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QUALITY OF SPRING WHEAT GRAIN VARIETIES UNDER APPLICATION OF MINERAL NUTRITION ELEMENTS

The article is dedicated to the research of qualitative (technological) indicators of spring wheat grain of different varieties under application of mineral nutrition elements.
It was found that during the years of research, yield of early-ripening and medium-ripening varieties of spring wheat was ensured by calculated rates at the level of 4–5 t/ha, however, yield of early-ripening varieties was lower than planned under the conditions of a dry year. Uliublena variety, among the early-ripening varieties, and Struna Myronivska as a medium-ripening variety reacted better to the application of mineral nutrition elements.
Calculation of the variation of the weight of 1000 grains depending on the influence of the variety and variants showed that the share of the variety influence changed from 52.5% in 2021 to 72.6% in 2022, and the share of the influence of fertilizer backgrounds – from 0.3% in 2021 to 6.6% in 2022. The weight of 1000 grains of all productivity elements was most strongly related to yield (r = 0.337 in 2021; r = 0.553 in 2022).
Medium-ripening varieties formed grain with a higher nature indicator compared to early-ripening ones. A reasonable influence of the research variants on grain nature was not found.
The level of gluten content in grain was quite high during the research years: 28.9–32.2% in early-ripening varieties and 25.8–26.5% in medium-ripening ones.
Nitrogen fertilization contributed to the growth of gluten content, and varieties reacted ambiguously. Barvysta variety showed itself best with combined application of nitrogen and Kristalon, varieties of Uliublena and Elehiia Myronivska – under fractional application of nitrogen, and Struna Myronivska variety did not react to nitrogen fertilization. Early-ripening varieties of spring wheat showed themselves best in terms of protein content in grain. The greatest differences between these groups of varieties were found in the variant with a fertilizer rate of 3 t/ha, regardless of the variety.
Key words: *spring wheat, mineral nutrition, technological indicators.*

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ЯКІСТЬ ЗЕРНА СОРТІВ ПШЕНИЦІ ЯРОЇ ЗА УМОВ ВНЕСЕННЯ ЕЛЕМЕНТІВ МІНЕРАЛЬНОГО ЖИВЛЕННЯ

Стаття присвячена дослідженням якісних (технологічних) показників зерна різних сортів пшениці ярої за умов внесення елементів мінерального живлення.
Встановлено, що в досліджувані роки врожайність ранньостиглих та середньостиглих сортів пшениці ярої забезпечувалась розрахунковими нормами на рівні 4–5 т/га, однак урожайність ранньостиглих сортів була нижчою за планову через умови посушливого року. Серед ранньостиглих сортів краще реагував на внесення елементів мінерального живлення сорт Улюблена, середньостиглих – Струна Миронівська.
Розрахунок варіювання маси 1000 зерен залежно від впливу сорту та варіантів показав, що частка впливу сорту варіювала від 52,5% у 2021 році до 72,6% у 2022 році, а частка впливу фонів добрив – від 0,3% 2021 р. до 6,6% у 2022 році. Маса

1000 зерен з усіх елементів продуктивності була найбільш пов'язана з урожайністю (у 2021 році r = 0,337; у 2022 році r = 0,553).
Середньостиглі сорти формували зерно з більш високим показником натури порівняно з ранньостиглими. Закономірного впливу варіантів досвіду на натуру зерна не виявлено.
Рівень вмісту клейковини в зерні був досить високим за роки дослідження: 28,9–32,2% у ранньостиглих сортів та 25,8–26,5% у середньостиглих.
Азотні підживлення сприяли зростанню вмісту клейковини, причому сорти реагували неоднозначно. Сорт Барвиста найкраще проявив себе за спільного внесення азоту та Кристалону, сорти Улюблена та Елегія Миронівська за дробного внесення азоту, а сорт Струна Миронівська не реагував на азотні підживлення. За вмістом білка у зерні найкраще проявили себе ранньостиглі сорти пшениці ярої. Найбільші відмінності між цими групами сортів виявлено у варіанті з нормою добрив на 3 т/га незалежно від сорту.
Ключові слова: *пшениця яра, мінеральне живлення, технологічні показники.*

Formulation of the problem. Wheat in terms of food importance and production scale occupies a prominent place in the world. Grain production of this crop on all continents is 615 million tons. Five countries: Canada, the USA, China, India and Ukraine account for about half of wheat grain production.

