

ROLE OF PROMISING SOURCES OF OAT PRODUCTIVITY IN THE DEVELOPMENT OF THE DALECH VARIETY

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Topicality. Plant productivity represents the main indicator of the original breeding material in the development of new varieties of oats (*Avena sativa* L.). Therefore, increasing the productivity, which depends on the genetic potential of the variety, its plasticity and resistance to fungal diseases, remains a relevant issue.

Purpose To select promising oat lines and evaluate the newly developed oat variety, ensuring yield increment, high grain quality, resistance to drought and disease. **Methods:** Field, laboratory, analytical and statistical methods. **Results.** The oat lines resistant to damage by loose smut and crown rust both on provocative and infectious backgrounds were obtained. The oat line 585-7 significantly exceeded the average group standard in terms of yield, plant height – by 13 cm, shorter growing season - by 15 days, resistance to loose smut damage – by 0.5 points, resistance to lodging and drought – by –1.0–0.5 points, low hoodness – 23.1 %, 1000 grain weight – 33.2 g and protein content – up to 13.6 %. **Conclusions.** Common oat lines were developed with high indicators of plant height, panicle length, 1000 grain weight, grain volume weight, hoodness, resistance to fungal diseases, high productivity and quality. Yield of Dalech variety was 5.50 t/ha in the Forest-Steppe zone and 4.27 t/ha in Polissia, which was 1.53 and 0.64 t/ha higher than the average yield of varieties registered in all zones for the previous 5 years. Dalech variety is resistant to loose smut and crown rust. It is listed in the State Register of Plant Varieties Suitable for Dissemination in Ukraine and recommended for cultivation in the Forest-Steppe and Polissia zones starting from 2022.

Key words: common oats, productivity, adaptability, resistance, Dalech variety

Introduction. Oats are considered as a niche crop that occupies a small sown area and is the most cost-effective, as the average cost of producing 1 tonne of grain is UAH 2,458 [1]. In Ukraine, oats are grown for fodder and food use. Its processed products are valuable due to the biochemical composition of the grain, which contains 10–15 % protein, which is balanced in amino acid composition (lysine, arginine, tryptophan) and is 95–96 % digestible by both humans and animals [2]. Compared to other cereals, oats contain 2-3 times more fats (3-11 %), they are characterised by high digestibility and assimilation, and are more resistant to oxidation.

Carbohydrates are presented in the form of starch (40 %), sugars (1.6–2.5 %) and fibre (8.0-10.0 %) [3]. In addition, the grain of this crop contains a large amount of organic compounds of iron, calcium and phosphorus, and a lot of manganese, copper, molybdenum and cobalt among trace elements [4].

Changing the current structure of sown areas and crop rotations, as well as global climate change, which is accelerating in Ukraine, are causing threatening meteorological characteris-

tics, and most cereal crops are losing their productivity and resistance to a number of abiotic and biotic factors [5].

Therefore, the importance of oats as a stabilising factor in grain production is growing even more.

Development and implementation of high-yielding varieties is one of the main tasks of grain crop breeding [6]. Achieving higher yields is not an easy task due to its complexity [7].

New varieties require a source material with a set of valuable traits. At the early stages of the breeding process, we need to predict how hybrids from different combinations of crosses will inherit traits from their parents [8].

In the face of global meteorological changes, the main task for domestic breeders is to create spring oat varieties with high productivity, adaptability and resistance to fungal diseases.

In this direction, we have done considerable work on the development of a model variety for cultivation in the specific regions of Ukraine, using modern achievements in spring oat breeding [9].

The Register of Plant Varieties of Ukraine

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for 2023 includes 46 varieties originated by: Nosivska Breeding and Research Station of the V. M. Remeslo Myronivka Institute of Wheat, Institute of Agriculture in the Carpathian Region, Synelnykove Breeding and Research Station of the SE Institute of Grain Crops, Luhansk Institute of Breeding and Technology, etc. The varieties Dekameron (2007), Darunok (2011), Diitychnyi (2015), Dioskurii (2017), Denka (2018) and Dalech (2022) bred by Verkhniachka Research and Selection Station of the Institute of Bioenergy Crops and Sugar Beet account for 13.0% of the total, are not inferior in productivity to foreign varieties and fully meet the needs of the domestic market [10].

The study aims to select promising oat lines and characterise a new oat variety designed to provide yield increment, high grain quality, and drought and disease resistance.

