

THE PRODUCTIVITY OF SPRING BARLEY VARIETIES DEPENDING ON THE OPTIMIZATION OF NUTRITION IN THE SOUTHERN STEPPE OF UKRAINE

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Abstract

The article presents the results of research carried out in 2013 - 2017 in the conditions of the experimental field of the Mykolayiv National Agrarian University in southern chernozem to study the efficiency of the treatment of barley crops with modern growth-regulating preparations in the background of mineral fertilizers. The influence of variety (Adapt, Stalker, Aeneas) and fertilization ($N_{30}P_{30}$, Urea K1, Urea K2, Escort-bio, Organic D2) of barley plants on the formation of elements of the crop structure (total number of stems and productive stems, number of grains in the ear and weight of grain from one ear) and the level of grain yield were investigated. It was determined that the application of preseedling cultivation of spring barley with mineral fertilizer at a dose of $N_{30}P_{30}$ (background) and the application of extra-root cropping at the beginning of the phases of stooling and the earing with fertilizers Urea K1, Urea K2, Organic D2 and Escort-bio created favorable conditions for the formation of optimal grain yield levels. It was determined that the highest yield of barley grain was formed in experimental variants using Organic D2 (3.22-3.56 t ha⁻¹) and Escort-bio (3.25-3.61 t ha⁻¹), depending on the variety. These exceeded the yield rate on an unfertilized plot by 20.5-21.3 and 21.2-22.4% for Organic D2 and Escort-bio, respectively, and with the application of mineral fertilizers only, the yield rate grew by 12.0-13.5%. The highest yield of grain was formed by plants of the Aeneas's variety: 2.80-3.61 t ha⁻¹, depending on the variants of nourishment.

Key words: spring barley, variety, plant nutrition, growth-regulating substances, crop structure, grain yield.

INTRODUCTION

Grain production belongs to the strategically important branches of the agrarian economy in Ukraine. Since it provides a significant part of the income at the agricultural enterprises, it also occupies more than half of the area under cultivation and predetermines the constant demand and high demand of people for the consumption of food products. The grain is a raw material, is also an indispensable source for the establishing of complete forage base for the development of livestock industries (Kushniruk et al., 2016; Kozera et al., 2017).

The spring barley is one of the leading grain-harvesting crops in Ukraine and in the flat area, and the gross collection it takes the second place after the winter wheat. With a high potential grain yield of modern varieties (about 9.0 t ha⁻¹), the average level of barley yield remains low (because the precipitation is low during vegetation, non-compliance with elements of technologies), unstable with fluctuations within years under the influence of

many factors - it varies up to 40% or more, which does not fully meet the needs of the national economy with food grain, fodder and brewer's grain (Kaminskaya et al., 2012; Kolesnikov et al., 2016). Growing barley in the zone of the Southern Steppe of Ukraine after a better predecessor (soybean), in the background of making integrated mineral fertilizers contributes to the yield of grain yield at the level of 4.03 t ha⁻¹. The sowing of barley after sunflower leads to a shortage of the yield by 15.4%, and the sowing of barley after winter wheat leads to a shortage of the yield by 7.7%. At the same time the application of fertilizer contributed to the growth of grain yield regardless of its precrop (it increased by 23.0-39.3%). At the same time, the profitability of spring barley growing after soybeans was 102.7%, and it after sunflower and winter wheat was 68.5 and 98.4%, respectively. At the same time, the level of profitability of cultivating the crop was 102.7% (Gyrka et al., 2014).

Improving the technology of spring barley growth is an extremely urgent task, since under the current economic conditions cheapening of grain production and increase of its profitability is possible only in the case of application of new agrotechnical methods which do not involve high costs. Modern intensification of crop production in the conditions of acute deficiency of organic fertilizers and too high prices for mineral fertilizers involves the development of alternative measures of technology of crop cultivating. In the context of this, the study of the influence of highly effective polymer chelate fertilizers, biopreparations, growth-regulating substances, etc. in combination with other agrotechnical elements on the formation of biometric indices of plants, productivity and quality of production becomes of increasing importance (Rozhkov et al., 2017). There is a need for the development and implementation of resource-saving elements in plant nutrition technology, which consists of applying of low doses of mineral fertilizers and, on their background, using of extra-root nutrition with modern substances in the main periods of their vegetation (Gamayunova et al., 2017).