Wheat grain contains: protein – 16.8%, nitrogen-free extractive substances (mainly starch) – 63.8%, gluten – 2%, fat – 2%, ash – 1.8%, water – 13.6%, as well as enzymes and vitamins (group B and provitamin A).

Variety is one of the main factors in the sustainable production of spring wheat grain. First of all, strong and valuable varieties, which are characterized by high potential yield, good reaction to fertilizers and changes in technology elements, complex resistance to adverse factors, which produce grain corresponding to high classes of the national standard, are grown.

Practice shows that not all varieties fully realize their productivity potential in the same way under the same cultivation conditions. For example, high-yielding varieties take a large amount of nutrients from the soil, use a lot of water, so such varieties are often more demanding of intensive elements of technology. If there are no such conditions, then a potentially more productive variety not only give decrease, but may forgo in terms of yield to another less productive, but also less demanding of growing conditions of the variety.

Increase in the production of high-quality food grain wheat is one of the leading problems of agro-industrial complex of the country. Correct combination of early-ripening and medium-ripening varieties in the sowing structure, rational use of mineral fertilizers and the possibility of controlling protein content in grain by applying nitrogen fertilizers in the late stages of wheat development have important value for sustainable production of high-quality food grain.

Analysis of recent research and publications. Grain quality is a complex concept that includes a large number of indicators. High-quality grain must meet certain requirements: it must be healthy, sufficiently hard, glass-like, filled, have a certain nature indicator, good flour-milling properties, contain a sufficient amount of protein substances, primarily gluten.

Nutrition conditions and moisture availability of crops affect not only the amount of yield, but also the quality of grain.

The problem of increasing and stabilizing the production of high-quality spring wheat grain was and remains relevant. The concept of "grain quality" must be considered in two aspects: firstly, from the point of view of nutritional value, which depends on the content and quality of protein; secondly, as an expression of its technological advantages – suitability of grain for bread production [1–3].

There are two main ways to improve wheat quality – selective, related to selection of new varieties of high-quality wheat, and agrotechnical. It is important that new high-productive varieties reveal their valuable properties only against the background of high agricultural technology [2]. Protein content in wheat grain not only increases, but also its fractional and amino acid composition improves, therefore the baking quality of the flour increases under the correct fertilization system.

In the conditions of intensification of agricultural production, optimization of mineral nutrition of plants, which ensures the full realization of the genetic potential of the variety and obtaining the maximum possible yield with the specified indicators of product quality, is considered one of the most important tasks [4]. The most effective factors for regulating mineral nutrition of plants include a fertilizer system developed in crop rotations for specific soil-and-climatic conditions. Nitrogen fertilizers, especially on soils with a higher content of phosphorus and potassium, take a special place in a fertilizer system.

The use of fertilizers for spring wheat has a decisive effect on increasing its yield, since most soils in all areas of the country have low reserves of available nutrients, insufficient to create a high yield. Almost everywhere, it is necessary to apply fertilizers in optimal proportions and doses taking into account the properties of soils, previous crops, climatic conditions, etc. [5–6].

Nitrogen is the most important element that is a part of proteins, nucleic acids, chlorophyll and other cell compounds. Wheat begins to absorb it from the first days after germination, and the high need for it remains until the milky ripeness of grain.

It is important to ensure sufficient supply of the plants with nitrogen throughout a growing season in order to obtain high-quality grain. Pre-sowing application of nitrogen in normal rates slightly improves grain quality. Fertilizers, especially at low rates, are used by the plant in the initial periods of growth, but it is lacking in the period of grain filling. Nitrogen deficiency in the late stages of spring wheat growth leads to worsening of a number of technological qualities: nature, glass-likeness, gluten [7–9].

