

Plot (soil) variety control as part of the varietal quality confirmation of soft wheat seed

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Purpose. To evaluate the effectiveness of plot (soil) variety control to confirm purity of varieties (hybrids, lines) and authenticity of seed characteristics of soft wheat varieties at all stages of seed reproduction, as well as to ensure quality assurance of the produced seed. **Methods.** Analysis and synthesis, comparison method, statistical analysis, systematic approach, tabular and graphical methods. **Results.** The study found that plot (soil) variety control is a mandatory component of the seed certification system, which ensures confirmation of varietal purity and detection of inconsistencies at the stages of production, storage and sale. Controls for pre-basic (PBS), basic (BS) and certified (CS) seed help to ensure high quality standards. In 2020–2023, the number of control samples of soft winter wheat seed passing the plot (soil) variety control decreased. This was due to military operations, logistical disruptions and a reduction in the area under cultivation. However, despite these factors, the varieties 'Bohdana', 'Mudrist Odeska' and 'Podolianka' remain the leaders in the number of control samples due to their stable yields and high disease resistance. **Conclusions.** Plot (soil) variety control plays an important role in quality assurance and detection of inconsistencies at the stages of seed production. The decrease in the number of control samples in 2020–2023 is due to military operations, reduced crop areas and economic difficulties. At the same time, the popularity of domestic wheat varieties, such as 'Bohdana' and 'Mudrist Odeska', demonstrates their high adaptability, yield and resistance to disease pathogens. To maintain and strengthen the position of the Ukrainian seed industry, it is necessary to actively develop the domestic seed market, support breeding programmes and encourage the export of domestic seed products.

Keywords: variety; plot (soil) variety control; seeds; Organisation for Economic Co-operation and Development.

Introduction

Varietal seed certification schemes, adopted by the member countries of the Organisation for Economic Co-operation and Development (hereafter – OECD), are a system of procedures, methods and approaches that ensure seed quality control at all stages of seed reproduction and guarantee varietal authenticity and varietal purity [1, 2]. These schemes are widely used in international trade for the sale of conditioned seed.

A batch of seed must conform to varietal and sowing qualities at all stages of production. Seed varietal quality is determined by field evaluation, plot (soil) varietal control for compliance with morphological characteristics determined during state registration.

The OECD Seed Variety Certification Schemes provide for the use of various methods to control the varietal and sowing qualities of seed at all stages of seed production, in particular:

- plot (soil) variety control to assess the conformity of the seed of a control sample taken from a batch of seed prepared for sale with a standard sample of seed of a variety having state registration;
- field assessment of seed crops to determine their conformity with the standards;
- analysis of the sowing qualities of seed by examination of samples taken from the batch.

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The purpose of plot (soil) variety control is to confirm the varietal purity of a given variety (hybrid, line) at different stages of seed propagation. This ensures the proper quality of conditioned seed that meets the requirements of international standards and is intended for commercial use.

Foreign experience in the field of plot (soil) variety control is important for improving Ukrainian practice. In particular, the countries of the European Union widely use standardized methods for assessing varietal purity and sowing quality of seed.

Plot (soil) variety control is a key element in the system for confirming the varietal quality of common wheat seed. The importance of this stage is due to the need to ensure genotypic homogeneity and varietal purity of the seed, which determines the quality of the future crop. As noted in the work of M. A. Lytvynenko and co-authors, genotypic homogeneity and heterogeneity at the pre-breeding stage is crucial for increasing yields and resistance of varieties to adverse growing conditions [3].

Such scientists as Y. Navrotsky, T. Matsyhora, O. Vyshnevetska, S. Melnyk, L. Khudolii, O. Zakharchuk and many others [4–7] have made significant contributions to the development of the market for varietal seeds, the organisation of methodological and methodical principles of the commercial circulation of conditioned seeds and planting material, and ways of solving common problems of the domestic seed industry in Ukraine. The main focus of research was on plant breeding, distribution of plant varieties and seeds, their commercial circulation, structure of seed production, legal support related to state regulation of plant variety rights protection. At the same time, not enough attention has been paid to the general aspects of plot (soil) variety control to ensure the production of conditioned seed, which requires further research to improve this important component of seed production.

