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ЭКОЛОГО-БИОЛОГИЧЕСКИЕ ОСНОВЫ ВЫРАЩИВАНИЯ СОРТА РИСА ЛИДЕР ПО БЕСПЕСТИЦДНОЙ ТЕХНОЛОГИИ

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Новый сорт риса Лидер был получен в результате ступенчатой гибридизации и многократных повторных отборов. Особенностью нового сорта является быстрый рост растений в период прорастания и получения всходов. Это дает возможность получать всходы из-под слоя воды 20-25 см, под которым ежовники (*Echinochloa*) погибают. Лидер выращивается в России без применения пестицидов

Ключевые слова: РИС, СОРТ, БЕСПЕСТИЦИНАЯ ТЕХНОЛОГИЯ, РИСОВОДСТВО, ЭКОЛОГИЧЕСКАЯ ОБСТАНОВКА

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ECOLOGICAL AND BIOLOGICAL BASES OF THE RICE VARIETY LIDER GROWING ON PESTICIDE-FREE TECHNOLOGY

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As a result of stepped hybridization and multiple replicated screening, the new rice variety Lider was received. The peculiarities of the new variety is a quick growth of plants at a sprouting – tillering stage. It gives the possibility to obtain sprouts from water lower than 20-25 cm which kills for *Echinochloa*. Lider is grown in Russia without application of pesticides.

Keywords: RICE, VARIETY, PESTICIDE-FREE TECHNOLOGY, RICE GROWING, ECOLOGICAL SITUATION

Introduction

The most harmful weeds in rice sowings from *Echinochloa* Beauv. are: *E. crus galli* (L.) Beauv., *E. coarctata* (Stev.) Koss. and *E. oryzicola* Vasing [1]. The majority of rice-growing countries use anti-grass weed herbicides to control *Echinochloa* using them before rice seeding or after rice and weed shooting. At present, there is a big choice of such herbicides, but their price is very high. Thus, treatment by 1,0 ha of Facet herbicide equals the price of 1,0 t of paddy rice; therefore in 90's, when economic position became worse in Russia, many rice-growing farms in Kuban had to grow rice without herbicide application. They came back to technology of obtaining rice shoots from water surface, which suppresses the shoots of *Echinochloa*. Such technology was developed by rice-growers of the former USSR and used successfully in the country in 30's and 70's. For such technology breeders received the most widely spread varieties in the European part of Russia: early-maturing variety Dubovsky 129, mid-

maturing variety Kuban 3 and mid-late-maturing – Krasnodarsky 424. With introduction of intensive technologies into rice-growing (it means by increase of mineral fertilizer dozes and herbicide application) in 80's these varieties were changed by new, short-stem varieties of intensive type – Spalchik, Kulon, Liman, Slavyanetz, etc. But, if these varieties don't get enough fertilizers and chemicals and if land leveling is not done, we'll not obtain the planned yield. To obtain such result, several specialists of the branch offered to return old rice varieties of Kuban 3 type to the fields. The variety was received in 1966 and was used for almost 25 years. In the northern rice growing zones (Astrakhan and Rostov regions) and also in Kazakhstan this variety is cultivated till nowadays. Variety Kuban 3 has unique qualities, the main one of them is that it is unpretentious to cultivation conditions. But at the same time, its plants have severe lodging, especially if high application rates of nitrogen fertilizers are used, they are affected by blast and kernels coming into water germinate in the phase of waxy ripeness. Therefore, under the conditions of intensive technologies application, all drawbacks of the variety were shown and Kuban rice-growers stopped its use. Thus, it was not necessary to use old variety in the fields; the objective to receive the new variety with good traits of Kuban 3 and without its drawbacks was actually for a long time.

Material and Methods

In 1996 the work on receiving such a variety was completed. It was obtained as a result of hybridization of varieties Kulon, Kuban 3 and Belozerny and the next replicated screening, with necessary breeding evaluation. The sample grew very quickly in the nursery. It gave shoots very easy from the water layer of 20-25 cm. In competitive trials at the yield of standard-variety Spalchik 5,7-6 t/ha, the new variety gave the result 20-25% higher at the same nutrition background and took first place in the nursery. That is why the variety was submitted to the state varietal test under the name Lider. Yield potential of Lider is

up to 10 t/ha. Maximum analogous index under production conditions on10,1 t/ha was fixed at the area of 31 ha in experimental farm “Ordynskoe” in 2000.