Flour-milling and bread-making qualities of spring wheat grain are largely related to the hereditary properties of the varieties and are largely determined by the hydrothermal conditions of the growing season. A number of technological qualities is improved with increasing the content of protein in grain. In combination of available data on the effect of fertilizers on grain quality, it can be concluded that only nitrogen has a direct effect on protein content in grain among the elements of mineral nutrition. Other macro- and microelements are necessary for plants to form yield, but the percentage of protein content in grain almost does not change at the same time [3].

An increase in each of the elements separately and instead of a sufficient content of other elements or an increase in the rate of all three elements at the same time has little effect on yield, but leads to a sharp increase in protein content in all cases when the rate of nitrogen increases [7: 10].

Researches of many scientists note the ambiguous reaction of different varieties of grain crops to the application of fertilizers [11]. Among the wheat varieties, there are more sensitive to nitrogen, depending on belonging to the ripeness group, features of the development of the root system and photosynthetic activity. Increasing the yield and grain quality of spring wheat is largely related to the influence of fertilizers. At the same time, there is a number of conditions and factors that strengthen or restrain this influence.

The purpose of the research is to study the productivity of early-ripening and medium-ripening varieties of spring wheat at different levels of mineral nutrition.

Research methodology. Research on the influence of the elements of mineral nutrition on the productivity and grain quality of spring wheat was conducted in the scientific-and-research laboratory of the Department of Food Technologies of Uman National University of Horticulture during 2021–2022.

Variants of the research included the study of rates of mineral fertilizers based on the planned yield, as well as fractional application of nitrogen fertilizers before sowing and fertilizing in the earing phase (variant 4). Kristalon which is recommended to increase the coefficient of nitrogen absorption by plants was applied together with ammonium nitrate as a nitrogen fertilizer in the tank mixture.

Scheme of the experiment was as follows: 1. Control (without fertilizers); 2. NPK of 3.0 t/ha; 3. NPK of 4.0 t/ha; 4. NPK of 4.0 t/ha, including nitrogen fertilization N30 (earing phase); 5. NPK of 4.0 t/ha, including nitrogen fertilization N30 (earing phase) + Kristalon, 1 kg/ha (earing phase).

Fertilizer rates were calculated using the balance method for the planned wheat yield. In variants 2 and 3, fertilizers were applied at one time (before sowing), and in variants 4 and 5 – 30 kg a.s. of nitrogen from the general rate were applied as top dressing during the earing phase. In the fifth variant, fertilizing with ammonium nitrate and Kristalon preparation was carried out in the earing phase.

The objects of the research were early-ripening varieties of spring wheat as Barvysta and Uliublena, as well as medium-ripening varieties – Elehiia Myronivska and Struna Myronivska.

In the post-harvest period, determination of the following technological qualities of grain were carried out: moisture – DSTU GOST 29144:2009; weight of 1000 grains – GOST 10842-89; nature – DSTU GOST 10840:2019; mass ratio of gluten and its quality – according to DSTU ISO 5531:2004; protein content – according to GOST 10846-74. When conducting statistical processing of experimental data, standard software packages StatSoft Statistica 13.3.7.704.19 and Microsoft Excel were used.

Table 1

Yield of spring wheat varieties, t/ha

Variety	Research year	Control	NPK of 3 t/ha	NPK of 4 t/ha	NPK of 4 t/ha + N	NPK of 4 t/ha + N + K
Barvysta	2021	1.84	1.45	1.54	1.46	1.63
	2022	3.08	4.55	5.53	4.83	5.19
	average	2.46	3.00	3.04	3.15	3.41
Uliublena	2021	1.80	1.98	1.96	1.92	1.92
	2022	5.05	5.40	5.38	5.27	5.18
	average	3.34	3.19	3.67	3.60	3.55
Elehiia Myronivska	2021	2.53	2.84	2.71	2.81	2.68
	2022	3.51	5.23	5.35	4.98	5.09
	average	3.02	4.04	4.03	3.90	3.88
Struna Myronivska	2021	2.58	2.81	2.58	2.71	2.65
	2022	3.47	5.74	6.38	5.77	6.00
	average	4.32	4.28	4.48	4.24	4.33
LSD_{05}		0.52				

Main results of the research. Yield of spring wheat grain is an indicator that is a combination of many economic and biological features and properties of plants. Analyzing obtained data (Table 1), we can say that the yield of all varieties was reduced in 2021 precisely because of the weather conditions.

