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06.01.05 - Селекция и семеноводство сельскохозяйственных растений (сельскохозяйственные науки)

СРАВНИТЕЛЬНАЯ ОЦЕНКА УСТОЙЧИВОСТИ ИНТРОДУЦИРОВАННЫХ ОБРАЗЦОВ И СЕЛЕКЦИОННЫХ ФОРМ ОЗИМОГО ЯЧМЕНЯ К НИЗКИМ ОТРИЦАТЕЛЬНЫМ ТЕМПЕРАТУРАМ

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Мы живем в эпоху изменяющегося климата и увеличения числа населения – эти два фактора приводят к необходимости поддержания продовольственной безопасности, в том числе методом создания высокоморозоустойчивых сортов озимых зерновых культур. Со времен зарождения селекции перед учеными ставились реальные задачи обеспечить свою страну необходимым количеством продовольствия. В области возделывания зерновых культур решение должны

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06.01.05 - Selection and seed production of agricultural plants (agricultural sciences)

COMPARATIVE ASSESSMENT OF THE RESISTANCE OF INTRODUCED SAMPLES AND SE-LECTION FORMS OF WINTER BARLEY TO LOW NEGATIVE TEMPERATURES

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We live in an era of a changing climate and an increasing population - these two factors lead to the need to maintain food security, including by creating highly resistant varieties of winter cereals. Since the beginning of breeding, scientists have been faced with real tasks to provide their country with the necessary amount of food. In the field of cultivation of grain crops, the decision should be based not only on the issues of

быть основаны не только на вопросах создания и внедрения высокопродуктивных сортов, но острым направлением является выведение морозоустойчивых форм. Это позволит сельхозтоваропроизводителям находящимся в северных регионах возделывания озимого ячменя, гарантированно получать урожай и дополнительные средства за счет введения в севооборот зимостойких сортов. В связи с этим, перед нами была поставлена цель – оценить морозоустойчивость коллекционных формы разного эколого-географического происхождения. В наших исследованиях мы применяли современный метод разработанный академиком В.М. Шевцовым. Данный метод позволяет за короткий период времени оценить тестируемый материал и получить четкую дифференцию по оцениваемому признаку. В опыте проморозку осуществляли при двух вариантах критических температур –11 и – 12 °С. Весь оцениваемый материал был сигментирован после обработки экспериментальных данных. Выявлены формы с различным уровнем устойчивости к заданным температурным режимам. Определены сорта отличающиеся высокой устойчивостью к прямому воздействию отрицательных температур

Ключевые слова: ОЗИМЫЙ ЯЧМЕНЬ, МОРОЗОУСТОЙЧИВОСТЬ, ПРОМОРАЖИВАНИЕ, СЕГМЕНТАЦИЯ МОРОЗОУСТОЙЧИВОСТИ

creation and introduction of highly productive varieties, but the main direction is the breeding of frost-resistant forms. This will allow agricultural producers located in the northern regions of winter barley cultivation to receive a guaranteed harvest and additional funds due to the introduction of winter-hardy varieties into crop rotation. In this regard, the goal was set for us – to assess the frost resistance of collectible forms of different ecological and geographical origin. In our research, we used a modern method developed by academician V.M. Shevtsov. This method makes it possible to evaluate the tested material in a short period of time and obtain a clear differentiation according to the assessed feature. In the experiment, the freezing was carried out at two critical temperatures of -11 and -12 °C. All the evaluated material was segmented after processing the experimental data. The forms with different levels of resistance to the specified temperature conditions have been identified. We have also identifies varieties characterized by high resistance to the direct effects of negative temperatures

Keywords: WINTER BARLEY, FROST RESISTANCE, FREEZING, SEGMENTATION OF FROST RESISTANCE

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COMPARATIVE ASSESSMENT OF STABILITY INTRODUCED SAMPLES AND BREEDING FORMS WINTER BARLEY TO LOW NEGATIVE TEMPERATURES

Barley is a cereal crop with one of the widest acreage ranges in the world. Compared to other cereals, barley ranks fourth in world production after corn, wheat and rice [1].

Barley varieties are cultivated in world agriculture on more than 80 million hectares due to their high plasticity. The average world crop yield is 2,4 t/ha, and the annual production is more than 160 million tons.

In Russia, barley is one of the main grain forage crops. The cultivation of winter barley is concentrated mainly in the North Caucasus, where it occupies from 6 to 10% in the structure of the sown area in this region.

