experimental fields of the Far Eastern Agrarian University under supervision of Professor I. A. Alekseyka [5]. In the course of the research, the following options for maintaining pre-irrigation moisture in the active soil layer were considered: a) 70% HB; b) 80% HB; c) 90% HB. To maintain humidity at the level of 70% of HB, 5...8 irrigations (depending on the precipitation in the cultivation season) were made with a rate of 670 m³ / ha; for 80% of HB 7...12 irrigations with 450 m³/ha rate, and for 90% HB – 10...15 irrigations with 220 m³/ha rate. In all these options irrigation was made by sprinkling. In the course of the research, rice yields ranged from 40 to 50 centners per hectare, the option with pre-irrigation humidity level at 80% HB was recognized as the best in terms of obtaining high yields and rational water usage (like in Volgograd region) [5,6]. The irrigation rate was 5...6 times lower than in case of rice cultivation under constant flooding, ranging from 3 to 6 thousand m³/ha and depended mainly on the level of precipitation during the cultivation season.

All of the above studies of the effectiveness of periodic irrigation usage by sprinkling, as well as along furrows and by stripes, were not made on rice systems; in addition, the possibility of using periodic irrigation of rice by flooding on checks of Krasnodar-type checks (KTT) and checks of the wide front of flooding and water discharge (KCD) was not studied either.

Purpose of research. The purpose of our research is to justify the possibility of using periodic irrigation of rice at the territories of the existing rice systems of the Danube river delta.

Research methods. In order to evaluate the possibility of using periodic watering of rice by flooding and sprinkling KTT and KCD checks, we carried out research of the initial flooding of rice checks of various constructions and parameters in the conditions of the Danube rice systems for rice cultivation in conditions of shortened flooding. The intensity of water discharge from checks of different structures was also studied.

The research was conducted on two experimental sites. The first site consisted of two KCDs and a control KKT with drain spacing of of 200 m, the second – of the same KCD and KKT with drain spacing of 250 m. Diagrams of KCD and KKT experimental sites are shown in the chart. Soils on experimental sites were mainly middle-loamy.