DESCRIPTION OF VARIETY LIDER

Botanical characteristics. Species – *Oryza sativa* L., jet – *zeravschanica* Brsches. Variety is awnless. Flower glumes are yellow-brown, poor pubescent. The fruit is white, vitreous. The stem of the variety is of middle thickness (7,0 mm), and very robust, stem length is 90-95 cm (fig.1). Stem nodes are colorless. The leaves are green, without antocianic color. The panicle is contracted, of middle length (15-16 cm), of candle form, with 150-160 spikelets. Spikelets sterility of panicles is low – 8-12%. Spikelets have poor pubescence of lower flower glumes. The grain is of middle size, round form. The correlation of length to width (l/b) is 2.1. 1000 grains weight is 30,0-31,0 g. Milled rice quality is excellent.

Fig.1 Variety Lider on experimental field of All-Russian Rice Research Institute

Biological traits. Vegetation period (from floading to full ripeness) at shorten floading is 116-118 days, and during obtaining shoots from water layer vegetation period is 120-125 days. Heading of the main and the lateral shoots is not long, therefore ripening in bush is good.

Results and Discussion

The main trait of this variety is unpretentiousness to growing conditions. The plants are fast-growing at the beginning of vegetation period, they overcome water layer at the germination stage well and compete well with weeds. It gives the possibility not to apply herbicides. Besides that, plants have well developed root system and for yield formation Lider needs 40% less fertilizers than analogous varieties of intensive type. This variety is preferred for obtaining dietetic rice.

Since 1997 Lider was at the state varietal test, where showed excellent results. It took first place by yield in Krasnoarmeisky state varietal plot in 1997 and 1998. It was included into the state register of breeding achievements in RF and since 2000 it was adopted for use in the Northern-Caucasus region.

Lider preserved the best qualities of parent forms. From Kulon it inherited high yield, resistance to lodging and good quality of milled rice. From Belozerny it inherited the type of bush and vertical panicle form. From Kuban 3 it inherited the colour of flower glumes, and also unpretentiousness to cultivation conditions, high tempo of plant growth from water layer and a special type of grain filling, giving the possibility for plants to ripen without water layer.

As for grain tilling, it is necessary to explain something. Several investigations [3] showed that short-stem rice varieties – Spalchik, Start, Liman, Regul etc. have grain filling by the current photosynthesis. That is why the plants of these varieties demand the support of water layer in check-plot almost till full grain ripeness. Kuban rice-growers cultivating short-stem varieties for more than 20 years follow the rule: biological yield is higher, when the less is the gap between water discharge from check-plot and full rice ripeness. But the economic

yield after harvesting in wet field was often lost, as in late October paddy soil is drying very slowly. That is why many agronomists start early water discharge not to accept big losses during harvesting; they have partial yield loss consciously.

During Lider cultivation this problem is not necessary to solve. Though plants of this variety are relatively low, grain filling is the same as for tall varieties (Krasnodarsky 424, Kuban 3, etc.): at the first period (15-20 days after flowering) the grain is filling by the current photosynthesis, and the second – by the flow of plastic matters from stem and leaves. Therefore, when grain achieves waxy ripeness stage in the mid part of panicle, Lider plants don't demand water layer in check-plot. Their strong root system consumes necessary moisture quantity from the soil, drying it. To the moment of full rice ripeness, as a rule, the fields are dry so, that optimum conditions for harvesting are created.

Immunological study at artificial inoculation showed that new variety had high tolerance to rice leaf nematode, it was also mid-resistant to blast. It gives the possibility not to use chemicals against these pathogens. High field resistance of Lider plants to blast was confirmed in 1997. Yield index of Lider practically didn't decrease even in that plots, where other tested varieties were almost affected by disease.

The advantage of the variety was shown at varietal test, which was carried out parallel with competitive trials in agrofirm "Russia" of Krasnodar Territory for 3 years. We studied its behaviour under conditions of different preceding crops (alfalfa, fallow, rice), with different seeding-rate and level of mineral nutrition. The shoots were obtained from water layer, without application of anti-grass weed herbicides. Taking into consideration that Lider plants can achieve the height of 95 cm and have good leaves and are competitive with *Bolboschoenus maritimus* (L.) Palla, it was not necessary to apply herbicides against it. Grain yield in separate test variants achieved 8,5-9,0 t/ha. It's very important that Lider variety plants didn't have lodging. Such trait was revealed in 1996,

when practically all varieties at the farm had lodging because of weather conditions, and in several cases they sprouted on root. Lider has survived and was harvested without losses. At that time 90 tons of high quality seeds of that variety were stored up to the moment of submission of the varieties to state varietal test for the first time in Russian breeding.

