УДК 631.674.6:633.18

# WATER-SAVING TECHNOLOGY OF DRIP IRRIGATED AEROBIC RICE CULTIVATION

I.P. KRUZHILIN[1], N.N. DOUBENOK[2], M.A. GANIEV[1], N.M. ABDOU[2],
V.V. MELIKHOV[1], A.G. BOLOTIN[1], K.A. RODIN[1]

([1] All-Russian Research Institute of Irrigated Agriculture;
[2] Russian Timiryazev State Agrarian University)

*With increasing demand for rice production and a severe shortage of water, it is necessary to develop innovative water-saving technology of rice cultivation which would allow reducing water consumption and increasing rice productivity. Therefore, field experiment was conducted at Agricultural Research Station of All-Russian Research Institute of Irrigated Agriculture (Volgograd, Russia) for two years (2013, 2014) to study the effect of different water regimes viz* $I_1$,$I_2$ *&* $I_3$ *in combination with three levels of mineral fertilizers (NPK) under drip irrigation system on growth, yield of aerobic rice and water-saving capacity of this technology. The obtained results revealed that, rice grain yield was 6 ton/ha, while the volume of required irrigation water varied within 499–538 mm/ha (on average) which is 60–80% less compared to those consumed under the flooding technology of rice cultivation. Therefore, it can be concluded that drip irrigation is characterized by great water saving capacity along with high productivity of aerobic rice varieties.*

*Key words: aerobic rice, drip irrigation, water regime, water consumption, mineral fertilizers, yield.*

Rice is the leading irrigated crop in agriculture and is one of the major arable crops in the world. It is grown in 115 countries on more than 150 million ha globally; it is also the second most cultivated cereal crop after wheat. Rice is one of the most important staple foods for more than half of the world's population [11] and influences the livelihoods and economies of several billion people. In 2010, approximately 154 million ha were harvested worldwide, among which 137 million ha (88% of the global rice harvested) were harvested in Asia, moreover, 48 million ha (31% of the global rice harvested) were harvested in Southeast Asia only, in Africa — 5.3%, North and South America and Europe — 4.7–0.5% correspondingly [5].

According to FAO resources the volume of rough rice production in 2013 reached more than 700 million tons. However, the demand for rice continues to rise due to population growth and its increased consumption in countries outside the Southeast Asia [4].

It was estimated that by the year 2025 it will be necessary to produce more rice by 60% compared to current production volume in order to meet the food needs of the growing world population. In addition, the area of lands available for crop production is steadily decreasing because of urban growth and land degradation. Hence, increase in rice production is supposed to be obtained from the same or even less land areas. This means that appropriate rice production practices should be adapted to increase rice yield per area unit [3].

The rice production areas can be classified into irrigated, which accounts for nearly 55% of the total rice cultivation area, and rainfed, which consist of upland rice territories (approximately 14 Mha — 11% of the total rice cultivation area), rainfed lowland rice territories (nearly 46 Mha concentrating mainly in Asia, representing 30% of the total rice cultivation area), and deep-water rice and floating rice areas (about 4 Mha in Asia) [9].

In the Russian Federation, as in most countries, traditionally, rice is grown under continuously flooded condition so the most conventional water management practices are used which are aimed at maintaining the constant water layer above the surface of the field throughout the season. Under flooded cultivation system, water consumption is more than 2000 mm/ha which significantly excesses the biological needs of rice in water (which ranges within the interval 600–800 mm/ha). However, this system of rice cultivation is limited by water shortage. Therefore, there is a necessity to find ways to reduce water consumption and increase water use efficiency in rice production and at the same time to maintain higher yields [15, 16, 25].

More than 75% of rice production comes from 79 million ha of irrigated lowlands. By 2025 over 17 million ha of irrigated rice areas in Asia may experience "physical water scarcity" and 22 million ha — "economic water scarcity" [23]. Reducing water input in rice production can have a high societal and environmental impact if the saved water can be diverted to areas where water deficiency is high. The reduction by 10% of water used for rice irrigation would save 150,000 million m$^3$, which corresponds to about 25% of the total fresh water globally used for non-agricultural purposes [12].

