

VARIETIES AND RESOURCE-SAVING ELEMENTS OF WINTER WHEAT GROWING TECHNOLOGY AS A MEASURE OF GRAIN PRODUCTION

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Topicality. Ukraine is a world known producer of high-quality grain. Actually, the potential for grain production of all grain crops, especially, winter wheat is quite powerful, especially in the southern region of Ukraine. At the same time, grain yield levels largely depend on influence of many factors: the moisture supply of plants during the growing years, the agricultural background of nutrition, the selection of varietal composition, the tillage method and measures, the plant protection, the weed infestation, and other factors. There are no trifles in plant cultivation, because strict compliance with all the necessary technological requirements will allow you to obtain constant productivity and ensure a gross harvest of grain every year. This is significantly important both for the state's own needs and for exports. Currently, it is not possible to successfully cultivate crops in all fields and agricultural lands due to military operations in Ukraine. The Ukrainian manufacturers should implement previously developed elements of technology and improve new less-known and resource-saving measures. The last aspect also becomes significant in term of the weakening the economic capacity of farms, the increase in the price of material resources and a certain decrease in soil fertility. Under such conditions, the most effective measure is to review of the list of agricultural crops and select the most unpretentious to environmental conditions crops for cultivation, and among them, it is necessary to select crops highly adapted to biotic and abiotic factors of the environment, and varieties that are able to show their genetically programmed biological and economically valuable characteristics. **Purpose.** We attempt to achieve a significant increase in both grain yield and its quality by means of selection and involvement of new varieties in the production, and improvement of certain elements of growing technology. **Materials and Methods.** Setting up and conducting field experiments was carried out in accordance with the generally accepted methodology of the research case. The experimental part of the work was carried out during 2007–2021 at the research field of the Educational and Scientific-Practical Centre of Mykolaiv National Agrarian University. **Results.** It was determined that winter wheat responds to predecessors, increases grain productivity against the background of fertilization. With regard to the selection of the varietal composition of soft winter wheat bred by Ukrainian breeding institutions in the last decades, it was established that most varieties are adapted to cultivation in the conditions of the Southern Steppe of Ukraine, and are able to form a stable level of harvest, which does not clearly fluctuate over the years. **Conclusions.** We substantiated that winter wheat should be planted after more favourable predecessors, a moderate dose of mineral fertilizers should be applied, and the most productive varieties should be selected, which have the best characteristics in the conditions of the growing zone.

Key words: winter wheat, selection of adapted varieties, grain harvest, weather and climate conditions, elements of cultivation technology

Introduction. In the grain production system, selection of high-yielding varieties that are adapted to the conditions of the growing area should be of strategic importance to ensure sus-

tainable gross production. Regardless of the climatic conditions of the growing season, the most suitable varieties should ensure a stable yield with high quality.

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In addition to variety selection, a number of effective agrotechnological measures, especially resource-saving ones, should be used to increase grain productivity: optimal sowing dates and predecessor, application of moderate rates of mineral fertilisers, etc. All of these elements of technology will contribute to both higher yield and grain quality. The research was aimed to identify the most productive winter wheat varieties adapted to the conditions of the Southern Steppe of Ukraine and their response to some elements of agricultural technology. According to variety suitability to the growing conditions, breeders have classified the varieties according to certain parameters of ecological plasticity and stability, which are the most informative indicators of genotypes' response to changing environmental conditions. The varieties with a low response to environmental changes during crop cultivation are the most valuable. They are able to produce a stable grain yield both under irrigation and without irrigation, and respond to improved growing conditions, unstable weather conditions, changes in the agrophone, etc.

Numerous climatologists and scientists have confirmed that in recent decades, certain climate changes have been taking place both in Ukraine and on the planet as a whole. This affects the productivity of all crops, including winter wheat [1–3]. In this context, the priority task for scientists and agrarians is to develop ways of achieving stable crop yield with high quality. The developed measures are aimed to ensure stable crop productivity while reducing and significantly mitigating the negative impact of climate change. In other words, they should minimise possible risks for the agricultural industry.

Currently, Ukraine has well-developed elements of technology for each soil and climatic zone. Their precise implementation helps to obtain high yields of all crops, including cereals [4, 5]. At the same time, most agrotechnological practices are highly intensive and costly due to decreasing soil fertility, depletion of humus and nutrients, and weed infestation, etc. [6].

