Evaluation of new rice varieties in the conditions of climate change

Ruslan Dzhamirze^{1,*}, Nadezhda Ostapenko¹, Sergey Garkusha¹, and Natalya Chinchenko¹

¹Federal Scientific Rice Centre, breeding department, 350921 Krasnodar, Belozerny 3, Russia

Abstract. In obtaining stable and high rice yields, the leading role belongs to the use of the best varieties, harmoniously combining productivity and technological indicators of grain and milled rice quality, adapted for cultivation in the main rice-growing regions. Therefore, the aim of our research is to evaluate new rice genotypes by a set of economically valuable traits that can replace obsolete varieties in the sowing area of the region and the country as a whole for industry efficiency. Experimental plots of competitive variety testing (CVT) were laid on the territory of the rice irrigation system of the experimental production department of the Federal Scientific Rice Centre, Belozerny, Krasnodar region for three years. The results are processed by analysis of variance and correlation analysis. All new varieties formed dense panicles of 10.0-11.9 pcs / cm with a sufficient number of fertile spikelets 139.7-165.9 pcs. on average, which is responsible for the high grain content of agrophytocenosis 44.1-58.2 thousand units/m². Hence the high grain yield - 9.2-10.2 t / ha with a good combination of the main technological indicators - the mass of 1000 grains and head rice content. The closeness of the interconnections of the main economically valuable traits and the heat supply of the growing season is determined. Four varieties (except VNIIR 10284) show a neutral yield response to one of the main factors of external influence on the plant - the sum of effective temperatures above 15 ° C. According to the results of the test, for three years in CVT and in the environmental testing, the variety Romans was transferred to State variety testing, VNIIR 10279 is being prepared for transfer.

1 Introduction

In solving the problems of modern crop production related to the steady growth of its productivity and profitability, development and widespread use of new varieties occupies a central place. Practical solution of such an important task in most ways depends on success of breeding work. According to available estimates, the contribution of breeding to increasing crop yields over the past decades is estimated at 30-70%, and taking into account possible climate changes, the role of breeding will increase [1, 2].

Depending on the tasks set for the breeder, the breeding is carried out according to individual, several or a variety of traits. In order for the new variety to meet high

* Corresponding author: dzhamirze01022010@yandex.ru

requirements, it is necessary to conduct breeding for a complex of traits. The main ones that you need to pay attention to during selection are yield (productivity), high quality of the product, resistance to diseases and pests, and suitability for mechanized cultivation [3].

In recent years, varietal change has been carried out at a rapid pace in the rice growing industry of Krasnodar region. New varieties with high potential yield and resistance to environmental stress factors for various cultivation technologies, with high grain quality and valuable consumer properties of milled rice are introduced into production [4, 5].

For the progressive development of rice growing, a scientifically based varietal policy is needed, including increasing the assortment of cultivated varieties of different technological energy intensity (varieties of intensive, extensive and intermediate types), taking into account their features, as well as agroclimatic conditions of cultivation [6, 7].

2 Materials and methods

As the research material we used varieties of competitive trials of the mid-late ripening group developed by the classical hybridization method and individual selection from the obtained hybrid populations.

For sowing the plots, we used the Wintersteiger Plotseed central seeder. The accounting area of the plots is 20 m², the fourfold repetition, the arrangement is randomized repetition, the standard – rice variety Flagman rice, the general mineral nutrition background is N₁₄₀P₆₀K₄₀.

The research work was carried out in accordance with GOST 15.101.80 "Procedure for conducting research work" and the methods developed in the All-Russian Rice Research Institute [8, 9, 10].

The experiments were laid on the rice irrigation system of the experimental production department (RIS EPD) of the Federal Scientific Rice Centre for three years 2017-2019. Sowing dates – 01/05 - 04/05, the initial flooding of the check - 07/05 - 11/05.

In the competitive variety testing, the dates of preventive treatments and the onset of phenological phases of heading and full ripening were noted. During the growing season, the plots were visually assessed on the field by the plant density, lodging resistance, disease and pest damage, uniformity and homogeneity of crops. After a field screening of the plots planned for harvesting, model sheaves of 10-15 plants were taken for biometric analysis.

