Studying varieties of winter durum wheat in interstation test on economic and valuable features

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Abstract. The purpose of the research was to identify sources of economically valuable traits of winter durum wheat for their further use in the breeding process. The material for the research was 53 varieties of winter durum wheat of various ecological origins: Federal State Budgetary Scientific Institution, Agrarian Research Center "Donskoy", Federal State Budgetary Scientific Institution "National Grain Center named after P.P. Lukyanenko", Federal State Budgetary Scientific Institution "North Caucasian Federal Scientific Agrarian Center" (Russia) and Selective Genetic Institute (Ukraine). High frost resistance characterized the following varieties: Helios (90.9%), Bosphor (91.1%), Lakomka (92.2%), Terra (92.9%), Amazonka (93.0%), Aksinit (94.6 %), Cyprida (95.4%). The sources of early ripeness were varieties: Diona, Krucha, Donskoy yantar, Helios, Continent, etc., heading, which was noted from May 20 to 22; short stems: Kurant (77.4 cm), Diona (83.6 cm), Donskoy yantar (84.2 cm), Aqueduct (84.9 cm), Zhivitsa (84.6 cm), Continent (85.1 cm) , Laska (85.1 cm); coarse grains: Yakhont, Lakomka (40.3 g), Krucha (41.2 g), Belka (41.5 g), Siniora (41.6 g), Odari (43.0 g), Continent (43.2 g), Bella (44.5 g), Bosphor (45.3 g); high productivity: Amazonka (8.86 t/ha), Yakhont (8.90 t/ha), Lakomka (9.60 t/ha), Donskoy yantar (8.87 t/ha), Krupinka (9.20 t / ha), Belka (9.21 t/ha), Siniora (9.24 t/ha), Gavan (9.28 t/ha), Citrina (9.65 t/ha), etc. Identified genotypes of valuable traits and properties can contribute to the implementation of breeding programs to create varieties of winter durum wheat.

1 Introduction

A wide variety of climatic and soil conditions in the Russian Federation, which often includes extreme factors (drought, freezing temperatures, flooding, salinization, etc.) for the vegetation of plants, contributes to significant yield losses for many crops. Therefore, the problem of plant resistance to unfavorable (stressful) conditions is a national one and has theoretical and practical significance [1–3].

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To solve these problems, the role of variety is extremely important. When creating a new variety, the breeder always faces the difficult dilemma of combining productivity with its general biological stability, which determines good adaptability to local natural conditions [4,5].

A variety of winter durum wheat should combine such traits as high productivity, frost resistance, resistance to shedding and disease, and form high quality grain. The genotype should be undersized with a thick, strong, lodging-resistant culm and have a relatively slow rate of growth and development in the autumn vegetation period, have medium or high tillering, large grained ears with a high weight of 1000 grains [6–9].

The purpose of the research: to identify the sources of economically valuable traits of winter durum wheat for their further use in the breeding process.

2 Materials and methods

The studies were carried out in 2020-2022. in the conditions of the southern zone of the Rostov region. In an inter-station test, 53 varieties of winter durum wheat of various ecological origins were studied: Federal State Budgetary Scientific Institution, Agrarian Research Center “Donskoy” (ARC “Donskoy”), Federal State Budgetary Scientific Institution “National Grain Center named after P.P. Lukyanenko”, Federal State Budgetary Scientific Institution “North Caucasian Federal Scientific Agrarian Center” and the Selection and Genetic Institute (Fig. 1). The variety Kristella was used as a standard.

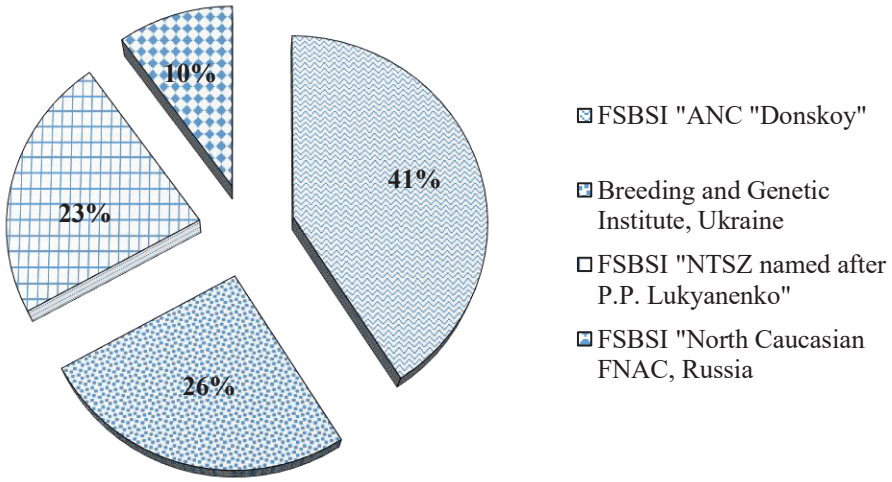

Fig. 1. Distribution of varieties of winter durum wheat of various ecological and geographical origin, 2020-2022