The problem of insufficient supply of organic matter to soils, deterioration of physical properties of soils, and increased compaction,

which in turn does not ensure sufficient precipitation and efficient use of moisture by plants, are particularly acute. In the Southern Steppe of Ukraine, moisture availability for crops is the first limiting factor that usually determines their yields. Sustainable crop yield is formed on irrigated land, where the moisture availability during the growing season is covered by irrigation. However, the sprinklered area has significantly decreased. The yield on irrigated land, and especially in dry years, is much higher than on rainfed land, however, grain grown without irrigation has higher quality. It is also well known that both yield and grain quality increase significantly with fertilisation, i.e. with improved plant nutrition [7–10]. In the Southern Steppe of Ukraine, research has shown that nitrogen fertilisation of winter wheat, depending on the date of application, increases yield by 0.61–0.89 t/ha and significantly improves the main grain quality indicators [11]. At the same time, the price of mineral fertilisers and other agricultural resources has risen, and they will be used in smaller and insufficient rates for plants. Under such conditions, the best predecessors [7, 12] and the most productive and adapted varieties to a particular zone should be selected [9, 13].

In 2020, the State Register of Plant Varieties Suitable for Dissemination in Ukraine includes about 430 varieties of winter wheat, including 120 (about 29 %) of foreign breeding. The main grain food crop is soft winter wheat. Its varieties differ in adaptive genetic properties and resistance to possible changes in biotic and abiotic factors. These features will help to form a sustainable productivity, maintain the genetic potential of varieties, and improve it both by breeding and by improving the agricultural technology, which include the sowing dates and rates [14, 15]. Sowing rates, in turn, depend on seed quality, germination, climate zone, variety, etc. [3, 15–17].

The varieties of Myronivka breeding are distinguished by their winter hardiness. The adaptive capacity of varieties is also determined by their resistance to drought, lodging, disease damage, etc. For this reason, farms with large areas of winter crops are recommended to grow 2–3 varieties with different properties and morphological

and biological traits, combining resistance to both critical low winter temperatures and drought.

Both variety characteristics and technology elements have a significant impact on the growth of winter wheat plants at all stages of organogenesis. In recent years, some wheat varieties, depending on the growing conditions, can manifest valuable quality traits as both winter and spring wheat [18]. According to the same authors, varieties with these characteristics respond less to sowing dates and slightly reduce grain productivity compared to typical winter wheat varieties. The above obliges farmers and scientists to carefully select both varieties and the essential technological elements and adapt them to climate change. In the face of increasing aridity and rising temperatures, one of the most important factors is the soil moisture accumulation and the creation of conditions for its efficient use by plants. This is achieved through plant density, leafiness, nutrition, etc. [10, 19, 20]. It is important to choose the most optimal combination of all components and technological elements [21, 22].

Materials and Methods. Over the years of the experiments, winter wheat varieties were grown on the fields of the Educational and Scientific-Practical Centre of Mykolaiv National Agrarian University. The soil phase is southern chernozem with an average supply of mobile nutrients (NPK) in the topsoil. The humus content is on average 3.0–3.3 %, water-physical and main soil structure parameters have optimal values for southern chernozem.

In the years of research, the weather conditions varied slightly in terms of temperature, precipitation and overwintering conditions. Generally, they were typical for the Southern Steppe of Ukraine. The driest years were 2007 and 2012, in which there was significantly less precipitation than long-term average, especially in 2007. The sum of positive temperatures did not significantly differ, and the precipitation amount during the growing season of winter crops in 2020–2021 was higher compared to the period of 2019–2020.

The zoned winter wheat varieties of well-known Ukrainian breeding institutions were grown. For determining the most optimal varieties of winter wheat, N₃₀ was applied backgroundly before sowing and at the beginning of growth resumption as foliar feeding in the demonstration

fields. Agrotechnical practices for growing the wheat varieties were generally accepted and recommended and developed for the research area [23, 24].