Winter barley has a number of advantages over other grain crops. Being characterized by early ripeness and high productivity, it provides agricultural producers with the earliest grain. Thus, supplying livestock with fodder, and when selling grain, it provides the first financial return on the harvest. For the climatic conditions of the Krasnodar Territory, winter barley is especially relevant and widely in demand in production.

The expansion of winter barley sowings to the northern regions is hindered by insufficient winter hardiness of varieties admitted for production. Many agrarians do not introduce winter barley into the crop rotation, fearing the instability of the guaranteed annual harvest. In this regard, the breeding and introduction of new highly winter-hardy varieties is an urgent task of breeding [2].

The main factor determining winter hardiness is the resistance of winter forms to negative temperatures [3]. In the southern regions of crop cultivation, the climatic conditions in the winter period are favorable for the overwintering of winter crops, and it is almost impossible to conduct a qualitative field assessment of winter hardiness. For these purposes, in breeding practice, the method of direct laboratory freezing in low-temperature chambers is used. It allows you to clearly differentiate the prototypes for frost resistance. In artificial climate chambers, when simulating low negative temperatures, it is possible to determine the critical temperature for each particular variety and to mobilely evaluate significant amounts of breeding material [4].

Material and technique. When conducting our research, frost resistance testing was carried out on varieties and breeding lines of our own selection, forms of the NCZ name P.P. Lukyanenko, LLC «Agrostandart», FGBNU ARC «Donskoy», as well as in the study used samples of the world collection of VIR. In total, the study included 116 varieties and breeding forms. The varieties Molot and Strateg were used as standards.

Frost resistance was assessed at the Center for Artificial Climate using a modified method by B. M. Shevtsov. For this, an EKSI freezer was used (figure 1).

Figure 1 – EKSI freezer and programmer for a flexible freezing temperature control system

The technical characteristics of the chamber, its increased accuracy of maintaining the temperature throughout the working volume, as well as the stability of the operation of the automatic control system for the freezing process, make it possible to obtain high-precision experimental data.

The programmer, developed and designed for the tasks of freezing modes, authorizes the set temperature automatically and performs an operational recording of the entire process in real time.

The analyzed material was sown in plastic boxes (38 x 27 x 13 cm with a drainage hole) in 7 rows (one row, one variety or breeding line), the standard variety Molot was sown in the second and sixth rows. Freezing of prototypes was carried out at temperatures of –11 and –12 °C. After freezing, the test material

was removed from the chambers and subsequently the percentage of frost resistance was determined by the ratio of the number of preserved plants to the number of plants before freezing.

The data obtained during the research were processed by the methods of mathematical statistics in the edition of B. A. Dospekhov. The obtained results were processed using computer programs.

Results. In our breeding work, as parental forms, we also traditionally involve varieties and samples of various ecological and geographical origin. In programs whose goal is to create winter-hardy varieties, it is imperative to study the frost resistance of the original forms. The varieties studied by us were represented by different origins (figure 2).

The studied collection was represented by samples of Russian selection 63,8 %, forms of their France – 11,2 %, Germany – 9,5 %, Ukraine – 5,2 %, Canada – 4,3 %, Bulgaria – 3,4 %, Austria – 1,7 %, Czech Republic, USA, Mexico, Japan and Belarus less than 1 percent. When studying the experimental material, the main goal was to identify sources of high frost resistance.

