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INFLUENCE OF PREDECESSORS ON THE FORMATION OF INDIVIDUAL PRODUCTIVITY OF SPRING TRITICALE VARIETIES

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Ukraine's agricultural production is dominated by winter crops, with winter wheat accounting for the largest area. At the same time, due to dynamic climate change and unstable weather conditions in the autumn-winter and early spring periods, there is a need to reseed significant areas of winter crops every year. Spring triticale is one of the insurance crops. Due to its high productivity and unpretentiousness to growth and development conditions, its cultivation on large areas can contribute to a significant increase in food grain production.

In the current conditions of reforming the agricultural sector of Ukraine's economy, as well as climate warming, there is an urgent need to develop agrotechnological methods that would ensure the efficient use of crop rotations in general. One of the methods to increase the efficient use of arable land in modern business conditions is to grow crops that produce less costly and competitive products. Triticale meets these requirements best of all. Modern varieties, in particular those of Ukrainian breeding, are characterized by high physical properties, and in terms of grain quality and technological properties of flour are not inferior, and in some respects even superior to bakery wheat. Thanks to this, spring triticale can be grown as a major food crop. To date, many technological methods have been developed that ensure sufficiently high grain yields of this crop both in irrigated and non-irrigated farming. However, the technology of triticale cultivation in the context of climate change remained insufficiently developed and studied. In particular, such important elements of the technology as triticale varieties, precursors and doses of mineral fertilizers have not been determined.

Therefore, the study of the peculiarities of growth and development of high-yielding varieties of spring triticale and the introduction of basic methods of growing the crop, establishing the effect and interaction of the variety and mineral fertilizers, which significantly affect the yield and quality of grain, sowing and yielding qualities of seeds in the conditions of the Right-Bank Forest-Steppe are relevant, which determined the choice of the topic of the master's thesis.

On average, over two years of research, the influence of different precursors was also significant in the cultivation of spring triticale. Thus, the most mineral fertilizers significantly influenced the formation of grain yield of spring triticale varieties, namely increased it, but a significant increase in yield - 1.58 t/ha was obtained only when N30P60K60.+ N30 was applied in the earing phase. Thus, the highest grain yield of the studied spring triticale varieties was obtained in the most favorable year of 2019 - 6.48 t/ha, in 2020 it was 5.99 t/ha, which is 0.49 t/ha less. The yield of the spring triticale variety Boriviter in 2019 was the highest and amounted to 6.48 t/ha, respectively, in 2020 it was 5.47 t/ha and on average for two years of research did not exceed 5.97 t/ha.

Keywords: *variety, spring triticale, agrocenosis, precursor, productivity, yield.*
Table 4. Lit. 15.

Problem statement. Spring triticale is rapidly gaining priority positions in the grain sector due to its high yield potential. And modern varieties of spring triticale are characterized by fullness of grain and relatively larger sizes than wheat or barley. The difference is clearly visible when determining the weight of a thousand seeds, which is about 50 g. The root system is also better developed than in other cereals and penetrates to a depth of 2-3 meters. Compared to wheat, spring triticale absorbs and utilizes nutrients much better. It is possible to obtain high yields of spring triticale by observing the main elements of the technology of growing this crop [1]. In his experiments, V.A. Ishchenko studied the effect of fertilizers, which determine the level of competition between plants in crops, on the grain yield of spring triticale varieties and proved the high efficiency of their use. The grain yield of spring triticale significantly increased with the use of mineral fertilizers (4.48 t/ha) compared to the natural background (3.39 t/ha). The yield increase was 1.09 t/ha or 32.1%. The highest yields in the Steppe were formed by the varieties Khlibodar Kharkivskyi (4.72 t/ha), Lehyn Kharkivskyi (4.58 t/ha), Sontsedar Kharkivskyi (4.57 t/ha), and Boriviter (4.55 t/ha). Significant variability in the yield of varieties on different backgrounds of mineral nutrition (25.5-41.4%, 25.8-35.3%) is due to their biological properties and plasticity in contrasting growing conditions over the years. Protein and gluten content in triticale grain depended on both weather conditions and varietal characteristics. In triticale, the protein and gluten content was 9.7-11.8% and 14.2-17.1% (without fertilizers), and in N30P30K30 - 10.4-12.2% and 14.9-17.3%, respectively. Higher protein content on both nutrition backgrounds was provided by Volya variety, and gluten content by Dar Khliba [2].

