

Полтавський державний аграрний університет

**ЯКІСТЬ ТА БЕЗПЕЧНІСТЬ ПРОДУКЦІЇ У ВНУТРІШНІЙ ЗА
ЗОВНІШНІЙ ТОРГІВЛІ Й ТОРГОВЕЛЬНЕ
ПІДПРИЄМНИЦТВО: СУЧАСНІ ВЕКТОРИ РОЗВИТКУ ТА
ПЕРСПЕКТИВИ**

Колективна монографія

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У колективній монографії представлені результати досліджень, які розкривають різні аспекти якості та безпечності продукції у сфері внутрішньої та зовнішньої торгівлі. Наукова новизна та комплексність проведеного дослідження виявляється у тому, що колективна монографія є частиною науково-дослідних тем «Якість і безпечність продукції у внутрішній і зовнішній торгівлі та торговельне підприємництво: сучасні вектори розвитку і перспективи» академії (номер державної реєстрації 0121U110650 від 18.04.2021 р.); «Формування стратегії еко-інноваційного розвитку виробництва органічної продукції як складової економічної та продовольчої безпеки України» (номер державної реєстрації 0119U103942 від 13.02.2019 р.) та дозволяє на основі обміну цінною і актуальною інформацією ефективно підійти до пошуку шляхів вирішення проблем якості та безпечності товарів і, як наслідок, до досягнення високих стандартів життя громадян України в цілому. Дане дослідження, безсумнівно, може бути корисним не тільки широкому колу науковців, викладачів, аспірантів і студентів, а також всім, хто цікавиться проблемами якості і безпечності продукції.

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EVALUATION OF SPRING COMMON WHEAT VARIETIES FOR ENVIRONMENTAL PLASTICITY AND GRAIN YIELD STABILITY

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***Annotation.** One of the main conditions for obtaining grain with higher yields is the introduction of new but most high-yielding varieties in production, which have increased winter hardiness, drought resistance, resistance to many diseases and pests, with high baking properties and good yield potential. The variety can show its high productivity and good quality only when the technology of its cultivation to the greatest extent corresponds to their biological characteristics. Comparative study, as well as new more high-yielding varieties of winter wheat and already studied remains relevant. Varieties in specific soil-climatic zones allow the most objective assessment of their relationship, to identify the most effective methods that will ensure higher and stable grain yields of good quality.*

Keywords: *spring wheat, varieties, ecological plasticity, productivity, stability of quality.*

Soft spring wheat is one of the food crops of Ukraine. It is cultivated in almost all regions of the country and is the basis of nutrition, processing of important products, and also constitutes the fodder base of animal husbandry. Sown areas of spring soft wheat occupy more than 40% of the total sown areas [1].

In Ukraine, more than 10 million tons of high-quality spring soft wheat grain is produced annually, however, periodically recurring drought and epiphytotic diseases in wet years are the main restraining factors for further production growth. Due to the cyclical nature of weather change processes, periodic analysis of meteorological data over a multi-year period in a specific region allows correcting the strategy of selection and selection of varieties [2].

Soft spring wheat as the main food crop is characterized by increased demands on the most important factors of the external environment, which are characterized by exceptional diversity, severity and variability in time and space. Therefore, selection faces extremely difficult tasks related to the objective assessment of varieties in extremely difficult climatic conditions [13].

A further increase in grain production is possible, mainly due to the growth of productivity and reduction of losses, including from diseases. Increasing and maximally using the adaptive potential of varieties is the main task of modern plant breeding, the solution of which is determined by the knowledge of the biological features manifested by the culture in specific environmental conditions [3].

Ecological testing at the final stages of the selection process allows to obtain a more objective assessment of the adaptive potential of the tested varieties [4-7].

In modern conditions, there is a shortage of wheat grain in the world, and humanity is once again facing an acute problem of food crisis. The annual production of wheat grain averages about 840 million tons. Meeting this need is a difficult task given that the world's sown area is declining and wheat yields in more developed countries have already reached a maximum, for example, in European countries is more than 8 t/ha. Variety is one of the cheapest and most affordable ways to increase yields. Without it, it is impossible to realize the achievements of scientific and technological progress in agriculture [6].

Producing the necessary volumes of high-quality food and feed grain is a strategic task of the agroindustrial complex at the present stage of food security and will be crucial for the world community in the future, as the annual population growth confirms the fact that many do not eat enough. and starves.

The purpose of the research is to evaluate new varieties of spring soft wheat in terms of ecological plasticity and grain yield stability. The wheat genus *Triticum* L. belongs to the bluegrass family (Poaceae Barnhart), or, according to the old classification, to the cereal family (Gramineae Juss). Among bread cereals, the genus *Triticum* L. is distinguished by the greatest polymorphism [4]. All types of wheat, and there are 27 of them, are divided into four groups according to the number of chromosomes, forming a polyploid series [4, 9].

The phylogeny of the genus *Triticum* was studied in detail using various methods: morphological, cytological, immunochemical, and electrophoretic [10]. Wheat, in the process of evolution with the assistance of man, received a huge variety in its species and varietal composition [12].

Currently, the system of the genus *Triticum* L., developed in the department of wheat VIR named after N.Y. Vavilov [1]. Among hexaploid wheat, common wheat (*T. aestivum* L.) is the most common. It is the main bread culture in many countries of the world. Wheat is soft, thanks to the variety of hereditary material, - one of the most plastic types of cultivated plants. The range of this species covers all the continents of the globe, it is grown in a wide variety of soil and climatic conditions [11].

The second period is the generative phase, during which the reproductive organs are formed: ears, spikelets, flowers, and grains [2]. The need of plants for

environmental factors in different periods of ontogenesis is different and depends on the genotype, temperature, water and light regimes, place of growth, soil and many other factors. The potential opportunities of the plant genotype are manifested the brighter the ecological factors meet its requirements, and it is not by chance that outstanding breeders have always attached great importance to various factors of the environment [6].