Recently, the term 'water-saving irrigation techniques' has been introduced [8] to denominate irrigation strategies, aimed at reducing seepage and percolation (SP) rates by: i) reducing the depth of ponded water; ii) keeping the soil just saturated or iii) alternate wetting/drying, i.e., allowing the soil to dry out to a certain extent before re-applying the irrigation water. According to Paurd et al. [19], rice is not an aquatic plant so achieving economy in water use without affecting the crop yield seemed to be the hit world in rice cultivation considering the fact that farmers irrigate their paddy crop more than it is required [6]. It is reaffirmed that flooding was not the best practice to produce rice [1].

Aerobic rice is the latest technology that reduces water inputs due to growing rice as any other irrigated upland crop, which consists of dry-seeded rice cultivation under non-flooded conditions with irrigated upland rice cultivation, and which is being developed to increase water-use efficiency. In this system plants are grown on non -puddled, unsaturated and well-drained soils. Water requirements can be lowered by reducing water losses due to seepage, percolation, and evaporation [7].

Drip irrigation is a promising system for economizing on available irrigation water. However, there are still many things unclear about the applicability of this irrigation system for rice cultivation in terms of water use efficiency, yield ability and impact on environment and production costs.

## Materials and Methods

Field experiment was conducted for two years (2013, 2014) to optimize water and nutrient soil regimes under drip irrigation by using aerobic rice cultivar «Volgograd » at Agricultural Research Station, of All-Russian Research Institute of Irrigated Agriculture

(Volgograd, Russia). Three irrigation regimes and three levels of mineral nutrition (NPK) were tested in split-plot design with three replications.

The studied irrigation regimes $I_1$, $I_2$ and $I_3$ (the first factor) were the following:

$I_1$ — Soil moisture content was maintained at the level no less than 80% FC (field capacity) at soil layer h = 0–0.6 m during the whole growing period of rice plants (from sowing to the stage of fully mature grain) [80% FC & h = 0.6 m].

$I_2$ — Soil moisture content was kept at 80% FC level an higher during the vegetative period (from sowing to panicle initiation stage) at the soil layer to 0.4 m depth, then during reproductive and ripening phases (from panicle initiation to the stage of fully mature grain) the wetting depth was increased up to 0.6 m [80% FC & h = 0.4 and 0.6 m].

$I_3$ — Soil moisture content was maintained as mentioned above at $I_2$ and at the same depth, but starting from the dough phase to the phase of fully mature grain soil moisture content was slightly reduced and kept at the level not lower than 70% FC at soil horizon 0–0.6 m [80% FC & h = 0.4 and 0.6 m, and 70% FC –h = 0.6 m].

The second factor was three levels of mineral fertilizers viz. 1 — ($N_{109}$ $P_{62}$ $K_{75}$); 2 — ($N_{131}$ $P_{74}$ $K_{90}$) and 3 — ($N_{157}$ $P_{90}$ $K_{108}$) NPK kg $ha^{-1}$. Doses of fertilizer treatments were calculated in view to obtain the planned productivity of 5, 6 and 7 t/ha of grain. Nitrogen fertilizer was applied in 3 splits — 50% at sowing, 25% at tillering and the remaining 25% at flowering stages, while both phosphate and potassium fertilizers were applied once at sowing.

Irrigation water was supplied through PVC pipe after filtering. The pressure in the system was maintained at 1 kg $cm^{-2}$ level. The lateral lines were laid with space interval of 0.5 m and characterized by 1.0 lph discharge rate, emitters were integrally set in at a pitch of 30 cm. Irrigation was performed in accordance with the actual soil moisture content at the studied soil depths measured by means of the digital soil moisture meter (Aquaterr — M350).

Dry direct seeding by drilling method was performed when the soil temperature at the seeding depth reached 13°C, seeding rate being at 5 million seeds per 1 ha, on the $28^{th}$ of April (2013–2014).