Perennial observation for rice development showed that Lider reacted negatively to plant density (more than 300 per 1 m^2). Plant stand density should be so, that plants can form 2-3 lateral shoots. And with each shoot, as it is known, 5 or more additional roots are formed; they increase ability of plant to get nutrition from big water layer. One stem plants are formed in sowings of thick density: these plants have weaker root system. Besides that, competition for light between them increases. Only upper leaves developed efficiently, and the lower leaves die under the conditions of shadow. As a result of it small panicles are formed, spikelets sterility increases. The attempts to decrease the competition between plants by increase of mineral fertilizer application rate (especially nitrogen fertilizers) didn't solve the problem but made it more serious: rice stem became longer, leaf size increased, parallel mutual shadow increased. As a result of it, spikelets sterility increased more, and plant productivity decreased. Thus, optimum seed rate is 6,0-6,5 million per ha, or 180-200 kg/ha.

In 1998 Lider had industrial test in 12 farms of Krasnodar Territory at the general area about 1000 ha. In the majority of cases, the yield appeared to be higher than in released varieties. Lider was grown without herbicide application.

In 1999 it was grown at the area of 5500 ha. That time weather conditions in Kuban were very unfavourable for all rice varieties, especially at the period of sprouts. April was dry season, thus, in the majority of farms the soil was prepared, rice seeding and checks flooding was finished in the first decade of May. Such working tempo was never for recent 10 years. But hopes of farmers didn't come true. Average 24 hours temperature for the period since 1 to 25 May didn't exceed 14^{o}C and at night on 4-5 May was up to minus 5^{o}C. Water temperature

coming to check plots was 10-11°C. Under such conditions rice was germinated very slowly. For example, 23 May, water temperature in irrigation canal was 11°C, in the first check-plot water temperature was 14°C at the water layer of 25 cm; in the second check-plot water layer was 12-15 cm, though both checks were flooded at the same day, 4 May.

High water layer both decreases its temperature and accelerates the necrosis of leaves. It is necessary to take into consideration that lateral shoots during tillering are formed only from axils of a live leaves. After bouting and heading, photosynthesis stops in leaves, covered by water and they die. Thus, water layer in checks should not exceed 15-20 cm during rice vegetation period.

Specialists of many farms had to discharge water from check-plots to warm the soil and to escape from mass dying of rice sprouts. This stimulated not only rice growth but also of Echinochloa; which didn't die under water layer, and developed quickly. In farms having enough financial and technical resources, rice sowings had weed control by herbicides; higher rates were applied. This influenced on rice yield negatively. In that cases, when herbicides were not purchased or applied, weedy rice sowings had low yield. As a result of it, it was bad.

Only in several farms specialists together with scientists could find optimum variant of water regime, at getting sprouts in cold May. Two-step of taking water into check-plots was used. At first flooding we created water layer of 5-7 cm in height and supported it for 5 days. While seed swelling took place, water was heated. After that water layer was increased up to 20-25 cm and supported at such level till dying of Echinochloa; then the level decreased to 10-12 cm, that rice would not appear at the surface. Under such conditions Lider had advanced other rice varieties by growth tempo and formed thicker plant stand. Later these factors influenced on yield positively. There is a good example in TSC "Anastasiyevskoe", Slavyansky region. Here, at the area of 350 ha Lider formed grain yield of 6,88 t/ha, Liman variety formed 4,8 t/ha. In experimental farm

“Kuban”, belonging to Agricultural University, at the area of 270 ha, without herbicide application, Lider had the yield of 5,54 t/ha. In the following three years (2000-2003) we got Lider yield 6,0-6,5 t/ha.

In 2000 (a year of release) Lider was growing at the Territory of 11000 ha. Then the farms could economize 33 million of rubles: they didn’t apply Facet herbicide. It seemed to be a big increase of the sawn areas for this variety. But it didn’t happen so. There are several reasons. One of these reasons is our recommendation to grow Lider by the worst pre-seeding crops, at low and weedy check-plots, where other varieties don’t give yield. It is really so that under such conditions the yield was higher than of other varieties, but not so high, as it could be under normal conditions. The problem is that as a rule, such check-plots in many farms were sawn in late May, but not from 5 to 8 May, as it was recommended. At deep water layer the spare sowings had big bushes, vegetation period was delayed. Harvesting was carried out late, when lateral shoots were not ripened. Then several specialists, rice-growers discussed Lider as a variety “difficult to threshing”.