Natural selection, being a consequence of the environment, has a significant influence on the formation of the genotype of selected plants. "The deeper the research goes, the higher the requirements for selection become, the more attention must be paid to the relationship between the environment and the variety, the identification of individual varietal features in the sense of the requirements of agricultural technology, fertilization, selection of certain conditions and areas of culture" [13].

The selection of parental forms during hybridization is one of the decisive conditions for the success of any breeding program, therefore, this issue receives a lot of attention. The stronger and harsher the environmental conditions, the more important it is that one of the parent varieties during hybridization is adapted to specific conditions [2].

According to scientists, ecological plasticity of varieties is their ability to stably produce a high yield in a wide area and with a sufficient variety of weather and agrotechnical conditions [5].

The influence of environmental factors makes significant adjustments to the processes of growth and creation of the productive potential of plants. By their nature, extreme factors are different, and their action is differentiated into adaptive, damaging, and lethal. The stronger the "pressure" of the environment, the higher the plant's energy expenditure to maintain a stable level of its vital activity [2].

Resilience is understood as the ability to preserve and maintain the normal functioning of the body under the influence of extreme factors. Resistance is a genetically controlled inherited trait, characterized by the norm of the reaction of the genotype [3]. Realization of stability is manifested only in the case when the plant is under the influence of an extreme factor. Extreme temperatures, strong insolation, moisture deficit, excess of salts, etc. should be attributed to the main environmental influences, the action of which causes a response and reduces stability [2].

The problem of adaptation has always occupied a central place in evolutionary theory and especially in selection [1]. The term "adaptability" refers to the ability of an organism to adapt to one or another environment. Structural or functional changes in the organism that increase its vitality, survival, and rate of reproduction are called adaptive in population genetics [4]. Adaptability is

manifested through the acquisition of signs (adaptive) and adaptive functions that contribute to the adaptation of organisms to certain environmental conditions [1].

It is expedient to talk about adaptation only in relation to certain specific, both very general and special morphophysiological properties of the organisms in question [2]

Adaptation reflects the diversity of plant and phytocenosis relationships with the environment [5]. Adaptation may have a different character; Adaptation of the universal type is stable in the process of evolution, and therefore the organism constantly accumulates adapted features of wide significance [3]. Narrow ecological adaptability is characteristic of the optimal life activity of the organism in specific conditions of the external environment. Wide ecological adaptability shows high productivity in various agro-ecological zones and is of great interest in wheat culture.

Naturally periodic factors of the environment are distinguished: daily and seasonal changes in climatic conditions, the length of the day, which determine biological cycles. Adaptation to these conditions has an evolutionary origin. The manifestation of environmental factors is observed in the "genotype x environment" system.

At the same time, usually all factors are closely interrelated. Environmental factors or their combination act differently on plants in different phases of its ontogenesis, as well as depending on its vital state. The specificity of the environment depends on the method of reproduction and the genetic structure of the population. In agrocenosis, not only the interaction of "genotype x environment" takes place, but also the interaction of organisms with each other. At the same time, the action of one factor can be changed by another, but it cannot be replaced. However, a "compensation effect" can be observed with the complex action of the medium [3].

The amazing ability of biotic components of agroecosystems to adapt to varying environmental conditions is their main distinguishing feature. At the same time, the adaptive potential of each species is determined by modification and genotypic variability, the functional interrelationship of which at the level of heterozygotes and heterogeneous populations acts as the main mechanism of self-regulation of living systems.

Despite the universality of the main ways of adaptation of all living organisms, the adaptive potential of each species, which characterizes its ability to adapt in ontogenesis, reproduction, and genotypic variability, is specific and evolutionarily determined. A characteristic feature of the adaptive reactions of higher eukaryotes is their genetically determined integration, which significantly enhances the possibilities of their compensatory, synergistic, cumulative self-

regulation [6].

A living organism is a product of the environment and the ego's genotype. Ecologists define the environment as the result of all external influences affecting the organism. Numerous studies have proven the presence of specific reactions of specific organisms to specific environmental conditions [10]. Undoubtedly, the modern world production of plant-growing products is largely limited by unfavorable environmental conditions. One of the directions for the creation of new varieties uses the theoretical development of models of varieties with certain characteristics and properties corresponding to high levels of yield and its quality under given environmental conditions [17].

The second way is aimed at improving the conditions of growth and development of plants in the process of ontogenesis with the aim of obtaining a high-quality and high yield [18]. However, it should be noted that these directions are closely interconnected, as they are based on knowledge of the environment in which the plant grows and develops.

The concepts of "plasticity" and "stability" are often used to characterize the degree of response of a genotype or population to changes in environmental conditions [12].

Genotypes adapted in the conditions of the limit of environmental factors and weakly adapted in the unlimited conditions show approximately the same levels of productivity in different ecological zones, which characterizes them as stable. Genotypes that are weakly adapted under conditions of limited environmental factors and highly adapted under unlimited conditions behave as responsive to favorable environmental factors and are considered plastic [15].

Since the degree of reaction of genotypes to changing environmental conditions characterizes the properties of the variety - its plasticity and stability - in the implementation of the development of the trait, the concepts of plasticity and stability are used both in the genetic and in the agronomic sense.

The stability of the variety is an indicator of the stability of implementation or a certain phenotype in different environmental conditions. In a broad sense, a genotype that is so stabilized that a change in the environment does not affect the development of traits is considered stable, that is, the value of a trait in different environmental conditions does not differ from the average for the variety, from its genetic average [2].

In a narrow sense, stability is defined as the degree of stability of the implementation of the adaptive effect of the genotype and the environment or the degree of deviation of the form of the response to changes in the environmental conditions of a specific genotype from the average response of the entire system of studied genotypes [17].

For intensive technologies, varieties of new types are required, with the highest possible productivity in certain agrotechnological conditions. This gives an additional incentive to the development of the problem of the idiosyncrasy, or model of the variety. The second such incentive is the need to create plastic varieties with a relatively stable yield in years that differ sharply in terms of meteorological conditions.

Plasticity is the ability of a variety to give a high and stable yield in various growing conditions [11].