Today, soft winter wheat seed production faces a number of challenges, including climate change and the need to adapt technologies to local conditions. In this context, particular attention is being paid to innovative approaches to improve seed quality and its compliance with international standards [8, 9].

The use of agro-technological measures to improve seed quality is actively researched. Rational management of these measures

helps to reduce the negative impact of adverse climatic factors. In addition, the environmental aspects of wheat growing are crucial to ensuring long-term crop productivity in the different soil and climate zones of Ukraine [9, 10].

Certification plays an important role in the seed quality control process, ensuring that products meet international requirements. It involves the introduction of innovative methods for assessing varietal purity and genotypic uniformity, which helps to improve the competitiveness of seed in domestic and foreign markets [11–13].

Purpose – to evaluate the effectiveness of plot (soil) variety control to confirm purity of varieties (hybrids, lines) and authenticity of seed characteristics of soft wheat varieties at all stages of seed reproduction, as well as to ensure quality assurance of the produced seed.

Materials and methods

The research was conducted in 2020–2023 on the experimental fields of the Cherkassy Branch of the Ukrainian Institute for Plant Variety Examination, located in the Forest-Steppe zone of Ukraine. The experimental fields are characterised by homogeneous soil and climatic conditions, which ensure the quality and reliability of the results.

During the plot (soil) variety control, the conformity of the plants grown from the seeds of the control sample with the plants grown from the seeds of the standard sample or the official description of the variety was assessed. The examination was carried out at the appropriate phenological stages of growth and development in the field and in the laboratory in accordance with the Methodology for Conducting Plot (Soil) Varietal Control and Laboratory Varietal Control [14], taking into account the requirements of the Methodology for the Examination of Plant Varieties for Distinctness, Uniformity and Stability for the relevant botanical taxon [15].

The method used was a visual comparison of the identification characteristics of the plants grown on the control plot with plants grown on the standard plot and/or taking into account the official description of the variety used for the state registration of the variety and/or the state registration of rights to the variety. The number of atypical plants in the control plot was taken into account to establish varietal purity.

Results and discussion

Plot (soil) variety control is carried out on all varieties, hybrids and lines included in the OECD seed schemes. This control is mandatory for seed of the pre-basic (PBS) and basic (BS) categories and for certified seed (CS), the scope of which is determined by the relevant certification body.

Depending on the category of seed, the results of the confirmation of varietal qualities by the method of plot (soil) variety control are taken into account as part of the post-control, which is carried out after the sale of seed and involves checking its varietal qualities by sowing control samples in specially designated areas. These checks take place on all categories of seed, including pre-basic (PBS), basic (BS) and certified (CS).

The purpose of post-control is to confirm that seed meets established standards of varietal purity and authenticity. This makes it possible to assess the quality of seed material already sold and provides consumers with a guarantee that the seed used has the declared characteristics.

Post-control is an important part of the seed quality control system as it allows us to identify any deviations or problems that may have occurred during production, transport or storage.

The use of plot (soil) variety control for pre-control during seed multiplication to produce subsequent generations provides important information on seed varietal quality before or at the time when the next seed crop is ready for field evaluation, as the study takes place simultaneously with the cultivation of the next generation of seed.

For certified seed intended for further propagation, the control plot can fulfil two functions:

- control of the varietal quality of the seed from the last harvest;
- preliminary control of seed crops for the next harvest.

As the varietal identity and purity of first generation hybrids cannot be fully verified in the field where the seed is grown, due to the influence of agronomic and natural factors, their quality is controlled in specially designated plot (soil) variety control areas.

Confirmation of seed varietal qualities by the method of plot (soil) variety control is carried out by the Ukrainian Institute for Plant Variety Examination in accordance with the Procedure for Confirmation of Seed

Variety Qualities by Plot (Soil) and/or Laboratory Variety Control, approved by the Order of the Ministry of Agrarian Policy of 30.04.2024 No. 1343 and registered by the Ministry of Justice of Ukraine on 22.05.2024 No. 744/42089 [5, 6].