Plant nutrition during the vegetation period provides the reduction of plant stress caused by adverse weather and climatic conditions, which, according to many scientists, is an integral part of intensive agricultural production (Sepiedeh et al., 2014; Begum et al., 2015).

Mineral fertilizers, including increasing doses of nitrogen fertilizers, contribute to the growth of the biomass of plants and the increase in grain yield (Novotna et al., 2015; Povilaitis et al., 2018). One of the ways for increasing the effectiveness of mineral fertilizers, used for reducing their norms, is the use of growth stimulants. Due to synthetic fertilizers, the plant resistance to adverse weather conditions increases, also to the damage by pests and diseases, etc. According to the data of research, it was determined that the use of modern growth-regulating substances on grain and legumes (Fabaceae) crops is worth the cost of a yield increments (growth) for 30-50 times, and is in sunflower - for 50-100 times, in fact, this measure is one of the most profitable in yield

raising (Panfilova et al., 2018; Kolesnikov et al., 2016).

Numerous studies of scientists in the world found that the use of complex organic fertilizers, composite biological growth-regulating substances, inoculants, nanoparticles, and nutrient elements contributed to the regulation of growth processes and development of plants, their resistance to stress through increased plant immunity, activation of biological processes, synthesis of organic substances, increasing the area of the leaf surface, the increasing in the net productivity of photosynthesis and the yield (Singh et al., 2018; Pestovsky et al., 2017; Piskaeva et al., 2017; Wakchaure et al., 2016; Klein et al., 2018). However, today, the market presents a very wide range of substances, which complicates their choice, and the number of scientific evidence regarding the impact of these substances on the productivity of barley in the world of scientific literature is not studied. Taking into account the acuteness of the problem, the aim of the study was to determine the impact of modern certified substances, in particular organo-mineral fertilizers Organic D2 and natural microbial complex Escort-bio, on the productivity of barley of spring varieties Adapt, Stalker and Aeneas, which involves the partial replacement of mineral fertilizers and chemical pesticides in order to increase the yield. The relevance of this study increases with the globalization of the influence of anthropo-technological load on the natural environment and the growth of the rate of depletion of natural ecosystems.

MATERIALS AND METHODS

Experimental researches were carried out during 2013-2017 years in the location of the educational-scientific-practical center of the Mykolayiv National Agrarian University.

The soil of experimental sites was represented by the southern, resiliently weakly sunny, heavy-sooty black soil on the loesses. The reaction of the soil solution was neutral (pH 6.8-7.2). The content of humus in the 0-30 cm layer was 3.1-3.3%. The arable layer of soil contained moving forms of nutrients on average: nitrates (by GrandvalLiagou) as 15-25, mobile phosphorus (by Machigin) as 41-46,

exchangeable potassium (on a flame photometer) as 389-425 mg/kg of soil.

The territory of the farm locates in the third agro-climatic region and belongs to the subzone of the southern steppe of Ukraine. The climate here is temperate-continental, warm, dry, with unstable snow cover. Weather conditions by hydrothermal indices during the research years varied, which gave an opportunity to obtain objective results. During the period of spring barley vegetation, the temperature of the air exceeded the average annual parameters by 0.3-1.4°C, depending on the year. The only exception was 2016, where the temperature of the air during the vegetation period was +14.9°C, which was somewhat lower than the long-term figures. During the vegetation of spring barley, depending on the year of the study, the precipitation fell as 95.8-189.5 mm. At the same time, in 2015 and 2016, the largest precipitation was 189.5 and 179.0 mm respectively, which exceeded the average annual figures by 15.1-19.8%.

The object of research was spring barley - varieties Adapt, Stalker and Aeneas. The technology of their cultivation, with the exception of the investigated factors, was generally accepted to the existing zonal recommendations for the Southern Steppe of Ukraine. Weather conditions in the years of research varied, in particular, in 2015 and 2016 during the vegetation the considerably more rainfall dropped. In general, they were typical for the southern step peregion of Ukraine.

