

## EVALUATION OF THE SOURCE MATERIAL OF WINTER OATS IN THE CONDITIONS OF THE CENTRAL FOREST-STEPPE OF UKRAINE

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**Topicality.** Cultivars of winter oats (*Avena sativa* L.) with a high yields and its insignificant fluctuations over the years should be involved in the breeding process to accelerate the development of a new breeding material with stable productivity that does not depend on environmental and climatic factors. **Purpose.** The work was aimed to study and evaluate the collection of winter oats in the conditions of the Central Forest-Steppe of Ukraine. **Methods.** The field, laboratory, and analytical and statistical methods were used. **Results.** Twenty-one samples from the winter oat collection were studied. A detailed analysis of the weather and climatic conditions for the growing season in 2020–2023 was carried out. The conditions of this period favoured the growth and development of winter oats, although there were some deviations in both air temperature and precipitation. **Conclusions.** According to the results of three-year research, the oat samples with a set of valuable traits and properties can be used in the breeding process as genetic sources and donors. A high lodging resistance was observed in 66.7 % of the samples due to strong straw and plant height in the range of 73.6–103.0 cm. The highest number of kernels per head (100.7–143.6 kernels) was observed in the seven samples: BN 5, SW Dalguise, Gerald, Hopenel, BN 1, BN 2 and Tardis. The studied cultivars are sources of high grain weight per head with indicators from 2.66 to 6.30 among hulled and from 2.25 to 4.25 g among naked cultivars, respectively. Five cultivars with a high 1,000 grain weight were identified: Kabardinets, Gerald, Broshan, BN 2, Tardis, SW Dalguise and Mascani. The plant height varied from short-growing (73.3 cm) to tall-growing (120.0 cm) for all the cultivars. All the samples are resistant to loose smut, crown rust and powder mould, both on provocative and infectious backgrounds. Over the years of research, the average grain yield of hulled winter oats ranged from 5.20–9.26 and 5.60–7.00 t/ha for naked oats, respectively.

**Key words:** winter oats, collection samples, productivity, adaptability, disease resistance

**Introduction.** The recent global climate change has had a significant negative impact on crop productivity and requires a revision of breeding objectives. Most of the existing spring oat varieties are susceptible to adverse climate change [1]. The question of involving winter oat forms in hybridisation aimed at obtaining new source breeding material with optimal parameters of all properties and traits has arisen. We should clearly understand what requirements the future variety should meet, as well as what changes may occur at the level of agricultural production during its development. This allows us to select the right source material and evaluate promising lines [2, 3].

One of the main objectives of grain crop breeding is to develop and introduce high-

yielding varieties into agricultural production. In order to increase yields, simultaneous selection for indirect parameters such as productivity and its components (number and weight of grains per head, productive tillering, plant height and head length) is advisable. Evaluation of these parameters, their relationship with yield and inheritance is an important issue in breeding [4].

The comprehensive and substantiated studies in the source material of winter oats allows us to reduce volumes and increase the efficiency of breeding work, and accelerate the development of varieties with given productivity and quality parameters [1].

The research objective is to evaluate the collection of winter oats in the growing conditions of the Right-Bank Forest-Steppe of Ukraine.

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**Materials and Methods.** The research was carried out by the Department of Grain and Bioenergy Crops Breeding, Seed Production of the Verkhniachka Research and Breeding Station of the Institute of Bioenergy Crops and Sugar Beet NAAS of Ukraine in accordance with the ‘Basics of Scientific Research in Agronomy’ [5]. The study was based on 21 collection samples of winter oats, including 16 hulled and 5 naked oats, of different ecological and geographical groups and genetic origin, respectively, characterised by a diversity of morphological and biological traits and properties that are naturally associated with the relevant soil and climatic conditions.

The collection samples of winter oats were sown at the optimum date (late September) with a SKS-6-10 seeder after peas. Plot arrangement was randomised, the registration plot area was 5 m<sup>2</sup>, with two replications, and the Kabardynets variety was the standard.