Early-ripening varieties suffered the most due to lack of moisture. Yield of Barvysta variety in all variants with the use of mineral fertilizers was lower than the control by 0.21–0.39 t/ha. Uliublena variety was less affected by the drought of 2021 – a tendency to increase yield in cases with the use of fertilizers is viewed (0.12–0.18 t/ha).

Over the years of studying early-ripening varieties, the maximum yield was formed in 2022 in Barvysta variety in the third variant (5.53 t/ha), in Uliublena variety in the second variant (5.4 t/ha), and the minimum yield, as mentioned above, in 2021 – in Barvysta variety in the fourth variant (1.46 t/ha), in Uliublena variety – in the control (1.8 t/ha).

Struna Myronivska variety stood out in terms of yield among all varieties. The maximum yield of this variety was in 2022 with a calculating rate of fertilizer for the yield of 4 t/ha (6.38 t/ha).

Elehiia Myronivska variety during all the years of research formed the lowest yield in the control, and the maximum in 2021 in the second variant (2.84 t/ha), in 2022 – in the third variant (5.35 t/ha).

The maximum yield by years in Struna Myronivska variety, as well as in Elehiia Myronivska variety was recorded in the same variants in 2021 in the variant with a dose of mineral fertilizers calculated for a yield of 3 t/ha (2.81 and 2.84 t/ha, respectively), and in 2022 – in the third variant (5.35 and 6.38 t/ha, respectively).

Comparing the average indicators of yield of early-ripening and medium-ripening varieties, we can say that variant 3 with a dose of mineral fertilizers calculated for a yield of 4 t/ha stood apart. The use of late nitrogen top dressing (earing phase) did not, generally, increase the yield of wheat. This could be explained by the fact that the laying of the elements of the yield took place already in the tillering phase, and in the variants 4 and 5 (with top dressing) the rate of pre-sowing nitrogen application was reduced compared to the variant 3. Late foliar top dressing did not contribute to an increase in yield; it was carried out to improve the quality of grain.

The weight of 1000 grains characterizes the density and fullness of grain, that is, a high weight of 1000 grains indicates a large supply of nutrients in grain. Lack of moisture in the soil, high temperature and excessively low relative humidity of the air can interrupt the growth of the dry mass of grain at any of the moments of its formation, which is manifested in a reduced weight of 1000 grains and a low yield. The weight of 1000 grains depends on the genotype by 42%, and on the vegetation conditions by 24%.

In our research, the weight of 1000 grains depended on the weather conditions of the growing season and calculated dose of mineral fertilizers (Table 2).

In early-ripening varieties, the maximum weight value of 1000 grains was in 2022: in Barvysta variety – 33.9 g in the control, in Uliublena variety – 35.2 in the third variant. In medium-ripening varieties, the maximum indicator was 34.3 g in Elehiia Myronivska variety in 2022 (control), and 40.9 g in Struna Myronivska variety in 2022 in the second variant.

The minimum value of the indicator in all varieties was in 2021, which is explained by the dry conditions of that year.

The effect of mineral fertilizers on the weight of 1000 grains in different years was ambiguous. The maximum indicator in Barvysta variety in 2021 and 2022 was observed in the control, and after applying