The results obtained were processed by the methods of variance and correlation analyzes [11], and the coefficient of variation (CV) was used to compare the degree of variability of traits. According to Dospekhov B.A. (1979) and Dzyuba V.A. (2007) variability is considered insignificant if the coefficient of variation does not exceed 10%; medium if V is above 10% but less than 20%, and significant if the coefficient of variation is more than 20%.

3 Results and discussion

Currently, rice varieties are bred taking into account 35-45 traits. When transferring to State variety testing, characteristics and estimates obtained by breeders at the stage of the control nursery (CN) and competitive variety testing (CVT) for 4-5 years are used. The most widely used assessment is based on a comparison of the characteristics of plants of new varieties with a standard variety.

In addition to individual traits and indicators, the connection of traits among themselves is widely used. The researchers noted that the strength and structure of the relationships between the traits in rice are significantly affected by the conditions of plant growth, i.e.

heat supply of the growing season. Moreover, the direction of variability in different genotypes is specific.

To identify and further evaluate the nature of the relationship of the sum of temperatures above 15 °C with biometric characteristics and technological indicators of grain and milled rice quality of the presented genotypes, we analyzed the dynamics of average daily air temperatures and calculated the heat supply of the vegetation period during 2017-2019. (Figure).

Fig. 1. Temperature regime during the research period, 2017-2019.

An analysis of three-year data showed that the temperature regime during the study period was generally favorable for rice. In 2017, the sum of effective temperatures above 15 °C in the first two decades of May was ahead of the long-term average. From the third decade of May to the end of the second decade of June, heat supply was lower than the annual average. This short period was characterized by low night temperatures, which led to a decrease in the seed vigor, getting unprotected seedlings and inhibition of seedlings metabolism. We assume that this is due to an increase in the length of the growing season in 2017. From the third decade of June to the third decade of September, heat supply for the growing season increased at a faster rate and reached 1089 °C, which is 306 °C higher than the long-term average.

From the first to the second decades of May in 2018, a decrease in the average daily air temperature below 15 degrees (up to 12-13 °C) was also noted due to low temperatures at night, but it did not adversely affect rice sprouts. The sum of effective air temperatures above 15 °C during the entire rice growing season in 2018 (May-September) significantly exceeded the long-term average. Positive dynamics of heat accumulation was observed until the end of September, which significantly reduced the risk of ripening of mid-late ripening and late-ripening rice varieties in terms of heat supply. However, high daytime

temperatures and extremely low air humidity during the flowering and dry season during milky-wax ripeness could adversely affect pollen quality and viability, fertilization and filling of the grain. There was an increased sterility of the panicle and the prevalence of shrunk grain. The difference in heat supply with the long-term average in 2018 by the end of the growing season was 455 °C.

The average decade air temperature during the entire growing season in 2019 (May-September) generally exceeded the long-term average. In the rice crops, seedlings formed thick, plant growth rates were high, due to prevailing temperatures. There were slight decreases in daily average air temperatures from the second decade of July to the first decade of August. The amount of precipitation during the same period practically did not differ from the long-term average. An exception is the second or third decade of July, when it fell to 132 mm, i.e. the norm was exceeded by almost 2.5 times. In addition, there is a non-uniformity of precipitation - from 0 mm to 67.7 mm for the third decade of July. The sum of effective air temperatures above 15 °C during the entire growing season (May-September) significantly exceeded the long-term average. By the end of September, the difference was 296 degrees.

In general, the thermal regime during the study period (2017-2019) was positive and had no critical deviations from mean annual values, but the individuality of each year contributed to a specific reaction of the studied varieties.

Development and introduction of new and more productive rice varieties into production is gaining relevance, as this is one of the main reasons for increasing yields [4].

The opinion of scientists about the set of traits characterizing the variety does not differ significantly. Reliable selection criteria, regardless of growing conditions, are the duration of the growing season, plant height, panicle length, number of spikelets on it, panicle and plant productivity, mass of 1000 grains, shape and linear dimensions of the grain, etc. [10].

It is known that most of the economically valuable traits are closely related to the growing season, therefore its duration will affect the yield and other characteristics of the varieties (Table 1). 2017.