The field experiment was established on light brown heavy loamy soils, which were characterized by low organic matter content — 1.29, 1.87% in 0.00–0.28 m and 0.00–0.6 m soil layers, respectively. Soil pH of the aqueous extract fluctuated from 7.2 to 7.7 at the same soil depths. The content of available forms of the main soil nutrients was the following: low in nitrogen, high in exchangeable potassium and labile phosphorus was at the medium level. Soil bulk density was 1.27 and 1.29 t/$m^3$ measured at depths 0.0–0.4 and 0.0–0.6 m, correspondingly. Field capacity was 24.7 and 23.8% by weight. Porosity ranged from 47.06 to 51.59% and Soil particle density — 2.52–2.54 t/$m^3$ at the same depths, respectively.

Daily meteorological parameters (daily rainfall, air temperature — minimum and maximum and relative humidity) were collected from the weather station at the site. The amount of precipitation during the period from April to September in 2013 and 2014 were 306.9 and 108.9 mm respectively. The sum of daily average air temperatures reached 3605.7 and 3662.1°C. The growing seasons in 2013 and 2014 were characterized as wet and hemi arid, respectively.

Experimental measurements and observations were calculated according to methods of experimental work [2, 18]. Total water consumption was determined through water balance equation developed by A.N. Kostyakov. Irrigation rate under drip irrigation was calculated using the formula of A.N. Kostyakov modified by I.P. Kruzhilin et al. [13, 14, 17].

## Results and Discussion

*1. Drip irrigation scheduling of aerobic rice*

The experimental results revealed that the time and number of the applied irrigation rates varied with hydrothermal conditions and the maintained soil moisture regimes during the growing season of rice. For the first water regime ($I_1$) the first watering in 2013 and 2014 was made on 14 and 25 May, respectively. Under this conditions of soil moisture regime, irrigation rate was 370 $m^3$ $ha^{-1}$, the number of water applications for those years of study was 12 and 15 times, and the total consumption of irrigation water was 4440 and 5550 $m^3$ $ha^{-1}$, respectively (Table 1). In case of the second water regime ($I_2$) the first irrigation in 2013 and 2014 was applied on 9 and 20 May, respectively. Maintaining the planned soil water regime required 4 and 5 waterings with irrigation rate of 250 $m^3$ $ha^{-1}$, 10 and 13 times with irrigation rate of 370 $m^3$ $ha^{-1}$, and the total irrigation water use was 4700 and 6060 $m^3$ $ha^{-1,}$ respectively.

Table 1

**The number and rates of water applications using drip irrigation during the studied period**

| Irrigation regimes | Number of water applications / Irrigation rate, $m^3$ $ha^{-1}$ | | Total irrigation water consumption, $m^3$ $ha^{-1}$ | |
|---|---|---|---|---|
| | 2013 | 2014 | 2013 | 2014 |
| $I_1$ | $\frac{12}{370}$ | $\frac{15}{370}$ | 4440 | 5550 |
| $I_2$ | $\frac{4}{250}$ and $\frac{10}{370}$ | $\frac{5}{250}$ and $\frac{13}{370}$ | 4700 | 6060 |
| $I_3$ | $\frac{4}{250}$ and $\frac{8}{370}$ and $\frac{1}{550}$ | $\frac{5}{250}$ and $\frac{10}{370}$ and $\frac{1}{550}$ | 4510 | 5500 |

The first irrigation of the third water regime ($I_3$) was performed in the same way as the one of the second regime ($I_2$). The total number of water applications over the years of study was 4 and 5 with the irrigation rate of 250 $m^3ha^{-1}$, and 8 and 10 with the irrigation rate of 370 $m^3$ $ha^{-1}$. The last watering (550 $m^3$ $ha^{-1}$ in 2013 and 2014) was conducted on 9 and 6 August. The total irrigation water consumption in this variant of the experiment was 4510 and 5500 $m^3$ $ha^{-1}$. The crop water requirement was quite low during the initial growth stages; therefore, irrigation scheduling was based to provide lesser water during the initial stages of rice development and increase water supply during the later stages.