The Method for Plot (Soil) Varietal Control and Laboratory Varietal Control [14] describes plant identification methods which make it possible to establish the conformity of a control sample of seed of a particular variety with a standard sample. Plants from both samples are grown under the same conditions, which ensures the accuracy of the comparison of their morphological characteristics.

The methods, tried and tested over many years, are widely used and accepted by most OECD countries participating in seed schemes.

Field evaluation in control plots is carried out to determine whether the morphological characteristics of the variety agree with the sample selected from the seed lot with the standard sample and/or the official description of the variety.

The requirements for growing plants of a particular botanical taxon on control and standard plots will normally correspond to generally accepted technology, taking into account the growing zone. The level of agricultural technology is determined by the conditions of field research for plot (soil) variety control, taking into account the botanical taxon and the type of plant development.

Plot (soil) variety control is carried out during one growing season, in one replication, at one research site.

To confirm the varietal qualities of soft (winter) wheat seed, 1834 control samples were tested in 2020 by plot (soil) variety control.

In 2021–2023 there was a decrease in the number of control samples subject to plot (soil) variety control. Compared to 2020, their number decreased by a factor of 2.7 (Fig. 1).

A significant factor affecting this indicator is the military conflict in Ukraine, which has disrupted supply chains and reduced the area under seed in regions where hostilities are active.

In addition, the small price difference between certified and commercial seed, given the high cost of certification procedures, reduces its economic attractiveness to producers, which also contributes to a reduction in the number of control samples.

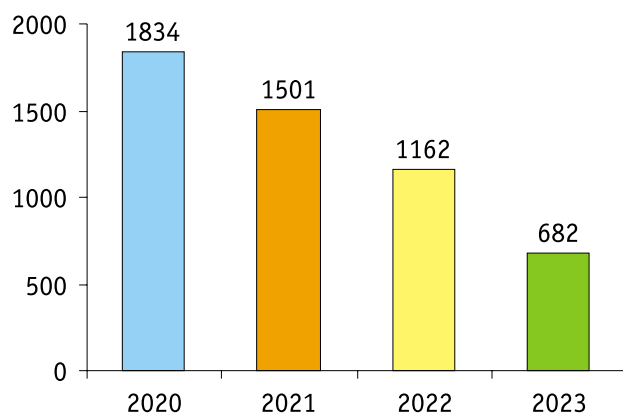


Fig. 1. Number of control samples of soft winter wheat varieties examined as part of the plot (soil) variety control in 2020–2023

The analysis of control samples of common winter wheat for the studies of plot (soil) variety control carried out by the Ukrainian Institute for Plant Variety Examination in 2020–2023 shows that during this term the largest number of samples was examined for the varieties ‘Bohdana’ (2020 – 77 samples, 2021 – 54 samples, 2022 and 2023 – 38 samples each), ‘Mudrist Odeska’ (2020 – 69 samples, 2021 – 51 samples, 2022 – 25 samples, 2023 – 24 samples), ‘Podoliianka’ (2020 – 60 samples, 2021 – 50 samples, 2022 – 25 samples, 2023 – 24 samples) and ‘Katrusia Odeska’ (2020 – 14 samples, 2021 – 30 samples, 2022 – 31 samples, 2023 – 25 samples) (Fig. 2). The popularity of these varieties is explained by their high economic performance, including stable productivity, increased disease resistance and ability to adapt to different climatic conditions in the regions of Ukraine.

Thus, the most common varieties of soft winter wheat grown on the production fields of agricultural producers in Ukraine are those of the Institute of Plant Physiology and Genetics of the National Academy of Sciences of Ukraine and the Plant Breeding and Genetics Institute – National Center of Seed and Cultivar Investigation of the National Academy of Agrarian Sciences of Ukraine. In 2023, ‘Bohdana’ (Institute of Plant Physiology and Genetics of the National Academy of Sciences of Ukraine) occupied the largest area among these varieties.