Modern agriculture needs to assess the efficiency of productive processes, the result of which is a certain yield and its components. Such an assessment will allow to better understand the main trends of improvement of varieties, and also gives the opportunity to choose for hybridization forms that differ in the level of individual processes according to the principle of mutual complementation [11].

Yield of agricultural crops, incl. grains, depends on many factors, among which the weather occupies a significant place. According to scientific institutes, weather conditions account for 44 to 55% of the total amplitude of yield fluctuations caused by the joint influence of many factors [9].

There is an opinion that the relationship between productivity and climate and weather weakens as the level of agricultural technology and general agricultural culture increases.

The main factor determining the level and stability of productivity is the nature of water and thermal regimes. Depending on them, the level of grain yield over the years either falls to 2-4 or rises to 15-20 t/ha [9].

In modern agriculture, the variety acts as an independent factor in increasing the yield and quality of any agricultural crop. Along with agricultural technology, it is crucial for obtaining high and stable yields. It is known that the introduction of more productive varieties into production increases the yield from 12.0 to 15.0% [18].

Analysis of correlation relationships and regression relationships between traits can be widely used in breeding.

Since the quantitative traits of plants are random values, the relationship between them can only be statistical or correlational in nature. At the same time, a certain value of one characteristic corresponds to several values of other characteristics [14].

Correlation coefficients (r) vary in the range from -1.00 to +1.00. A positive value indicates a joint increase in values, and a negative value indicates the opposite relationship [5].

The presence of correlations harmful to the researcher indicates that this contradiction can be resolved with the use of other genetic factors that contribute to

the fact that connections weaken or break. At the same time, the presence of positive correlations makes it possible, with the help of selection by one feature, to "pull" the related values of others to a new level [7].

A negative relationship was revealed between productivity and the length of the growing season [12]. Some authors did not find significant connections between these signs [8].

The relationship between plant height and productive tillering ($r=0.13$), the number of ears of corn ($r=0.17$) and grains in an ear ($r=0.19$) was very low, and with the harvesting index it was negative ($r=-0.05$). Between the number of productive stems on a plant and the number of grains on it, as well as their weight, an average positive relationship was revealed [14].

A significant correlation ($r = 0.74-0.81$) was revealed between the weight of grains per ear and their number [13].

Studies have established a positive correlation between the length of the stalks and the length of the inflorescence ($r=0.63$), the number of seeds in it ($r=0.40$) and the mass of seeds per ear ($r=0.27$).

A number of researchers [8, 11] established a strong correlation of seed productivity with the surface area of winter wheat leaves and their photosynthetic potential. The length and width of the flag leaf was highly correlated with the number of seeds in the ear [19].

The main reserve for increasing the yield of wheat and the efficiency of grain production as a whole is the creation and introduction into production of the latest high-yielding varieties that possess a complex of economically valuable traits and properties.

The selection strategy is aimed at creating varieties that form high productivity, possess high plasticity and adaptability to changes in environmental conditions. At the same time, new varieties must have comprehensive resistance to harmful environmental factors.

In breeding practice, they strive to create varieties with a complex of basic characteristics and properties close to the flawless type. Only similar varieties can occupy a worthy place in agricultural production [16].

However, not all varieties show themselves equally in the same cultivation conditions. Consequently, a differentiated approach to the selection of varieties in specific conditions is necessary. It is especially important at the present time, when many households cannot provide crops with a high agricultural background and plant protection complex. Therefore, it is quite obvious that farms with different economic levels also need different varieties [5].

It is known that in Ukraine, there is the annual yield shortfall because of the harmful effects of pathogens and pests is 12-14%. The most common and harmful

diseases of winter wheat are hard smut, septoria blight, powdery mildew, tan spot, or yellow spot. In recent years, the health situation in winter wheat crops on the territory of Ukraine has changed slightly. A number of factors contributed to this. Firstly, for several years in a row, there have been rather extreme conditions for the autumn sowing campaign: sowing in dry soil and lack of moisture during the emergence of winter crops.

Secondly an early renewal of vegetation, a gradual temperature increase, its sharp fluctuations during the day and spring frosts have been taking place throughout Ukraine in recent years. As a result, winter grain crops form additional stems in spring and due to this we have good yields. But weakening of plants at the initial stage and under spring extreme conditions leads to a weakening of crops and, as a consequence, to change of the usual phytopathological balance of pathogens [3].

Today, among the leaf spot of wheat, septoria blight takes one of the first places in terms of harmfulness and distribution and is one of the most progressive diseases in Europe and in the world. Septoria blight develops in two stages: anamorph *Septoria tritici*, teleomorph – *Mycosphaerella graminicola* (Fuckel) J. Schröt. In Cohn. All aboveground plant organs are affected. The first signs are observed on the coleoptile in the form of separate brown spots. The pathogen can affect an ear. The infection sources are plant residues, seedlings and seeds. The disease develops especially intensively under conditions of frequent precipitation, temperatures at a level of 20-25°C and moderate wind.

The incubation period range from 6 to 25 days depending on weather conditions. Insufficient moisture in spring and following summer months can reduce the spread of the disease. The potential yield losses can reach 15-50% depending on a level of the phytopathogen development [4-7]. The harmfulness of the disease is that significant changes in physiological and biochemical processes take place in the affected plant. The main indicators of yield structure are deteriorated under the influence of the disease.

The epidermis rises slightly in the center of the spot. In the future, the spots may grow in the longitudinal direction, acquiring the irregular shapes and color of the drying tissue. With a secondary infection of plants with conidia, dark brown oval spots are formed on the leaves, growing and leading to drying of the leaves. In addition to leaves, leaf sheaths, stems and spikelets can also be affected, where the symptoms are in the form of small dots or lines, do not grow. Increased attention to tan spot in recent decades has been connected with significant disease damage. The loss of grain during the epiphytotic development of the disease can reach 40-60%. This is due to a decrease in grain weight and a decrease in the number of grains in an ear [8].

