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INFLUENCE OF PRECURSORS ON BIOMETRIC INDICATORS AND YIELD OF WINTER WHEAT IN DIFFERENT AGROBIOCENOSES

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Abstract

In the structure of sown areas of Ukraine an important place is given to winter wheat. To obtain high and sustainable profits in production, it is necessary to analyze and evaluate the conditions that affect the productivity of crops, in particular winter wheat in different agrophytocenoses. There are many factors on which the yield of this crop depends: soil moisture, agrophysical, agrochemical and microbiological indicators of its fertility. It is known that in modern conditions the choice of precursors based on profitability and market demand, so putting winter crops primarily occurs after such crops which can not provide optimal conditions for its development. Increasing the sown areas of sunflower, corn, soybeans and rapeseed forces farmers to grow winter wheat after these crops. The data obtained to determine the density of productive stems, plant height, ear fullness of grain, the weight of grain from the ear indicate that the precursors affect these indicators throughout the growing season of winter wheat, thus forming its yield. It was found that fallow as a precursor provided the best conditions for the formation of high grain yields of winter wheat. Unsatisfactory precursors were sunflower and corn, which created poor starting conditions for the development of winter wheat in autumn and subsequent stages of development, which in turn led to a decrease of winter wheat yield. Legume precursors: peas, soybeans, and beans significantly improved the starting conditions for wheat plants, which contributed to better formation of vegetative mass and reproductive organs. In terms of yield structure, these options were inferior to fallow, but also had high values and, accordingly, yield.

Key words*: Winter wheat, precursor, yield structure, yield.*

INTRODUCTION

Predecessors of winter wheat occupy a special place in terms of the impact on its yield. Their agrotechnical significance depends on biological features, namely: the impact on the content of moisture and nutrients in the soil, the phytosanitary condition of the field after harvesting, etc. Under modern conditions, the list of precursors of winter wheat is constantly changing, responding to market demand, and not for the better. After all, now in the economic crisis, agricultural production seeks to increase the area of such highly profitable crops as sunflower, rapeseed, corn, soybeans. In the absence of sustainable livestock development and reduced need to grow perennial grasses and other fodder crops on farms, which were previously used as the best precursors of winter wheat, there is a need to place it after these crops.

According to O. V. Demydenko, P. I. Boyka, M. I. Blashchuk and others. due to the transformation of the structure of sown areas, the structure of the precursors of winter wheat changed. In the period 2017–2018, the correlation between the percentage of industrial crops and the areas of suboptimal predecessors was at the level of strong direct correlation ($R = 0.71–0.83 \pm 0.02$; $R = 0.51–0.69$). The percentage of areas of industrial crops with the percentage of areas of forage crops and early and optimal predecessors correlated at the level of inverse correlation. The increase in the percentage of areas of industrial crops in the transformed structures of sown areas to 31.0-33.0% radically subordinates the formation of the structure of precursors of winter grain areas of sowing of industrial crops and weakens the relationship with the area of fodder and legumes (Boyko, & Blashchuk, 2019).

As a result, there is a decrease in grain yield and deteriorating soil fertility, as well as the need to create better conditions for plant growth and development. And this is usually the use of high doses of fertilizers, pesticide treatment of plants, which leads

In recent years, the problem of placing winter wheat in crop rotations and selecting the best predecessors for it is quite relevant – it was studied by many scientists: P. I. Boyko, Ye. M. Lebid, A. I. Khorishko, I. S. Hodulyan and others (Boyko & Blashchuk, 2019; Lebid et al., 2005; Khorishko, 1997; Godulyan, 1974)

MATERIALS AND METHODS

Studies to study the impact of different precursors on the productivity of winter wheat were conducted in the period 2017-2020 under the conditions of a stationary experiment of the Department of Agriculture named after O. M. Mozheyka in the research field of Kharkiv National Agrarian University named after V. V. Dokuchaiev. A large part of the territory of Kharkiv region together belongs to the Left Bank Forest-Steppe of Ukraine. The southern and south-eastern parts of the region are located in the Northern Steppe. Kharkiv region in the forest-steppe zone of Ukraine is marked by the largest manifestation of continentality, which noticeably increases from northwest to southeast.

