Genetic sources of naked oat for selection in the climate of Central Siberia

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Abstract. The study of the genetic characteristics of plant response to changes in environmental conditions makes it possible to use the achievements of selection in more effective ways. In 2019-2020 in the conditions of the open forest-steppe of Krasnoyarsk region naked samples of spring oat have been studied to identify the parent material. Sources for important selection characteristics have been highlighted: early maturity of Gosha (k-15120, Belarus), which matured seven days earlier than the standard and the American sample MF9521-19 (k-15226, USA) which matured six days earlier than the standard; two early ripening samples of Gosha (k-15120, Belarus) and MF9521-19 (k-15226, USA) were assigned to the lodging resistant cultivar (8.5 points according to a 9-point system); the most coarse-grained cultivar with a mass of 1000 grains over 30 g are the following: the mass of MF9521-19 (k-15226, USA) is 38.4 g; the mass of Vladyka (k-15408, Belarus) is 37.7 g; the mass of Zhytomyr (k-15502, Ukraine) is 36.8 g; the mass of Local China (k-15149, China) is 34.0 g; the mass of Visis (k-15501, Ukraine) is 30.2 g; the mass of Progress (k-15339, Omsk region) is 29.7 g; the mass of Gosha (k-15120, Belarus) is 29.6 g.

1. Introduction
Naked oat began to be cultivated in the 5th century AD. Now it is cultivated in Russia, Finland, Germany, Great Britain, France, Poland, Sweden, USA, Canada and Australia. At the same time, at market price, naked oat is on average 65-90% more expensive in the market than ordinary hulled oat. It is a culture high in lysine, methionine and cysteine. The inclusion of oat grain products in the diet of a person with gluten intolerance can provide a sufficient amount of fiber necessary for a normal digestive process. The viscosity of decoctions from it is due to β-glucans of dietary fibers, which improve the functioning of the gastrointestinal tract, slow down the absorption of carbohydrates by the body, reduce the glycemic index, and are used to prevent vascular atherosclerosis and reduce cholesterol levels. The content of β-glucans in the grain of naked oat varieties is from 3.8-4.9%. A grain of naked oats contains up to 17 percent protein. Naked oats and their processed products are used to prepare almost any dish: muesli, cookies, baked goods, bars, snacks, etc. Oat oil in naked oat contains fat-soluble vitamin E tocopherols (a natural antioxidant which prevents the formation of toxic free radicals and at the cellular level fights aging) and tocotrienols (normalizes cholesterol levels) [1-25].

Considering all the above advantages of naked oat grain in the harsh soil and climatic conditions of Siberia, it is necessary to carry out selection work in this direction to improve the quality and level of nutrition of the Siberian population. The purpose of the research is to study and select the best genotypes of naked oat in terms of early maturity, grain size in combination with high productivity indicators.
2. Materials and methods
The studies were carried out in 2019-2020 in a selection crop rotation on the experimental field of Krasnoyarsk Research Institute of Agriculture in the open zone of Krasnoyarsk forest-steppe. The soil of the site is characterized by low nitrogen content (4.5-6.2 mg/100 g), increased phosphorus content (20.1-24.8 mg/100g), high potassium content (13.1-15.0 mg/100g), according to Chirikov. The predecessor is pure steam. Sowing is II decade of May with the SSFK-7 selection seeder. The seeding rate is 500 germinating grains per 1 m². Repetition is single. Accounting area is 2 m². Harvesting is III decade of August with a selection harvester “Hege-125”. The objects of research are the varieties of naked oat (16 samples, standard Golets). Phenological observations and counts are made according to the methodology of the State Commission for Variety Testing of Agricultural Crops. The growing seasons in terms of temperature conditions are close to the average long-term indicators. In terms of moisture availability, 2019 is dry, 2020 is highly humid.

3. Results
The raw material of naked oat has been studied for use in the soil and climatic conditions of Krasnoyarsk region.

3.1. Vegetation period
The duration of the growing season for naked oat samples in our experiments ranged from 61 to 73 days, with an average growing season of the standard Golets variety of 68 days. The earliest maturing varieties are of the Belorussian selection Gosha (k-15120, Belarus), which matured seven days earlier than the standard, and the American sample MF9521-19 (k-15226, USA), matured six days earlier than the standard. There were five samples for one day (Gavrosh, Zhytomyr, Avgol, Vladyka, Local Chin, and there were two samples for two days (Progress and Korolek).

3.2. Plant height and lodging resistance
Many researchers associate lodging resistance with plant height. In field experiments, the height of naked oat plants was about 88.2 - 121.0 cm. Based on the assessment of the studied oat samples, two early maturing samples of Gosha (k-15120, Belarus) and MF9521-19 (k-15226, USA) were assigned to the lodging resistant cultivar (8.5 points according to a 9-point system)

3.3. Productive bushiness
In terms of productive bushiness, the trait varied from 1.0 to 3.7 productive stems per plant. High tillering has a negative effect on the overall yield in Krasnoyarsk forest-steppe. Therefore, samples are considered valuable if they have a minimum value of 1.0-1.3 productive stems per plant.