Table 1. Economically valuable traits of rice varieties from competitive testing, 2017-2019.

Variety	Trait	2017	2018	2019	Mean value	CV, %
Flagman (st)	Duration, days	110	106	115	110	4.1
	Plant height, cm	82	93	90	88.3	6.4
	Productivity of growing day, kg/days /ha	60.9	86.8	96.5	81.4	22.6
	Grain content of agrophytocenosis, thous. pcs. /m ²	37.5	44.3	41.9	41.2	8.4
	Number of filled grains on the main panicle, pcs.	142.9	150.3	169.7	154.3	9.0
	Density of the main panicle, pcs./cm	8.3	11.2	10.4	10.0	15.0
	Yield, t/ha	6.7	9.2	11.1	9.0	24.5
	Mass of 1000 grains at a moisture 14%, g	26.7	29.6	28.7	28.3	5.2
	Mass of grain from the plant, g	9.2	7.2	6.8	7.7	16.6
	Head rice content, %	77.3	90.1	98.6	88.7	12.1
Romance	Duration, days	126	120	120	122	2.8
	Plant height, cm	84	96	94	91.3	7.0
	Productivity of growing day, kg/days /ha	57.2	81.4	87.8	75.5	21.4

	Grain content of agrophytocenosis, thous. pcs. /m ²	39.3	44.0	45.4	42.9	7.4
	Number of filled grains on the main panicle, pcs.	172.7	158.3	166.8	165.9	4.4
	Density of the main panicle, pcs./cm	11.1	12.4	12.2	11.9	5.9
	Yield, t/ha	7.2	9.7	10.6	9.2	19.2
	Mass of 1000 grains at a moisture 14%, g	28.6	31.0	30.3	30.1	4.3
	Mass of grain from the plant, g	10.3	8.4	7.6	8.8	15.8
	Head rice content, %	85.7	98.1	80.8	88.2	10.1
VNIIR 10279	Duration, days	122	118	115	118	3.0
	Plant height, cm	94	99	95	96.0	2.8
	Productivity of growing day, kg/days /ha	59.1	91.0	110.4	86.8	29.8
	Grain content of agrophytocenosis, thous. pcs. /m ²	38.9	47.3	58.2	48.1	20.1
	Number of filled grains on the main panicle, pcs.	149.4	154.1	159.5	154.3	3.3
	Density of the main panicle, pcs./cm	10.8	12.5	11.8	11.7	7.3
	Yield, t/ha	7.2	10.7	12.7	10.2	27.3
	Mass of 1000 grains at a moisture 14%, g	30.1	30.8	31.4	30.8	2.1
	Mass of grain from the plant, g	10.5	9.4	5.8	8.6	28.7
	Head rice content, %	79.3	95.0	82.9	85.7	9.6
VNIIR 10281	Duration, days	130	123	123	125	3.2
	Plant height, cm	96	104	101	100.3	4.0
	Productivity of growing day, kg/days /ha	57.7	86.3	93.2	79.1	23.8
	Grain content of agrophytocenosis, thous. pcs. /m ²	37.7	43.0	44.1	41.6	8.2
	Number of filled grains on the main panicle, pcs.	145.9	139.0	151.4	145.4	4.3
	Density of the main panicle, pcs./cm	10.5	10.5	9.7	10.2	4.5
	Yield, t/ha	7.5	10.6	11.5	9.9	21.3
	Mass of 1000 grains at a moisture 14%, g	33.6	32.1	35.0	33.6	4.3
	Mass of grain from the plant, g	10.2	7.2	7.2	8.2	21.1
	Head rice content, %	90.1	95.1	77.9	87.7	10.1
VNIIR 10284	Duration, days	125	124	124	124	0.5
	Plant height, cm	98	104	101	101.0	3.0
	Productivity of growing day, kg/days /ha	66.4	77.9	96.5	80.3	18.9
	Grain content of agrophytocenosis, thous. pcs. /m ²	39.2	44.6	57.4	47.1	19.9
	Number of filled grains on the main panicle, pcs.	137.3	147.3	134.6	139.7	4.8
	Density of the main panicle, pcs./cm	9.6	12.2	9.5	10.4	14.7
	Yield, t/ha	8.3	9.7	12.0	10.0	18.7