Geomorphologically, the land on which the experiments were conducted is located on the southeastern edge of the forest-steppe zone near the fourth left-bank terrace of the Uda River and crosses it in a narrow strip.

The soil cover on the territory where the research was conducted is represented mainly by chernozem typical leached low-humus heavy loam on forest-like loam. Formed under conditions of well-developed grassy vegetation and moderate moisture on unsalted forest species, typical chernozem is characterized by agronomically valuable granular-lumpy structure, good physical and mechanical properties, large reserves of nutrients available to plants, high content of humus and humus content.

According to the data of soil mapping, a macromorphological description of the profile of agrochernozem (Tykhonenko & Dehtiarov, 2014) of a typical deep low-humus (weakly structural) heavy loam on loess-like loam is given (Tykhonenko & Dehtiarov, 2016).

The arable layer of soil (0-30 cm) contains humus according to Tyurin – 4.9-5.1%, light hydrolysis nitrogen (according to Cornfield) - 8.1 mg per 100 g of soil, mobile phosphorus and exchangeable potassium (according to Chirikov) – 10 and 20 mg per 100 g of soil, respectively. According to the content of mobile forms of phosphorus and potassium, the soil is characterized by increased security. The content of exchangeable cations: calcium – 37.8%, magnesium – 6.6%, sodium – 0.49%, potassium – 0.5%, hydrogen - 21 mg. eq./kg of soil. The soil has a neutral reaction of the soil solution (pH: water – 7.0, salt – 5.2-5.6). Groundwater lies at a depth of about 18 m.

This soil is characterized by agronomically valuable structure, good physical and mechanical properties and intensive biological activity.

According to the amount of precipitation, the territory of the experimental field belongs to the zone of insufficient moisture. The annual amount of precipitation in the area, according to the meteorological station of KhNAU, is on average 529 mm. Depending on the intensity and recurrence of precipitation processes, the amount of precipitation in some years varies significantly from 342 mm (65% of normal) to 767 mm (145% of normal).

A characteristic feature of the climate is aridity, which is due not so much to the total rainfall as to the uneven distribution of them during the year and especially during the growing season. The average annual air temperature is + 7.2ºC with fluctuations in some years from +4.7 to + 9.2ºC (Obraztsova, 2001).

Agricultural techniques for growing crops in the experiment are generally accepted for the conditions of the Kharkiv region (Nezdiur et al., 2016).

Six variants of crop rotations were studied in triplicate. Placement of options is systematic. The area of the sown area is 750 m^2, the accounting area is 100 m^2. The following precursors of winter wheat were studied: pure steam, peas, sunflower, soybeans, beans, corn in short-rotation crop rotations with the following scheme:

1. Precursor of winter wheat.
2. Winter wheat.
3. Row crops.
4. Winter wheat.
5. Sunflower.

RESULTS AND DISCUSSIONS

The productivity of winter wheat is determined by the action of many factors: the conditions of moisture, agrophysical indicators of soil fertility, nutrient regime, the action of biological factors that develop after the cultivation of various predecessors. The combined action of these factors in combination with meteorological conditions affects the formation of elements of the crop structure, and, as a consequence, its yield.

The main elements of the structure of the crop include: the density of productive stems, plant height, the filling of the ear with grain, the mass of grain from the ear. Each of these elements can increase or decrease under the action of the environment. The study of this indicator allows us to trace the relationship between plants and the environment in different periods of the growing season against the background of a predecessor (Kudria, 1999)

One of the elements affected by precursors is the density of productive stems. This indicator depends on the density of plants, the characteristics of the variety, the availability of plants with available moisture, light, nutrients, etc.

In our studies, the number of productive stalks of winter wheat varied significantly depending on the predecessor. On average, in two years of research, the largest number of spike-shaped stems had variants with pure steam – 439 and peas – 449 pcs./m^2 (Table 1). Moreover, the number of plants per 1 m^2 in these variants was almost the same, respectively 192 and 190 pcs./m^2. It was after these predecessors that the most favorable conditions developed in the initial phases of winter development, especially in autumn, when wheat plants formed the most resistant to adverse conditions productive stems and in early spring, during continued tillering. And the variant with peas exceeded steam on 10 pcs./m^2 of productive stalks.