But let’s give an example, disproving such meaning. In private enterprise “Rosstan”, Krasnoarmeisky region, Krasnodar Territory Lider was sawn for the first time in 1994 at the area of 98 ha. Later on it was widen up to 730 ha; it is more than 30% from total rice area. Such structure exists up to nowadays. It is so because the head of “Rosstan” is sure that the variety is more efficient economically: minimum quantity of fertilizers are used during its growing, plants can give sprouts from water layer; it is not necessary to apply herbicides and fungicides. The yield of Lider is 4,8-5,0 t/ha, it is more economically profitable then 6,0 t/ha of such varieties as Liman and Rapan, in which sowings it is necessary to apply chemicals. “Kuban” combine threshes any yield of Lider without difficulties for one run.

Very important peculiarity of variety is its ability to form high yield at relatively low providing with mineral nutrition, especially by nitrogen. But as

for other varieties, it should be, first of all balanced. Earlier established correlation of nitrogen, phosphate and potassium: 1,5:1,0:0,5 is a standard proportion for calculation of fertilizer application rate. As it is known, yield level is determined by the element, existing in soil, in minimum quantity. For recent years in many farms of the Territory, potassium fertilizers are not applied to the soil. As a result of it, rice plants of all varieties have deficit of potassium for normal development. It causes their lodging, increase of spikelets sterility, puny grain, blast. The yield decreased. The test showed that it was necessary to apply mineral fertilizers 35-40% less, than for Liman to obtain yield of Lider variety 6 t/ha.

Under the conditions of getting rice sprouts, from water layer, the plants need foliar spraying. As for the terms of carrying out foliar spraying specialists have different opinions. The majority of farms apply first foliar nutrition when rice rises from water layer to prevent algae development. As a rule, it is carried out in early June.

In TSC “Anastasiyevskoe” rice, seeded in late April – early May has foliar nutrition with appearance of leaves above water layer (23-25 May). If it is necessary (by leaf diagnostics) 10 days after first foliar nutrition to make another one. Such sowings, even if they are not thick enough, thanks to intensive tillering, form compact plant stand and give high yields.

In experimental farm “Kuban”, where aerial foliar spraying is not used, it is carried out by ground method, using urea, when rice begins to raise from water surface. When there is a big quantity of *Bolboschoenus maritimus* (L.) Palla, we apply Londax. Foliar nutrition gives positive effect very quickly. Rice plants grow energetically, have good bushing, form compact plant stand.

In agrofirm “Russia” Lider is seeded for recent 3 years in late April. Shoats are taken from water layer. Foliar nutrition is carried out once 100-150 kg of urea per ha by airplane. If there are swampy weeds, we use aerial spraying by Agritox solution – 1,5 l/ha and urea 20 kg/ha (urea solution is prepared pre-

viously in separate reservoir, with permanent stirring) working application rate is 100 l/ha. Application rate of fertilizers is lower, and efficiency is the same as common top-dressing.

A large amount of birds on fields of rice systems are the index of ecological situation stability in the zone of rice growing. (fig.2). Different types of birds such as herons, bitterns and mallards and others are nested here. For the last time the amount of glossy ibis (*Plegadis falcinellus* Binnaeus) population increases. This species was recorded in the Red books of the RF and Krasnodar region as a rare one [4].

Fig.2 Birds – indicators of ecological purity of rice fields (author's photo)

In consideration that plants of Lider grow fast at shooting, to overcome the water layer with ease, this variety is adjusted to grow without application of anti-grain herbicides. This property of the variety is successfully used in

Kazakhstan where the rice sprouts are received only from subwater layer on the salted soils [2]. In 2010 the Russian rice variety Lider is grown in Kazakhstan on 20% of rice growing area.

Conclusions

Thus, widely introduction of new variety Lider into agricultural production, at use of knowledge of morphological and biological peculiarities of the variety will give the possibility to farms not only to have high rice yields but well decrease their costs for cultivation of this crop by decrease of fertilizer rates and chemicals. And this, without any doubt, will improve ecology in rice-growing zones.

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