	Mass of 1000 grains at a moisture 14%, g	29.2	28.7	30.6	29.5	3.3
	Mass of grain from the plant, g	7.3	8.6	6.2	7.4	16.3
	Head rice content, %	93.2	97.2	87.7	92.7	5.1
LSD	Yield, t/ha	0.62	0.61	0.63		
CV, %	Duration, days	6.2	6.1	3.6		
	Plant height, cm	8.0	4.9	5.0		
	Productivity of growing day, kg/days /ha	6.2	6.0	8.6		
	Grain content of agrophytocenosis, thous. pcs.	2.2	3.6	15.7		
	Number of filled grains on the main panicle, pcs.	9.1	4.9	9.0		
	Density of the main panicle, pcs./cm	11.3	7.4	11.4		
	Yield, t/ha	8.0	6.5	7.0		
	Mass of 1000 grains at a moisture 14%, g	8.6	4.3	7.5		
	Mass of grain from the plant, g	14.0	11.7	10.9		
	Head rice content, %	8.0	3.3	9.5		

The duration of the growing season of most rice varieties cultivated in Krasnodar region and the Republic of Adygea depends on agro-climatic conditions (average daily temperature in certain phases of growth and development, heat supply, daylight hours, rainfall, etc.). From the data obtained, it can be seen that, according to the duration of the growing season, all studied varieties belong to the group of late-ripening (122-127 days), except for the standard: it is medium ripening (110 days on average). Variation of the trait is weak and amounted to 0.5-4.1%, despite the long duration of the growing season in 2017 for all varieties. The agro-climatic conditions of the region allowed the plants to form full-fledged generative organs and obtain reliable data on yield.

Plant height is one of the traits determining the resistance of a rice plant to lodging under the negative effects of abiotic stressors (wind, rain). The most widespread varieties in Krasnodar region are rice varieties with a plant height of up to 100 cm. The height of the studied rice varieties for an average of three years ranged from 88.3 to 101.0 cm. All varieties presented were aligned in height, which leads to weak variability of the trait (up to 7.0%).

The productivity of one growing day characterizes the potential ability of a certain area of cenosis to accumulate dry matter during the day and is a calculated indicator. It is determined by the ratio of productivity to the duration of the growing season. The average values of this trait ranged from 75.5 to 86.8 kg / day / ha. The table shows that the variety VNIIR 10279 has a high potential for the accumulation of dry matter - 91.0 and 110.4 kg / day / ha, as noted in 2018 and 2019 respectively. The average and high degree of variability of this trait of 18.9-29.8% is due to the fact that it is calculated and consists of several indicators, each of which is influenced by certain factors, including the genotype.

The number of grains per unit of sown area is a complex trait, determined by the number of productive sprouts in this area and grain content in their panicles. Of the disadvantages of this traits, it should be recognized that it does not take into account the mass of 1000 grains. Nevertheless, it deserves much attention when evaluating breeding samples for productivity [15]. Grain content of agrophytocenoses from 41.2 thous. pcs./ m² (Flagman and VNIIR 10281) to 48.1 thous. pcs./ m² (VNIIR 10279) shows that all the rice varieties presented have a high degree of realization of the potential of this trait. It should be noted that in 2019 the largest number of grains was formed - 44.1-58.2 thous. pcs./m², which allowed to maximize the yield potential of all new varieties. Varieties VNIIR 10279 and VNIIR 10284 were distinguished as genotypes with maximum grain content - 48.1 and 47.1 thous. pcs./m², respectively, and variability was 20.1 and 19.9%. We assume that such a high variability of the trait in these varieties is caused by climatic fluctuations.

The number of fertile spikelets on a panicle is one of the main structural elements of productivity. In our studies, this trait on average for three years ranged from 139.7 (VNIIR 10284) to 165.9 pcs. (Romance). On the variety Romance, the maximum number of fertile grains was noted during the entire research period - 172.7, 158.3, and 166.8 pcs. respectively by years. The remaining varieties were at the standard level. It is noted that during the years of research, this trait has proved to be the most stable and varies slightly - 3.3–9.0%.