Triticale is one of the most unpretentious wedge crops. The high quality of gluten makes it possible to use spring triticale flour to make blends with low-quality wheat flour, so producers often use this to make more profit with low-grade grain. Interestingly, the biochemical properties of spring triticale grain allow it to be used in cereal production and for starch production. Also, spring triticale grain is used to produce high-quality alcohol. As for the cultivation technology, it is no different from spring wheat and spring barley [3].

People's desire for stable grain harvests led to the creation of a new grain crop, spring triticale, which was popularly called "breadbasket."

The creation of commercial triticale varieties was made possible by many years of work by geneticists and breeders who combined the heredity of wheat and rye and identified biotypes with high productivity, adaptability and grain quality.

In 2005, winter and spring triticale varieties were harvested from an area of about 4.0 million hectares worldwide. At the same time, 14.7 million tons of grain were harvested. Spring triticale is most widely grown in Austria, Germany, Poland, Ukraine, Belarus, Spain and other countries.

What makes spring triticale so popular? First of all, it makes it possible to produce food grains where there are problems with the traditional bread crop, winter soft wheat.

As the climate has become more continental, the frequency of negative weather effects on plants has increased. This is especially true for farmers in the eastern and southern regions, where most of the winter wheat crops are located. The May frosts of 1999 and 2000, the complex of harmful factors in winter and spring 2003, the dry fall of 2005 and severe frosts on snowless fields in January 2006 are still fresh in the memory. Winter wheat did not come out of wintering without losses in the abnormally warm winter of 2016/2017.

At the same time, the "planned" reseeding of winter wheat, even under more favorable conditions, reached 14-15% of the area. This is due to late sowing of winter crops after the worst predecessors, damage to seedlings by pests: larvae of winter moth, borer, bread beetle, damage to crops, especially in the early stages, by fungal and viral diseases.

Thanks to its valuable biological characteristics: high ability to absorb nutrients, increased resistance to frost, drought, diseases and pests, spring triticale is successfully grown after corn for grain and silage, soybeans, sugar beets, and other row crops - even sunflower. When sowing spring triticale after stubble predecessors, grain yield losses from pests and diseases are reduced compared to winter wheat.

Spring triticale has become a reliable grain crop in the Central and Northern Steppe, Forest-Steppe and Polissya regions of Ukraine, where its area is about 70 thousand hectares, according to unofficial data.

In the Forest-Steppe and Steppe zones, 12-15% of the area under winter crops can be allocated for spring triticale annually. Under dry autumn conditions, some of these areas may increase, reducing the risk of losses from reseeding with winter crops. Spring triticale is effectively used as an insurance crop for winter crops [4].

Among the non-steamed predecessors, the best is pea, which, under favorable weather conditions, is close not only to the busy but also to the black fallow. The value of such a precursor is due to the early maturity of the crop, sufficient residual reserves of productive moisture in the soil and the accumulation of easily digestible nutrients [5]. Under dry conditions, which are increasingly common in the Steppe, predecessors play an important role in obtaining high and sustainable grain yields, as they leave behind sufficient moisture and nutrients, and hence significantly affect the emergence of wheat germination, plant development, wintering, grain yield and quality. According to Konashchuk I.O., an increase in the share of spring triticale in field crop rotations above 30% inevitably leads to its repeated sowing and placement after stubble predecessors [5, 6].

According to P. I. Boyko, the most important thing in the farming system to stabilize yields in extreme years is the selection and alternation of crops with different levels of water consumption [7]. After the reform of the agro-industrial complex, the production of reproductive seeds in the western region is carried out by farmers and small peasant farms, where 9-10-seed rotations recommended for seed crops have been replaced by short rotations (3 - 4), saturated with economically profitable crops. This has led to the placement of cereals not after the best predecessors (perennial legumes, corn for green mass, early potatoes, etc.), but after non-traditional ones (winter rape, oats) [8].

The precursors have an indirect effect on seed quality, leaving different moisture and nutrient reserves in the soil, as well as causing the development of diseases and pests. A four-split with the following crop rotation may be optimal for winter triticale under such conditions: Field 1 - perennial legumes; Field 2 - winter triticale; Field 3 –

beets, rapeseed, potatoes, legumes other than cereals; Field 4 - spring barley, spring wheat, annual grasses with underplanting of perennial grasses. Scientifically based crop rotation is the basis for regulating the number of pests and allows us to keep them at levels that do not exceed the thresholds of harmfulness. If crop rotation is disrupted, massive reproduction of pests and disease epiphytoties is observed [9].