Sowing was carried out with a "Wintersteiger Plotseed S" seeder with a seeding rate of 500 pcs. germinating seeds per m^2. The accounting area of the plot is 10 m^2, the repetition is 3-fold, the placement of the plots is systematic. The predecessor is green manure fallow. Harvesting was carried out with a Wintersteiger Classic combine. Field assessments, phenological observations, crop records were carried out according to the method of state variety testing.

The 2019-2020 agricultural year, despite the optimal conditions for sowing, adversely affected the formation of a high grain yield. The lack of moisture in the spring-summer period (-65.4 mm compared to the long-term average), as well as a large amount of precipitation during the ripening and harvesting of winter wheat, led to the formation of puny, low-grade grain with low vitreousness.

The 2020-2021 agricultural year was characterized by an increased temperature regime (+2.0 ˚C to the long-term average) and uneven distribution of precipitation throughout the year. In general, the prevailing weather conditions made it possible to obtain a high yield (from 8.0 to 10.0 t/ha) and to fully evaluate the breeding material according to the main economically valuable traits and properties.

The 2021-2022 agricultural year was characterized by an increased temperature in the winter period (+3.7 ˚C compared to the long-term average) and an uneven but sufficient distribution of precipitation throughout the year, which had a positive effect on the formation of a high grain yield of winter durum wheat.

3 Results and discussion

The problem of obtaining frost-resistant varieties of durum wheat has been and remains very relevant. For the accelerated determination of frost resistance (as the main component of winter hardiness), the method of direct freezing of plants in refrigerators is widely used in research work [10–12].

During the research period, the survival of plants in the experiment varied widely from 37.1% for the Andromeda variety (Ukraine) to 95.4% for the Cyprida variety (Russia), for the Kristella standard – 81.2% (Fig. 2).

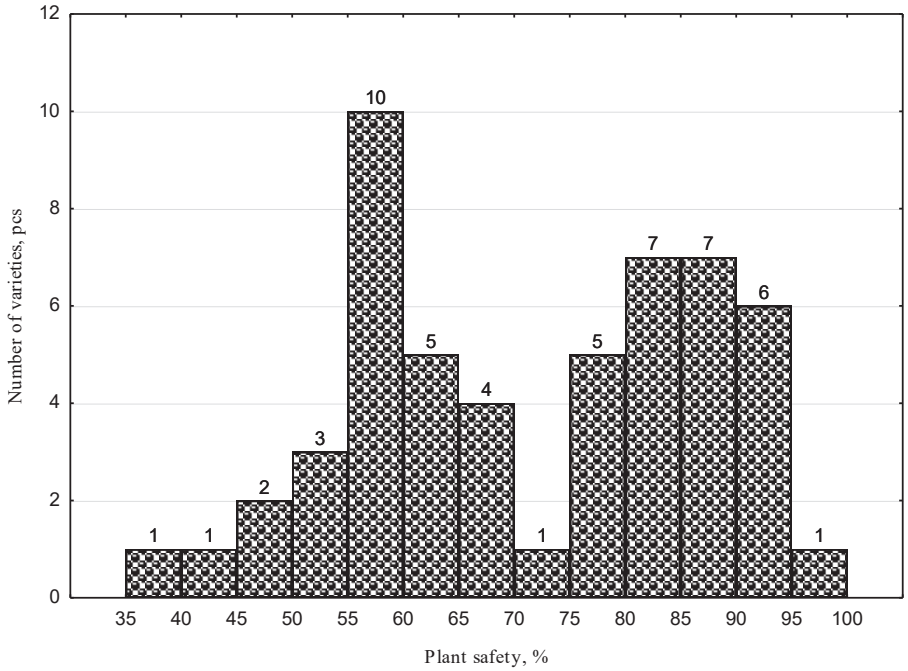

Fig. 2. Distribution of varieties of winter durum wheat by frost resistance in an inter-station test, 2020-2022

High rates for this trait were obtained in samples: Helios (90.9%), Bosphor (91.1%), Lakomka (92.2%), Terra (92.9%), Amazonka (93.0%), Aksinit (94.6%), Cyprida (95.4%), these varieties can be used as sources of frost resistance.