Materials and Methods. In 2017–2019, the Department of Breeding and Seed Production of Grain and Bioenergy Crops of the Verkhniachka Research and Breeding Station of the Insti-

tute of Bioenergy Crops and Sugar Beet of NAAS of Ukraine conducted research of promising oat lines.

During the years of research (2017–2019), the climatic conditions during the growing season of common oats were different. Thus, 2017 was characterised by insufficient moisture supply (HTC 0.8), an average daily air temperature higher by +2.9...+5.0 °C and precipitation (97.3 %) of the long-term average.

During the growing season of oats in 2018, a significant amount of precipitation of 317.0 mm (110.8 % of the long-term average) fell at the average daily air temperature at the level of long-term indicators, which means an excessive level of moisture supply (HTC = 1.2), and in 2019, the temperature regime and total precipitation of 294.5 mm (102.9 % of the long-term average) were within the long-term average (HTC = 1.0) (Fig. 1).

Cultivars of common oats of the main variety testing were sown in optimal dates (March - April) with a seeder SKS-6-10 after peas.

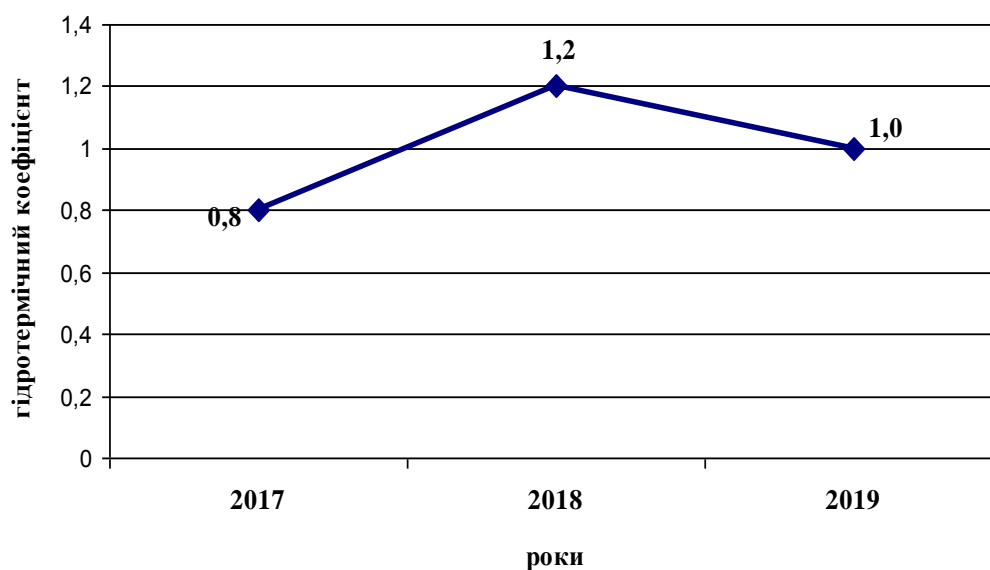


Fig. 1 Hydrothermal coefficient for the growing season of common oat, 2017–2019

The location of the plots was randomised, the registration plot area was 10 m², and the replication was six times. The standard varieties were sown every 19 numbers (for hulled oat – Zakat and for naked oat – Skarb Ukrainy).

During the growing season, phenological observations were carried out according to a five-point system.

The resistance of the cultivars to loose smut and crown rust was evaluated in accordance with

the requirements of "Methods of selection and assessment of resistance of grain crops to diseases" using artificial infectious and provocative backgrounds [11], and phenological observations were carried out in accordance with the "Methodology for examination on the difference, homogeneity and stability of oat varieties (*Avena sativa* L.)" [12].

The registration data were processed by the analysis of variance for single-factor experi-

ments [13].

Results and Discussion. The main method of developing new oat source material was individual selection from hybrid material produced by the intervarietal hybridisation using the Shyshlov's method [14].

Parental pairs were selected based on productivity, resistance to lodging and fungal diseases. These are mainly zoned varieties, cultivars of our own selection and foreign collection samples of different ecological and geographical origin obtained from the National Centre of Plant Genetic Resources of Ukraine. At the same time, considerable attention was paid to the detailed analysis of the material in the initial stages of the breeding process, since new homozygous and heterozygous plant forms with economically valuable traits are manifested in F₂ – F₅ hybrids.

The homozygous lines were sown in a

breeding nursery. During the growing season, we conducted phenological observations and evaluated the following indicators using a five-point system: seedling condition, tillering, stem height uniformity, plant monotypy, tillering and panicle shape, and resistance to lodging.