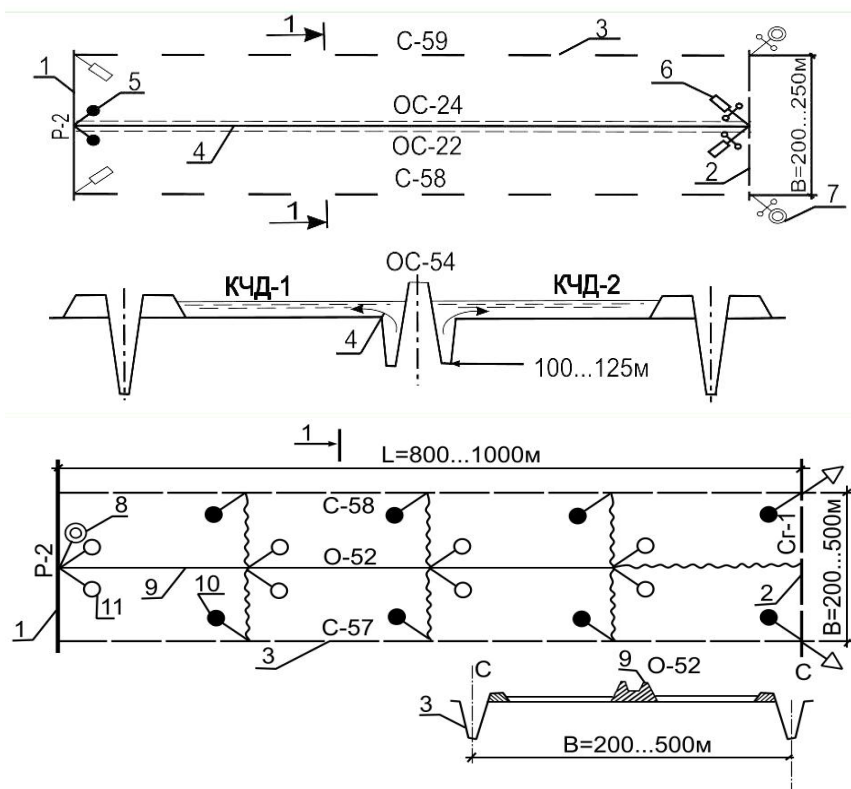


Chart. Chart of large check with water drainage (KCD) and check of Krasnodar type (KKT) of the Danube rice irrigation systems: 1 – distribution canal; 2 – water discharge canal; 3 – field drain (KCD), or discharge drain (KKT); 4 – one-side irrigation and discharge canal; 5 – water discharge from the distribution canal to

the irrigation drain; 6 – water discharge from the irrigation system to the discharge canal; 7 – water drainage from the field drain into the drainage canal; 8 – water discharge from the distribution canal to the check irrigation; 9 – check irrigation; 10 – water discharge from the check to the drainage canal; 11 – water discharge from the card irrigator to the KKT check.

The period of initial flooding was chosen since during this period all canals of the rice system operate in the most intense mode. Analysis of initial flooding on checks of various structures at drain spacing of 200 m showed that the value of the hydromodule flooding was higher in the KCD compared with the control KKT by 2.5 times (table 1). For conditions of 250 m drain spacing, the value of the hydromodule of flooding on KCD was higher than the KKT by 2,25 times (for KCD-1 the value of the hydrodynamic water supply was 18 l/s·ha, for KCD-2 – 17,4 l/s·ha, and on the control KKT-1 only 7,7 l/s·ha). The obtained data proves significant advantage of KCD above KKT in terms of the efficiency of initial flooding.

Table 1. Duration of initial flooding of irrigation checks of different designs and parameters

Land plot number	Check number and type	Area, ha	Supplied water volume, m ³	Duration of supply, hours	Average consumption per supply period, l/c	Created layer of water on the check, cm	Hydromodule of flooding, l/c·ha
1	KCD-1	7,7	17620	26,5	184,5	12,1	24,0
	KCD-2	7,7	17150	26,8	177,8	11,5	23,1
	KKT-1	15,2	30120	57,5	145,5	10,8	9,6
2	KCD-1	9,3	19430	32,2	167,6	8,5	18,0
	KCD-2	9,3	18960	32,5	162,1	8,0	17,4
	KKT-2	18,4	40260	78,6	142,5	10,7	7,7

The mean value of water spending at irrigation and discharge canals at KCD of the first site was higher than that of the second site, since these sites were located at different points of the distribution canal P-2 and, accordingly, there was a different pressure of water supply (in the first site, the pressure of the water supply is higher, so water spending is also higher).

Estimation of the efficiency of water discharge in technological needs on the checks of various projects and parameters also shows a significant advantage of field checks in comparison with the checks of the KKT (table 2), where the water discharging module is 1,6...1,7 times higher. In addition, it has been discovered that the KCD safflower was not formed at lower levels since these checks are drained along the perimeter owing to the presence of a irrigation drain on the one long side and a check drain - on the other.

It is practically impossible to eliminate the saucer along the check irrigation canal at KKT, and therefore, along this canal, the inhibition of rice plants is inevitable

Our calculations showed that for soils prevailing in the rice systems of the Danube delta, to maintain pre-irrigation moisture in the optimal range at the level of 80% of HB (conditions of the Volgograd Region) it is necessary to conduct 13...15 irrigations with an irrigation rate of 400 m³/ha, depending on the peculiarities of the climatic conditions of the respective year.