Among the varieties of foreign breeding, taking into account the analysis of the number of control samples for conducting plot (soil) variety control, the most common varieties of soft winter wheat, which are suc-

cessfully grown in Ukraine, are the variety ‘RGT Reform’ (RAGT 2nd, France) and the variety ‘Skagen’ (Saaten-Union GmbH, Germany). Fig. 2 shows that the most popular variety among foreign varieties in 2020 was ‘Nordica’ (Limagrain Europe, France) – 34 samples were evaluated by plot (soil) variety control. The sharp decline in the number of control samples of foreign varieties such as ‘Nordika’, ‘RGT Reform’ and ‘Skagen’ may be due to the rising cost of imported seed, particularly due to currency fluctuations, which reduces their availability to agricultural producers. In addition, logistical difficulties caused by the military conflict, including disruptions to supplies and transport routes, have significantly hampered seed imports into Ukraine.

If we analyze the number of control samples submitted for soil (plot) variety control of the soft winter wheat variety ‘Bohdana’ of the Institute of Plant Physiology and Genetics of the National Academy of Sciences of Ukraine, the largest number of samples in 2023 was submitted by agricultural seed producers in Kharkiv (19 samples), Dnipro (5 samples) and Kyiv regions (8 samples) (Fig. 3).

Vinnitsia region, Dnipropetrovsk region, Zaporizhzhia region, Kyiv region, Odesa region, Poltava region, Sumy region, Kharkiv region, Khmelnytsk region, Cherkasy region, Chernihiv region

In 2023, the soft winter wheat variety ‘Mudrist Odeska’ of the Plant Breeding and Genetics Institute – National Center of Seed and Cultivar Investigation (Odesa) was the most cultivated variety in the Kirovohrad region (5 samples) (Fig. 4).

In 2020–2023, we received the largest number of control samples of soft winter wheat variety ‘Mudrist Odeska’ for plot (soil) variety control from Mykolaiv, Odesa and Poltava regions.

It should be noted that the volume of conditioned seeds of spiked cereals has been decreasing in recent years, which is due both to the problems of financial support for agricultural producers and to military operations in our country.

In Ukraine, not only the production of conditioned seed of national and foreign varieties of cereals, especially soft wheat, is decreasing, but also the proportion of conditioned seed of cereals per 1 ha of production crops [16, 17] (Table).