Results and Discussion. Over a long period of time (2007–2017), we studied the influence of the predecessor on the grain productivity of 5 varieties of soft winter wheat: Viktoriia Odeska, Selianka, Albatros Odeskyi, Kuialnyk, Khersonska 99. The studied varieties were planted after fallow, maize and stubble predecessor without the application of mineral fertilisers and against the fertiliser background. We found that, on average, grain yield of varieties over the 11-year period of cultivation on the extensive background of the fallow field was 4.04 t/ha. Grain yield fluctuations were significant depending on the growing conditions and predecessor, ranging from 1.28 (2007 after stubble predecessor) to 5.79 t/ha (2016 on fallow) in the most unfavourable and favourable years, respectively (Fig. 1). Grain yields with fertilizer application by fallow were 5.68 and 4.75 and 7.27 t/ha, respectively. With nutrition optimisation, the difference in yield levels formed in unfavourable years with insufficient precipitation and in years with more optimal moisture supply was noticeably levelled.

The grain yield of winter wheat varieties placed after maize and stubble predecessor also changed with a similar dependence. Yields were 3.19 and 3.17 t/ha without fertilisers, and 4.98 and 4.97 t/ha with fertiliser application, respectively. As shown in Figure 1, the levels of grain yield in relation to these predecessors were similar in the context of the most optimal and unfavourable years. It should also be noted that fertilisers increased grain productivity to a greater extent in years with insufficient precipitation compared to years with sufficient moisture content for all predecessors, and especially for non-fallow ones. This was determined by experiments with winter wheat and other crops [19], which is explained by significantly lower moisture consumption by fertilised plants due to better field shading.

A number of soft winter wheat varieties have been studied to compare their productivity by stem height, and it was found that short-stemmed varieties are capable of producing slightly higher yields (Fig. 2).

In 2020–2021, the average grain yield for

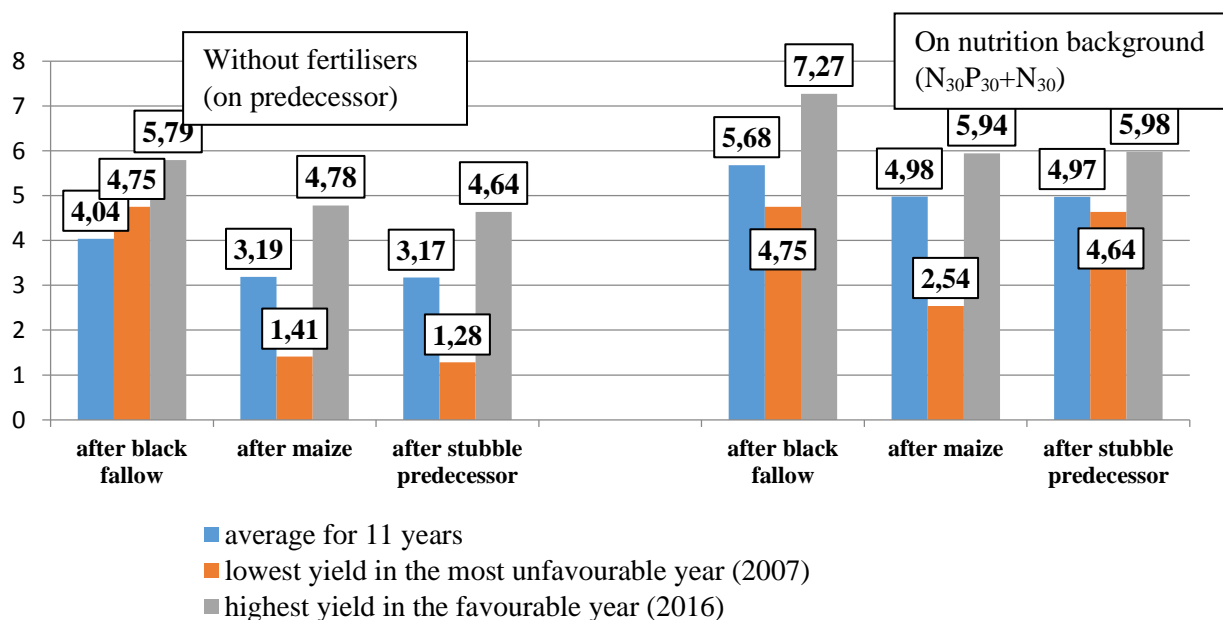


Fig. 1. Winter wheat grain yield under the influence of predecessor and nutrition background (average for 5 varieties of Steppe ecotype for 2007–2017), t/ha.