Phenological observations were made during the growing season and evaluated according

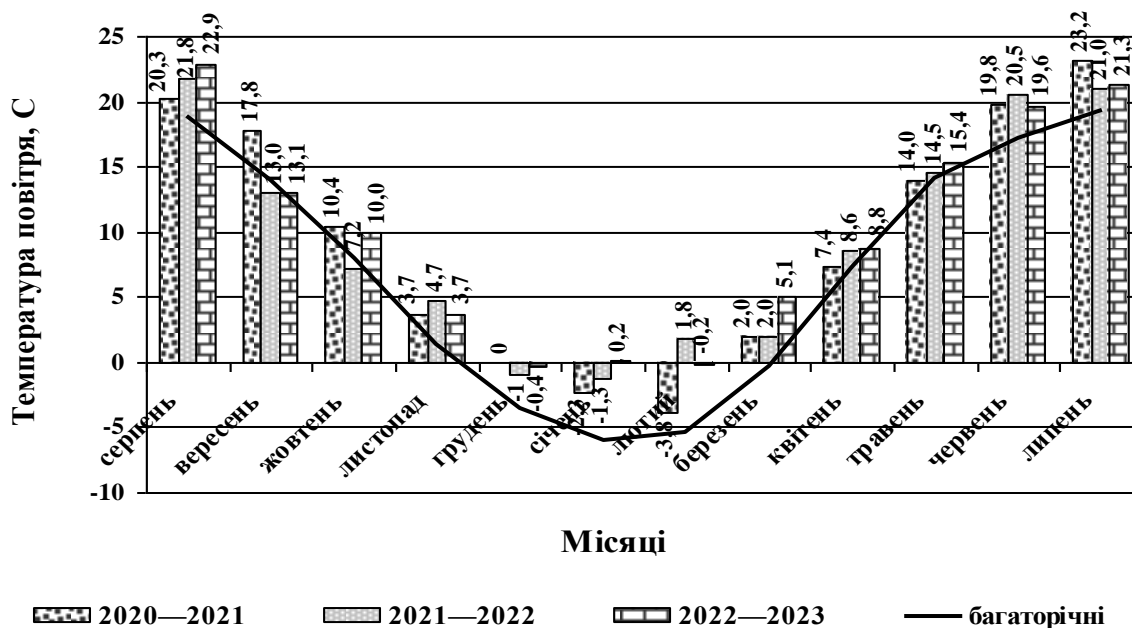
to a five-point system.

Evaluation of cultivars for resistance to head smut and crown rust was carried out in accordance with the requirements of ‘Methods of selection and assessment of resistance of grain crops to diseases’, using artificial infectious and provocative backgrounds [6], and phenological observations in accordance with the ‘Methodology for carrying out examination for difference, homogeneity and stability of common oat (*Avena sativa* L.) varieties’ [7].

The registration data were analysed using the ANOVA method for single-factor experiments [8].

A detailed analysis of the weather and climatic conditions of the growing season of winter oats in 2020-2023 was carried out. In general, the weather and climatic conditions favoured the plant growth and development, although there were some deviations in terms of both air temperature and precipitation in certain periods (Fig. 1, 2).

The average daily temperature in August by



**Fig. 1.** Air temperature during the growing season of winter oats, °C (2020–2023).

year was 1.5, 3.0 and 4.1 °C above the long-term average. Precipitation was 69.5 and 6.0 mm (139.0 and 12.0 % of the norm) in 2021 and 2023, respectively. However, precipitation was 104.7 mm in 2022 (209.4 % of normal), which resulted in a decrease in seed quality and yield, as well as a delay in the harvest date (24 August). Temperatures were above the norm in

September 2020 and below the norm in 2021 and 2022, respectively. In terms of precipitation, the September was dry in 2021 (49.1 % of the long-term average), and wet in 2020 and 2022 (120.0 % and 232.6 %), respectively.