The data indicates a decline in production, from 202.4 thousand tons in 2020, to

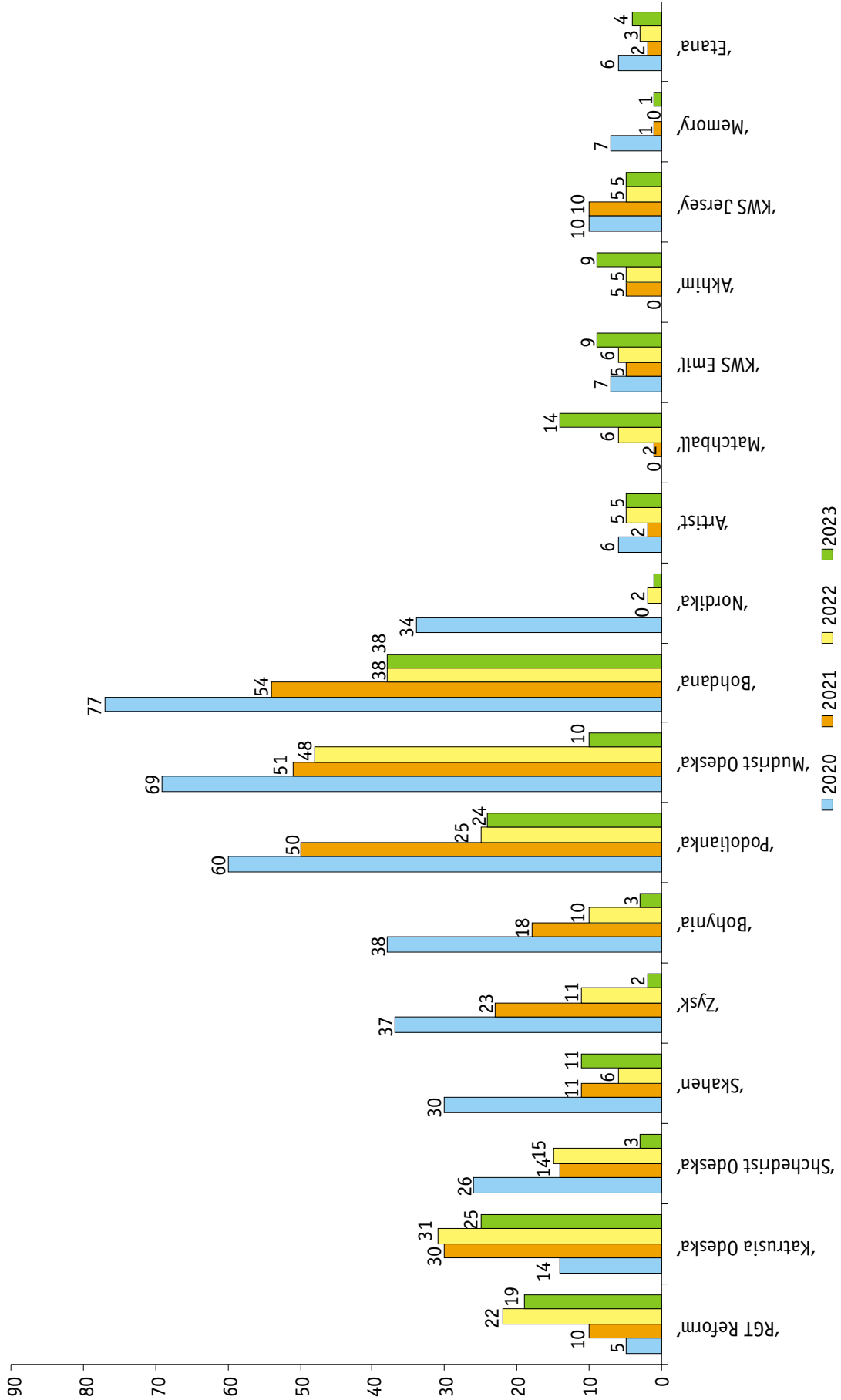


Fig. 2. Number of control samples of seed of different soft winter wheat varieties used for plot (soil) variety control (2020–2023)