5 short-stemmed varieties was 6.28 t/ha, while for 12 medium-stemmed varieties it was lower - 5.44 t/ha. The fluctuations between the lowest and the highest levels ranged from 5.02 to 7.54 and 3.60 and 7.15 t/ha of grain, respectively. In our opinion, this was caused by a larger number of medium-stemmed varieties used in experiments, including varieties with low potential of productivity. In addition, the most productive varieties Smuhlianka and Chyhyrynka, which formed the

highest yield among the varieties of the studied groups, differed less in terms of productivity. Therefore, in our opinion, the selection of varietal composition by stem height is not entirely appropriate. Mainly, varieties should form a stable yield with high grain quality.

In recent years, our research has also confirmed that grain yields between winter wheat varieties of the Steppe and Forest-Steppe ecotypes have been levelling off (Table 1).

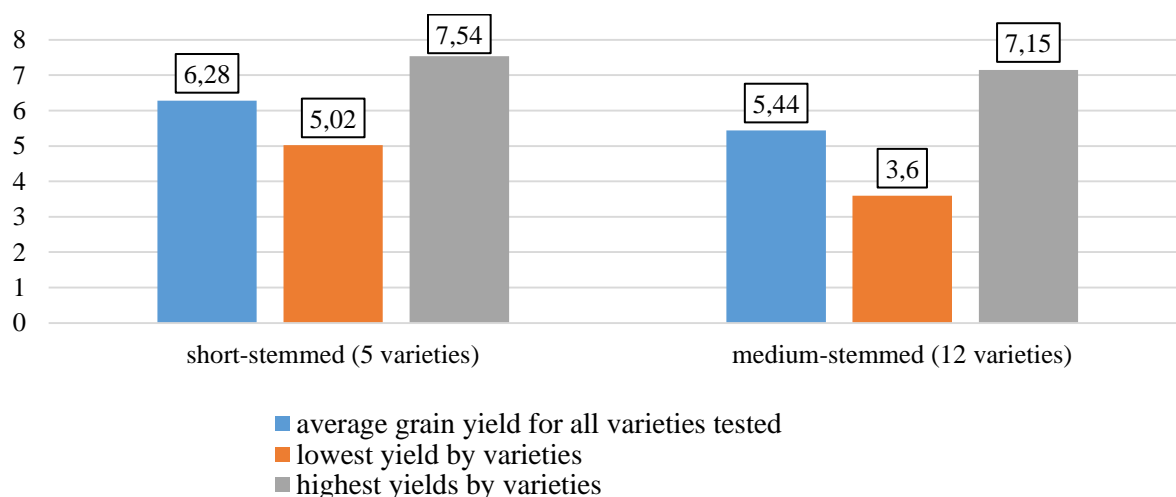


Fig. 2. Dependence of winter wheat grain yield on the stem height (average for 2020–2021), t/ha

Under the optimisation of the elements of cultivation technology, less studied varieties are capable to achieve high productivity, which does not change significantly under the influence of weather conditions. The deviations between the lowest and highest yields range from 0.75 to 1.04 t/ha for varieties of the Steppe ecotype and from 0.98 to 1.17 t/ha for the Forest-Steppe ecotype. In our

opinion, they all can be successfully grown in the Southern Steppe of Ukraine. The weather conditions in these regions are levelling out and the bred winter wheat varieties are capable to produce sustainable productivity. The primary challenge is to provide the plants with moisture and favourable nutrition conditions.

Conclusions. Ukrainian research institution

Table 1. Parameters of grain productivity of winter wheat by varieties depending on ecotype (2017–2021), t/ha

Variety	Grain yield, t/ha			
	average	maximum	minimum	deviations
Steppe ecotype				
Blaho	5.28	5.74	4.79	0.95
Kokhana	5.45	6.01	4.97	1.04
Ovidii	5.64	6.17	5.16	1.01
Khersonska 99	5.34	5.76	4.79	0.97
Pylypivka	5.28	5.69	4.74	0.95
Lastivka Odeska	5.43	5.98	5.23	0.75
Sluzhnytsia Odeska	5.42	5.96	5.08	0.88
Uzhunok	5.37	5.92	5.01	0.91
Average	5.40	5.90	4.97	0.93
Forest-Steppe ecotype				
Charodiika Bilotserkivska	5.31	5.81	4.83	0.98
Lisova Pisnia	5.57	6.03	5.01	1.02
Vidradna	5.63	6.21	5.04	1.17
Shchedra Nyva	5.59	6.23	5.24	0.99
Poliska 90	5.32	5.78	4.78	1.00
Artemida	5.24	5.67	4.65	1.02
Average	5.44	5.96	4.96	1.00

have developed a significant number of winter wheat varieties with high yield potential (5 t/ha and above) and high grain quality. Most of these varieties are adapted to the current climate change in the Southern Steppe of Ukraine. This is confirmed by the results of our research in 2019–2021.