The total area of the experimental plot (the research work was organized by the random method of choosing the plots) was 80 m², the basic plot was 50 m² (length - 21.18 m, width - 2.36 m), repetition in the experiment was done three times. Pre-crops was sown peas *Pisum sativum* L. The scheme of the experiment included the following options:

Factor A - variety: 1. Adapt; 2. Stalker; 3. Aeneas.

Factor B - plant nutrition: 1. Control (without fertilizers); 2. N₃₀P₃₀- under pre-sowing cultivation - background (nitrogen was used in the form of ammonium nitrate (34% N), and phosphorus was in the form of double phosphorus (46% P); 3. Background + Urea K1 (1 l/ha); 4. Background + Urea K2 (1 l/ha); 5.

Background + Escort-bio (0.5 l/ha); 6. Background + Urea K1 + Urea K2 (0.5 l/ha); 7. Background + Organic D2 (1 l/ha). The standard working solution was 200 l/ha. The fertilization of crops by fertilizers was carried out at the beginning of the phases of the spring barley stooling (BBCH 31) and earing (BBCH 51).

Preparations to be used for foliar application of barley crops were listed in the List of pesticides and agrochemicals authorized for use in Ukraine. Preparations of Urea K1 and Urea K2 are registered as fertilizers containing respectively N as 11-13%, P₂O₅ as 0.1-0.3%, K₂O as 0.05-0.15%, micronutrients as 0.1%, succinic acid as 0.1% and N as 9-11%, P₂O₅ as 0.5-0.7%, K₂O as 0.05-0.15%, sodium humate as 3 g/l, potassium humate as 1 g/l, trace elements as 1 g/l. Organic D2 is organo-mineral fertilizer containing N as 2.0-3.0%, P₂O₅ as 1.7-2.8%, K₂O as 1.3-2.0%, total calcium as 2.0-6.0%, organic matter as 65-70% (in terms of carbon). Escort-bio is a natural microbial complex that contains strains of microorganisms of genera *Azotobacter*, *Pseudomonas*, *Rhizobium*, *Lactobacillus*, *Bacillus*, and biologically active substances produced by them.

In the process of research, the method of the State Variety Testing of Agricultural Cultures was used (Volkodav et al., 2001). The sowing was done during the third ten-day period of March, harvesting - the first ten-day period of July. The crop structure (total number of stems and productive stems, number of grains in the ear and weight of grain from one ear) was analyzed by the sheaves, which were taken before harvesting from the sites of 1 m².

The structure of the crop was analyzed by the sheaves, which were taken before harvesting from the plot of 1 m² in two non-adjointing reiteration. The average number of ears in the ear was determined by counting the number of ears per 25 spikes. The average mass of grain from one ear was calculated by dividing the weight of the grain of the spikes sample per the number of productive stems. The yield was determined by the method of continuous harvesting of each registration area (Sampo - 130 combine harvester).

The statistical analysis (repetition was three times during 5 years of growing grain) of the

research were processed using the method of multivariate disperse analysis.

The obtained data were compared using analysis of variance (ANOVA). All statistical analyses were performed with Statistica 10, Agrostat New and Microsoft Office 2010.

RESULTS AND DISCUSSIONS

The crop structure is a quantitative expression of the result of the plant's vital activity, which determines the size of the yield and reflects the interaction of the plant and the environment at certain stages of its growth and development. Important components of the crop structure of spring barley are the coefficient of productive bruising, the length of the ear, the number of grains in the ear and the mass of 1000 grains (Girka et al., 2017).

The main factors which form the productive stalk are the genetic features of the variety, the nutrition of plants with nutrients and hydro-thermal conditions of the growing season. Tamm (2003) reported a relatively low genetic variability in the tillering among the European spring barley varieties, however, information

on the differences in the relative proportion of individual tiller categories is not available.

The critical period for grain number determination is generally between the end of the tillering and the end of the stem elongation (Chmielewski and Köhn, 1999), so that a sufficient number of strong fellers at the beginning of this period are critical for achieving a high number of grains in the spike. From the studied varieties of spring barley, on average, over the years of research and in terms of nutrition, somewhat higher density of productive stems, were formed by plants of the Aeneas variety as 379 pcs./m², while Adapt and Stalker plants were slightly smaller as 349 and 361 pcs./m² (Table 1). It should be noted a more pronounced response to the optimization of plant nutrition of the Aeneas variety, with this indicator varied from 341 to 401 pcs./m².