3.4. Weight of 1000 grains (seeds)
The weight of 1000 grains (seeds) in naked oat varied on average from 21.4 to 38.8 g. Among the coarse-grained cultivar with a mass of 1000 grains over 30 g are the following: the mass of MF9521-19 (k-15226, USA) is 38.4 g; the mass of Vladyma (k-15408, Belarus) is 37.7 g; the mass of Zhytomyr (k-15502, Ukraine) is 36.8 g; the mass of Local China (k-15149, China) is 34.0 g; the mass of Visit (k-15501, Ukraine) is 30.2 g; the mass of Progress (k-15339, Omsk region) is 29.7 g; the mass of Gosha (k-15120, Belarus) is 29.6 g.

3.5. Grain weight
The grain mass from the main spike in naked oat was on average 0.94 g and varied from 0.59 to 1.14 g. By the grain mass from the main panicle, samples with a mass exceeding 1 gram were distinguished: Vladyma (k-15408, Belarus) is 2.18 g; Zhytomyr (k-15502, Ukraine) is 1.84 g; Local China (k-15149, China) is 1.48 g; Abel (k-14638, Czech Republic) is 1.25 g; MF 5711-35 (USA) is 1.19 g; MF9521-19 (k-15226, USA) is 1.07 g; Visit (k-15501, Ukraine) is 1.05 g, Golets is 0.69 g on the standard.
By the weight of grain from the plant, samples higher than 1.7 grams were distinguished: Vladyka (k-15408, Belarus) is 2.84 g; Zhytomyr (k-15502, Ukraine) is 2.76 g; Abel (k-14638, Czech Republic) is 2.50 g; MF 5711-35 (USA) is 2.27 g; MF9714-35 (k-15228, USA) is 1.07 g; Local China (k-15149, China) is 1.69 g; Visit (k-15501, Ukraine) is 1.70 g, Golets is 1.60 g on the standard.

3.6. Yield
The naked oat samples formed an average of 364 g/m² with fluctuations from 222 to 622 g. Among the naked varieties that significantly exceeded the standard variety Golets (236 g/m²) by 10-386 g, three samples with a yield of more than 500 g/m² were highlighted: Vladyka (k-15408, Belarus) – 622 g, Local China (k-15149, China) – 500 g; Progress (k-15339, Omsk region) - 500 g and samples with a yield of more than 300 g/m² were highlighted: Zhytomyr (k-15502, Ukraine) – 473 g; Abel (k-14638, Czech Republic) – 444 g; Korolek (k-15461, Belarus) – 433 g; Gavrosh (k-15439, Kemerovo region) – 389 g; Gosha (15120, Belarus) -333 g; Avgol (15505, Ukraine) – 322 g; Local Poland (15248, Poland) – 300 g.

3.7. Comprehensive assessment of naked oat samples
Based on the results of studying the source material of naked oat, the best samples of interest in terms of a set of traits for practical selection have been identified:

- Zhytomyr (k-15502, Ukraine);
- Vladyka (k-15408, Belarus);
- Local China (k-15149, China).

The characteristics of the studied material in terms of the duration of the growing season, individual elements of productivity and the yield as a whole are the basis for the crossing plan in 2021.

4. Conclusion
As a result of studying samples of spring naked oat, the sources of valuable traits and properties which are interesting for use in selection programs under the conditions of Krasnoyarsk region were identified for important selection traits:

- early maturity of Gosha (k-15120, Belarus), which matured seven days earlier than the standard and the American sample MF9521-19 (k-15226, USA) matured six days earlier than the standard.
- two early maturing samples of Gosha (k-15120, Belarus) and MF9521-19 (k-15226, USA) were assigned to the lodging resistant cultivar (8.5 points according to a 9-point system).

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Relating to yield, the naked oat samples formed an average of 364 g/m² with fluctuations from 222 to 622 g. Among the naked varieties that significantly exceeded the standard variety Golets (236 g/m²) by 10-386 g, three samples with a yield of more than 500 g/m² were highlighted: Vladyka (k-15408, Belarus) - 622 g, Local China (k-15149, China) - 500 g; Progress (k-15339, Omsk region) - 500 g and samples with a yield of more than 300 g/m² were highlighted: Zhytomyr (k-15502, Ukraine) - 473 g; Abel (k-14638, Czech Republic) - 444 g; Korolek (k-15461, Belarus) - 433 g; Gavrosh (k-15439, Kemerovo region) - 389 g; Gosha (15120, Belarus) - 333 g; Avgol (15505, Ukraine) - 322 g; Local Poland (15248, Poland) – 300 g.

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