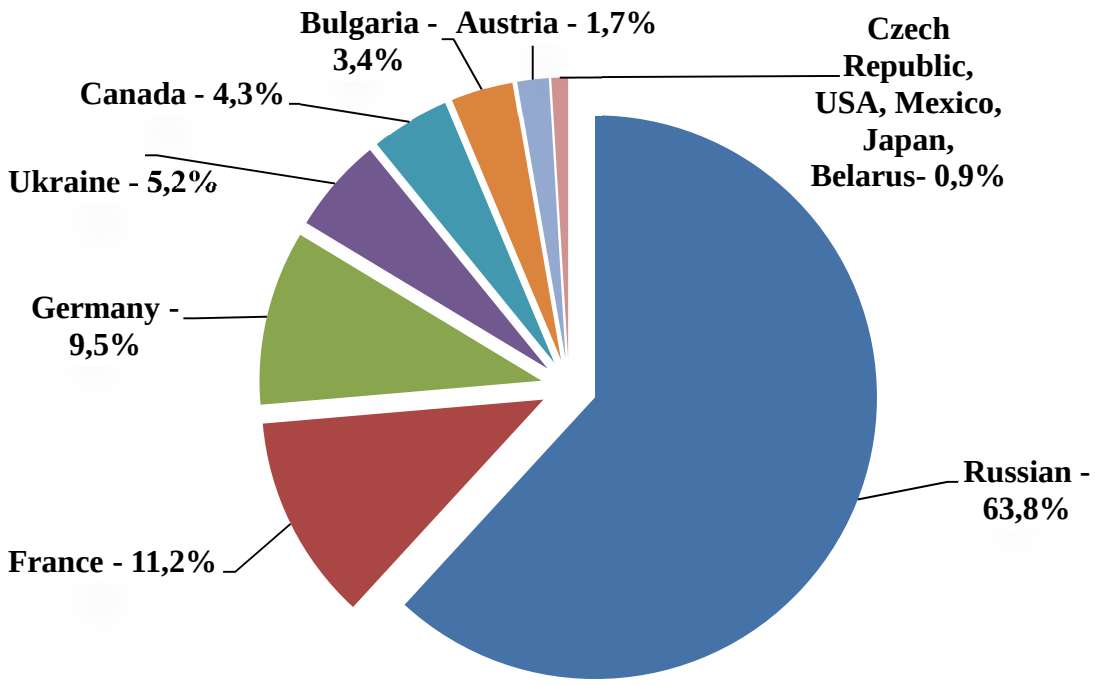


Figure 2– Origin of experimental varieties winter barley

According to the results of the test, all material was distributed intofive resistance groups. With the preservation of up to 20% of living plants, the samples were assigned to a group with very low frost resistance. From 21 to 40% of the preserved plants are a group with low frost resistance. More than 41, but up to 60 % – belonged to the group with medium resistance. From 61 to 80% – high resistance, and above – with very high frost resistance.

Based on the results of freezing at a temperature of – 11 °C, we made the following distribution (figure 3).

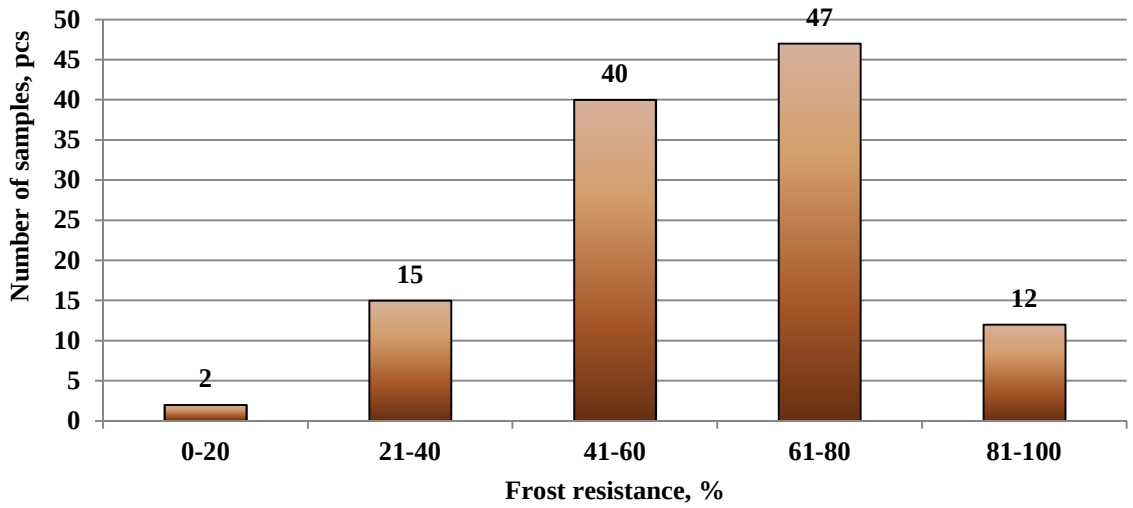


Figure 3 – Segmentation of frost resistance of varieties and samples winter barley at a temperature of – 11 ° C

The first group, with very low frost resistance, included 2 experimental forms. Low resistance was determined in 15 samples, average frost resistance (41–60%) was found in 40 varieties, 47 varieties were distinguished by high rates, their survival of living plants was at the level of 61–80%, very high resistance from 81 to 100% was found only in 12 samples from all studied material.

In general, 99 out of 116 prototypes had high data on frost resistance, at a freezing temperature of 11 °C. 15 % of varieties showed medium resistance.

In the future, we subjected the same varietal composition to freezing at a lower temperature – 12 ° C.