Table 2

Weight of 1000 grains, g

Variety	Research year	Control	NPK of 3 t/ha	NPK of 4 t/ha	NPK of 4 t/ha + N	NPK of 4 t/ha + N + K
Barvysta	2021	30.7	32.5	32.9	31.2	31.2
	2022	33.9	33.8	33.3	32.8	31.1
	average	32.3	33.2	33.6	32.0	31.1
Uliublena	2021	30,7	30.3	31.4	31.5	31.9
	2022	35.0	33.8	35.2	33.0	34.0
	average	32.9	32.6	33.1	32.3	33.0
Elehiia Myronivska	2021	30.6	32.0	31.8	31.8	31.6
	2022	34.3	33.7	31.1	30.9	33.9
	average	32.5	32.9	31.5	31.4	32.8
Struna Myronivska	2021	31.7	31.0	30.9	30.7	30.0
	2022	37.8	40.9	38.6	37.4	38.0
	average	34.8	36.0	34.8	34.1	34.0
LSD_{05}		1.3				

fertilizers it decreased by 0.6–1.4 g in 2021, by 0.1–2.8 g in 2022. The effect of fertilizers on the weight of 1000 grains in Uliublena variety was more significant than in 2022, where fertilizers reduced the indicator in variant 2, 4 and 5 by 1–2 grams.

In the group of medium-ripening varieties, the effect of using mineral fertilizers was observed in Elehiia Myronivska variety only in 2021 (the weight of 1000 grains compared to the control increased by 1.0–1.8 g), and in Struna Myronivska variety, an increase in the indicator was observed in 2022.

The grain nature is not directly related to the baking power of the flour, but it is directly related to its yield. Weather conditions at the end of the growing season, i.e. during grain filling, significantly affected the indicator of grain quality. This was also confirmed by our research (Table 3).

In 2021, grain nature in early-ripening varieties was lower than in the following year, because its formation was affected by drought. The highest indicator was noted in Barvysta variety and it was 756 g/l (control), and 746 g/l in Uliublena variety (variant 3 of the experiment with applying of mineral fertilizers calculated for a yield of 4 t/ha). In 2022, grain nature was lower than the basis in the varieties of Barvysta and Uliublena. The maximum value of nature was formed in the variant with a dose of mineral fertilizers, for a yield of 4 t/ha + nitrogen fertilization in earing phase – 742 and 740 g/l, and the minimum was in the second variant: 720 and 714 g/l, respectively.

The lower nature value of grain in early-ripening varieties was recorded in 2022. Most likely, weather conditions during a grain filling phase – the end of August and the first decade of September were characterized by high rainfall and low temperatures. And as a result, harvesting of grain crops was delayed until the end of the second decade of September.

Medium-ripening varieties during research conducting formed grain with higher nature compared to early-ripening ones.

The maximum value of nature was in Elehiia Myronivska variety in 2021 – 817 g/l (calculated dose of mineral fertilizers for a yield of 4 t/ha). It should be noted that the conditions of 2021 for the formation of the value in the medium-ripening varieties were the most favourable. Even the minimum value was 793 g/l (in the control of Elehiia Myronivska variety; 3 and 4 variants in Struna Myronivska variety). In addition, only in 2021, mineral fertilizers had a positive impact on the formation of nature in Elehiia Myronivska variety: the excess over control was 13–24 g/l.

In 2022, the maximum value of nature of 766 g/l in Elehiia Myronivska variety was formed in the control, and the minimum value of 743 g/l was in the variant with a calculated dose of mineral fertilizers for a yield of 4 t/ha.

Analyzing average values during the years of research, we could conclude that nature of wheat grain depended mainly on the weather conditions of the second half of the growing season, while the use of mineral fertilizers was poorly affected it. Uliublena variety was the exception, which had a tendency to increase grain nature when applying fertilizers.

Gluten content in wheat grain is one of the main indicators, which determines technological properties of grain and flour produced from it.

Spring wheat grain in severe dry years at low yield can be very small and low by nature, but at the same time, gluten content, as well as the strength of flour can be the highest.

In our research, the amount of raw gluten was directly dependent on the rate of mineral fertilizers and changed under the influence of weather conditions (Table 4). The minimum content of gluten in all varieties was, generally, in the control variant.