Powdery mildew (*Blumeria graminis* (DC.) Speerf. sp. *Tritici* March) (teleomorph- asci with ascospores, anamorph - conidia) mainly affects winter wheat varieties with a high yield potential, as well as crops with high stem density. Visual signs of the disease appear at the early stages of organogenesis. Plants are affected at a temperature of 0 to 20°C and a relative humidity of 50-100%. The harmfulness is primarily manifested in a decrease of the assimilative surface of leaves and the destruction of chlorophyll. There is a direct impact on the effectiveness of photosynthesis in a plant. Bushiness and the number of productive shoots are reduced because of pathogenic effect on the plant. The intensive crops damage in autumn slows down the development of root system and plants overwinter poorly. In some years, the loss of plants in wheat crops due to the harmfulness of the disease is 15-30 % [9, 10].

Hard smut (*Tilletia tritici* Tul.) (teleomorph - teliospores, anamorph - basidiospores) is a widespread disease in winter wheat crops. The most disease symptoms appear at the beginning of the period of milky ripeness of grain. Signs of the disease are: slightly flattened ear of intense green color with a blue tint, spikelets in an ear unnaturally loosened, chaff is open.

The harm of hard smut is caused by a yield decrease, both as a result of the formation of spore mass instead of grain in an ear, and thinning of crops, because of the death of affected plants. Affected plants are usually lower in height than healthy plants due to shortening of internodes [11]. Concealed yield losses are caused by a 30-40 % decrease in the productivity of the aboveground part of the plant, a 15- 20 % reduction in the size of the stem and ear, compared with uninfected plants; fewer grains are formed in an ear by 10-15 % and the weight of 1000 grains decreases [11].

An important task in the breeding of soft winter wheat is to create varieties with comprehensive resistance to diseases and pests. Breeders use the theoretical achievements of immunologists to determine the mechanisms of plant resistance. The transfer of resistance genes in the breeding of new varieties and hybrids provides control over the resistance trait that does not require any chemical treatments.

And this, in turn, improves the environmental situation. The peculiarity of disease resistance selection is that new genotypes as donors can quickly lose this ability due to changes in virulence of pathogen and weather conditions [12].

Therefore, there is a need to constantly search for new sources of resistance to pathogens, which is relevant and requires further study of genofond. The effectiveness of breeding for immunity depends on the availability of comprehensively studied source material and a scientifically based approach to its use.

This is a relatively difficult task, as it is further complicated by the fact that the complex stability of varieties must be combined with maximum productivity, high grain quality, and other economically valuable characteristics [19].

When selecting for resistance to brown rust, it is necessary to select precocious varieties. They are not only drought-resistant, but in many cases they are less affected by brown rust, since the tissues of these plants physiologically age and are less affected by the mass formation of the disease [7].

Powdery mildew of wheat (*Blumeria graminis* (DC) Speer.) (*Erysiphe graminis* DC) order Erysiphales belongs to the number of extremely harmful diseases, especially when it manifests itself in the early stages of plant development. Crop failure due to powdery mildew can reach 10-15 %, and with epiphytotic development of the disease, it can reach 30-35 %. At the same time, the quality of the grain - the content of protein and starch - also decreases [16].

Along with this, in accordance with global trends, intensive technologies for the cultivation of grain crops are being actively implemented, which in turn contribute to the increase in the harmfulness of foliar diseases due to the microclimate created in the crops. The use of chemical means of plant protection, which are provided for in the technology, is connected not only with huge costs of funds, but also, most importantly, with a negative impact on the environment. At the same time, the chemical method does not always guarantee the expected result, and this, first of all, applies to rust diseases of grain crops [12].

Close attention of breeders to stem rust of wheat is caused by the high aggressiveness of this pathogen. A characteristic feature of this type of rust, unlike brown rust, is that it can almost completely destroy wheat crops. It is no accident that during the Cold War this pathogen was considered a biological weapon [9].

The main aspects of selection for long-term resistance of wheat to the most harmful pathogens are: implementation of constant control over the composition and degree of virulence of the population of pathogens; regulation of the use of donors with identical resistance genes by region. Conducting a constant search for new sources of resistance both among collection samples of various origins and among wild forms of wheat and its relatives; inclusion in the selection process of highly effective genes of race-specific resistance in combination with non-specific protection against the pathogen.

The process of host plant selection must be continuous with the use of modern biotechnology methods that accelerate it. It must be ahead of the "selection" of pathogens [2, 10], which every hour destroy a significant part of the areas of grain crops. The most effective and economical way to protect crops from drought is the breeding and cultivation of drought-resistant varieties [7].

In the conditions of drought, the increase in the rates of grain filling at the

final stages of ontogenesis is of particular interest. Visual selection for grain performance makes it possible to identify the most drought-resistant genotypes, especially during the rainy season, which is consistent with the data of researchers in other soil and climatic zones [10].

It is very important that in the conditions of an arid climate, varieties of spring soft wheat should form not only a high yield, but also have a high stability. The higher the stability, the smaller the yield fluctuations over the years [12].

From a physiological point of view, the increase in the yield of varieties in the arid zone depends on the work of the assimilation apparatus and a whole set of processes that determine the accumulation of biomass and its economically useful part, which is caused by more productive use of moisture [5].

An important feature in the selection of plants was and remains their productivity. Manifestation of productivity potential is determined by genetic information embedded in the plant cell and environmental conditions in which plants grow. Breeding for increased productivity is one of the most difficult tasks. According to existing estimates, the contribution of breeding to increasing productivity over the past decades is estimated at 30-70 %, and there is every reason to say that the role of this factor will invariably increase [4]

The yield of wheat depends not only on environmental factors, but also on cultivated varieties, due to the fact that plasticity and adaptability to various cultivation conditions are essential varietal characteristics that establish its productive stability [11].

The majority of researchers believe that varieties with high potential productivity are more sensitive to environmental stressors and are characterized by a significant amplitude of variability in the size and quality of the harvest in adverse environmental conditions. However, with the appearance of varieties of local selection, adapted to specific weather and climatic conditions, the coefficient of variation can decrease to 19.1–22.1 %. This confirms the conclusion that varieties of agricultural crops produce the highest yield, as a rule, where they are selected [5, 8].