The results of this freezing cycle were different. The most numerous were the first two resistance groups, which included up to 95 % of all studied forms (figure 4).

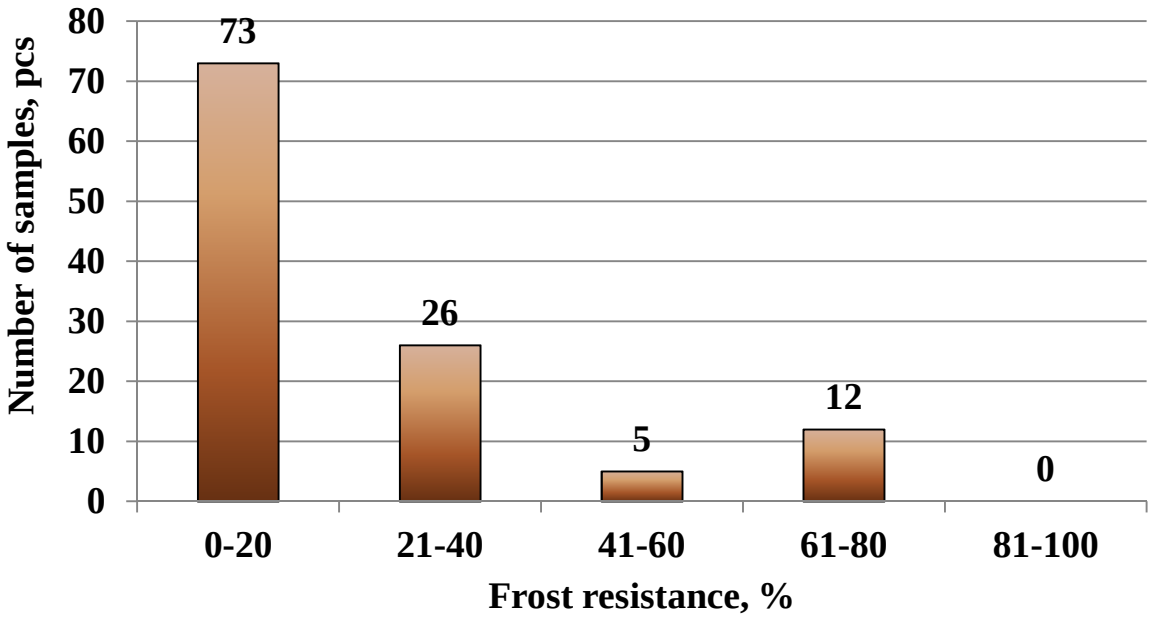


Figure 4 – Segmentation of frost resistance of varieties and samples winter barley at a temperature of – 12 ° C

The resistance of prototypes to lower temperatures turned out to be much lower. Thus, most varieties and accessions were distinguished by low frost resistance of 0–20 and 21–40%, and only 12 varieties had a high percentage of survival of living plants from 61–80% and higher. It is these forms that are of particular interest as the starting material in breeding programs for the creation of highly frost-resistant varieties.

Analyzing the obtained data on frost resistance, it was possible to obtain a clear individual differentiation of all the studied forms. In general, high rates of frost resistance were found mainly in varieties of Russian breeding. In this group, we included forms that had a plant survival rate of 70 % and more than 90 % at a freezing temperature of –11 °C, and in order to identify a decrease in resistance to direct frost exposure, the indicators of these forms at a lower temperature are given (table 1).

Table 1 – Average frost resistance of selected varieties and accessions of winter barley (Kuban State Agrarian University)

Variety, sample	Frost resistance, %		± to standard			
			– 11°C		– 12°C	
	– 11°C	– 12 °C	Molot	Strateg	Molot	Strateg
Molot st.	93,6	72,3		14,7		-13,0
Strateg st.	78,9	59,3	– 14,7		-13,0	
Kubagro 100	81,2	60,8	– 12,4	2,3	– 11,5	1,5
Agrodeum 21	79,4	59,5	– 14,2	0,5	– 12,8	0,2
89/22	80,6	61,4	-13,0	1,7	– 10,9	2,1
Sel'hoz	74,8	59,6	– 18,8	– 4,1	– 12,7	0,3
Versal'	80,6	61,4	–13,0	1,7	– 10,9	2,1
Timothy	82,5	62,1	– 11,1	3,6	– 10,2	2,8
Yerema	97,3	75,2	3,7	18,4	2,9	15,9
Samson	94,5	72,6	0,9	15,6	0,3	13,3
Vasya	76,1	57,4	– 17,5	– 2,8	– 14,9	– 1,9
Toma	79,5	59,7	– 14,1	0,6	– 12,6	0,4
NSR_{05}	11,2	12,4				