Worse starting conditions for the development of winter wheat were formed after other legume predecessors: beans and soybeans. In these variants at rather high indicator of density of standing of plants of 195 and 193 pcs./m^2 of plants much less productive stalks were formed, according to our data on the average for two years of researches – 388 and 400 pcs./m^2. These two legumes are row crops and are harvested late. The number of leftovers left after them can be much smaller than after peas. In the complex, it affects the soil moisture and the content of nutrients in it, especially nitrogen, and, as a consequence, determines the timeliness of emergence of winter wheat seedlings and their further development

Variants with sunflower and corn had the lowest values of plant density: 165 and 170 pcs./m^2, and the productive bushiness on these variants was respectively: 401 and 411 pcs./m^2.

The tallest plants of winter wheat before harvesting were in the version with pure steam – 93.5 cm.

The height of plants in the variants with leguminous predecessors was inferior to the steam variant and the plants after them were lower by an average of 8.4 cm. It should be noted that this is a significant difference, which indicates some deterioration of development conditions throughout the growing season. The lowest plant height values were obtained in the variants with sunflower and corn – 79.5 and 78.1 cm, respectively.

Table 1. The structure of the winter wheat yield depending on the predecessors

Predecessor	Density, pcs./m^2	Number of productive stems, pcs./m^2	Stem height, cm	Ear length, cm	Number of spikelet's in the ear, pcs.	The number of grains in the ear, pcs.	Weight of grain from the ear, g
Pure steam	193	439	93,5	14,3	16,5	43,5	1,6
Pea	190	449	84,5	14,2	16,0	38,0	1,4
Sunflower	195	388	85,6	12,6	14,0	38,0	1,1
Soybean	193	400	85,8	13,4	15,5	38,5	1,1
Bean	165	401	79,5	14,1	15,5	31,0	1,3
Corn	170	411	78,4	12,9	14,0	31,5	1,1

The yield of winter wheat also depends on the size of the ear and its grain content. Ear formation in plants occurs in early spring and is determined by the conditions that develop during the period of bookmarking and differentiation of the ear and wheat flowering. This process is best done with the optimal amount of nutrients in the soil solution. Insufficient amount of nitrogen leads to delayed ear development and reduced size of its elements (Kudria, 2018).

According to A. I. Nosatovskoho, the presence of sufficient phosphorus in the soil accelerates the process of ear differentiation, as a result of which the number of spikelet's often decreases. According to the scientist, the delay in the formation of the ear, as well as the difference in its structure is due to a violation of the ratio of nutrients, namely: the ratio of nitrogen to phosphorus or nitrogen to potassium (Nosatovskiy, 1963).

As a rule, the amount of moisture in the soil during the spring restoration of winter vegetation is sufficient for its development. It continues to bush and intensively accumulate vegetative mass. It is known that the content of nutrients in the soil depends on the precursors, which accordingly affected the structure of the ear in our studies.

The version with pure steam had a longer ear length – 14.3 cm. Winter wheat placed after peas and beans on average for two years of research had the length of the ear at the level of the option with pure steam. The difference was insignificant and amounted to 0.1; 0.2 cm, respectively. After soybeans, wheat plants formed a slightly shorter ear and compared to the steam version, the difference was 0.9 cm. The lowest indicator of ear length was in the variants with sunflower and corn – 12.6 and 12.9 cm.

A similar trend was observed in determining the number of spikelet's in the ear. Most of them were in the version with pure steam – 16.5 pcs. After legume predecessors, the number of ears in the ear decreased and this figure ranged from 15.5 to 16.0 pcs., but the difference was insignificant. More significant was the difference in options with sunflower and corn. The number of spikelet's in the ear when placing wheat after these crops was the smallest and was in both cases 14.0 pcs., which is less than the steam version by 2.5 pcs.