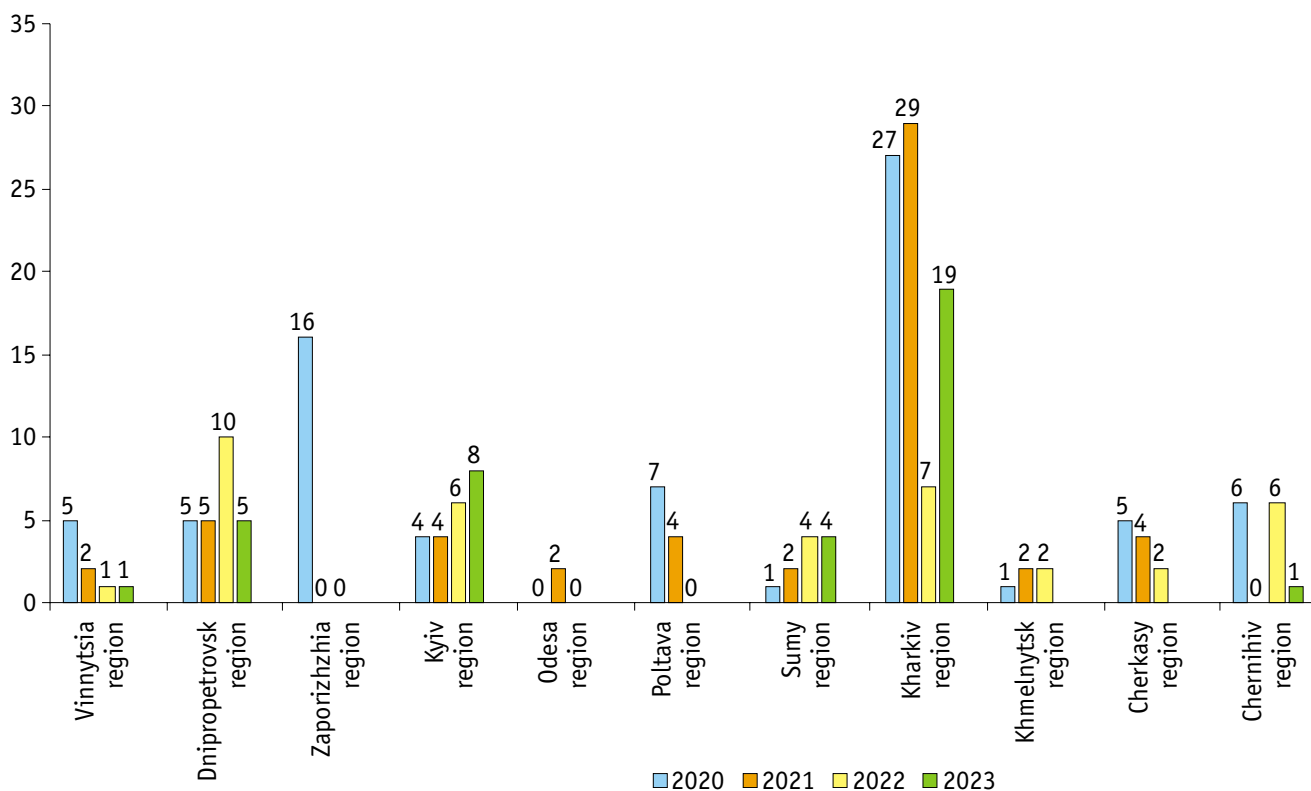


Fig. 3. Number of control samples for soil (plot) variety control of soft winter wheat variety 'Bohdana' submitted by economic entities from different regions