*2. Growth stages of rice plants*

Life cycle of rice consists of a series of consecutive changes in the growth and development of plants that express a characteristic of the potential ability of every organism to reproduce and replicate. Rice plant growth can be divided into three agronomic stages of development: vegetative (from germination to panicle initiation); reproductive (from panicle initiation to flowering); and ripening or maturation (from flowering to maturity).

These stages influence the three yield components: 1) number of panicles per unit area, 2) the average number of grain produced per panicle and 3) the average weight of the individual grains. These three components determine grain yield. Each phase is characterized by morphological features and physiological characteristics; therefore, during the vegetation period the plant itself belongs to the same environmental factor which varies with time [10].

According to the results of the studied water regimes and their effects on growth period of rice plants it can be concluded that, the growth period of rice plants fluctuated 113, 111 & 108 days depending on water regimes $I_2$, $I_3$ & $I_1$ that were applied, respectively (Table 2).

Table 2

**The effect of the studied water regimes and mineral fertilizers rates on duration of growth stages of rice plants, days**

| Years of research | Water regimes | Sowing-seedling | Seedling-tillering | Tillering-booting | Booting-flowering | Flowering – end of milk ripeness stage | Dough ripeness stage - full ripeness | Total |
|---|---|---|---|---|---|---|---|---|
| *Effect of watering regimes and mineral fertilizers application ($N_{131}$ $P_{74}$ $K_{90}$) to obtain the planned grain yield of 6 t/ha* | | | | | | | | |
| 2013 | $I_1$ | 10 | 25 | 12 | 26 | 17 | 18 | 108 |
| | $I_2$ | 10 | 27 | 14 | 27 | 17 | 18 | 113 |
| | $I_3$ | 10 | 27 | 14 | 27 | 17 | 16 | 111 |
| 2014 | $I_1$ | 13 | 23 | 12 | 28 | 16 | 16 | 108 |
| | $I_2$ | 13 | 25 | 14 | 29 | 16 | 16 | 113 |
| | $I_3$ | 13 | 25 | 14 | 29 | 16 | 14 | 111 |
| *Effect of different mineral fertilizer levels applied along with water regime $I_3$[80% FC — h =0.4 and 0.6 m, and 70% FC — h = 0.6 m]* | | | | | | | | |
| 2013 | $N_{109}$ $P_{62}$ $K_{75}$ | 10 | 26 | 13 | 26 | 17 | 15 | 107 |
| | $N_{131}$ $P_{74}$ $K_{90}$ | 10 | 27 | 14 | 27 | 17 | 16 | 111 |
| | $N_{157}$ $P_{90}$ $K_{108}$ | 10 | 28 | 15 | 27 | 18 | 16 | 114 |
| 2014 | $N_{109}$ $P_{62}$ $K_{75}$ | 13 | 24 | 13 | 28 | 16 | 13 | 107 |
| | $N_{131}$ $P_{74}$ $K_{90}$ | 13 | 25 | 14 | 29 | 16 | 14 | 111 |
| | $N_{157}$ $P_{90}$ $K_{108}$ | 13 | 26 | 15 | 29 | 17 | 14 | 114 |

However, improving soil nutrient regime, as well as soil moisture regime led to increase in duration of interphase periods and the whole growing season of rice crop. The obtained data demonstrated that, water regime $I_3$ and using dose of mineral fertilizer estimated to produce 5 ton of grain yield per hectare resulted in the average rice growing period of 107 days. With the increase of mineral nutrition rates, calculated to obtain a grain yield of 7 t/ha, the duration of rice growing season increased as well up to 114 days. It can be concluded that, keeping favorable moisture and nutrient soil regimes led to improving the water content in rice plant tissues, which contributes to prolongation of growing season and thereby creating favorable conditions for increasing their productivity.