On average for the period from 2020 to 2022 earing of winter durum wheat varieties took place from May 20 (Diona) to May 29 (Belka) (Fig. 3).

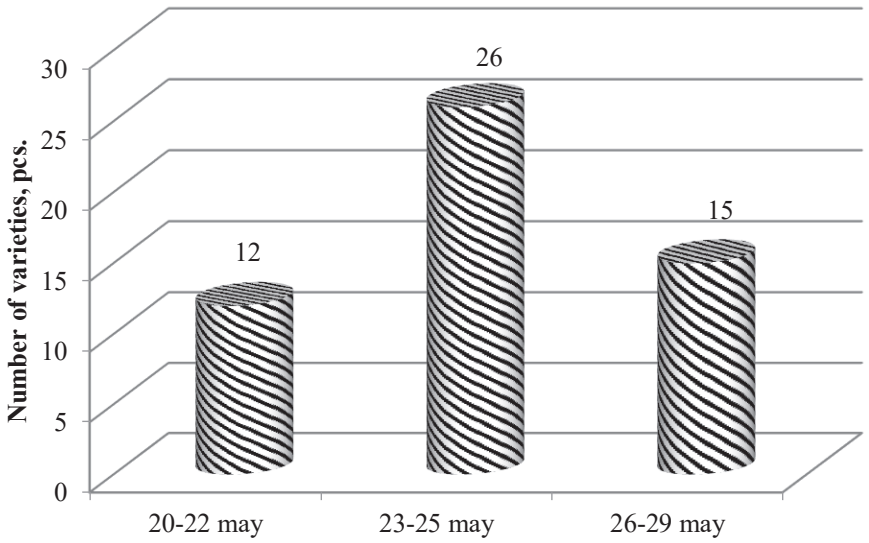

Fig. 3. Distribution of varieties of winter durum wheat by heading date in an inter-station test, 2020-2022

According to the heading date, the varieties studied in the experiment were represented by three groups of maturity. The main part of the samples – 26, belonged to the mid-ripening group of ripeness, their heading came from May 23 to 25. The late-ripening group included 15 varieties, earing occurred from May 26 to May 29. The mid-early group included 12 varieties, the earing of which occurred from May 20 to May 22: Diona, Krucha, Donskoy yantar, Helios, Continent, etc., they are recommended to be used as sources of early ripeness.

A significant number of high-intensity wheat varieties are not sufficiently resistant to lodging. This leads to large yield losses and a decrease in grain quality. Therefore, special attention in breeding programs is paid to the creation of short-stemmed varieties of winter durum wheat [13,14].

Thus, the plant height of winter durum wheat varieties in the inter-station test varied from 77.4 cm in the Kurant variety (Russia) to 100.6 cm in the Golden Fleece variety (Russia) (Fig. 4).

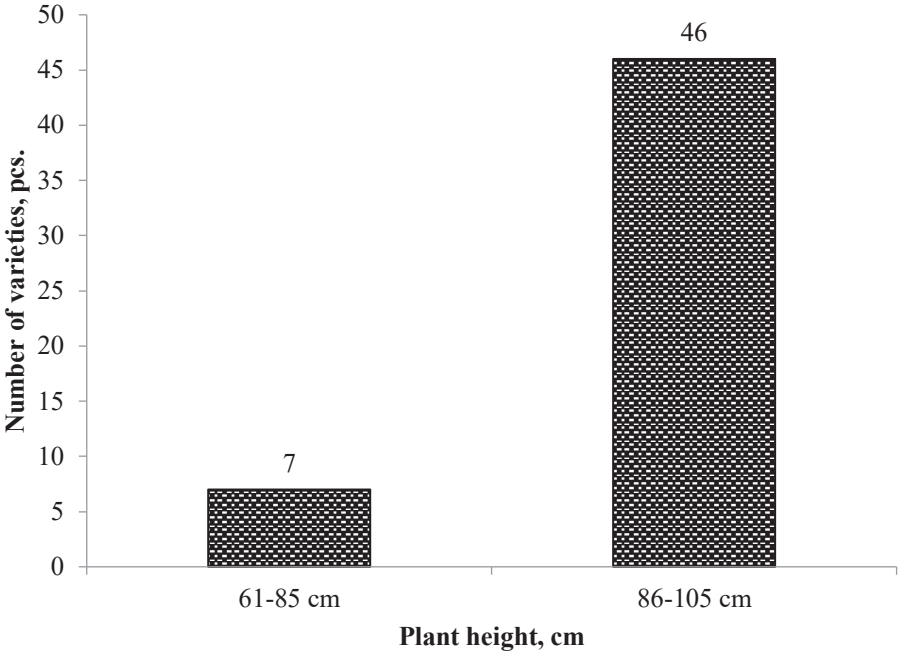

Fig. 4. Plant height and yield of winter durum wheat varieties in an inter-station test, 2020-2022