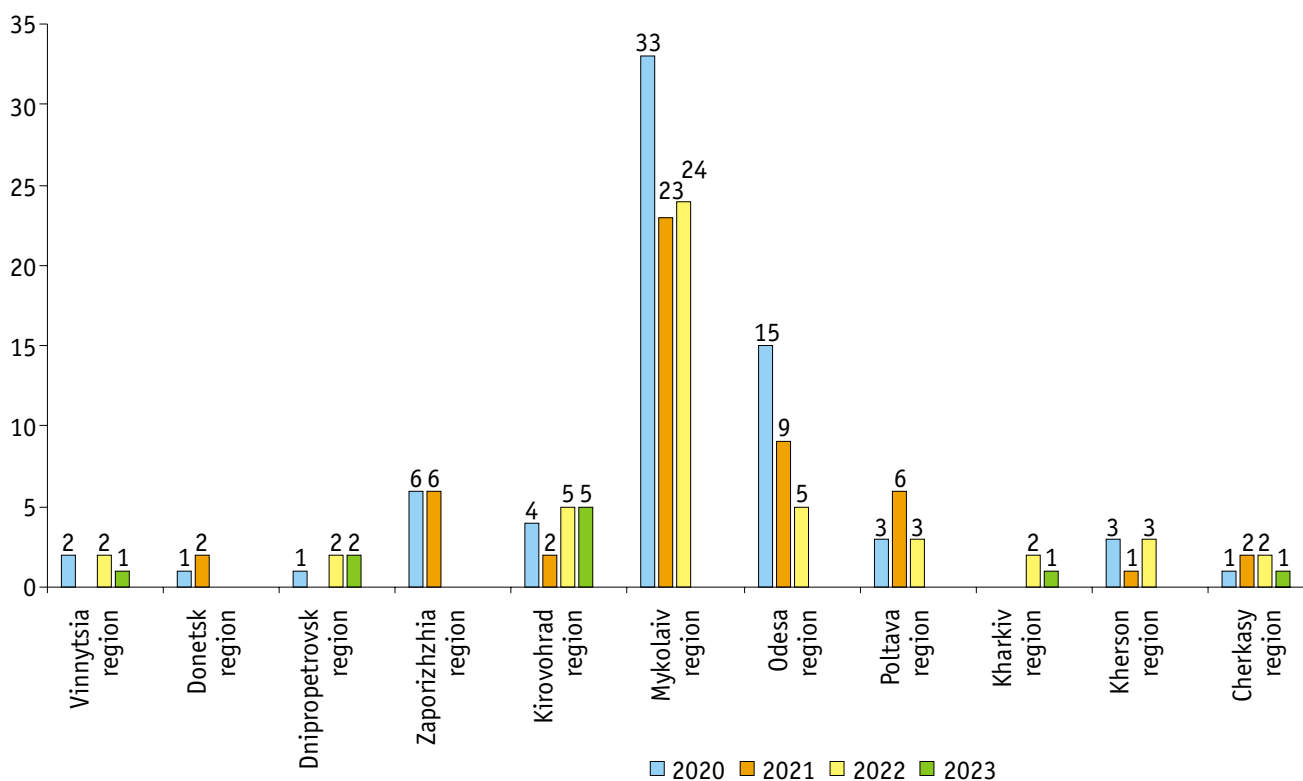


Fig. 4. Number of control samples for soil (plot) variety control of the soft winter wheat variety 'Mudrist Odeska' in different regions

170.0 thousand tons s in 2021, and further to 101.8 thousand tons in 2022. The most recent figure, for 2023, is 107.6 thousand

tons. This indicates a 47% decline in production over the period from 2020 to 2022, a decline that is especially reflected in the

Table

Dynamics of production of conditioned seed of soft wheat and other cereals in Ukraine

Year	Conditioned seed production in Ukraine, thousand tons		Area of commercial crops, thousand ha		Conditioned seed produced per 1 ha, kg		The share of conditioned seeds per 1 ha at a sowing rate of 200 kg, %	
	grain crops	in particular, soft wheat	grain crops	in particular, soft wheat	grain crops	in particular, soft wheat	grain crops	in particular, soft wheat
2020	202.4	141.4	9960.3	6429	20.3	22.0	10.2	11.0
2021	170.0	120.9	10 466.2	6903	16.2	17.5	8.1	8.8
2022	101.8	72.1	7457.5	4853	13.7	14.9	6.9	7.5
2023	107.6	78.8	6871.9	4472	15.6	17.6	7.8	8.8

production of conditioned soft wheat seeds, which decreased from 141.4 thousand tons in 2020 to 78.8 thousand tons in 2023.

In addition, the share of conditioned seed per 1 ha at a seed rate of 200 kg for cereals decreased, indicating a decline in the quality of seed used in agricultural production. In 2020, this figure was 10.2% for all cereals, 8.1% in 2021, 6.9% in 2022 and 7.8% in 2023. Thus, between 2020 and 2022, there was a 2.4% decrease in the share of conditioned seed, which was a serious signal of a decline in the quality of seed used for sowing. Although this figure increased slightly in 2023, it was still lower than in 2020, indicating a continuation of the negative trend.

In this context, the number of samples for plot (soil) variety control also decreases. The share of conditioned seed per 1 ha at a seed rate of 200 kg was reduced by 2.4% in 2023 compared to 2020 and further reduced to 6.9% in 2022.

Ukraine differs from other European countries in the low level of supply of production crops with high quality conditioned seed of the highest categories and meeting potential exports. This is an extremely threatening phenomenon, as the state may lose its own breeding due to the decrease in the level of condition and the use of seeds of higher categories (PBS, BS, CS).