*3. Effect of water and nutrient regimes on grain productivity*

The analysis of the obtained results (Table 3) allows concluding that the highest grain yield of rice variety (Volgograd) was harvested in the variant $I_2$, where soil moisture content was maintained not lower than 80% of filed capacity till the end of tillering stage in soil layer 0–0.4 m with a subsequent deepening to 0.6 m at all levels of fertilization calculated for obtaining grain yield of 5, 6 and 7 ton/ha. In fact the yield amounted 5.20; 6.14 and 6.90 t/ha of grain. While in the variant $I_3$ with the same doses of fertilizers rice grain yield turned out to be lower — 5.06; 6.03 and 6.83 t/ha. The minimum grain yield of rice was obtained in the variant $I_1$ at all levels of fertilizer applications and amounted 4.81; 5.67 and 6.67 t/ha as average for the years of study (2013–2014).

Table 3

**Effect of water and nutrient regimes on grain productivity**

| Water regimes treatments | Mineral fertilizers treatments | Years of research | | Average |
|---|---|---|---|---|
| | | 2013 | 2014 | |
| $I_1$ | $N_{109}P_{62}K_{75}$ | 4,79 | 4,82 | 4,81 |
| | $N_{131}P_{74}K_{90}$ | 5,74 | 5,59 | 5,67 |
| | $N_{157}P_{90}K_{108}$ | 6,64 | 6,70 | 6,67 |
| $I_2$ | $N_{109}P_{62}K_{75}$ | 5,26 | 5,14 | 5,20 |
| | $N_{131}P_{74}K_{90}$ | 6,15 | 6,12 | 6,14 |
| | $N_{157}P_{90}K_{108}$ | 6.92 | 6,88 | 6,90 |
| $I_3$ | $N_{109}P_{62}K_{75}$ | 5.10 | 5,02 | 5,06 |
| | $N_{131}P_{74}K_{90}$ | 6,03 | 6,02 | 6,03 |
| | $N_{157}P_{90}K_{108}$ | 6,85 | 6,81 | 6,83 |
| $LSD_{05}$: 2013 — 0.117; 2014 — 0.143 | | | | |

The grain yield varied significantly among the studied treatments. In addition, it is important to note that the rice variety named "Volgograd" can be successfully classified as aerobic rice variety which can grow under non flooded conditions and provide sufficient yield with significant irrigation water saving when cultivated under drip irrigation compared to flooding irrigation. High productivity of rice variety "Volgograd" under drip irrigation can be explained by the sufficient amount of water supplied with drip irrigation which is enough to saturate the soil during the reproductive stage which resulted in better spikelet fertility and finally higher yield, and/or it may be ascribed to combined favorable effects of improved leaf nitrogen (N) concentration, photosynthetic rate of flag leaves and increased percentage of filled grain by delayed leaf senescence [20]. Similar trend was observed by Sritharan et al. (2010), Soman (2012), and Vanitha (2012) on rice in India.

*4. Effect of water regimes on water use and water productivity*

Water use efficiency (WUE) is an accurate indicator of agricultural productivity in relation to crop water consumption. Results of the study (table 4) showed that the highest amount of irrigation water consumption $m^3$ for obtaining 1 ton of rice grain was recorded when water regime $I_1$ was applied and amounted to 881.7 $m^3$ /ha. While the minimum amount of irrigation water per ton of grain — 830.7 $m^3$ was expended at regime $I_3$.The higher water productivity under aerobic drip-irrigated conditions was attributed to lower yield reduction in comparison with the amount of water saved on average (2013–2014).