The panicle density characterizes the variety's ability to form a certain number of grains per centimeter of panicle length. It is believed that 9-10 pcs / cm is the optimal value of this trait in order to form a sufficient yield. The average values of the trait in the presented varieties ranged from 10.0 pcs/cm (Flagman and other) to 11.9 pcs / cm (Romance and VNIIR 10279). The weak variability of the trait over the years ($CV = 4.5\text{--}7.3\%$) was found in the varieties Romance, VNIIR 10279 and VNIIR 10281. The average variability of the trait ($CV = 14.7\text{--}15.0\%$) was found in Flagman and VNIIR 10284.

Yield is the result of a harmonious combination of its structural elements (traits) described earlier. On average, a reliable excess of the Flagman standard (9.0 t/ha) was noted at VNIIR 10279, VNIIR 10281 and VNIIR 10284 - 10.2, 9.9 and 10.0 t/ha, respectively, and Romance at the level of LSD_{05} . The variability of the trait in the range of 18.7-27.3% indicates its dynamism and close dependence on agro-climatic conditions with the same cultivation technology.

The mass of 1000 grains is a slightly varying trait that reliably characterizes the variety [8, 14, 16], which is confirmed in our experiment (CV between varieties is 4.3-8.6%, and intra-varietal - 2.1-5.2%). It was noted that all varieties in our experiment exceed the Flagman standard with a value of this trait of 28.3 g on average over three years. For new rice varieties, the weight of 1000 grains varied within the range of 29.5-33.6 g. The maximum values throughout the entire research period correspond to the VNIIR 10281 - 33.6; 32.1 and 35.0 g, respectively, by years.

The mass of grain from the plant is one of the key traits in the formation of rice grain yield. This trait is integrated and in combination with the number of productive stems per unit area reliably characterizes varieties by yield. Exceeding the Flagman standard in terms of grain weight per plant for three years (7.7 g) was noted on the varieties Romance, VNIIR 10279 and VNIIR 10281 - 8.8, 8.6 and 8.2 g, respectively. The average degree of variation of the trait (CV within 15.8-28.7%) is due to its dependence on many factors and other traits (grain content in the panicle, sterility, etc.).

Head rice content is one of the main technological quality indicators, indicating the economic efficiency of rice varieties in grain processing.

The studied varieties have high trait values: from 85.7% (VNIIR 10279) to 92.7% (VNIIR 10284). The table shows that almost all varieties were at the level of the Flagman standard (88.7%) and only VNIIR 10284 (92.7%) exceeded it. The average variability over the years is noted for Flagman, Romance and VNIIR 10281 ($CV = 10.1\text{--}12.1\%$) and weak for VNIIR 10279 and VNIIR 10284 ($CV = 5.1\text{--}9.6\%$).

Yield and product quality are two parameters that are difficult to combine in one variety. Using a correlation analysis of economically valuable traits and technological indicators of grain quality of each of the varieties studied in the experiment, it was found that their relationship is specific, and its closeness is due to the genotype and growing conditions (table 2).

Table 2. Correlation of economically valuable traits in rice varieties of competitive testing, 2017-2019.

Variety	Q	Mean value	Dispersion	Q								
				1	2	3	4	5	6	7	8	9
Flagman (st)	1	1136	89.39									
	2	110.3	4.51	0.862								
	3	88.3	5.68	0.670	-0.202							
	4	41.2	3.45	0.733	-0.287	0.996						
	5	154.3	13.84	-0.304	0.745	0.503	0.425					
	6	10.0	1.49	0.673	-0.205	0.999	0.996	0.500				
	7	9.0	2.21	0.023	0.487	0.757	0.696	0.946	0.755			
	8	28.3	1.48	0.700	-0.242	0.999	0.999	0.467	0.999	0.730		
	9	7.7	1.29	-0.306	-0.218	-0.912	-0.872	-0.814	-0.910	-0.959	-0.894	
	10	88.7	10.72	0.060	0.454	0.781	0.723	0.933	0.779	0.999	0.755	-0.969
Romance	1	1136	89.39									
	2	122.0	3.46	-0.451								
	3	91.3	6.43	0.584	-0.988							
	4	42.9	3.19	0.244	-0.976	0.930						