The influence of fertilizers on the content of raw gluten in Barvysta variety was clearly revealed. In addition, during the years of research, the maximum values were in the variant with top dressing with a nitrogen fertilizer and Kristalon. The

Table 3

Nature of spring wheat grain, g/l

Variety	Research year	Control	NPK of 3 t/ha	NPK of 4 t/ha	NPK of 4 t/ha + N	NPK of 4 t/ha + N + K
Barvysta	2021	756	750	739	739	744
	2022	735	720	733	742	736
	average	745	735	736	740	740
Uliublena	2021	729	731	746	744	732
	2022	721	714	722	740	733
	average	725	723	734	742	733
Elehiia Myronivska	2021	793	807	817	806	810
	2022	766	757	743	746	747
	average	780	732	780	776	779
Struna Myronivska	2021	795	796	793	793	796
	2022	765	752	736	757	745
	average	780	774	765	775	771
LSD_{05}		8				

Table 4

Mass ratio of gluten in grain of spring wheat varieties, %

Variety	Research year	Control	NPK of 3 t/ha	NPK of 4 t/ha	NPK of 4 t/ha + N	NPK of 4 t/ha + N + K
Barvysta	2021	35.3	37.3	36.3	39.9	39.0
	2022	32.7	35.6	37.2	36.9	38.0
	average	34.0	36.5	36.8	38.4	38.5
Uliublena	2021	30.7	34.7	35.5	33.6	38.0
	2022	31.3	32.1	32.6	35.4	34.9
	average	31.0	33.4	34.1	34.5	36.5
Elehiia Myronivska	2021	27.3	29.9	34.6	34.3	32.5
	2022	24.6	25,8	28.1	34.2	33.9
	average	25.9	27.9	31.4	34.2	33.2
Struna Myronivska	2021	27.5	27.2	33.6	33.3	30.9
	2022	26.3	26.8	29.2	28.9	28.8
	average	26.9	27.0	31.4	31.1	29.9
LSD_{05}		1.6				

Table 5

Indicator of gluten elasticity in grain of spring wheat varieties, a device unit

Variety	Research year	Control	NPK of 3 t/ha	NPK of 4 t/ha	NPK of 4 t/ha + N	NPK of 4 t/ha + N + K
Barvysta	2021	70	70	70	75	80
	2022	75	72	68	71	66
	average	73	71	69	73	73
Uliublena	2021	70	80	85	85	85
	2022	73	73	74	72	74
	average	72	76	79	78	80
Elehiia Myronivska	2021	87	87	88	90	87
	2022	74	79	83	80	82
	average	81	83	85	70	85
Struna Myronivska	2021	87	83	87	78	82
	2022	81	79	79	79	86
	average	84	81	83	78	84
LSD_{05}		1.2				

maximum content of gluten was in 2022 – 39.9% in the fourth variant. Uliublena variety as well as Barvysta variety showed the best indicators in the fifth variant of 2021 year of research (it was the fourth variant of the experiment in 2022). The maximum gluten value in grain of this variety was 38.0% in the dry 2021.

Medium-ripening varieties in gluten content were very inferior to early-ripening varieties. The maximum content of gluten was recorded in 2021 in the third variant – 34.6% in Elehiia Myronivska variety and 33.6% in Struna Myronivska variety.

It is necessary not only the amount of gluten, but also its good quality, which is characterized by the following indicators: the ability to swell in water; colour; elongation; elasticity – the ability of gluten to restore the shape after deformation, elasticity is determined on IDK devices.

To a large extent, the quality of gluten depends on the temperature and supply of wheat plants with moisture during the period of filling and ripening of grain, but in most cases it is established that the quality of gluten is mainly a genotypic peculiarity.

The best indicator of gluten elasticity in our research was noted in Barvysta variety (Table 5).

Quality of gluten in all variants of the experiment corresponded to the first group in Barvysta variety in 2021 (except for the fifth variant) and 2022. Gluten in Uliublena variety in all variants corresponded to the first quality group only in 2022.

Medium-ripening varieties during the years of research mainly formed gluten of the second quality group (satisfactory weak).