Modern high-intensity triticale varieties are characterized by high technological properties of grain, capable of accumulating 13-16% of protein, which contains up to 350 mg/% of essential acid lysine, and carotenoids content of 1.5-2.0 mg, and these characteristics can ensure its high nutritional value. However, despite its valuable economic and useful properties, triticale culture has not been widely used in different soil and climatic zones [10].

Research methods and techniques. Field experiments to establish the main agrotechnical methods of growing spring triticale were conducted during 2019-2020 in the field and laboratory conditions.

The three-factor field experiment was set up in accordance with the methodology of field research (2020) [11].

Factor (A) - varieties of spring triticale (Boriviter, Darkhliba and Lebed); Factor (B) - predecessor (sunflower; corn and soybean); Factor (C) - fertilizer: 1. control (background - $P_{60}K_{60}$); 2. $N_{30}P_{60}K_{60}$; 3. $N_{30}P_{60}K_{60}$ + N_{30} in the earing phase.

The sowing period is the first decade of April. The total area of the sowing plot is 50 m^2, the accounting area is 25 m^2. Replication is three times.

Agrotechnical measures and the level of mechanization in the experiment are typical for the Right-Bank Forest-Steppe zone, except for the factors studied.

Phenological observations and relevant records, measurements, calculations, and sampling were carried out according to the Methodology of the State Service for the Protection of Plant Variety Rights (now the State Veterinary and Phytosanitary Service of Ukraine) [6]. The date when 10-15% of the plants entered the phase was taken as the beginning of the phase, and 75% as the full phase. The duration of the growing season was calculated from the date of germination to the waxy ripeness of the grain.

1. The density and bushiness of plants were determined on specially fixed test plots of 1/6 m^2 (2 rows of 28 cm) in three places along the diagonal of the plots, in two non-contiguous replications.

2. Laboratory analysis of plants included the determination of elements of the crop structure: stem and ear length, number of spikelets and grains in the ear, weight of 1000 grains, weight of grain from 1 ear.

3. The yield of spring triticale was determined by sectional harvesting of grain with a SAMPO-500 combine and weighing with subsequent correction for standard moisture (14%) and purity (100%).

4. The statistical analysis of the crop data was performed using the computer program Microsoft Exel, "Statistika 6.0" by the method of analysis of variance and correlation.

5. The economic efficiency of the studied agricultural measures was calculated using the computer program Microsoft Exel on the basis of the technological map at average prices that were established during the years of research.

Research methods: field - phenological observations of plant growth and development, measurements of plant organs, harvest accounting; laboratory - to determine the quality of spring triticale grain; mathematical and statistical - to assess the reliability of the research results and calculation and comparison - for economic and energy assessment of agrotechnical methods of growing spring triticale varieties studied in field experiments.

Summary of the main material. The main elements of the yield structure of spring triticale are the density of productive stem, the number of grains in the ear and their weight, and the size of the ear. Each of these elements can vary significantly, depending on the agrotechnical methods of cultivation and lead to a proportional increase or decrease in crop yield [12]. A deeper understanding of the peculiarities of grain crop yield formation is possible by taking into account changes in its structure, since the level of its yield directly depends on the number of productive stems per 1 m2 and the weight of grain per 1 ear, as well as the number of plants before harvesting (pcs./m^2), productive bushiness, the average number of grains per ear and the weight of 1000 grains. Therefore, when growing spring triticale, it is necessary to create such conditions that all elements of the crop structure reach their greatest quantitative manifestation.

The formation of the elements of the yield structure of spring triticale largely depends on both varietal characteristics and the level of mineral nitrogen nutrition of plants. The influence of different doses of nitrogen fertilizers on the formation of crop productivity elements has a number of specific features. Therefore, most scientific institutions note that the main elements of productivity are stem density and ear productivity.

At the same time, regulating only the density of the stem, it is not always possible to ensure a high yield of the crop. To increase the yield of spring triticale, it is necessary to increase the productivity of the ear.

The main components of the ear that contribute to the formation of the yield are the number of grains in the ear and the weight of grain per ear. According to the Lviv National Academy of Agrarian Sciences, the development of the ear depends on many factors, the main ones being the genetic characteristics of the variety. After all, each variety is characterized by a certain number of ears.

The formation of the ear of spring triticale occurs from the third to the eighth stage of organogenesis, so its size and number of grains in it significantly depend on external conditions during this period, the most important of which are temperature and daylight hours. High temperatures inhibit plant growth and accelerate the growth of the ear and its elements, which negatively affects its size and, accordingly, productivity [13].