In Ukraine, seed production for only certain niche crops ensures an adequate level of food security. In particular, the production of buckwheat, millet, oats and triticale is fully ensured by seeds of Ukrainian breeding. According to experts, most Ukrainian varieties and hybrids are not inferior to foreign ones in terms of economic and biological characteristics and are quite competitive, and in terms of winter hardiness, drought resistance, disease resistance and taste they often exceed their foreign counterparts [7].

Increasing dependence on imported seeds, the decline of domestic seed production and the displacement of Ukrainian varietal resources from the seed and planting

material market will threaten Ukraine's food security.

The war with Russia is also exacerbating the existing problems of seed production in Ukraine. Disruptions in the logistical supply chain of conditioned foreign seed require fundamental changes in the current system of seed breeding and production in Ukraine. Replacing foreign seed with Ukrainian seed, which is better adapted to local growing conditions and meets modern quality and yield requirements, will help provide agricultural producers with quality seed in the quantities and at the time they need it for planting.

Conclusions

During the period 2020–2023, there was a decrease in the number of control samples undergoing plot (soil) variety control, especially for soft winter wheat. The main reasons for this were the military conflict, logistical difficulties, a decrease in planted area and increasing certification costs.

The popularity of certain wheat varieties, such as 'Bohdana', 'Mudrist Odeska' and others, is due to their high agronomic characteristics, including adaptation to Ukrainian climatic conditions, disease resistance and stable yields.

In the foreign bred seed segment, the number of samples sent for testing fell sharply due to the rising cost of imported seed, economic difficulties of agricultural producers and logistical problems.

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Захарчук О. В.¹, Гринів С. М.², Таганцова М. М.², Курочка Н. В.² Ділянковий (ґрунтовий) сортовий контроль як складник підтвердження сортових якостей насіння пшениці м'якої. *Plant Varieties Studying and Protection*. 2024. Т. 20, № 4. С. 211–218. <https://doi.org/10.21498/2518-1017.20.4.2024.321918>

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Мета. Оцінити ефективність ділянкового (ґрунтового) сортового контролю для підтвердження сортової чистоти гібридів і ліній, автентичності прояву характеристик насіння сортів пшениці м'якої на всіх етапах його розмноження, а також забезпечення якості виробленого насіння. **Методи.** Аналіз і синтез, порівняння, статистичний аналіз, системний підхід, табличний і графічний методи. **Результати.** За результатами дослідження встановлено, що обов'язковим складником системи сертифікації насіння, спрямованої на підтвердження сортової чистоти та виявлення невідповідностей на етапах виробництва, зберігання й реалізації, є ділянковий (ґрунтовий) сортовий контроль. Його проведення для насіння базової (ДН), базової (БН) та сертифікованої (СН) категорій сприяє забезпеченню високих стандартів якості. У 2020–2023 рр. зафіксовано зменшення кількості контрольних проб насіння сортів пшениці м'якої озимої, що пройшли ділянковий (ґрунтовий) сортовий контроль. Це спричинено військовими діями, порушенням логістики та скороченням

площ посівів. Однак попри ці фактори сорти 'Богдана', 'Мудрість одеська' та 'Подольнка' залишаються лідерами за чисельністю контрольних проб завдяки стабільній врожайності та високій стійкості проти хвороб. **Висновки.** Ділянковий (ґрунтовий) сортовий контроль відіграє важливу роль у забезпеченні якості та виявленні невідповідностей на етапах виробництва насіння. Зменшення кількості контрольних проб у 2020–2023 рр. зумовлено військовими діями, скороченням площ посівів та економічними труднощами. Водночас популярність таких сортів пшениці вітчизняної селекції, як 'Богдана' та 'Мудрість одеська', свідчить про їхню високу адаптивність, врожайність і стійкість проти збудників хвороб. Для збереження та зміцнення позицій українського насінництва необхідно активно розвивати внутрішній ринок, підтримувати селекційні програми та стимулювати експорт продукції вітчизняної селекції.

Ключові слова: сорт; ділянковий (ґрунтовий) сортовий контроль; насіння; Організація економічного співробітництва та розвитку.

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