Table 2. Minimal duration of water discharge from the surface of checks of various parameters and projects

Land plot number	Check number and type	Area of KKT check or large check, ha	Discharged water volume, m ³	Duration of water discharge, hours	Average discharge, l/c	Hydromodule of discharge, l/c·ha
1	KCD -1	7,7	7,93	16,1	136,8	17,8
2	KKT -1,Чек2	2,0	1,94	26,4	20,4	10,2

Based on the above-mentioned possibilities of water discharges at КЧД (table 1) and our calculations, the irrigation rate of 400 m³/ha is achievable for KCD with a drain spacing of 200 m in the course of 5-6 hours, with a drain spacing of 250 m – in the course of 7-8 hours even under complete flooding of the irrigation-discharge canal. In this case, the flood will pass the entire length of the irrigation and discharge canal (1000 m) relatively evenly. For a KKT with a drain spacing of 200 m, the irrigation rate of 400 m³/ha can be achieved within 12-13 hours depending on the check irrigation capacity; and for KKT with a drain spacing of 250 m – within 15-16 hours. But at the KKT more problems may arise with evenness of the irrigation, than with the duration of water supply to all checks, since only one water discharge canal is used to flood checks on the area of 2,5 ha. So, if it is necessary to reach an irrigation rate of 400 m³/ha for each check through only one water discharge canal, the excess of irrigation rate at the water drainage sites and along the check irrigation and discharge canal and a lower irrigation rate in the areas near the check drainage will be observed. The problem of uneven irrigation can be partially solved by cutting the grooves along the diagonals of the check and concentrating the flow of the practically entire water discharge in turns only to certain checks. But even with this mode of water supply the uneven irrigation can happen. Therefore, at KKT, before using periodic irrigations by flooding it is necessary to investigate, under which irrigation rates the relatively uniform irrigation level of the entire surface of the check can be achieved.

Given the width of both KKT and KCD it is possible to conduct periodic irrigation by sprinkling with the usage of DDA-100MA sprinkling machine, as well as of foreign sprinkling machines, which use centrifugal pumps to take water from canals.

While using DDA-100MA at KKT it is necessary to make a temporary irrigation and discharge canal in the middle of each check in the beginning of each irrigation season [7], where the water will come from the check water supply (chart, position 11). While using DDA-100MA at KCD it is also necessary to arrange temporary sprinklers in the middle of the checks, where the water can be supplied to from dischargers irrigation (chart, position 4), but the irrigation and discharge canal must be closed in the spot of connection with the temporary discharge canal to avoid that the latter is filled with water.

«TL» Irrigation sprinkling machines with water intake from open water canals in the earth bed, produced by «TL Irrigation» (USA) are technically and economically feasible for use mainly at KCD, where these machines can take water directly from the irrigation and discharge canal (chart, position 4), which has a considerable length (up to 1000 m). Also, instead of DDA-100MA, «Ouadrostar QS-100» sprinkling machine produced by «Bauer» (Austria) and frontal action machines by the French firm «Otech» (e.g. Otech Linear 4RMG) can be used for irrigation from the temporary irrigation and discharge canal at KCD.

In the conditions of the Danube rice irrigation systems the optimal irrigation rates stand within 15...18 m³/ha for rice cultivation under conditions of shortened flood regime [8]. In the cost of rice cultivation under such conditions, the cost of water pumping is about 30% [9], given the necessity to spend energy resources not only on water supply, but also on pumping drainage and wastewater to the Danube River. Thus, the above data on similar objects shows that during rice cultivation with periodic irrigation, the irrigation rate can be reduced to 4000... 000 m³/ha, i.e. by 4...4,5 times. In this case, it is possible to save on water pumping about 2 ... 2,5 thousand UAH per each hectare.

Conclusions

Based on the aforementioned the following conclusions can be made:

1. Under the conditions of the Danube rice irrigation systems it is possible to cultivate rice with periodic irrigation both by sprinkling and by flooding the checks at KKT and large checks.
2. Comparison of the possibility of periodic rice irrigation by flooding the KKT checks and large checks shows a significant advantage of the KCD above the KKT under the same parameters. At KKT irrigation by flooding with small irrigation rates (about 400 m³/ha) may cause significant problems related to unevenness of the irrigation.
3. In case of periodic rice irrigation by sprinkling, including that by sprinkling machines of foreign origin, KCD has significant advantages over the KKT.
4. Rice cultivation with periodic irrigation in the conditions of the Danube rice irrigation systems will save about 2 ... 2,5 thousand UAH on pumping water for each hectare of rice crop, as well as energy resources, which is relevant in the context of the energy crisis.

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