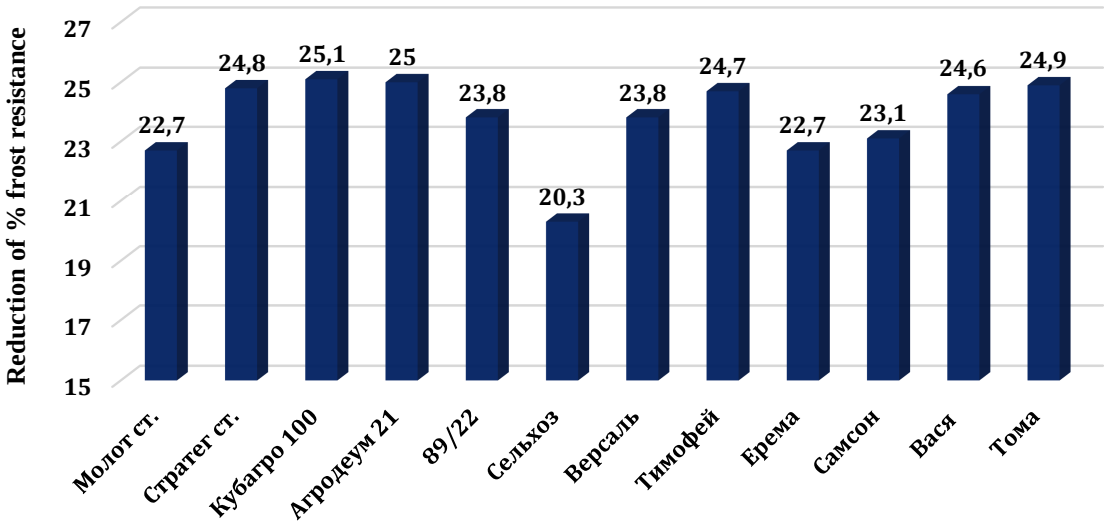
As a result of the analysis of experimental data during freezing at – 11 ºC, the safety of plants in isolated samples varied from 74,8 to 97,3 %. A high percentage of frost resistance was found in varieties Samson and Yerema 94,5 – 97,3 %, these are the highest rates in the experiment, the increase to the standard variety Molot was 0,9 and 3,7 %, respectively. Also, the varieties Kubagro 100, 89/22, Versal' and Timothy were distinguished by high frost resistance, in which more than 80 % of living plants were preserved during the first freezing cycle, but all these varieties showed a decrease in the indicator relative to the standard variety. In other varieties, frost resistance was in the range of 76,1 – 79,5 %. Taking into account the data of mathematical processing, only three varieties Timothy, Yerema and Samson had frost resistance within the experimental error.

In the experiment, two standard varieties were purposefully used, Molot as a highly frost-resistant variety and Strateg as one of the most popular in production.

A comparison of the frost resistance indices of the isolated forms with the Strateg variety showed that basically all samples had an advantage from 0,5 to 18,4 %, and only two varieties Sel'hoz and Vasya yielded to this standard by 4,1 and 2,8%, respectively.

Analyzing the frost resistance of the same forms with a decrease in temperature by 1ºC, it was found that the identified trend persisted. The varieties with high frost resistance were Yerema and Samson they exceeded the standard by 0.3 and 2.9%, but these figures were within the experimental error. A significant decrease in relation to the Molot variety was found in Strateg, Agrodeum 21, Sel'hoz, Vasya and Toma. In comparison with the Strateg variety, significantly high frost resistance values were determined in the Yerema and Samson varieties.

In the future, we studied the frost resistance indicators of the best forms and revealed a tendency for its decrease with a decrease in freezing temperature by 1ºC. The results are shown in figure 5.



Picture 5 – The trend of decreasing frost resistance varieties of winter barley

In general, all forms had a fairly high percentage of reduction from 20,3 to 25,1 %. That is, when the temperature drops by only 1 ºC at the depth of the tillering node, winter barley varieties can lose their resistance by 20–25 %.

Of all the experimental samples, the smallest variation of the trait was found in the Selkhoz variety.

Thus, studying the frost resistance of extensive breeding and collection material, we have identified forms that have different responses to negative temperatures. Forms with high rates of frost resistance have been identified, which will later be included in breeding programs to create new frost-resistant varieties.

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