For the successful implementation of the tasks of increasing grain production and improving its quality, not only the achievements of selection, but also the further intensification of grain farming, the acceleration of scientific and technical progress, and the rapid introduction of new varieties into production are important [7, 10].

Consequently, the spring wheat variety has now become the most important factor in the economic growth of agricultural production. The underestimation of the role of the variety in increasing the yield and quality of production is due to the fact that its advantages can be found in absolute measure only when the necessary

growing conditions are created. Only in the unity of the variety with technological conditions is ensured the growth of productivity and its stability [13].

High productivity corresponds to the optimal parameters of the main elements of the crop structure, which are formed in certain phenological phases and depend on the natural and climatic conditions of cultivation and the level of agricultural technology [2].

It was established that the elements of the structure are in a rather complex relationship with each other and are closely related to productivity. The number of grains in an ear and the weight of an ear of grain are of great importance in increasing the productivity of plants. The number of grains in an ear is of significant interest for selection and in most cases is of great importance in increasing grain yield. The mass of grain from an ear is the most important element of the crop structure. Both of these signs vary depending on the variety and environmental conditions.

The number of ears in an ear determines the potential productivity of the ear and depends on the genotype of the variety and the influence of various environmental factors. A clear connection between the length of the spike and the number of spikes in it was not revealed, since these signs, in turn, are closely related to the density of the spike.

A positive correlation was found between the yield and the number of grains in the ear ($r = + 0.53 \pm 0.09$). Correspondingly, between the yield and the weight of the ear of grain ($r = + 0.61 \pm 0.11$), between the yield and the weight of 1000 grains ($r = + 0.42 \pm 0.12$). The relationship between the length of the ear and the number of grains in the ear ($r = + 0.38 \pm 0.10$), between the length of the ear and the mass of the grain of the ear ($r = + 0.30 \pm 0.09$), the length of the ear and the mass of 1000 grains was also revealed. ($r = + 0.32 \pm 0.11$) [18].

With the gradual increase in grain production, the need for its quality increases. Achieving this goal is very problematic, due to the existing negative correlation between the size of the harvest and its quality. The correlation coefficients between grain mass per unit area, gluten and protein content on average across ecological and geographical groups of varieties were $r = -0.25$ and $r = -0.40$, respectively [3].

Wheat grain quality is a complex concept. It contains a number of features characterizing its nutritional value, flour milling and baking properties. For a more in-depth and objective assessment of grain quality, it is necessary to use a set of signs, the most important of which are the protein content, the nature and glassiness of the grain, the amount and quality of gluten, and the assessment of baking properties.

Protein quality is a genetic trait, but it also depends on certain conditions of

growth (amount of precipitation and air temperature during grain pouring). The protein content of wheat grain depends mainly on the climatic conditions of its cultivation and increases from west to east and from north to south in the European part of the country. The decisive role in protein biosynthesis in plants belongs to humidity and temperature of soil and soil air [12].

Gluten is the most valuable component of wheat grain, determining its nutritional, technological and commercial advantages. Research has determined that gluten is a protein substance that consists almost entirely of gliadin and glutenin, the ratio of which is approximately 1:1. It is known that glutenins consist of approximately 20% of subunits with high molecular weight and low sulfur content and 80% of subunits with low molecular weight and high sulfur content. Glutenin subunits with a high molecular weight play an important role in increasing the elasticity of gluten, and also influence the baking qualities of grain [17].

At the current stage of wheat breeding, significant progress has been made in increasing yield and preserving the quality of grain of adapted varieties. The active expansion of sown areas for this culture, the selection of varieties adapted to local growing conditions, the organization of seed production and the improvement of cultivation methods will contribute to the increase in the production of high-quality wheat grain throughout the country [19].

We conducted field research on soft spring wheat varieties at the "AF Urozhai" PSP, and quality indicators (physical and qualitative) in the PDAU Grain Quality Laboratory, placement of experiments, selection of soil samples for fertility analysis were performed in accordance with generally accepted methods [5].

Five varieties of soft spring wheat were sown for research: Ulyubena, Barvysta, Etude, Panyanka, Elegia Myronivska.

Field experiments, records and observations were carried out in accordance with the methodology of state variety testing of agricultural crops [13].

The predecessor is pure steam. The repetition of the experiment is four times, the placement of the plots in the repetitions is systematic. The plot area is 25 m².

The main and pre-sowing soil treatment was carried out in accordance with zonal recommendations.

Autumn processing after crop harvesting - flat-cut processing (KPG-250). In winter - snow retention (SVU-2.6). Spring processing - closing moisture by harrowing in two tracks (BZSS-1). Pre-sowing cultivation (KPS-4). Sowing - 2.3 decades of April. The sowing rate is 4.5 million similar seeds per hectare. Post-sowing rolling (ZKKSH - 6).

During the growing season, the following observations, records and analyzes were carried out:

1. Determination of sowing qualities of seeds in accordance with current standards for seeds and planting material of agricultural crops. Reproductive seeds that meet the requirements of GOST 52325-2005 were used for sowing.

2. All plants were removed, combining within the area into bundle samples, which were later used for laboratory analysis of the crop structure.

3. Harvest accounting was carried out by weighing the grain yield from each plot and simultaneously determining its moisture content.

The actual grain yield was determined by bringing the grain to a standard moisture content of 14 %.

Research methods described in the relevant standards and instructions were chosen to determine the quality indicators of the grain, in particular its physicochemical and biochemical properties.

Grain moisture was determined using a moisture meter in the field [13], moisture was determined in percent.

The natural mass of grain was determined according to DSTU 10840-82, in g/l [14].

The general vitrification was determined according to DSTU 10987-86 [1].

The mass of 1000 grains, after removal of garbage and grain impurities, was determined by the manual method [12].

The amount of gluten and its quality were determined in laboratory conditions (hand washing). The elastic properties of gluten were determined on the VDK-1 device.

The mass fraction of protein in the grain was determined by the Kjeldahl method [16], which is based on the combustion of organic components of the product sample in the Kjeldahl flask in the presence of sulfuric acid.