The results of many years of research have shown that plant height performs important economic and biological functions in ontogeny, and is closely related to other traits and properties: resistance to lodging, nutrient absorption, productivity and product quality.

The results of our research showed that spring triticale varieties depended on the influence of mineral fertilizers on the formation of productivity and differed in plant height, which is due to their genetic basis and high heritability. Thus, the formation of the main elements of productivity and bushiness of winter triticale varieties depended on the influence of the use of individual elements of the technology of growing this crop, for example, as a variety, fertilizer and sowing method, rather than on other factors that are in some way interrelated with weather conditions during the years of research. It was noted that on average for two years of research, the total number of triticale plants of the Darkhliba variety was in the range of 352-358 pcs./m^2, for the Boriviter variety, and, accordingly, was 12-19 pcs./m^2 less than that of the Lebed variety. The number of productive stems was 567-657 pcs./m^2, which is 45-71 pcs./m^2 more than in the Boriviter variety and 1 8-40 pcs./m^2 less than in the Lebed variety. [14].

It was found that the height of triticale was significantly influenced by the norms of nitrogen fertilizers. This indicator was the lowest in triticale plants fertilized with $P_{60}K_{60}$, which averaged 74.1 cm in the Lebid variety, and the highest in the case of full fertilization - 75.2 cm. The highest plant height was formed by the variety of spring triticale Boriviter when applying the norms of mineral fertilizers $N_{60}P_{60}K_{60}$ together with fertilizing in the earing phase, which was 101.4 and 102.1 cm, respectively. The lowest plant height was characterized by crops with the use of fertilizer rates $P_{60}K_{60}$-background, which did not exceed 98.1 and 98.7 cm.

Along with this, the height of spring triticale plants was significantly affected by weather conditions during the years of research. Thus, in the dry (95%) year of 2020, due to very dry weather conditions in spring, spring triticale of the Lebed variety formed a height that averaged from 73.1 cm to 94.6 cm. And in the average dry year (75%) in terms of precipitation in 2019, the height of plants varied from 75.1 cm to 91.4 cm. On average, over the two years of research, among the other varieties studied, the Lebed variety formed the lowest plant height, which reached 74.1 cm.

The second most important element of the yield structure is the number of grains per ear. On average, over the two years of research, the highest grain size of the spike of the Boriviter variety was formed after sowing soybeans with 30.9 - 33.8 grains per spike. Whereas after sunflower, the grain size was the smallest 28.9 - 30.7 grains per ear. Weather conditions also play an important role in this indicator. Thus, the highest grain size was formed under favorable conditions in 2019, which amounted to 29.9-30.4, after sunflower, 31.5-31.7 and soybeans 32.9-34.4 grains per ear, respectively. As our research has shown, the number of grains per ear varied significantly not only from different predecessors, but also with the use of mineral fertilizers (Table 1).

On average, over two years of research, the Boriviter variety formed 31.4 grains per ear when fertilized ($P_{60}K_{60}$), respectively, $N_{30}P_{60}K_{60}$ - 31.6; $N_{30}P_{60}K_{60}$ + N_{30} in the earing phase - 32.2 grains per ear.

Table 1

Productivity and main elements of the yield structure of spring triticale variety Boriviter depending on fertilizer and predecessor (average for 2019-2020)

Predecessor	Plant height, cm.	Number of grains per ear, pcs.	Grain weight per 1 spike, g	Weight of 1000 pieces of grains, g	Biological yield, t/ha
$P_{60}K_{60}$					
sunflower	98,1	28,9	1,08	37,3	3,16
corn for grain	98,4	30,2	1,14	37,7	3,46
soybean	98,7	30,9	1,18	38,3	3,77
$N_{30}P_{60}K_{60}$					
sunflower	98,9	29,7	1,16	39,0	4,45
corn for grain	99,1	30,9	1,24	40,2	4,80
soybean	99,6	32,4	1,32	40,9	5,25
$N_{30}P_{60}K_{60}$ + N_{30} in the earing phase					
sunflower	101,4	30,7	1,31	42,8	5,08
corn for grain	101,8	32,0	1,39	43,6	5,46
soybean	102,1	33,8	1,50	44,5	5,97

the source is formed on the basis of own research results

However, according to scientists [15], much wider opportunities for increasing the yield of grain crops are inherent in another indicator - the weight of grain per ear, since it is the number of productive stems and the weight of grain per ear determined before harvesting that give us the value of the biological yield.