	5	165.9	7.24	-0.889	0.810	-0.891	-0.661					
	6	11.9	0.70	0.574	-0.990	0.999	0.934	-0.885				
	7	9.2	1.76	0.208	-0.967	0.915	0.999	-0.633	0.920			
	8	29.9	1.29	0.676	-0.962	0.993	0.880	-0.938	0.991	0.861		
	9	8.8	1.39	-0.174	0.958	-0.901	-0.997	0.606	-0.906	-0.999	-0.843	
	10	88.2	8.92	0.975	-0.243	0.391	0.024	-0.766	0.379	-0.013	0.497	0.047
VNIR 10279	1	1136	89.39									
	2	118.3	3.51	-0.026								
	3	96.0	2.65	0.970	-0.269							
	4	48.1	9.68	-0.130	-0.988	0.115						
	5	154.3	5.05	-0.096	-0.993	0.150	0.999					
	6	11.7	0.86	0.777	-0.650	0.907	0.523	0.552				
	7	10.2	2.78	0.100	-0.997	0.339	0.973	0.981	0.704			
	8	30.8	0.65	-0.012	-0.999	0.232	0.993	0.996	0.621	0.994		
	9	8.6	2.46	0.347	0.929	0.108	-0.975	-0.967	-0.321	-0.899	-0.942	
	10	85.7	8.23	0.962	-0.298	0.999	0.145	0.180	0.919	0.368	0.262	0.077
IR 10	1	1136	89.39									

	2	125.3	4.04	-0.451								
	3	100.3	4.04	0.750	-0.929							
	4	41.6	3.42	0.301	-0.987	0.857						
	5	145.4	6.21	-0.920	0.065	-0.431	0.096					
	6	10.2	0.46	0.548	0.500	-0.143	-0.633	-0.832				
	7	9.9	2.09	0.249	-0.977	0.827	0.999	0.150	-0.674			
	8	33.6	1.46	-0.901	0.020	-0.390	0.141	0.999	-0.856	0.195		
	9	8.2	1.73	-0.451	0.999	-0.929	-0.987	0.065	0.500	-0.977	0.020	
	10	87.7	8.85	0.762	0.235	0.143	-0.388	-0.955	0.959	-0.438	-0.967	0.235
VNIIR 10284	1	1136	89.39									
	2	124.3	0.58	-0.451								
	3	101.0	3.00	0.837	-0.866							
	4	47.1	9.35	-0.283	-0.729	0.289						
	5	139.7	6.69	0.989	-0.315	0.747	-0.420					
	6	10.4	1.53	0.999	-0.471	0.849	-0.260	0.985				
	7	10.0	1.87	-0.194	-0.788	0.375	0.996	-0.336	-0.171			

8	29.5	0.99	-0.742	-0.264	-0.254	0.853	-0.832	-0.726	0.802		
9	7.4	1.20	0.913	-0.048	0.541	-0.649	0.963	0.904	-0.577	-0.951	
10	92.7	4.77	0.848	0.091	0.419	-0.748	0.917	0.835	-0.685	-0.985	0.990

Note: Q – trait / factor;

- 1 – sum of effective temperatures above 15 °C, $\Sigma t > 15\text{ °C}$;
- 2 – duration of growing period, days;
- 3 – plant height, cm;
- 4 – grain content of agrophytocenosis, thous. pcs. /m²;
- 5 – number of filled grains on the main panicle, pcs.;
- 6 – density of the main panicle, pcs./cm;
- 7 – yield, t/ha;
- 8 – mass of 1000 grains, g;
- 9 – mass of grain from the plant, g;
- 10 – head rice content (HRC), %.

Productivity in varieties is high during the entire study period (9.0-10.2 t / ha). Correlation analysis revealed some general patterns in the experiment. Grain productivity is strongly positively associated with the number of fertile spikelets on the main panicle, with the height and grain content of agrophytocenosis, and strongly negatively with the growing season. And individual varietal characteristics indicate that, in Flagman and Romanc, the yield, in addition to the aforementioned, is strongly positively related to the density of the panicle, while in Romance it strongly negatively depends on the number of fertile grains on the panicle.