In 2020 and 2022, October was warm with the average monthly temperature of 2.5 and 2.1 °C above the long-term average, respectively, while

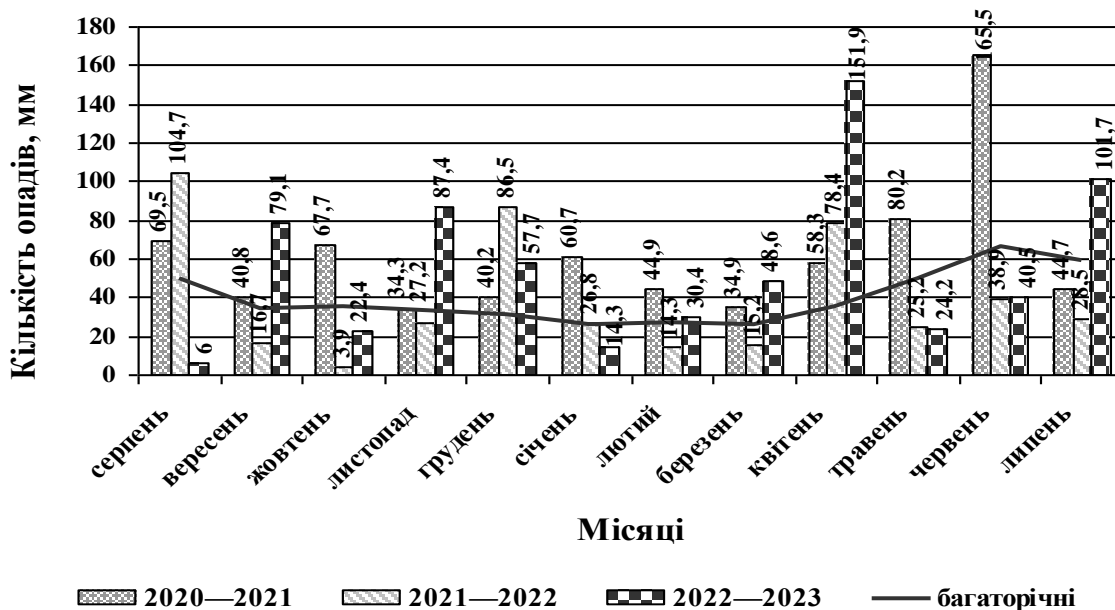


Fig. 2. Precipitation during the growing season of winter oats, mm (2020–2023).

it was cool with an average daily temperature of +7.2 °C, which is 0.5 °C below the long-term average in 2021. In terms of precipitation, the 2021 was characterised as dry, with only 3.9 mm of rainfall (11.1% of the long-term average). 2020 was wet (193.4%) and 2022 was moderately wet (63.1%). Such weather conditions contributed to the timely sowing of winter oats.

Precipitation was 34.3 mm in November 2020, 27.2 mm in 2021, and 87.4 mm in 2022, which was 103.9, 82.4, and 264.8 % of the average long-term norm, respectively. The average monthly air temperature over the years was +3.7, 4.7 and 3.7 °C, respectively (with a long-term average of +1.3 °C), which contributed to friendly seedlings and their further vegetation.

All winter months were warmer than the long-term average by year, with December by 3.1–4.5 °C, January by 3.7–6.2 °C, and February by 1.6–7.2 °C, respectively. The maximum temperature increased to +11.7°C in 2021 and 2022 and +13.2°C in 2023, respectively, and the minimum temperature on some days dropped to -21.0 °C in January 2021. Precipitation in the form of rain and wet snow increased the productive moisture reserves in the lower soil layers. December, January 2021 and 2022, as well as February 2021, were wet, and January 2023 and February 2022 and 2023 were moderately wet, respectively.

Soil temperature at the depth of the tillering node did not drop below 4.4 °C and contri-

buted to good overwintering of oat plants. The temporary drop to -6.0 to -8.5 °C in January 2021 did not have any negative effects due to the stable 12 cm snow cover formed in December.

In the years studied, the springs were cool, although the average daily air temperature in March in 2021 and 2022 was +2.0 °C and +5.1 °C in 2023, which is 2.3 and 5.4 °C above the long-term average, respectively. However, frosts ranging from -5.5 to -9.2 °C were observed during the month. Precipitation amounted to 134.2, 58.5 and 186.9 % of the long-term average by years. The average daily air temperature in April was 7.4, 8.6 and 8.8 °C, and no soil frosts were observed.