To a large extent, the productivity of spring triticale spike in our studies depended on the supply of plants with mineral nutrition elements. Thus, when applying phosphorus and potassium fertilizers ($P_{60}K_{60}$), the weight of grain from one ear did not exceed 1.18 grams on average over two years of research, while when applying $N_{30}P_{60}K_{60}$ - 1.32 grams. It was also found that the weight of grain from 1 ear of Boriviter variety in 2019, compared to 2020, regardless of mineral fertilizers and precursor, was the highest and amounted to 1.57 g/ear, respectively, in 2020 - 1.44 g/ear.

In the final stages of development of spring triticale plants, a high level of yield is also achieved due to the fullness of the grain, which is characterized by such an indicator as the weight of 1000 grains. It has been established that grain size is a clearly expressed varietal trait, so each variety of cereals is characterized by a corresponding weight of 1000 grains [6].

Our studies have shown that the Boriviter variety formed the lightest grain on average over the two years of research, the weight of which significantly depended on the use of mineral fertilizers, which on average varied from 37.8 to 43.6 grams and on the predecessor, respectively, 39.7 to 41.2 grams.

The results of the research showed that the height of triticale plants of the spring variety Darkhliba varied both by years and by research variants. The largest stem length was noted for the conditions of 2019 with a range from 93.1 to 97.1 cm. The smallest for the conditions of 2020 - from 73.1 to 87.1 cm. On average, for all the years studied, the height of the plants was 83.1 to 92.1 cm, which is significantly less than that of the Boriviter variety (by 13 cm). Optimization of mineral nutrition of the variety Darkhliba on average for two years of research had a positive effect on plant growth, since the use of mineral fertilizers significantly contributed to an increase in plant height: $P_{60}K_{60}$ - background - 83.1-83.7 cm, respectively, $N_{30}P_{60}K_{60}$ -84.1-84.9 cm; $N_{30}P_{60}K_{60}$ + N_{30} in the earing phase - 91.4-92.1 cm.

Studies have shown that the weight of grain per 1 ear was highest when sown after soybeans, which was 1.15-1.29 grams against 1.12-1.23 grams after corn and 1.08-1.20 grams after sunflower. Based on the results of field experiments, it was found that for the variety Darkhliba, when applying $N_{30}P_{60}K_{60}$ with fertilization in the earing phase, the optimal number of productive stems is 657 pcs./m², and the weight of grain per 1 ear is 1.29 grams.

Under such conditions, on average, over two years of research, a biological yield of 5.08 t/ha was formed. When sowing after sunflower at the above rate of mineral fertilizers, the optimal number of productive stems is 636 pcs./m², and the weight of grain per 1 ear is 1.20 g, respectively, when sowing after corn for grain - 640 pcs./m²

Table 2

Productivity and main elements of the yield structure of spring triticale variety Darkhliba depending on the predecessor and fertilizer (average for 2019-2020)

Predecessor	Plant height, cm.	Number of grains per ear, pcs.	Grain weight per 1 spike, g	Weight of 1000 pieces of grains, g	Biological yield, t/ha
$P_{60}K_{60}$					
sunflower	83,1	28,6	1,08	37,6	3,59
corn for grain	83,4	29,4	1,12	38,2	3,75
soybean	83,7	29,8	1,15	38,7	3,95
$N_{30}P_{60}K_{60}$					
sunflower	84,9	30,7	1,17	38,1	4,44
corn for grain	84,1	31,2	1,21	38,7	4,63
soybean	84,6	31,9	1,25	39,2	4,86
$N_{30}P_{60}K_{60}$ + N_{30} in the earing phase					
sunflower	91,4	31,4	1,20	38,2	4,57
corn for grain	91,5	32,1	1,23	38,3	4,72
soybean	92,1	33,2	1,29	38,8	5,08

the source is formed on the basis of own research results and 1.23 g. Under these conditions, the biological yield reaches 4.57 t/ha and 4.72 t/ha.

The interaction of all the factors that were put into the study had a positive effect on the formation of yield. When N30 was applied in the earing phase, the Darkhliba variety responded much better to sowing spring triticale after soybeans. At the same time, the number of grains in the ear and its weight were the highest.