The bulk of the samples (46 pcs.) had a plant height of 86-105 cm. It is necessary to identify 7 genotypes-sources of short stems: Kurant, Diona, Donskoy yantar, Zhivitsa, Laska (Russia), Continent, Aqueduct (Ukraine), with a stem length of from 77.1 to 85.1 cm.

An important feature in increasing the productivity of wheat plants is the weight of 1000 grains [15].

Thus, in our studies, the weight of 1000 grains of winter durum wheat varieties ranged from 32.3 g for the Stepnoy Yantar variety (Russia) to 45.3 g for the Bosphor variety (Ukraine) (Fig. 5).

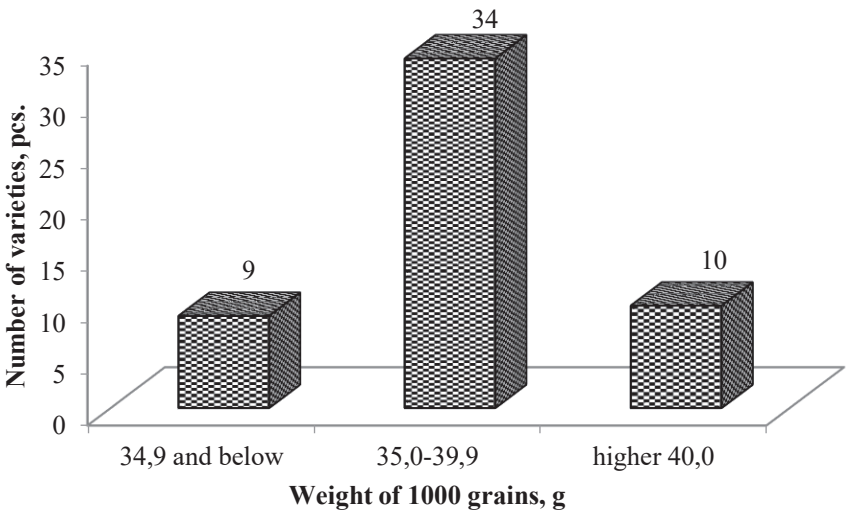

Fig. 5. Weight of 1000 grains of winter durum wheat varieties in inter-station testing, 2020-2022

The value of the standard variety Kristella was 38.1 g. The main part of the samples (34 pieces) had a grain of medium size (35.0-39.9 g). It is necessary to identify genotypes with a weight of 1000 grains above 40.0 g: Yakhont, Laska (40.3 g), Krucha (41.2 g), Belka (41.5 g), Kordon (41.6 g), Odari (43 0 g), Bella (44.5 g) (Russia), Bosphor (45.3 g), Continent (43.2 g) (Ukraine), which are recommended for use in breeding practice as sources of coarse grains.

In the course of the correlation analysis, an average correlation relationship between the weight of 1000 grains and frost resistance was revealed ($r=0.35\pm0.13$).

In cereals, the ideal type should include those plants that ensure the accumulation of the largest grain yield, its stability over the years under various weather conditions [16-18].

The yield of winter durum wheat varieties in the inter-station test varied from 6.60 t/ha (Argonaut) to 9.79 t/ha (Kordon), for the Kristella standard – 8.40 t/ha (Fig. 6).