The largest number of productive stems in the studied spring barley varieties was formed on the background of mineral fertilizers in a dose of N₃₀P₃₀ under pre-sowing cultivation and conducting of extra-root crops fertilization in the main phases of growth and development of plants with the preparations Organik D2 and Escort-bio.

Table 1. The number of common and productive stems in plants of spring barley varieties depending on the optimization of plant nutrition (average for 2013-2017 years), pcs./m²

Plant nutrition (factor B)	Variety (factor A)					
	Adapt		Stalker		Aeneas	
	total number of stems, pcs./m ²	number of productive stems, pcs./m ²	total number of stems, pcs./m ²	number of productive stems, pcs./m ²	total number of stems, pcs./m ²	number of productive stems, pcs./m ²
Control (without fertilizers)	364	315	383	324	411	341
N ₃₀ P ₃₀ (background)	389	335	406	350	450	371
Background + Urea K1	402	348	421	361	499	379
Background + Urea K2	410	353	431	366	509	382
Background + Escort-bio	442	369	475	381	558	401
Background + Urea K1 + Urea K2	424	358	446	370	533	386
Background + Organic D2	435	363	463	372	543	391
LSD _{0.5} 2013: factor A	13.0	6.9				
factor B	8.1	11.0				
2014: factor A	11.0	15.0				
factor B	9.0	7.0				
2015: factor A	12.0	5.0				
factor B	8.0	8.0				
2016: factor A	2.0	8.0				
factor B	8.0	7.0				
2017: factor A	6.0	4.0				
factor B	6.0	6.0				

According to the LSD test the difference between the studied variants of the experiment significant ($P > 0.05$).

Thus, in these variants of plant nutrition of the Aeneas variety, 391 and 401 pcs./m² of productive stems were formed, respectively, and Adapt and Stalker varieties were respectively 363-369 and 372-381 pcs./m², which exceeded the control respectively by 12.8-17.6; 13.2-14.6 and 12.9-15.0%.

Somewhat lower density of productive stalk was formed by co-treatment of spring barley crops with substances Urea K1 and Urea K2 in the background of mineral fertilizers. Thus, on average, over the years of research, 1 m² at the same time there were 358-386 productive stems in terms of varieties, which exceeded the indices of variants without fertilization by 12.0-13.2%.

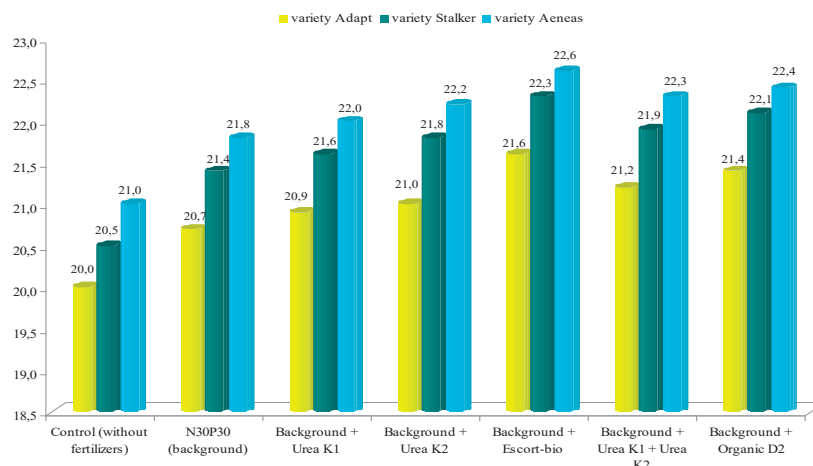
It should be noted that the application of mineral fertilizers in the moderate recommended dose of N₃₀P₃₀ contributes to the increasing of the specified indicator of the crop structure of spring barley compared with the control of 6.0-8.1% depending on the variety. But compared with the variants of foliar fertilization (Urea K1, Urea K2, Organic D2, Escort-bio), the number of productive stems by fertilizing in dose of N₃₀P₃₀ was less than 3.7-9.2% for the cultivation of the Adapt variety, 3.1 to 8.1% for the cultivation of the Stalker variety and 2.1 to 7.5% for the Aeneas variety.