Table 4

**The coefficient of water consumption at different water regimes of drip irrigation**
(mineral fertilizer rate ($N_{131}P_{74}K_{90}$) calculated to obtain planned grain yield of 6 t/ha)

| Water regimes | Years of research | Total water consumption, $m^3$/ha | Yield t/ha | Irrigation rate, $m^3$/ha | The coefficient of water consumption, $m^3$/t | Irrigation water consumption per 1 ton of grain, $m^3$/t |
|---|---|---|---|---|---|---|
| $I_1$ | 2013 | 6136.9 | 5.74 | 4440 | 1069.2 | 773.5 |
| | 2014 | 6122.0 | 5.59 | 5550 | 1095.2 | 992.8 |
| | average | 6129.4 | 5.67 | 4995 | 1081.1 | 881.7 |
| $I_2$ | 2013 | 6602.2 | 6.15 | 4700 | 1073.5 | 764.2 |
| | 2014 | 6605.0 | 6.12 | 6060 | 1079.3 | 990.2 |
| | average | 6603.6 | 6.14 | 5380 | 1076.4 | 876.9 |
| $I_3$ | 2013 | 6464.2 | 6.03 | 4510 | 1072.0 | 747.9 |
| | 2014 | 6465.0 | 6.02 | 5500 | 1073.9 | 913.6 |
| | average | 6464.6 | 6.03 | 5005 | 1072.1 | 830.7 |

## Conclusions

Irrigation water input in drip irrigated aerobic rice was 513mm $ha^{-1}$ (the average for two years 2013–2014) and saved 60–80% compared with that consumed under flooded conditions. Water requirements under aerobic condition were decreased by reducing water losses due to seepage, percolation, and evaporation. Moreover, it can be demonstrated that, the higher water use efficiency had been achieved when the irrigation regime $I_3$ was applied. In addition, under drip irrigation was found to create better conditions for growth and yield of aerobic rice. Thus it can be concluded that drip irrigation has greater water saving capacity compared with the flooding irrigation, and therefore is a better water-saving technology in areas of water scarcity.

**References**


1. Amischan Gani. Proceedings of an International workshop on Water Saving Rice Production Systems at Nanjing University, China, April 2–4, 2001.

2. *Dospekhov B.A.* Methods of field experience (with the fundamentals of statistical processing of the results of research). 5th ed., Ext. and rev. M.: Agropromizdat, 1985. 351 p.

3. Fageria NK (2007) Yield Physiology of Rice. Journal of Plant Nutrition. 30 (6): 843–879.

4. FAO Rice Market Monitor — November, 2013

5. FAOSTAT. 2012 (available at: www.faostat.fao.org/).

6. *Ganesh H.V.* Mysore J. Agric. Sci. 2000; 34: P. 222–226.

7. *Grassi C.* Aerobic Rice: Crop Performance and Water Use Efficiency. Journal of Agriculture and Environment for International Development. 2009. 103. P. 259–270.

8. *Guerra L.C., Bhuiyan S.I., Tuong T.P. et al.* SWIM Paper 5, IWMI/IRRI, Colombo, Sri Lanka. 1998. 24 p.

9. IRRI. Rice Almanac. 3rd edition. International Rice Research Institute, Los Bacos, Philippines. 2002. 181.

10. IRRI, 2007. http://www.knowledgebank.irri.org/

11. IRRI. Bringing hope, improving lives: Strategic Plan 2007–2015. Manila. 2006. 61 p.

12. *Klemm W.* Water saving in rice cultivation. In: Assessment and orientation towards the 21st Century.Proceedings of 19th Session of the International Rice Commission. Cairo, Egypt. 7–9 September, 1998. FAO, Rome. 1999. P. 110–117.

13. *Kostyakov A.N.* Fundamentals of Land Reclamation. M.: Selkhozgiz, 1960. 621 p.

14. *Kruzhilin I.P., Hodyakov E.A., Kruzhilin U.I., Saldaev A.M., Galda A.V.* A method for determining irrigation rates under drip irrigation of tomatoes // Patent № 2204241, 20.05.2003.

15. *Kruzhilin I.P., Ganiev M.A., Rodin K.A., Lyuboushkin S.N.* The cultivation of rice at a sprinkling // Irrigation and Water Management. 2009. № 1. P. 28–31.