Along with such important indicators as the number of productive stems, the number of grains in the ear and the weight of grains per 1 ear, the variety Darkhliba had the highest weight of 1000 grains in the variants after soybean with the introduction of $N_{30}P_{60}K_{60}$ and amounted to 39.2 grams. This indicator fluctuated slightly and did not exceed the error of the least significant difference at the five percent level. The Lebid variety was more plastic to weather conditions. Thus, at elevated temperatures and slightly reduced precipitation in 2020, plant height ranged from 73.1-94.6 cm. While in 2019, when the amount of precipitation during the growing season was 78 mm higher, the height of plants ranged from 75.1-91.4 cm. The data obtained are explained by the fact that this variety is adapted to the conditions of the Steppe zone and Polissya. However, in the conditions of the Forest-Steppe, this variety was more productive and elastic than other varieties of spring triticale.

The data obtained indicate that on average over two years of research, the Lebid variety formed the highest plant height when sown after the soybean predecessor and fertilizer at the rate of $N_{30}P_{60}K_{60}$, with fertilization in the earing phase at the rate of N_{30}, which was 93.0 cm (Table 3).

Table 3

Productivity and main elements of the yield structure of spring triticale variety Lebed depending on the predecessor and fertilizer (average for 2019-2020)

Predecessor	Plant height, cm	Number of grains per ear, pcs	Grain weight per 1 spike, g	Weight of 1000 pieces of grains, g	Biological yield, t/ha
$P_{60}K_{60}$					
sunflower	74,1	27,9	1,05	37,8	3,70
corn for grain	74,9	30,3	1,15	38,1	4,03
soybean	75,2	31,2	1,20	38,5	4,25
$N_{30}P_{60}K_{60}$					
sunflower	79,0	29,7	1,15	38,6	4,52
corn for grain	79,6	32,6	1,29	39,7	5,16
soybean	80,1	33,2	1,32	39,8	5,46
$N_{30}P_{60}K_{60}$ + N_{30} in the earing phase					
sunflower	89,0	33,4	1,29	38,8	5,14
corn for grain	91,5	35,4	1,41	40,0	5,70
soybean	93,0	36,3	1,48	41,0	6,19

the source is formed on the basis of own research results

This is due to the fact that legumes are a better predecessor for this variety.

It was found that the mass and number of developed grains in the ear depends on the duration of their growth, which can vary significantly under the conditions of deficit of productive soil moisture, high average daily air temperatures and insufficient nitrogen nutrition. Thus, in spring triticale plants of the Lebed variety, on average over two years of research, the number of grains per ear did increase proportionally with the increase in the level of nitrogen nutrition from 27.9 to 33.4 pcs./m^2 on crops after sunflower, from 30.3 to 35.4 pcs./m^2 after corn, and 31.2-36.3 pcs./m^2 after soybeans. The data indicate that along with mineral nutrition of plants, the results were influenced by the precursors and their aftereffects on the plants of spring triticale.

Therefore, as with all other varieties that participated in the study, the optimal predecessor for the Lebid variety is a legume.

The analysis of the yield structure of spring triticale varieties with different biological characteristics shows that a significant reserve for increasing the crop yield, along with ensuring the required density of productive stems, is also an increase in the weight of grain per ear. On average, over the years of research, with the elimination of nitrogen nutrition and changes in the predecessor, the weight of grain per ear did not exceed 1.48 grams. This indicator significantly depended on the tillering intensity of all studied varieties. Therefore, the weight of grain per ear of Lebid variety increased significantly when nitrogen fertilizers were applied, which contributed to a sufficiently high crop yield. With the formation of the number of productive stems up to 687 pcs./m^2 and the weight of grain from 1 ear equal to 1.48 grams, the biological yield reached 6.19 t/ha in the variants where there was a soybean predecessor with the introduction of $N_{30}P_{60}K_{60}$ + N_{30} in the earing phase .

The fullness of the grain is best characterized by the weight of 1000 grains. Lebed variety, regardless of the predecessor, formed a weight of 1000 grains ranging from 37.8-41.0 g. This indicator for this variety increased slightly with an increase in nitrogen fertilizer rates by 1.0-2.5 g.

Experimental data obtained during two years of research indicate that the studied spring triticale varieties were characterized by high productivity. Obtaining high yields of spring triticale grain in the conditions of Khmilnyk district of Vinnytsia region is limited, first of all, by weather conditions during the growing season of the crop. However, despite the fact that during the two years of spring triticale vegetation the weather conditions were different, the yield of Boriviter, Darkhliba and Lebid varieties, with the simultaneous study of the influence of various precursors and the use of mineral fertilizers, was quite high.