The dispersion analysis showed that the studied factors affect on the total number of stems per

the spring barley plant. Thus, on average, over the years of research, the highest impact on this indicator had variety (factor A) - the share of the impact was 53.2%. The share of the impact of factor B was 42.4%. The interaction of the studied factors was 4.2%.

In the distribution of the impact of the studied factors on the number of productive stems, it was observed another dependence. So, the factor of plant nutrition (factor B) provided 65.7%, the factor of variety (factor A) provided 32.7%, the interaction of both factors (factor A and B) provided 0.4%.

One of the most important elements which characterize the productivity of a spike of spring barley is the number of grains in the ear. Studies by Del Moral et al. (2003) shows that the stability of yield of spring barley varieties in various conditions is closely related to the number of grains in the ear. It provides the formation of the greater number of grains per area unit with the availability of the lesser number of ears. But the quantity of ears can decrease. And, conversely, according to Jockovic et al. (2014) the number of grains in the ear can not significantly affect the grain yield. Our research established that the specified element of the productivity of spring barley depended on the variety and plant nutrition variant (Figure 1).



LSD_{0.5} (pcs.): Factor A (variety): 2013 - 2, 2014 - 4, 2015 - 8, 2016 - 7, 2017 - 2

Factor B – plant nutrition: 2013 - 1, 2014 - 2, 2015 - 2, 2016 - 4, 2017 - 1

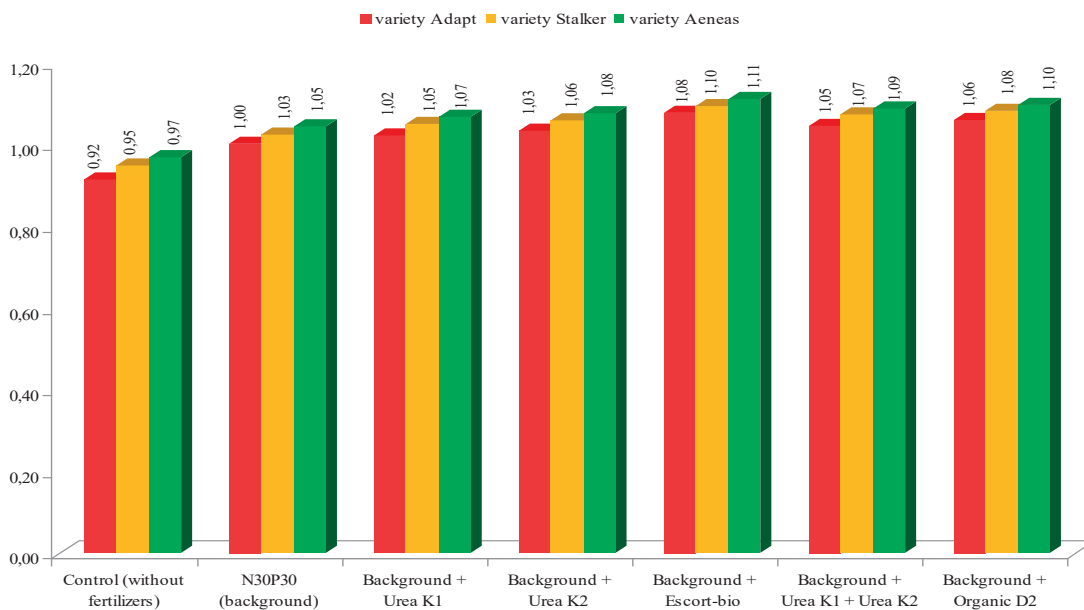
According to the LSD test the difference between the studied variants of the experiment significant (P > 0.05).

Figure 1. Number of grains in the ear of spring barley varieties depending on the optimization of plant nutrition, pcs. (average for 2013-2017)

Thus, on average, over the years of research, plant nutrition variants have significantly influenced on the number of grains in the ear of the studied varieties of spring barley. So on the control (without fertilizers) the ear of the Adapt varieties plants numbered 20.0 grains, the ear of the Stalker variety numbered 20.5 pcs. and the ear of the Aeneas variety numbered 21.0 pcs., then the pre-planting of only mineral fertilizers provided the increasing of this index in terms of the studied varieties by 3.5-4.4%, and for conducting in the background of fertilizers of extra-root nutrition by 4.5-8.0% for the cultivation of the Adapt variety, by 5.4 to 8.8% for the Stalker variety, and by 4.8 to 7.6% for Aeneas variety.