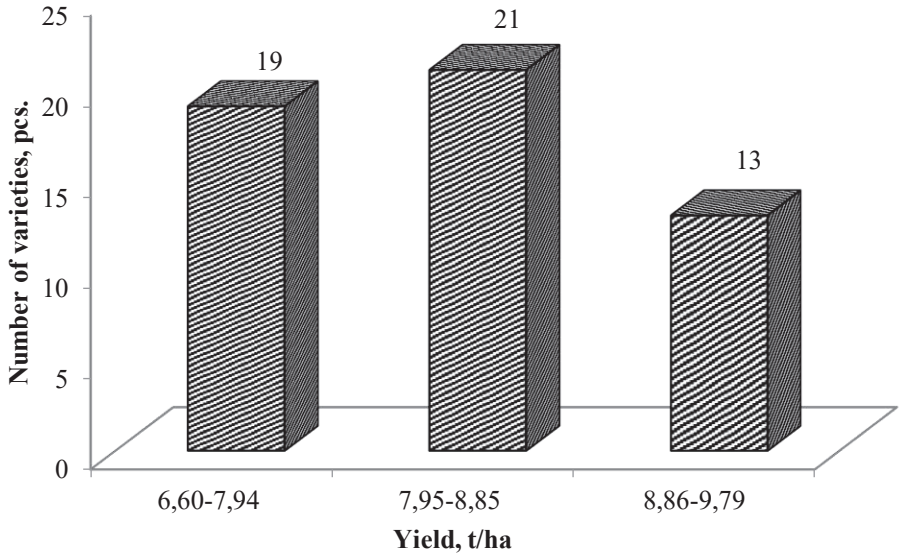

Fig. 6. Distribution of winter durum wheat varieties by yield in inter-station testing, 2020-2022

The bulk of the samples (21 pcs.) had a productivity at the level of the standard variety Kristella (LSD_{05}=±0,45 t/ha). 13 varieties of winter durum wheat had a high yield in the experiment: Amazonka (8,86 t/ha), Yakhont (8,90 t/ha), Lakomka (9,60 t/ha), Donskoy yantar (8,87 t/ha), Krupinka (9,20 t/ha), Belka (9,21 t/ha), Siniora (9,24 t/ha), Gavan (9,28 t/ha), Citrina (9,65 t/ha), Kordon (9,79 t/ha).

In the course of the correlation analysis, average positive correlations of yield with the weight of 1000 grains (r=0.48±0.12) and frost resistance (r=0.30±0.13) were revealed.

In the course of research for 2020-2022 selected varieties – sources for the conditions of the Rostov region, distinguished by economically valuable traits (Table 1).

Table 1. Characteristics of winter durum wheat varieties in an inter-station test distinguished by yield, 2020-2022

Variety	Originator/ country	Productivity, t/ha	Earing date, May	Plant height, cm	Weight of 1000 grains, g	Frost resistance, %
Kristella, st.	ARC "Donskoy", Russia	8,40	22	88,7	38,1	81,2
Amazonka		8,86	22	89,1	39,1	93,0
Donskoy yantar		8,87	21	84,2	38,5	69,9
Yakhont		8,90	24	94,8	40,3	87,5
Lakomka		9,60	23	91,0	34,3	92,2
Krupinka	National Grain Center named after P.P. Lukyanenko	9,20	25	88,1	42,6	58,2
Siniora		9,24	26	89,8	39,8	57,9
Belka		9,21	29	94,0	41,5	68,7
Odari		9,62	24	87,0	43,0	77,4
Kordon		9,79	23	88,2	41,6	53,1

Bella	, Russia	9,33	25	93,0	44,5	75,4
Gavan	Selective Genetic Institute, Ukraine	9,28	24	88,9	37,0	89,0
Citrina	North Caucasian Federal Scientific Agrarian Center, Russia	9,65	26	93,2	39,7	73,9
LSD_{05}		0,45	-	-	-	-

The identified genotypes of valuable traits and properties can contribute to the implementation of breeding programs to create varieties of durum wheat.

4 Conclusion

During the study period, source varieties with high frost resistance (over 90%) were identified: Helios, Lakomka, Terra, Amazonka, Aksinit, Cyprida (ARC "Donskoy"), Bosphor (Selective Genetic Institute); early maturity (May 20-22): Diona, Donskoy yantar, Helios (ARC "Donskoy"), Krucha (National Grain Center named after P.P. Lukyanenko), Continent (Selective Genetic Institute); short stem (77.1-85.1 cm): Kurant, Diona, Donskoy yantar (ARC "Donskoy"), Zhivitsa (North Caucasian Federal Scientific Agrarian Center), Continent, Aqueduct (Selective Genetic Institute), Laska (National Grain Center named after P.P. Lukyanenko); grain size (more than 40.0 g): Yakhont (ARC "Donskoy"), Laska, Krucha, Belka, Kordon, Odari, Bella (National Grain Center named after P.P. Lukyanenko), Continent, Bosphor (Selective Genetic Institute); high productivity (8.86 t/ha and more): Amazonka, Yakhont, Lakomka, Donskoy yantar (ARC "Donskoy"), Krupinka, Siniora, Belka (National Grain Center named after P.P. Lukyanenko)", Gavan (Selective Genetic Institute), Citrina (North Caucasian Federal Scientific Agrarian Center).

Properly selected source material gives the greatest result in increasing the economically valuable traits and properties, as well as the yield of winter durum wheat.

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