Precipitation amounted to 58.3, 78.4 and 151.9 mm, respectively, compared to the norm of 35.0 mm. Such weather conditions contributed to the gradual growth resumption of winter oats.

Temperatures in May were within the long-term average. In terms of precipitation, 2021 was wet (160.4 % of the long-term average) and moderately wet in 2022 and 2023 (50.4 % and 48.4 % of the long-term average), which did not affect the growth of vegetative mass.

Air temperatures in the summer were above the long-term average. June was hot, with average daily temperatures ranging from +19.6 to +20.5 °C, which is 2.5–3.4 °C above the long-term average, with the maximum on some days rising from +31.3 to +33.3 °C, and precipitation by year 165.5, 38.9 and 40.5 mm or 250.8,

58.9 and 61.4 % of the long-term average.

In 2021 and 2022, July was also hot with insufficient precipitation (44.7 and 28.5 mm or 75.8 and 48.3 %), respectively. In 2023, precipitation was 101.7 mm (172.4 %), which led to local lodging of crops and a delay in harvesting dates.

The crops were not affected by fungal diseases, indicating high immunity of the samples.

Thus, during the years of research, the weather conditions prevailing during the

growing season of winter oat samples provided detailed information on resistance to fungal diseases such as head smut, crown rust and snow mould.

**Results and Discussion.** Based on the results of three years of research, we have identified oat samples that contain a set of valuable traits and properties. They can be used as genetic sources and donors in the winter oat breeding (Table 1).

Most (66.7 %) of the studied samples have

**Table 1. Characteristics of winter oat collection cultivars by a complex of valuable traits, (2021–2023)**

no.	Name of cultivar	Type of development	Plant height, cm	Head length, cm	Number of grains, pcs	Grain weight per head, g	1000 grain weight, g
<b>Hulled oat samples</b>							
1	Kabardynets	alternate	120.0	22.6	99.3	4.05	36.0
2	Virnyi	winter	98.0	23.2	84.4	3.70	35.0
3	Mezkhai	winter	101.0	29.7	85.6	3.56	30.0
4	Pidhornyi	winter	103.1	24.8	74.2	3.11	31.0
5	Huzerypl	winter	105.1	34.6	73.6	2.66	26.5
6	Mascani	winter	86.6	23.8	88.0	4.07	38.5
7	Tardis	winter	73.6	26.0	143.6	6.30	38.0
8	Gerald	winter	111.3	27.7	110.0	5.11	37.0
9	SW Dalguise	winter	110.2	25.7	103.0	4.25	38.0
10	Hopenel	winter	100.2	23.7	113.0	4.11	31.0
11	Broshan	winter	79.2	20.6	90.0	3.32	37.0
12	BN no.1	winter	93.0	24.7	110.3	5.21	34.0
13	BN no.2	winter	86.3	26.7	126.0	5.14	37.0
14	BN no.3	winter	94.8	28.0	96.6	4.31	34.0
15	BN no.4	winter	81.8	25.0	93.6	4.26	34.0
16	BN no.5	winter	106.3	25.7	100.7	5.30	32.0
<b>LSD<sub>05</sub></b>			<b>3.8</b>	<b>1.0</b>	<b>2.7</b>	<b>0.31</b>	<b>0.5</b>
<b>Naked oat samples</b>							
1	Expression	winter	74.8	28.0	88.6	3.36	24.8
2	Hordon	winter	75.8	27.0	85.6	3.35	24.0
3	Pilango	winter	73.3	27.7	86.3	3.32	26.0
4	Grafton	winter	94.2	23.7	97.0	4.25	30.0
5	Cyuston	winter	104.0	21.0	91.0	2.25	19.0
<b>LSD<sub>05</sub></b>			<b>3.5</b>	<b>0.7</b>	<b>2.5</b>	<b>0.23</b>	<b>0.3</b>

high resistance to lodging due to strong straw and plant height in the range of 73.6–103.0 cm, the rest 33.3 % have no resistance to lodging.