A somewhat larger number of grains in the ear in all years of the research were formed by plants of the Aeneas variety. So, on average, over the years of research on the plant nutrition factor, they formed 22.0 pcs., which exceeded other varieties by 0.3-1.0 pcs. or 1.4-4.8%. The application of Organic D2 and Escort-bio contributed to an increase in the number of grains in the ear from 6.3 to 7.6% for the Aeneas variety.

We found that on average over the years of research, varieties and variants of plant nutrition affected on the mass of grain from one ear (Figure 2).



LSD_{0.5} (pcs.): Factor A (variety): 2013 – 0.010, 2014 – 0.017, 2015 – 0.023, 2016 – 0.036, 2017 – 0.002

Factor B – plant nutrition: 2013 – 0.008, 2014 – 0.0013, 2015 – 0.019, 2016 – 0.032, 2017 – 0.003

According to the LSD test the difference between the studied variants of the experiment is not significant (P > 0.05).

Figure 2. Weight of grain from one ear of spring barley, depending on the variety and the background of nutrition, g (average for 2013-2017 years)

So, for the application of the background recommended dose of mineral fertilizers for spring barley in a variety of varieties Adapt the weight of grain from the ear in comparison with unchecked control increased by 9.4%, the weight of grain from the ear of the Stalker variety increased by 8.0%, and weight of grain from the ear of the Aeneas variety increased by 7.9%. Conducting of extra-root nutrition on the background of mineral fertilizers increased the specified index of crop yield structure, respectively, by 11.9-17.7; 10.6-15.5 and 10.2-14.7% for control.

Similarly, the studied factors were also reflected in the levels of grain yield of spring barley varieties (Table 2).

The given data testified that plant nutrition significantly influenced on the productivity of spring barley varieties. According to the results of the dispersion analysis, it was found that on the average over the years of research, the share of the impact of factor B (plant nutrition) was 74.5%. The factor A (variety) had a weaker effect on the crop yields as the share of impact was 23.9%. The interaction of factors A and B was 0.3%.

It was established by the research that application of Urea K1 and Urea K2 for foliar fertilization of plants increased the grain yield of spring barley. Thus, on average, over the years of research and by factor variety, it were formed 3.21 and 3.26 t ha⁻¹ grains, which exceeded the control by 0.55-0.60 t ha⁻¹ or by 20.7-22.6%, N₃₀P₃₀ (background) - by 0.15-0.20 t ha⁻¹ or by 4.7-6.1%. But compared to the use of Organic D2 and Escort-Bio, the yield of barley was somewhat

lower by 3.3-4.7 and 4.4-5.9%. The co-administration of these drugs provided the grain yield of spring barley at almost the same level as 3.33 t ha⁻¹.

Yields are significantly dependent on the characteristics of the variety. At the present time, the spring barley and winter wheat variety acts as an independent factor in increasing of grain yield (Panfilova et al., 2018; Panfilova & Mohylnytska, 2019).

Table 2. Yield of spring barley depending on varietal characteristics and optimization of plant nutrition, t ha⁻¹