Thus, the highest grain yield of the studied spring triticale varieties was obtained in the most favorable year of 2019 - 6.48 t/ha, in 2020 it was 5.99 t/ha, which is 0.49 t/ha less. The yield of the spring triticale variety Boriviter in 2019 was the highest and amounted to 6.48 t/ha, respectively, in 2020 it was 5.47 t/ha and on average for two years of research did not exceed 5.97 t/ha.

The Darkhliba variety has shown high yields during all years of research. In 2019, its yield was the highest and amounted to 5.49 t/ha, in 2020 - 4.68 t/ha, which averaged 5.08 t/ha over the two years of research. At the same time, the increase in grain yield of the Darkhliba variety compared to the Boriviter variety in 2019 was 0.99 t/ha lower, and compared to the Lebid variety it was 0.91 t/ha lower. In 2020, the Lebid variety produced a grain yield of 5.99 t/ha, which is 0.52 t/ha higher than the Boriviter variety and 1.31 t/ha higher than the Darkhliba variety.

The increase in grain yield of spring triticale variety Darkhliba with the use of mineral nitrogen fertilizers, compared to the background ($P_{60}K_{60}$) in 2019 was: $N_{30}P_{60}K_{60}$ - 0.80 t/ha and $N_{30}P_{60}K_{60}$+ N_{30} in the earing phase - 1.1 t/ha, respectively, in 2020 - 0.96 t/ha and 0.96 t/ha.

On average, by variety, the yield of spring triticale grain when applying nitrogen fertilizers, compared to the background ($P_{60}K_{60}$), in 2019 was: when N30 was applied - 1.01 t/ha, N_{30} + N_{30} in the earing phase - 1.63 t/ha. In 2020, the yield increase reached 1.20 and 1.54 t/ha, respectively. On average, over the three years of research, the increase in grain yield when applying mineral fertilizers at the rate of $N_{30}P_{60}K_{60}$ is 1.1 t/ha and $N_{30}P_{60}K_{60}$ + N_{30} in the earing phase is -1.58 t/ha.

At the same time, during all the years of research, the same trend was observed - obtaining high grain yields when sowing spring triticale on soybeans and applying mineral fertilizers - $N_{30}P_{60}K_{60}$ with N_{30} fertilization in the earing phase (Table 4).

Table 4

Grain yield of spring triticale varieties depending on the predecessor and fertilizer rates (average for 2019-2020), t/ha

Varieties Factor A	Predecessor of Factor B	Fertilizers (Factor C)			Average for factor B	Average by factor A
		$P_{60}K_{60}$	$N_{30}P_{60}K_{60}$	$N_{30}P_{60}K_{60}$ +N_{30}		
Borovita	sunflower	3,16	4,45	5,08	4,23	4,60
	corn for grain	3,46	4,80	5,46	4,57	
	soybean	3,77	5,25	5,97	5,00	
Darkhliba	sunflower	3,59	4,44	4,57	4,20	4,40
	corn for grain	3,75	4,63	4,72	4,37	
	soybean	3,95	4,86	5,08	4,63	
Лебідь	sunflower	3,70	4,52	5,14	4,45	4,91
	corn for grain	4,03	5,16	5,70	4,96	
	soybean	4,25	5,46	6,19	5,30	
Average by factor C		3,74	4,84	5,32		

$HIP_{05,}$ t/haA – 0,20; B – 0,35; HIP05 C – 0,20; AB - 0,06; AC - 0,12; BC - 0,10; ABC - 0,14
the source is formed on the basis of own research results

On average, over two years of research, the influence of different precursors was also significant in the cultivation of spring triticale. Thus, the most mineral fertilizers significantly influenced the formation of grain yield of spring triticale varieties, namely increased it, but a significant increase in yield - 1.58 t/ha was obtained only when $N_{30}P_{60}K_{60}$+ N_{30} was applied in the earing phase.

When growing spring triticale for sunflower, the average yield of the varieties for two years of research was 3.48 t/ha against the background of mineral nutrition $P_{60}K_{60}$. The gradual addition of nitrogen fertilizers increased the growth by 0.72 t/ha on the background of $N_{30}P_{60}K_{60}$ and by 0.82 t/ha on the background of $N_{30}P_{60}K_{60}$+ N_{30} in the earing phase. The same trend was observed in all studied varieties.

At the same time, the share of the main factors of influence studied in the field experiment - varieties, fertilizer doses and predecessors on the formation of the yield of spring triticale varieties was different. The influence of the variety factor on the grain yield of spring triticale varieties during all years of research was 13.5-19.2%, the predecessor did not exceed 5.9-8.1%, and mineral fertilizers, primarily nitrogen fertilizers, had the greatest influence on the formation of the grain yield of spring triticale varieties during all years of research. In 2019, the share of the influence of this factor was 67.3%, respectively, in 2020 - 60.6%.