Selection for head length is considered to be promising, as its size is characterised by a clear phenotypic manifestation and is an important trait in productivity breeding. The head length in hulled oat samples varies from 20.6 to 36.4 cm and from 21.0 to 28.0 cm in naked oat samples.

An important indicator of productivity is the number of grains per head. Among the stud-

ied samples, only BN no.5, SW Dalguise, Gerald, Hopenel, BN no.1, BN no.2 and Tardis have the highest number of grains per head (100.7–143.6 pcs.), the rest – within 74.2–99.3 and 85.6–97.0 pcs, respectively.

The studied oat cultivars are sources of high grain weight per head with values ranging from 2.66 to 6.30 g for hulled oats and from 2.25 to 4.25 g for naked oats, respectively.

The 1000-grain weight is an important yield attribute that characterises grain size and plumpness. There were 5 varieties with a high value of

1000 grain weight: Kabardynets (36.0 g), Gerald, Broshan and BN no.2 (37.0 g each) and Tardis, SW Dalguise and Mascani (38.0, 38.0 and 38.5 g, respectively). The rest of the samples had 1000-grain weight in the range of 26.5–36.0 g for hulled and 19.0–30.0 g for naked samples, respectively.

The features of the anatomical structure of the plant, in particular, the length of the stem, have a significant impact on plant productivity.

The plant height of winter oat cultivars varied from short-growing (73.3 cm) to tall-growing (120.0 cm), but most of them were characterised by a high weight per head/g and 1000 grain weight/g.

Also, all samples are resistant to head smut, crown rust and snow mould (9 points each) with average yields in the range of 5.20–9.26 t/ha for hulled and 5.60–7.00 t/ha for naked oats, respectively (Table 2).

**Table 2. Characteristics of collection cultivars of winter oats in terms of yields and resistance to fungal diseases, (2021–2023)**

no.	Name of cultivar	Grain yields of oats by years of testing, t/ha				Resistance to diseases, point		
		2021	2022	2023	average	head smut	crown rust	snow mould
<b>Hulled oat samples</b>								
1	Kabardynets	9.20	5.80	8.80	7.93	9	9	9
2	Virnyi	8.22	6.22	7.20	6.85	9	9	9
3	Mezkhai	6.00	5.60	6.10	5.90	9	9	9
4	Pidhornyi	7.40	5.40	7.70	6.73	9	9	9
5	Huzerypl	5.30	5.10	5.20	5.20	9	9	9
6	Mascani	8.40	6.30	8.60	7.77	9	9	9
7	Tardis	7.40	6.40	7.60	7.13	9	9	9
8	Gerald	8.40	7.20	8.60	8.06	9	9	9
9	SW Dalguise	8.60	7.20	8.70	8.13	9	9	9
10	Hopenel	7.22	6.35	7.40	7.00	9	9	9
11	Broshan	8.22	7.45	8.70	8.12	9	9	9
12	BN no.1	9.22	9.20	9.35	9.26	9	9	9
13	BN no.2	8.10	8.00	8.50	8.20	9	9	9
14	BN no.3	7.50	7.20	7.75	7.48	9	9	9
15	BN no.4	8.00	8.10	8.30	8.13	9	9	9
16	BN no.5	8.50	7.60	8.70	8.27	9	9	9
<b>LSD<sub>05</sub></b>		<b>0.43</b>	<b>0.48</b>	<b>0.39</b>				
<b>Naked oat samples</b>								
1	Expression	6.40	6.00	6.60	6.33	9	9	9
2	Hordon	6.50	7.40	7.10	7.00	9	9	9
3	Pilango	6.00	6.00	6.20	6.10	9	9	9
4	Grafton	6.00	6.00	6.00	6.00	9	9	9
5	Cyuston	5.40	5.80	5.60	5.60	9	9	9
<b>LSD<sub>05</sub></b>		<b>0.24</b>	<b>0.31</b>	<b>0.28</b>				

Taking into account the data obtained on the yield attributes, cultivars with high productivity potential will be used in the hybridisation nursery to develop new source breeding material for winter oats, as well as to eliminate negative traits in varieties and to preserve their productivity.