Variety (factor A)	Plant nutrition (factor B)	Years					Average for 2013-2017 yrs
		2013	2014	2015	2016	2017	
Adapt	Control (without fertilizers)	2.25	2.61	2.55	2.86	2.52	2.56
	N ₃₀ P ₃₀ (background)	2.51	2.96	2.90	3.28	2.89	2.91
	Background + Urea K1	2.69	3.10	3.08	3.46	2.93	3.05
	Background + Urea K2	2.71	3.14	3.10	3.59	3.00	3.11
	Background + Escort-bio	2.83	3.27	3.21	3.75	3.20	3.25
	Background + Urea K1 + Urea K2	2.74	3.21	3.14	3.65	3.12	3.17
	Background + Organic D2	2.79	3.24	3.18	3.71	3.18	3.22
Stalker	Control (without fertilizers)	2.34	2.69	2.62	2.88	2.64	2.63
	N ₃₀ P ₃₀ (background)	2.66	3.09	3.01	3.30	3.06	3.02
	Background + Urea K1	2.79	3.20	3.18	3.65	3.15	3.19
	Background + Urea K2	2.81	3.23	3.20	3.70	3.22	3.23
	Background + Escort-bio	2.95	3.36	3.31	3.84	3.39	3.37
	Background + Urea K1 + Urea K2	2.86	3.29	3.26	3.76	3.30	3.29
	Background + Organic D2	2.91	3.32	3.29	3.80	3.35	3.33
Aeneas	Control (without fertilizers)	2.36	2.80	2.79	3.18	2.89	2.80
	N ₃₀ P ₃₀ (background)	2.73	3.21	3.22	3.75	3.31	3.24
	Background + Urea K1	2.94	3.40	3.29	3.94	3.34	3.38
	Background + Urea K2	2.99	3.48	3.35	4.01	3.36	3.44
	Background + Escort-bio	3.12	3.58	3.52	4.30	3.51	3.61
	Background + Urea K1 + Urea K2	3.06	3.51	3.42	4.22	3.41	3.52
	Background + Organic D2	3.08	3.56	3.47	4.25	3.45	3.56
LSD _{0.5} factor A	0.08	0.10	0.09	0.08	0.11		
factor B	0.11	0.13	0.14	0.10	0.13		

According to the LSD test the difference between the studied variants of the experiment significant (P > 0.05).

According to Ayranci et al. (2014) and Ahmadi et al. (2016), the grain yield is more dependent on the environment during the growing season than on the genotype effect.

The application of a moderate dose (N₃₀P₃₀) of mineral fertilizers contributed to the slight increasing in the grain yield of winter wheat in all years of research irrespective of the variety (Panfilova et al., 2018). At the same time,

studies (Ammanullah, 2014; Sedlar et al., 2017) showed that moderate doses of nitrogen fertilizers (50-100 kg ha⁻¹) had a slight effect on the grain yield. At the same time, the grain yield of corn increased with an increase in the dose of N to 150 kg ha⁻¹. In our studies, the application of a moderate dose (N₃₀P₃₀) of mineral fertilizers contributed to the slight increasing in the grain yield of spring barley in

all years of research irrespective of the variety - by 0.35-0.44 t ha⁻¹.

According to the results of our research, it was established that, in addition to weather conditions and plant nutrition options, the variety played an important role in the formation of spring barley yield. Thus, on average, over the years of research on nutrition, the highest grain yield was formed by Aeneas plants as 3.36 t ha⁻¹, which exceeded its level in the Stalker variety by 0.21 t ha⁻¹ or 6.3%, and the Adapt variety by 0.32 t ha⁻¹ or 9.5% respectively. According to the LSD test the difference between the studied variants of the experiment significant ($P > 0.05$).

On average, over the years of research, it was proved that the grain yield of spring barley depended on the studied characteristics of the yield structure. Thus, according to the results of the correlation analysis, it was established the strong correlation between the yield and the number of productive stems of the plant ($R^2 = 0.979$), the yield and the number of grains in the ear ($R^2 = 0.974$), the yield and the weight of grains from the ear ($R^2 = 0.949$).

CONCLUSIONS

In the conditions of southern Ukraine, the application of mineral fertilizers at a dose of N₃₀P₃₀ under pre-sowing cultivation and the implementation of foliar nutrition of crops at the beginning of the phase of spring barley stooling and earing with the preparations Urea K1, Urea K2, Escort-bio and Organic D2 provides the best conditions for the growth and development of plants and, as a consequence, the formation of more optimal indicators of the yield structure and grain yield. Thus, according to these plant nutrition options, on the average over the years of research, the number of productive stems in plants of the Aeneas variety was 386-401 pcs./m², and it was in the Adapt and Stalker varieties, 358-369 and 370-381 pcs./m². In this regard, irrespective of the year of cultivation, the highest grain yield of spring barley was formed by the application of mineral fertilizers in a dose of N₃₀P₃₀ and nutrition of plants with the preparation Escort-bio. On average, over the years of research, in this version of the plant nutrition, the highest level of grain productivity among the studied

varieties was provided by the variety Aeneas as 3.61 t ha⁻¹. When fertilizing with other treatments, the grain yield of the Aeneas variety was not significantly less - 3.52-3.56 t ha⁻¹.

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