The released nitrogen was determined by titration and the protein content was calculated from its amount.

Parameters of ecological plasticity of varieties were calculated according to the method of S. A. Eberhart and B. A. Russell in the interpretation of V. A. Zykin and others, which made it possible to determine not only the plasticity of any genotype, but also its stability [6].

This method has sufficient simplicity of calculation and the possibility of biological interpretation of indicators, based on the calculation of the coefficient of linear regression (b_i), which characterizes the ecological plasticity of the variety, and the mean square deviation from the regression line (d_2), which determines the stability of the variety in various environmental conditions [17].

Statistical processing of experimental data was carried out using Microsoft

Office 2010, Statistics 20 programs [4].

Immunological evaluation of the degree and type of resistance of plants to brown and stem rust was carried out according to the international SIMMIT scale: R - resistant, TR - highly resistant, MR - moderately resistant, MS - moderately susceptible, M - overlapping (MR and MS), MSS - moderately susceptible, close to susceptible, S- susceptible (Appendix D) [18].

The duration of the growing season is important in the formation of the crop, since the growth and development of plants can proceed normally only under a certain set of external conditions [17].

In practical selection, the selection of varieties is carried out according to the duration of interphase periods with the aim of creating a variety that best suits the conditions of the region. At the same time, it is taken into account that the original parent pairs differed in the duration of phases: in one variety, one phase should be short, in the second, others. By selecting varieties with different durations of separate phases for crossing, it is possible to achieve a combination of the shortest of them and thus create an early-ripening variety [17].

The duration of the growing season is the most powerful factor in the adaptability of wheat and is important in the formation of the crop. To increase the stability of the harvest over the years and the effective organization of field work in the steppe zone, it is recommended to cultivate varieties of 3 maturity groups: early, mid-ripening, and late.

Vegetation period.

In experiments on ecological variety testing, the duration of the growing season in varieties of various maturity groups was on average: mid-early type (15% of the total number of samples) - 36 - 82 days. (lim. 76-92 days); medium-ripe (31% of the total number of samples) - 84 days. (lim. 76-95 days), 90-86 days. (lim. 79-95 days), -86 days. (lim. 80-96 days), 95-86 days. (lim. 78-99 days); mid-late (54% of the total number of samples) – 87 days. (lim. 79-98 days), 87 days. (lim. 81-98 days), 59-87 days. (80-100 days), -88 days. (lim. 81-98 days), 80-09 - 89 days. (lim. 81-103 days), 22 - 89 days. (lim. 81-104 days) 87 days. (lim. 80-98 days).

In the conditions of the forest-steppe, preference is given to medium-ripening and medium-late varieties with delayed development before the beginning of earing and an accelerated generative phase. Such forms of the ecological group, due to the slow rhythm of development in the period of sprouting - earing, tolerate the drought of the first half of the summer with less damage and use the sediments of the second half of the summer to a greater extent.

The expediency of combining varieties of different biotypes, differing in the vegetation period and other biological features, in crops is noted by many

researchers. This is a reliable way to increase gross grain harvests and its stability, especially in such regions with a sharply continental climate that is unstable over the years.

Yield and ecological plasticity.

The analysis of the meteorological results of the variety test on yield and its variability over the years indicate that spring soft wheat varieties should be distinguished by drought resistance and good responsiveness to increased moisture availability in favorable years. The strong variability of grain yield (23.3-44.2 %) of spring soft wheat varieties included in the state register of breeding achievements indicates the importance of the direction of selection to increase the plasticity of new varieties and the stability of their harvest over the years.

Increasing the yield potential of wheat has always been and remains fundamentally important in breeding programs. High and stable yield can be achieved by combining high potential productivity and resistance to adverse environmental factors in the genotype [13].

Grain yield is an integral feature. Ultimately, it is determined by the number of fruit-bearing stems per unit area and the productivity of the ear. The main condition for the formation of the optimal number of ears in a high-yield crop is a certain number of plants per unit area, which depends on the sowing norms accepted in the zone, field germination of seeds and plant survival during the growing season. Field germination is influenced by factors, among which the quality of the seed material, resistance to pathogenic microorganisms and adverse environmental factors are the most important [16].

To reveal the relative fate of variability taking into account two factors (varieties, years), a two-factor dispersion analysis of grain yield of soft spring wheat varieties over five years was conducted.

One of the most important modern tasks of agriculture is the selection of varieties that are stable in yield and suitable for cultivation in various soil and climatic conditions of the region. For this, it is necessary to carry out research and assessment of the productivity and yield of varieties of spring soft wheat in ecological zones that differ in terms of soil, climate and agrotechnological conditions of cultivation. In favorable conditions, preference should be given to varieties with high potential productivity, while in unfavorable and extreme conditions, the latter should be combined with sufficiently high environmental stability.

The phenotypic reaction of the studied varieties of spring soft wheat to various environmental conditions allows judging the adaptability and stability of the plant genotype and is defined as ecological plasticity. The main parameter for determining the ecological plasticity of the variety is the grain yield, as the final

indicator of the complex productivity of the plant.

The essence and mechanism of ecological plasticity is of paramount importance in the implementation of selection programs. Many leading breeders attached great importance to ecological plasticity in their research. In his theoretical works, N. I. Vavilov emphasized that the variety should be as plastic as possible, especially in the conditions of our unstable continental climate [5, 19].

For agricultural production, the most valuable will be plastic varieties that have a higher average level of productivity and a smaller range of fluctuating characteristics in changing growing conditions [6].

Varieties whose productivity is characterized by an average high value, a regression coefficient (b_i) close to or greater than 1, and a stability index (d_2) close to 0 belong to the group of varieties that react significantly to changes in environmental conditions. This group of varieties, the most demanding of the high agro background, belongs to the more intensive type.

Formation of the structure of the soft spring wheat crop depending on the variety

Elements of productivity - values are not constant. They can change depending on soil and climate, agrotechnical and other conditions. This is evidenced by the data of our research [13].

The number of grains in an ear varies from year to year depending on the difficult weather conditions during their formation.