Head rice content (HRC) (as the main technological quality indicator) in the varieties in the experiment is high (85.7-92.7%). Correlation analysis revealed some general patterns and individual features in the experiment. In all varieties, HRC is strongly positively correlated with the density of the main panicle. In the varieties Flagman, Romance, and VNIIR 10279, a strong positive relationship was revealed with the plant height. At Flagman and Romance - with a grain content of agrophytocenosis. In VNIIR 10279, VNIIR 10281, and VNIIR 10284, HRC directly positively depends on the sum of effective temperatures above 15 °C. The number of grains of the main panicle and HRC for Flagman and VNIIR 10284 have a strong positive relationship, and for the Romance and VNIIR 10281 they have a strong negative relationship. In the varieties VNIIR 10281 and VNIIR 10284, a strong negative relationship between HRC and the mass of 1000 grains was revealed.

To characterize the variety, strong relations, both positive and negative, must be considered, analyzed, and known, but this is not always a good indicator. Therefore, we consider both weak and medium dependencies of such important traits as productivity and head rice content.

Four varieties (except for VNIIR 10284) show a neutral yield response to one of the main factors of external influence on the plant - the sum of effective temperatures above 15 °C. For the Romance and VNIIR 10279, more than half of the indicators studied in the experiment do not affect the head rice content. Therefore, we distinguish the studied new varieties as promising and stable. According to the results of the test, for three years in the

CVT and in the environmental experiment, the variety Romance was transferred to State variety testing, the variety VNIIR 10279 is being prepared for transfer.

4 Conclusions

All varieties studied in the competitive testing belong to the group of medium-late, medium-height with a straw height of 80-100 cm, with a high yield potential and excellent milled rice quality. The varieties VNIIR 10279 and VNIIR 10284 have a high potential for the accumulation of dry matter of 86.8 and 80.3 kg/day/ha. All new varieties formed dense panicles of 10.0-11.9 pcs / cm with a sufficient number of fertile spikelets 139.7-165.9 pcs. on average, what causes a large grain content of agrophytocenosis in 44.1-58.2 thous. pcs./m². All this made it possible to form a high yield in the varieties VNIIR 10279, VNIIR 10281 and VNIIR 10284 - 10.2, 9.9 and 10.0 t / ha, respectively, significantly exceeding the Flagman (st). It should be noted that most of the new varieties, despite the relative large grain size - with a mass of 1000 grains equal to 29.5-33.6 g, in terms of head rice content were at the standard level.

The results of the correlation analysis testified to the diversity and degree (closeness) of the relationship between the studied traits, which indicates the specificity of each variety expressed by one or another set of genes. Common to the varieties in the experiment was a strong positive relationship between grain productivity and the number of fertile spikelets on the main panicle, with the height and grain content of agrophytocenosis, and a strong negative relationship with the growing season. In all varieties, HRC is strongly positively correlated with the density of the main panicle. In varieties Flagman, Romance, and VNIIR 10279, a strong positive relationship was revealed with the plant height. In Flagman and Romance - with grain content of agrophytocenosis. In VNIIR 10279, VNIIR 10281, and VNIIR 10284, HRC directly positively depends on the sum of effective temperatures above 15 °C. The number of grains in the main panicle and HRC for Flagman and VNIIR 10284 have a strong positive relationship, and for Romance and VNIIR 10281 they have a strong negative relationship. In the varieties VNIIR 10281 and VNIIR 10284, a strong negative relationship between HRC and mass of 1000 grains was revealed. Four varieties (except for VNIIR 10284) show a neutral yield response to one of the main factors of external influence on the plant - the sum of effective temperatures above 15 °C. For the Romance and VNIIR 10279, more than half of the indicators studied in the experiment do not affect the head rice content. Therefore, we distinguish the studied new varieties as promising and stable. According to the results of the test, for three years in the CVT and in the environmental experiment, the variety Romance was transferred to State variety testing, the variety VNIIR 10279 is being prepared for transfer.

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