The best lines were collected during individual selection and analysed for economically valuable traits: plant height, panicle length, 1000 grain weight, grain volume weight, grain hoodness, resistance to fungal diseases, plasticity and productivity, which were further studied in competitive variety testing.

At the same time, primary seed production was carried out by setting up nurseries for testing the first and second year progeny. As a result, a number of promising lines were obtained, including line 585-7 (Table 1).

Despite the fact that the weather condi-

Table 1. Characteristics of promising lines of common oats by quality traits, 2017–2019

Line	Yield, t/ha				Fat content, %	Protein content, %
	2017	2018	2019	average		
580-9	7.6	3.2	7.4	6.1	4.2	9.6
585-7	7.7	3.5	7.1	6.1	3.9	13.6
769-6	7.5	3.4	7.5	6.1	4.6	10.7
671-4	7.2	2.8	7.2	5.7	3.6	8.7
709-3	-	3.3	7.5	5.4	4.0	9.3
LSD ₀₅ t/ha	0.10	0.30	0.24			

tions during the trials varied over the years of research and did not always favour the manifestation and development of fungal diseases, line

585-7 stood out for its high resistance to crown rust and loose smut, both against provocative and infectious backgrounds (Table 2).

Table 2. Resistance of oat lines to crown rust and loose smut, 2017–2019

Line	Damage by loose smut, points			Damage by crown rust, points
	Year			
	2017	2018	2019	2019
580-9	8	9	7	
585-7	9	9	8	
769-6	8	9	8	6
671-4	9	9	8	5
709-3	9	8	8	6

Note: * 2017–2018 were not epiphytic for the development of crown rust

According to the results of a three-year competitive variety test, the line 585-7 of common oats was characterized by low grain hoodness (23.1 %), 1000 grain weight – 33.2 g, protein content – 13.6 % and high yield, which significantly exceeded the average group standard, under contrasting weather conditions (Table 3).

Therefore, this line, called Dalech, was passed to the State Variety Testing Service in 2019.

The variety was tested during 2020–2021 in eight State Centres for Plant Variety Examination of Ukraine, covering two zones in Ukraine – Forest-Steppe and Polissia.

Table 3. Characteristics of the line 585-7 of common oats by economic characteristics, 2017–2019

Indicator		Group standard*	Line 585-7
Yield, t/ha		5.80	6.10
Plant height, cm		92	105
Plant resistance, points	loose smut	7.5	8.0
	crown rust	9.0	8.0
	lodging	8.0	9.0
	grain shedding	9.0	9.0
	drought	8.5	9.0
1000 seed weight, g		32.3	33.2
Growing season, days		103	88

Note: * Spring oat varieties: Zakat, Iren, Muson

During this period, the average yield of Dalech variety was 5.50 t/ha in the Forest-Steppe zone and 4.27 t/ha in Polissia, which is 1.53 and 0.64 t/ha higher than the average yield of varieties that have passed the State Registration for the previous five years in all zones (Table 4).

Table 4. Characteristics of economically valuable traits of Dalech variety of common oats according to the State Variety Testing, 2020–2021

Indicator		Forest-Steppe		Polissia	
		average	Dalech	average	Dalech
Yield, t/ha		3.97	5.50	3.63	4.27
Plant height, cm		103.9	104.3	95.3	97.3
Plant resistance, points	loose smut	8.0	8.0	8.0	8.0
	crown rust	9.0	9.0	8.0	8.0
	covered smut	9.0	9.0	8.0	8.0
	lodging	8.0	8.0	9.0	9.0
	grain shedding	8.3	9.0	8.6	9.0
	drought	7.6	9.0	5.6	8.0
1000 seed weight, g		34.8	37.6	33.6	32.9
Growing season, days		91.9	80.0	98.7	82

Thus, during the testing period, the variety Dalech was characterised by high adaptability, namely: the growing season was on average 81 days, plant height – 97.3–104.3 cm, average resistance to lodging – 8.5 points, high resistance to fungal diseases – 8.3 points, drought resistance – 8.5 points.

Based on the results of the State Scientific and Technical Expertise, the Dalech variety was listed in the State Register of Plant Varieties suitable for dissemination in Ukraine, which is suitable for distribution in the Polissia and Forest-Steppe zones from 2022.