A sharp decrease in the number of grains in a wheat ear was noted in dry years, when atmospheric drought is combined with an insufficient amount of moisture in the soil [3].

On soils after steaming, due to their better hydration, plants usually lay a larger number of spikelets and grains in a spike, compared to grain predecessors. However, in years with a very strong June drought, steam also quickly loses its advantage in terms of moisture reserves in the arable layer of the soil or is even inferior to it, which has a negative effect on the seeding of the ear. The reason for this can also be unbalanced nitrogen-phosphorus nutrition of wheat crops [2].

A significant dependence was found between the size of the ear and the term of its formation [16]. In late-ripening varieties of spring wheat, ear formation occurs when the plants have 5-7 leaves, and in early-ripening varieties, 3-4 leaves, due to which, other things being equal, late-ripening varieties form larger ears.

The beginning of ear formation in most varieties coincides with the end of tillering. Strong, stretched tillering in spring wheat delays the differentiation of the ear, reduces its length and the number of grains in the ear. In some cases, with a negative impact, it can be equated to drought [3].

Conducting research on wheat varieties, the number of grains in an ear in

2019 was the lowest in the Etude and Ulyubena varieties and amounted to 29.0 and 29.1 pcs, respectively. grains Panyanka and Barvysta varieties in 2019 did not exceed 32.1 grains. The variety Elegia Myronivska stood out with the largest number of grains - 33.1 pcs.

The year 2021 was also at the level of 2019 in terms of the number of grains in an ear. The largest amount was allocated to the Barvysta variety - 31.1 pcs., Ulybnena and Elegia Myronivska varieties - 30.2 pcs., and the smallest from the Panyanka variety - 28.1 pcs.

The year 2020 stood out the most in terms of the number of grains in an ear. We observe the best results in Etude varieties - 36.1 pcs., Barvysta - 35.2 pcs., Elegy Myronivska - 35.0 pcs.

The Ulyubena variety had slightly worse indicators and amounted to 31.0 pcs., and the Panyanka variety - 34.2 pcs.

According to the average data by year, it is possible to single out the Barvysta variety (33.1 pcs.) and the Etude and Elegia Myronivska varieties with an indicator of 32.1 pcs.

The weight of an ear of grain is an integral feature of such structures as length, the number of spikelets and grains in an ear, the weight of 1000 grains and is determined by many genes with different types of interaction. In breeding practice, one of the central places was always assigned to the mass of the ear of corn. Selection by ear is the main principle of work of many breeders [4].

The indicator of grain mass from the ear was the highest in 2020 and ranged from 2.31 g in the Ulybnena variety to 2.91 g in the Etude variety, according to the years of research.

Barvysta, Panyanka and Elegia Myronivska varieties had an indicator of the mass of grains per ear in the range of 2.54 - 2.63 g.

The mass of grains from the cob in 2021 was somewhat lower compared to 2020. The Etude variety stands out with the largest weight of grains - 2.38 g, and the Panyanka variety - 2.33 g.

The lowest indicator of the mass of grains from an ear of corn was in 2019, which was significantly influenced by weather and climate conditions. The favorite variety is 1.98 g (the smallest) and the Barvysta variety is 2.32 g (the largest).

According to the average data for the years, the Etude variety was singled out as the best indicator in terms of the mass of grains from an ear of corn - 2.43 g, and Elegia Myronivska - 2.40 g.

From the selection point of view, traits that vary less under the influence of environmental conditions are of great importance. These include, first of all, the weight of 1000 grains, which is a reliable indicator when selecting for yield.

It was found that the weight of 1000 grains of wheat plants decreased on

saline soil [3].

The accompanying conditions of the "earing - ripening" period significantly affect the mass of 1000 grains, but the moisture of the deep layers of the soil is more important than the precipitation at this time.

The weight of 1,000 grains depends both on environmental factors and on the biological characteristics of the variety, as a result of which it can vary widely. The correlation between the mass of 1000 grains and the productivity of the ear in different maturity groups of varieties varies depending on agrometeorological conditions [8].

The year 2019 did not have a big difference in terms of spring wheat varieties and ranged from 36.8 g (Ulyubena variety) to 39.0 g (Elegy Myronivska variety). The Barvysta variety exceeded the Ulyubena variety by 1.0 g, the Panyanka variety exceeded it by 1.6 g. The Etyud variety showed a low weight of 1000 grains - 35.1 g.

Examining the data obtained in 2020, the varieties Elegia Mironivska – 44.1 g and Panyanka – 43.1 g were distinguished by the largest weight of 1000 grains. The weight of 1000 grains was 4.0 g less in the variety Ulyubena and by 2.9 g in the variety Varvysta (in comparison with Myroniv Elegy).

The mass index of 1000 grains in 2021 was from 37.0 g (Etude variety) to 42.0 (Elegy Myronivska variety).

According to average data, the varieties Panyanka and Elegia Myronivska had the largest mass of 1000 grains, 40.9 and 41.7 g, respectively. Barvysta varieties had slightly lower values - 39.7 g, Ulybnena - 38.4 g, and Etude variety - 37.1 g.

Wheat yield is the amount of grain obtained from one hectare as a result of the vital activity of a certain set of plants, which consists in the assimilation of nutrients and water from the soil and the synthesis of organic substances under the influence of solar energy [4].

Grain yield is an integral feature. In the end, it is determined by the number of fruit-bearing stems per unit area and the productivity of the ear. The main condition for the formation of the optimal number of classes in high-yield sowing is a certain number of plants per unit area, which depends on the sowing norms adopted in the zone, the field germination of seeds and the survival of plants during the growing season [13].

Field germination is influenced by factors, among which the quality of the seed material, resistance to pathogenic microorganisms and adverse environmental factors are most important [16].

The yield of soft winter wheat varieties in the years of research differed both by year and by variety.

The year 2019 was distinguished by the yield of the Elegy Myronivska variety - 5.09 t/ha. Other varieties had somewhat lower yields. The Etude variety is 4.91 t/ha, which is 1.0 t/ha less compared to the Elegy Myronivska variety. The Barvysta variety had the lowest yield among all other varieties - 4.38 t/ha.