16. *Kruzhilin I.P.* Water-saving irrigation technology of rice periodic watering // Bulletin of Agricultural Sciences. 2009. № 5. P. 39–41.

17. Methods of field experience under irrigation. Volgograd: Recommendations VNIIOZ, 1983. 149 p.

18. *Nikitenko G.F.* Experimental case in field. M.: Rosselkhozizdat, 1982. 190 p.

19. *Paurd M., Couchat P., Laseve G.L.* Agronomic Tropicale. 1989. 44. P. 156–173.

20. *Peng S.J., Yang F.V., Yarcia R.C., Laza M.V., Romeo A.L., Sanio A.K., Viramani S.S.* Physiology based crop management for yield maximization of hybrid rice. Paper Presented at the 3rd Symp. On Hybrid Rice, held at Hydrabad, India during 14–16 November, 1996.

21. *Soman P.* Drip irrigation and fertigation technology for rice cultivation (pp. 1–7). AIF D2S6b.http://www.scribd.com/doc/88516713/2012-AIF-D2S6b-Drip Irrigation-and-Fertigation-Technology-for-Rice-Cultivation-by-Dr-P-Soman. 2012.

22. *Sritharan N., Vijayalakshmi C., Selvaraj P.K.* Effect of micro-irrigation technique on physiological and yield traits in aerobic rice. Int. J. Agric. Environ. & Biotech. 2010. № 3. P. 26–28.

23. Tuong TP and Bouman BAM. Rice production in water-scarce environments, In: Proc. Water Productivity. 2003.

24. *Vanitha K.* Physiological comparison of surface and subsurface drip systems in irrigating aerobic rice (Oryza sativa L.). Unpublished thesis of the Department of crop physiology, Tamil Nadu Agricultural University, India. 2012.

25. *Velichko E.B., Shumakova K.P.* Watering rice without flooding. M.: Kolos, 1972. 88 p.

# ВОДОСБЕРЕГАЮЩАЯ ТЕХНОЛОГИЯ ВОЗДЕЛЫВАНИЯ АЭРОБНОГО РИСА ПРИ КАПЕЛЬНОМ ОРОШЕНИИ

И.П. КРУЖИЛИН[1], Н.Н. ДУБЕНОК[2], М.А. ГАНИЕВ[1], Н.М. АБДУ[2],
В.В. МЕЛИХОВ[1], А.Г. БОЛОТИН[1], К.А. РОДИН[1]

([1] Всероссийский НИИ орошаемого земледелия;
[2] РГАУ-МСХА имени К.А. Тимирязева)

*С ростом спроса на продовольственный рис и с резким обострением проблемы дефицита пресной воды, необходимы инновационные водосберегающие технологии его возделывания, которые значительно уменьшат потребность риса в воде при получении высокой урожайности. Чтобы оценить влияние водного режима почвы при капельном орошении в сочетании с дозами внесения минеральных удобрений обеспечивающих получение планируемой урожайности, в 2013–2014 гг. был заложен экспериментальный полевой опыт во Всероссийском научно-исследовательском институте орошаемого земледелия (Волгоград, Россия). Результаты исследований показали, что средняя урожайность составила 6 т/га зерна. При этом объем поданной на орошение риса воды по вариантам водного режима в среднем за 2 года изменялся в интервалах 499–538 мм/га, что на 60–80% меньше, чем при затоплении. Таким образом, возделывание аэробных сортов риса при капельном орошении обеспечивает получение высокой урожайности при эффективном использовании оросительной воды.*

*Ключевые слова: аэробный рис, капельное орошение, водный режим, минеральные удобрения, урожайность.*

**Dubenok Nikolay Nikolaevich** — Doctor of Agricultural Sciences, Professor, a member of the Russian Academy of Science, Head of the Department of Forestry and Land Reclamation, Russian Timiryazev State Agrarian University (127550, Moscow, Timiryazevskaya str., 49; tel.: +7 (499) 976-40-25; e-mail: ndubenok@mail.ru).