Over the years of research (2007–2017), grain yield levels fluctuated significantly and depended on soil moisture reserves at the sowing period and precipitation during the growing season, nutrition optimisation, the predecessor, nutrients, etc. Studies conducted under conditions of reasonable crop rotation have determined that grain yields ranged from 4.75 to 5.79 t/ha for black fallow, and from 1.28 to 4.78 t/ha for non-fallow predecessors. On average, over the years of research, grain yield increased by 40.6 % for winter wheat after fallow, 56.1 % after maize, and

56.8 % after stubble. In years with unfavourable moisture conditions, the nutrition optimisation increase in yields was even more significant – 80.1 % or more. This indicates that yield levels significantly depend on the mineral fertiliser applied to wheat. The role of fertilisers increases to a greater extent on depleted predecessors - fields with insufficient nutrient supply and especially in unfavourable growing years.

High-yielding adapted varieties and adherence to recommended agricultural practices developed for the growing area, including optimisation of plant nutrition, will allow farms of different ownership forms to obtain consistent levels of winter wheat yields and ensure a high level of grain production. Variety and predecessor are the most resource-saving elements in winter wheat cultivation technology.

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Гамаюнова В. В.¹, Смірнова І. В.¹, Євтушенко О. Т.², Бакланова Т. В.² Ресурсоощадні елементи технології вирощування пшениці озимої як захід зерновиробництва.

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Актуальність. Україна відома в світі як виробник високоякісного зерна. Дійсно, потенціал його виробництва є досить потужним й особливо в південному регіоні. Стосується це всіх зернових культур і в першу чергу пшениці озимої. Разом з тим рівні врожаю зерна значною мірою залежать і коливаються за впливу багатьох факторів: забезпеченості рослин вологою у роки вирощування, агрофону живлення, добору сортового складу, способу і заходу обробітку ґрунту, захисту рослин, стану забур'яненості поля, інших факторів. Дрібниць у вирощуванні немає, адже чітке дотримання всіх необхідних вимог технології дозволить щорічно отримувати сталу продуктивність та забезпечення валового збору зерна. Це має виключно важливе значення як для власних потреб держави, так і для експорту. Нині в Україні через військові дії не на всіх полях та сільськогосподарських угіддях можливо успішно вирощувати рослинницьку продукцію. Це зобов'язує виробників впроваджувати раніше розроблені елементи технології й удосконалювати нові менш відомі та ресурсозберігаючі заходи. Останній аспект також набуває значущості у зв'язку послабленням економічної спроможності господарств, здорожчанням матеріальних ресурсів та певним зниженням родючості ґрунтів. За таких умов найбільш дієвим заходом є перегляд переліку сільськогосподарських культур, вирощування найбільш невибагливих до умов середовища, а в їх складі добору високо адаптованих до біотичних та абіотичних факторів середовища, сортів, які здатні проявити свої генетично запрограмовані біологічні та господарсько-цінні ознаки. **Мета.** Шляхом добору, залучення у виробництво нових сортів та удосконалення окремих елементів технології вирощування, можливо досягти істотного підвищення як урожайності зерна, так і поліпшення його якості. **Матеріали і методи.** Закладку і проведення польових дослідів здійснювали у відповідності з загальноприйнятою методикою дослідної справи. Експериментальну частину роботи виконували впродовж 2007–2021 рр. на науково-дослідному полі ННПЦ МНАУ. **Результати.** Визначено, що пшениця озима реагує на попередники та підвищує зернову продуктивність по фоні удобрення. Стосовно добору сортового складу пшениці озимої м'якої ряду селекційних установ України, які виведені в останні десятиріччя, встановлено, що більшість із них є адаптованими до вирощування в умовах Південного Степу України та здатні формувати сталий рівень врожаю. **Висновки.** Пшеницю озиму слід розміщувати за можливості по більш сприятливих попередниках, вносити помірну дозу мінеральних добрив та добирати найбільш продуктивні сорти, які найкраще проявляють себе в умовах зони вирощування і найменше реагують на зміну клімату.

Ключові слова: пшениця озима, добір адаптованих сортів, урожай зерно, погодно-кліматичні умови, елементи технології вирощування