The Dalech variety is mid-ripening. It is characterised by a uniform stem and even ripening. It is a spring crop. The habit of the plant is semi-erect. The leaves are lanceolate-pointed, glaucous coloured. The pubescence of the lowest

leaves is absent or very weak. The highest node on the stem is not pubescent. Panicle has a spreading orientation of branches, semi-erect position of branches, drooping position of secondary spikelets, long panicle. The hard outer shell is present. The awniness is strong. The grain is well filled, white in colour. It is characterised by high productivity, adaptability and high resistance to loose smut and crown rust.

Conclusion. The research conducted at the Department of Breeding, Seed Production of Grain and Bioenergy Crops of the Verkhniachka Research and Breeding Station of the Institute of Bioenergy Crops and Sugar Beet of NAAS of Ukraine resulted in the following:

1. The best lines of common oats were selected for plant height, panicle length, 1000 grain weight, grain volume weight, and hoodness, re-

sistance to fungal diseases, productivity and seed quality.

2. Oat lines resistant to loose smut and crown rust on both provocative and infectious backgrounds were obtained.

3. The 585-7 line of common oats significantly exceeded the average group standard in terms of yield, plant height – by 13 cm, shorter growing season – by 15 days, resistance to loose smut – by 0.5 points, resistance to lodging and drought – by 0.5 and 1.0 points, respectively, and low hoodness – 23.1 %, 1000 grain weight – 33.2 g

and protein content – 13.6 %.

4. In 2020-2021, the average grain yield of Dalech variety was 5.50 t/ha in the Forest-Steppe zone and 4.27 t/ha in Polissia, which is 1.53 and 0.64 t/ha higher than the average yield of varieties that have been registered in all zones for the previous 5 years.

The Dalech variety is listed in the State Register of Plant Varieties for dissemination in Ukraine and is recognised as suitable for distribution in the Forest-Steppe and Polissia zones from 2022.

References

1. Pushchak, V. I., Bilovus, G. Ya. (2021). *Stiikist selektsiinykh henotypiv vivsa do vyliahannia ta zakhvoriuvan v umovakh Zakhidnoho Lisostepu* [Resistance of breeding oat genotypes to lodging and diseases in the conditions of the Western Forest Steppe]. *Selektsiia zernovykh ta zernobobovykh kultur v umovakh zmin klimatu: napriamy i priorityty: tezy dopovidei mizhnar. nauk. konf.* Proceeding of the *Breeding of grain and leguminous crops in conditions of climate change: directions and priorities: intern. scie. conf.* (pp. 111–112). May 5, 2021, Odesa. Ukraine. [in Ukrainian].
2. Solonechna, O. V., Ryabchun, V. K., Muzafarova, V. A. (2021). *Produktyvnist zrazkiv yaroї miakoї pshenytsi v umovakh skhidnoi chastyny Lisostepu Ukrainy* [Productivity of spring soft wheat samples in the conditions of the eastern part of the Forest Steppe of Ukraine]. *Selektsiia zernovykh ta zernobobovykh kultur v umovakh zmin klimatu: napriamy i priorityty: tezy dopovidei mizhnar. nauk. konf.* Proceeding of the *Breeding of grain and leguminous crops in conditions of climate change: directions and priorities: intern. science. conf.* (pp. 51–52). May 5, 2021, Odesa. Ukraine. [in Ukrainian].
3. Konovalov, Yu. B. (1990). *Chastnaya selektsiia polevykh kultur* [Private selection of field crops]. Moscow: Agropromizdat. [in Russian].
4. Chekalin, M. M., Tyshchenko, V. M., Batashova, M. E. (2008). *Selektsiia ta henetyka okremykh kultur: navchalnyi posibnyk* [Breeding and genetics of individual crops]. Poltava: FOP Govorov S. V. [in Ukrainian].
5. Lytvynenko, M. A. (2021). *Selektsiia i nasinnystvo pshenytsi v Ukraini: stan ta perspektyvy v umovakh zminy klimatu* [Breeding and seed production of wheat in Ukraine: state and prospects in conditions of climate change]. *Selektsiia zernovykh ta zernobobovykh kultur v umovakh zmin klimatu: napriamy i priorityty: tezy dopovidei mizhnar. nauk. konf.* Proceedings of the *Breeding of grain and leguminous crops in conditions of climate change: directions and priorities: intern. sci. conf.* (pp. 12–25). May 5, 2021, Odessa. Ukraine. [in Ukrainian].
6. Tverdohlib, O. (2011). Inheritance of traits in hybrids of species and forms of the subgenus Boeoticum with durum wheat and in their offspring from step crosses. *Visnyk Lvivskoho universytetu* [Bulletin of Lviv University], 55. 73-80. [in Ukrainian].
7. Tribel, S. O. (2005). Resistant varieties: problems and prospects. *Karantyn i zakhyst roslyn* [Quarantine and plant protection], 4. 3–5. [in Ukrainian].
8. Catalog of plant varieties suitable for distribution in Ukraine. (2023). [Kataloh sortiv roslyn prydatnykh dlia poshyrennia v Ukraini]. Kiev. [in Ukrainian].
9. Babaian L. T., Meshterhazi A., Vechter F. et al. (1988). *Metody selektsii i otsinky stiikosti zernovykh kultur do khvorob* [Methods of selection and assessment of resistance of grain crops to diseases]. Prague: N. p. [in Prague]
10. Vovkodav, V. V. (2002). *Metodyka provedennia ekspertyzy na vidmynnist, odnorodnist ta stabilnist sortiv vivsa posivnoho (Avena sativa L.)* [Methodology for carrying out examination on the difference, homogeneity and stability of seed oat varieties (*Avena sativa L.*)]. Kiev: N. p. [in Ukrainian].
11. Vovkodav, V. V. (2000) *Metodyka derzhavnoho sortovyprobuvannia silskohospodarskykh kultur* [Methodology of state variety testing of agricultural crops]. Kiev: N. p. [in Ukrainian].
12. Dosphehov, B. A. (1985). *Metodyka polevoho opyta (s osnovami statistichyeskoy obrabotki ryzultatov issledovaniy)* [Methodology of field experience with the basics of statistical processing of research results] (5-th ed., rev.). Moscow: Ahropromizdat. [in Russian]
13. Ermantraut, E. R., Bobro, M. A., Hoptsi, T. I. (2008) *Metodyka naukovykh doslidzhen v ahronomii* [Methods of scientific research in agronomy]. Kharkiv: N. p. [in Ukrainian].
14. Shishlov, M. P., Shishlova, A. M. (1986). New method of oat castration. *Selektsiia i semenovodstvo* [Breeding and seed production], 3. 3–5. [in Russian].