On average, for two years of research, the share of the variety factor did not exceed 17.1%, respectively, the precursor - 7.6 and fertilizer 57.3%). Based on the research, it should be noted that the greatest productivity potential was provided by the Lebid variety, which, when sown after soybeans and using mineral fertilizers $N_{30}P_{60}K_{60}$ when fertilizing during the earing phase, on average over two years of research, formed a grain yield of more than 6.19 t/ha, respectively, and the lowest variety Darkhliba - 5.08 t/ha.

Conclusions. Our work presents the results of experimental studies on the theoretical substantiation of obtaining high productivity and quality of spring triticale grain by optimizing the elements of crop cultivation technology:

1. The yield of spring triticale grain, when eliminating the influence of the variety and mineral fertilizers, did not exceed 5.14 t/ha for sunflower, respectively, for corn - 5.70 t/ha and for soybeans - 6.19 t/ha. However, the share of the predecessor's influence did not exceed 7.6%.

2. The correlation and regression modeling of the productivity of the studied varieties revealed a high level of influence on plant productivity of the background of nitrogen nutrition and the predecessor. The greatest potential for productivity with a grain yield of more than 6.19 t/ha was provided by the Lebid variety when nitrogen fertilizers were applied at the rate of $N_{30}P_{60}K_{60}$ + N_{30} in the earing phase of soybean.

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АНОТАЦІЯ
ВПЛИВ ПОПЕРЕДНИКІВ НА ФОРМУВАННЯ ІНДИВІДУАЛЬНОЇ ПРОДУКТИВНОСТІ СОРТІВ ТРИТИКАЛЕ ЯРОГО

В аграрному виробництві України провідне місце посідають озимі зернові культури, серед яких найбільші площі належать пшениці озимій. Водночас через динамічні зміни клімату й нестійкі погодні умови в осінньо-зимовий і ранньовесняний періоди щороку виникає потреба в пересіванні значних площ озимини. Однією зі страхових культур є тритикале яре. Завдяки високій продуктивності та невибагливості до умов росту й розвитку його вирощування на значних площах може сприяти суттєвому зростанню виробництва продовольчого зерна.

В сучасних умовах реформування аграрного сектору економіки України, а також потепління клімату, гостро виникла необхідність розробки агротехнологічних прийомів, які б забезпечували ефективне використання сівозмін в цілому. Одним з методів підвищення ефективного використання орних земель у сучасних умовах господарювання є вирощування сільськогосподарських культур, які формують менш затратну й конкурентоспроможну продукцію. Найбільше цим вимогам відповідає тритикале. Сучасні сорти, зокрема української селекції, відзначаються високими показниками фізичних властивостей, а за якістю зерна й технологічними властивостями борошна не поступаються, а за деякими *ознаками й переважають пшениці хлібопекарських класів. Завдяки цьому тритикале яре можна вирощувати як основну продовольчу культуру. До теперішнього часу розроблено багато технологічних прийомів, які забезпечують отримання достатньо високих урожаїв зерна даної культури як в умовах зрошуваного, так і неполивного землеробства. Проте технологія вирощування тритикале, в умовах зміни клімату, залишалася недостатньо розробленою та вивченою. Зокрема, не визначено такі важливі елементи технології як: сорти тритикале, попередники та дози мінеральних добрив.*

В середньому за два роки досліджень вплив різних попередників також мав істотне значення при вирощуванні тритикале ярого. Так найбільший мінеральні добрива значною мірою впливали на формування врожаю зерна сортів тритикале ярого, а саме збільшували її, проте істотний приріст урожайності – 1,58 т/га отримано лише при внесенні $N_{30}P_{60}K_{60}$.+ N_{30} у фазу колосіння. Так, найвищу урожайність зерна сортів тритикале ярого, що вивчалися, отримано в найбільш сприятливому 2019 році – 6,48 т/га, в 2020 році вона становила 5,99 т/га, що менше на 0,49 т/га. Урожайність сорту тритикале ярого Боривітер в 2019 р. була найвищою і склала 6,48 т/га, відповідно, у 2020 р. вона була 5,47 т/га і в середньому за два роки досліджень не перевищувала 5,97 т/га.

Ключові слова: *сорт, тритикале яре, агроценоз, попередник, продуктивність, урожайність.*

Табл. 4. Літ. 15.

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