**Conclusions.** According to the results of three years of research conducted at the Department of Grain and Bioenergy Crops Breeding and Seed Production of the Verkhniachka Research and Breeding Station of the Institute

of Bioenergy Crops and Sugar Beet of NAAS of Ukraine, we have identified 66.7 % of collection samples of winter oats with high resistance to lodging due to strong straw and plant height in the range of 73.6–103.0 cm, and 7 oat samples (BN no.5, SW Dalguise, Gerald, Hopenel, BN no.1, BN no.2 and Tardis) – with the largest number of grains per head (100.7–143.6 pcs). The studied cultivars should be used as sources of grain weight per 1 head with high values from 2.66 to 6.30 for hulled and from 2.25 to 4.25 g for naked oats, respectively. In terms of

1000 grain weight, five hulled cultivars varied from 36.0 to 38.5 g, while the rest varied from 26.5 to 36.0 g in hulled and 19.0 to 30.0 g in naked oat cultivars, respectively. The plant height varied from short-growing (73.3 cm) to tall-growing (120.0 cm). The whole presented range of winter oats is resistant to head smut, crown rust and snow mould both on provocative

and infectious backgrounds. The average yields over the years of research for hulled winter oats cultivars ranged from 5.20–9.26 and 5.60–7.00 t/ha for naked oats, respectively.

Our results indicate that the studied cultivars contain a set of valuable traits and properties and can be used in breeding as genetic sources and donors.

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УДК 633.13:631.527

**Нечепоренко Л. П., Ворожко С. П. Оцінка вихідного матеріалу зимуючого вівса в умовах Центрального Лісостепу України. *Зернові культури*. 2024. 8 (1). 44–50.**

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**Актуальність.** Використання у селекційному процесі зразків зимуючого вівса (*Avena Sativa* L.) з урожайністю високого рівня та незначним коливанням її за роками дозволить прискорити створення нового матеріалу із стабільною урожайністю не залежно від впливу екологічних та кліматичних чинників. **Мета роботи** – вивчити та оцінити колекцію зимуючого вівса в умовах Центрального Лісостепу України. **Методи:** польовий, лабораторний, аналітичний та статистичний. **Результати.** Наведено результати вивчення 21 колекційного зразка зимуючого вівса посівного. Проведено детальний аналіз погодно-кліматичних умов за вегетаційний період у 2020–2023 рр., який показав, що вони, в основному, сприяли росту і розвитку рослин. Хоча і були певні відхилення в окремі періоди як по температурі повітря, так і по опадах. **Висновки.** За результатами трьохрічних досліджень зразки, які поєднують у собі комплекс цінних ознак і властивостей можуть бути використані в селекції як генетичні джерела і донори. 66,7% зразків мають високу стійкість до вилягання, завдяки міцній соломині та висоті рослин в межах 73,6–103,0 см. За найбільшою кількістю зерен у волоті (100,7–143,6 шт.) виділилося 7 зразків: БН № 5, SW Dalguise, Gerald, Hopenel, БН № 1, БН № 2 і Tardis. Вивчені сортозразки є джерелами високої ваги зерна з 1 волоті з показниками від 2,66 до 6,30 серед плівчастих та від 2,25 до 4,25 г серед голозерних відповідно. Виділилось 5

сортозразків з високою масою 1000 зерен: Кабардинець, Gerald, Broshan, БН № 2, Tardis, SW Dalguise та Mascani. Висота рослин варіювала від низькорослих (73,3 см) до високорослих (120,0 см). Всі зразки стійкі до ураження летючою сажкою, корончастою іржею та сніговою пліснявою як на провокаційному так і на інфекційному фонах. Середня врожайність за роки досліджень півчастих зразків зимуючого вівса становила в межах 5,20–9,26 та 5,60–7,00 т/га серед голозерних відповідно.

**Ключові слова:** овес зимуючий, колекційні зразки, продуктивність, адаптивність, стійкість до хвороб