As you can see, in 2020 the yield was the highest. Elegy Myronivska varieties - 5.84 t/ha and Etude variety - 5.31 t/ha were selected as the best in terms of yield. Other varieties had a slightly lower yield compared to the selected ones.

In 2021, the yield of the Beloved variety was 4.32 t/ha, which is 0.7 t/ha less than the Etude variety, and 1.2 t/ha less than the Elegia Myronivska variety. The Panyanka variety exceeded the Barvysta variety by 0.4 t/ha and the Ulybena variety by 0.5 t/ha.

According to the average yields, the Elegia Myronivska variety and the Etude variety had the highest yield compared to other varieties. The varieties Ulyubena (4.48 t/ha) and the Barvysta variety 4.58 t/ha have the lowest yield.

The influence of the ecological variety on the formation of physical and quality indicators of soft spring wheat

Wheat grain quality is a complex concept. It contains a number of features characterizing its nutritional value, flour-milling and bread-making properties [13].

From the physical indicators of grain quality, we determined the vitreousness and nature of the grain. These indicators are included in the standard of Ukraine, which are required to determine the class of grain.

In 2019, there were no big differences in the nature of grain by variety. The largest was in the Ulyubena variety - 775 g/l Panyanka 770 g/l. the nature of the Barvysta and Etude varieties was 15 g/l lower and amounted to 760 g/l.

In 2019, the Elegia Myronivska variety had the lowest grain content - 745 g/l. The highest indicators of nature by year were in 2020. They ranged from 760 g/l (Elegy Myronivska variety) to 760 g/l (Barvysta and Etude varieties). In the Panyanka variety - 800 g/l. the high nature of the grain characterizes the grain as small-seeded.

The nature of grain in 2021 did not differ significantly by grade and was within 750-785 g/l.

According to the average indicators, the nature of the grain was the highest in the Panyanka variety – 783 g/l, the lowest was the Elegia Myronivska variety - 752 g/l. According to the indicator of vitrification, all varieties had no significant changes over the years. It ranged from 79 % in the Etude variety in 2019 to 93 % in the Elegy Myronivska variety in 2020.

According to average data, vitrification was in the range of 82-89 %.

One of the main indicators of the quality of wheat grain, which is closely related not only to the nutritional value of bread, but also to the technological and flour-milling and baking qualities, is the protein content in the grain.

Gluten is the most valuable constituent part of wheat grain, which determines its nutritional, technological and commercial qualities. The content of protein and gluten in wheat depends mainly on climatic conditions.

The decisive role in the biosynthesis of protein and gluten in plants belongs to the humidity and temperature of the soil and ground air [2].

According to the average data of 2019-2021, the gluten content was from 27.1 % (Barvysta variety), 0.8 % higher gluten content in the Etude variety, 2.3-2.2 % more in the Panyanka and Elegia Myronivska varieties, and the largest in the variety Ulyubena 31.5 %.

According to the quality indicator, all wheat varieties belong to the second group. The quality of gluten is from 88 to 100 units. of the VDK device.

Wheat grain proteins are the structural framework for the creation of gluten, and also determine the nutritional value of the final products. The protein content of wheat grains depends mainly on climatic conditions. The decisive role in the biosynthesis of protein in plants belongs to the humidity and temperature of the soil and soil air [5].

The protein content of wheat grains by varieties ranged from 12.8 % in the Barvysta variety (which is the smallest) to 14.6 %, the highest in the Elegia Myronivska variety. The protein content of the Etude variety is 0.2 % lower (compared to Elegia Myronivska), and the Panyanka variety is 0.6 % lower.

Disease resistance. The existing set of spring wheat varieties cultivated in Western Siberia does not fully meet production requirements, especially in terms of resistance to brown rust, stem rust and other diseases. Losses of grain during the development of epiphytotic brown rust amount to at least 30 % or more than 2 million tons of grain annually [9].

Most often, spring wheat is affected by fungal diseases: brown rust, powdery mildew, powdery mildew and others. All over the world, grain yield losses due to diseases are extremely large and amount to about 35 % [4, 12].

It was established that the productivity of plants decreased in proportion to the increase in the prevalence of both brown and stem rust. Despite the fact that all studied varieties have different values of complex resistance to leaf stem diseases common in the region, and form a strong and valuable grain [7].

Studies and practice have shown that in years with favorable moisture availability, crop losses are up to 30 % or more when brown rust is epiphytotic.

The results of the conducted studies testify to the existing problem of creating varieties resistant to brown and stem rust, only two new varieties had group resistance to brown and stem rust.

1. The need to create plastic and stable varieties is confirmed by data on the high variability of grain yield (coefficient of variation of 23.3-44.2 %) in varieties of spring soft wheat, included in the register of breeding achievements, periodic alternation of dry and favorable years in terms of moisture supply (up to 47 % dry years to varying degrees).

2. According to the parameters of ecological plasticity and grain yield stability, among the studied varieties of spring soft wheat according to maturity groups, the following stand out: medium-early Barvysta ($b_i=0.97$; $\sigma_d^2=0.07$); medium-ripe – Etude ($b_i=0.98$; $\sigma_d^2=0.04$); mid-late – Elegy of Myronivska ($b_i=1.18$; $\sigma_d^2=0.02$), Panyanka ($b_i=1.06$; $\sigma_d^2=0.10$), Beloved ($b_i=1.17$; $\sigma_d^2=0.08$).

3. The grain yield of the studied varieties of spring soft wheat was reliably associated with: field germination ($r=0.55-0.73$), weight of grain in the ear ($r=0.69$), weight of 1000 grains ($r=0.50$) and the number of grains in an ear ($r=0.56$). The selection of breeding material with greater expression of the above-mentioned characteristics will help increase the yield of the varieties created in the steppe zone.

4. Resistance to brown rust was shown by Etyud and Panyanka varieties. Barvysta and Ulyubena varieties differ in group resistance to brown and stem rust.

5. The highest amount of protein and gluten was found in Barvysta and Etude varieties.

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