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Нечепоренко Л. П. Перспективні джерела вівса та їх роль у створенні сорту Далеч.

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Верхняцька дослідно-селекційна станція Інституту біоенергетичних культур і цукрових буряків НААН України, вул. Шкільна, 1, смт. Верхнячка, Уманський район, Черкаська область, 20022, Україна

Актуальність. При створенні нових сортів вівса посівного (*Avena sativa* L.). продуктивність є основним показником цінності вихідного селекційного матеріалу. Тому, актуальним залишається вирішення проблеми підвищення продуктивності, яка залежить від генетичного потенціалу сорту, його пластичності і стійкості до грибкових хвороб. **Мета дослідження.** Відібрати перспективні лінії вівса та охарактеризувати створений новий сорт вівса, що забезпечить приріст урожаю, високу якість зерна, стійкість до посухи та ураження хворобами. **Методи:** польовий, лабораторний, аналітичний та статистичний. **Результати.** Отримано лінії вівса стійкі до ураження летючою сажкою та корончастою іржею як на провокаційному, так і на інфекційному фонах. Лінія 585-7 вівса посівного істотно перевищувала середній груповий стандарт за врожайністю, висотою рослин – на 13 см, коротшим вегетаційним періодом – на 15 діб, стійкістю до ураження летючою сажкою – на 0,5 бала, вилягання та засухи на –1,0–0,5 бала, низькою плівчастістю – 23,1 %, масою 1000 зерен – 33,2 г та вмістом білка – до 13,6 %. **Висновки.** Створено лінії вівса посівного за висотою рослин, довжиною волоті, масою 1000 зерен, натурою зерна, плівчастістю, стійкістю до грибкових хвороб, високими продуктивністю та якістю. Сорт вівса посівного «Далеч» мав середню врожайність 5,50 т/га у зоні Лісостепу та 4,27 у Поліссі, що, відповідно, перевищував на 1,53 та 0,64 т/га, усереднену врожайність сортів, які пройшли Державну реєстрацію за 5 попередніх років в усіх зонах. Стійкий до ураження летючою сажкою та корончастою іржею, занесений до Реєстру сортів рослин України і придатний до поширення в зонах Лісостепу та Полісся з 2022 р.

Ключові слова: овес посівний, продуктивність, адаптивність, стійкість, сорт Далеч