It should also be noted that the tendency for dissolving gluten was increased by all varieties with

Table 6

Protein content in grain of spring wheat varieties, %

Variety	Research year	Control	NPK of 3 t/ha	NPK of 4 t/ha	NPK of 4 t/ha + N	NPK of 4 t/ha + N + K
Barvysta	2021	15.80	17.00	17.75	17.85	18.27
	2022	11.40	13.34	14.88	15.56	14.19
	average	13.00	15.17	16.74	16.41	16.23
Uliublena	2021	14.81	16.59	16.79	16.08	18.10
	2022	12.54	14.65	15.90	15.39	14.99
	average	13.73	15.62	16.65	15.74	16.54
Elehiia Myronivska	2021	13.18	14.30	16.57	16.40	15.67
	2022	12.03	13.85	15.39	15.50	14.76
	average	12.62	14.03	15.98	15.95	15.23
Struna Myronivska	2021	13.28	13.03	16.00	15.87	14.82
	2022	12.26	13.40	14.59	15.16	14.25
	average	12.77	13.22	15.30	15.51	14.54
LSD_{05}		2.4				

the increase in the rate of mineral fertilizers – IDK indicator increased.

As a result of many years of research, scientists came to the conclusion that external factors that affected protein content in grain are the provision of plants with nitrogen, water and heat.

It was established that the content of protein and raw gluten increased with increasing temperature and decreasing of the relative humidity of the air during the phase of grain filling, and this action was increased with insufficient soil moisture.

This information was confirmed by the data of our research (Table 6). The maximum content of protein in wheat grain of all varieties was recorded in the arid 2021.

The influence of variants was obvious. With some exceptions, protein content in all varieties in the control variant was minimal.

Early-ripening varieties were different from the medium-ripening varieties with high protein content. Barvysta variety was the leader by indicators. The maximum protein content in grain was recorded in 2021 in the fifth variant – 18.27% in Barvysta variety and 18.10% – in Uliublena variety.

In the medium-ripening varieties, the maximum protein content in grain was in the variant with the calculated dose of mineral fertilizers for the yield of 4 t/ha – in Elehiia Myronivska variety – 16.57%, and 16.00% in Struna Myronivska variety (2021).

Depending on weather conditions of the second half of the growing season, application of mineral fertilizers gave a different gain in protein content with respect to control. Excess in Barvysta variety ranged from 1.14 to 4.56%, from 1.88 to 3.36% in Uliublena variety, from 3.34 to 3.76% in Elehiia Myronivska variety and from 1.71 to 2.97% in Struna Myronivska variety. It should be noted that variants with the use of mineral fertilizers gave a stable gain of protein in relation to control by years only in Elehiia Myronivska variety.

Calculation of the correlation between the content of protein and gluten showed that the closeness of the connection between them was at the level of an average positive r = 0.529 in 2022, and in the conditions of 2021, when these indicators were determined by the lack of precipitation and high temperatures during the growing season, the coefficient of correlation approached 1.

Conclusions. Calculated rates of fertilizers provided adequate yield in early-ripening and medium-ripening varieties of spring wheat in moderately wet years at the level of 4-5 t/ha. In the dry 2021 conditions, yield in the experiment variants was lower than the planned and especially reduced in early-ripening varieties. Uliublena variety reacted better to the fertilizer among early-ripening varieties, and it was Struna Myronivska among medium-ripening varieties.

Weight of 1000 grains (r = 0.909) among the productivity elements had the predominant effect on yield in the conditions of 2021. Grain nature in early-ripening varieties corresponded to the basic standards (not lower than 750 g/l) only in the conditions of 2021, and it was significantly reduced in 2022 (711–728 g/l). Medium-ripening varieties formed grain with a higher nature indicator compared to early-ripening ones. A regular influence of the experiment variants on grain nature was not found.

Medium-ripening varieties were significantly inferior to early-ripening ones by gluten content in grain, although the general level of this indicator in the experiment was quite high: 28.9–32.2% on average in 2021–2022 in early-ripening varieties, and 25.8–26.5% in medium-ripening ones.

Early-ripening varieties stood out by protein content in the grain. The biggest differences between these groups of varieties were found in the variant with a fertilizer rate of 3 t/ha (106.5 kg/ha), the smallest – with a rate of 4 t/ha (17.9 kg/ha).

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