**Kruzhilin Ivan Panteleevich** — Doctor of Agricultural Sciences, Professor, a member of the Russian Academy of Science, chief researcher of All-Russian Research Institute of Irrigated Agriculture (400002, Volgograd, Timiryazeva str., 9; tel.: (8442) 60-24-36; e-mail: vniioz@yandex.ru).

**Abdou Nasr Mahmoud** — PhD-student of the Department of Forestry and Land Reclamation, Russian Timiryazev State Agrarian University (127550, Moscow, Timiryazevskaya str., 49; tel.: +7 (499) 976-40-25; e-mail: nasr.abdo@mail.ru).

**Ganiev Muslim Abdulaevich** — PhD in Engineering Sciences, Head of the Sector of Irrigated Rice, All-Russian Research Institute of Irrigated Agriculture, (400002, Volgograd, Timiryazeva str., 9; tel.: (8442) 60-23-25; e-mail: vniioz@yandex.ru).

**Melikhov Viktor Vasilevich** — Doctor of Agricultural Sciences, Professor, Director of All-Russian Research Institute of Irrigated Agriculture (400002, Volgograd, Timiryazeva str., 9; tel.: (8442) 60-24-33, fax (8442) 60-24-38; e-mail: vniioz@yandex.ru).

**Bolotin Aleksandr Grigorievich** — PhD in Agricultural Sciences, Head of the Department of Irrigation L:and Reclamation, All-Russian Research Institute of Irrigated Agriculture (400002, Volgograd, Timiryazeva str., 9; tel.: (8442) 60-24-38, e-mail: vniioz@yandex.ru).

**Rodin Konstantin Anatolyevich** — PhD in Agricultural Sciences, Senior researcher of All-Russian Research Institute of Irrigated Agriculture (400002, Volgograd, Timiryazeva str., 9; tel.: (8442) 60-23-22; e-mail: vniioz@yandex.ru).

**Дубенок Николай Николаевич** — д. с.-х. н., проф., академик РАН, зав. кафедрой лесоводства и мелиорации ландшафтов РГАУ-МСХА имени К.А. Тимирязева (127550, г. Москва, ул. Тимирязевская, 49; тел.: (499) 976-40-25; e-mail: ndubenok@mail.ru).

**Кружилин Иван Пантелеевич** — д. с.-х. н., проф., академик РАН, главный научн. сотрудник ФГБНУ ВНИИОЗ (400002, г. Волгоград, ул. Тимирязева, 9; тел.: (8442) 60-24-36; e-mail: vniioz@yandex.ru).

**Абду Наср Махмуд** — асп. кафедры лесоводства и мелиорации ландшафтов РГАУ-МСХА имени К.А. Тимирязева (127550, г. Москва, ул. Тимирязевская, 49; тел.: (499) 976-40-25; e-mail: nasr.abdo@mail.ru).

**Ганиев Муслим Абдулаевич** — к. т. н., зав. сектором орошения риса ФГБНУ ВНИИОЗ (400002, г. Волгоград, ул. Тимирязева, 9; тел.: (8442) 60-23-25; e-mail: vniioz@yandex.ru).

**Мелихов Виктор Васильевич** — д. с.-х. н., проф., директор ФГБНУ ВНИИОЗ (400002, г. Волгоград, ул. Тимирязева, 9; тел.: (8442) 60-24-33, факс: (8442) 60-24-38; e-mail: vniioz@yandex.ru).

**Болотин Александр Григорьевич** — к. с.-х. н., зав. отделом оросительных мелиораций ФГБНУ ВНИИОЗ (400002 г. Волгоград, ул. Тимирязева, 9; тел.: (8442) 60-24-38; e-mail: vniioz@yandex.ru).

**Родин Константин Анатольевич** — к. с.-х. н., ст. науч. сотр. ФГБНУ ВНИИОЗ (400002, г. Волгоград, ул. Тимирязева, 9; тел.: (8442) 60-23-22; e-mail: vniioz@yandex.ru).