On average over two years of research, the number of grains in the ear ranged from 31.0 to 43.5 pcs. Most of them were in the ear of wheat placed after pure steam, and the least – after sunflower and corn. Variants with peas, beans and soybeans were equivalent and slightly inferior to the steam variant, the difference averaged 5.3 pcs.

The productivity of an ear is determined not only by the number of grains in it, but also by the weight of the grain. The mass of grain from one ear varied under the influence of predecessors. The heaviest ear was in the version with pure steam, its weight was on average for two years of research – 1.6 g, which exceeded the other options by an average of 0.3 g. The ear weighed the least when placing wheat after sunflower, soybeans and corn, 1.1 g each.

The weight of grain from one ear of winter wheat in the variants with leguminous predecessors: peas and beans were lower than in the steam variant, but exceeded the variants with sunflower and corn by an average of 0.3 g.

Indicators of ear fullness of grain largely depend on the conditions that developed during its formation. Differences between options are due to both meteorological factors and the ability of plants to accumulate plastic substances during grain formation. Winter wheat placed after pure steam, peas, beans and soybeans developed better during the growing season and used moisture and nutrients from deeper soil layers, which contributed to the formation of whole grains. Deterioration of conditions of formation of elements of a crop after sunflower and corn led to decrease in indicators of all components of structure of a crop in these options.

Differences between the options for the formation of elements of the structure of the winter wheat crop determined its yield, which was determined during three years of research (2018-2020). The role of pure steam in crop rotation is known. Many researchers report the highest yields of winter wheat after this predecessor (Lebid, Medved, Kyrchuk, & Pishta, 2005).

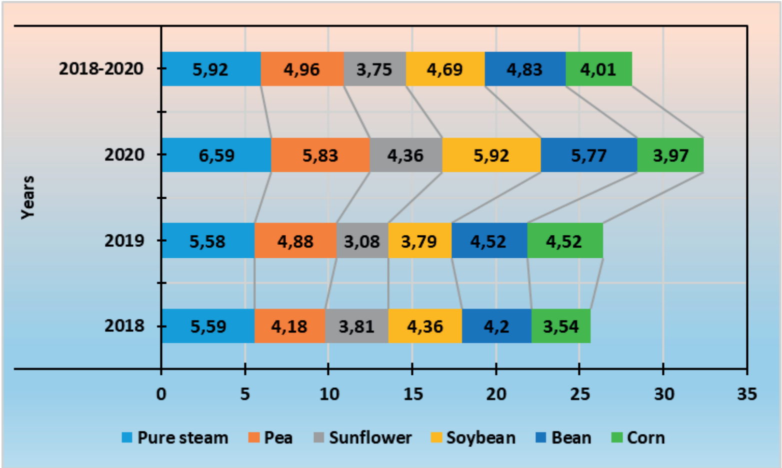

Figure 1. Yield of winter wheat depending on predecessors, t/ha

In our research, the highest yield of winter wheat was formed in the variant with pure steam – 5.92 t/ha, which indicates the positive effect of the steam field and the creation of the necessary conditions for plant growth and development regardless of the weather. According to our data, in each year of research, the yield of wheat in this option was quite high compared to other options.

Studies have shown a significant reduction in grain yield for the placement of winter wheat after legumes predecessors: peas, soybeans and beans.

Compared to the steam version, this figure is lower by an average of 1.09 t/ha. Compared to the steam version, this figure is lower by an average of 1.09 t/ha. This is a significant difference and it indicates the deterioration of plant development conditions after these predecessors (Figure 1).

Peas, as a precursor of winter wheat, have a positive effect on its yield. But this effect is limited by the level of its yield and the amount of crop residues that remain after it. According to V. S. Chumak, O. I. Tsilyurik, I. E. Fedorenko, the amount of crop residues after peas was very low and amounted to 2.15-2.80 t/ha. While after sunflower they remained 66.2–78.9, after corn – 3.49–4.49 t/ha (Chumak, Tsyliuryk & Fedorenko, 2005).

In addition, peas compete poorly with weeds, especially in the early stages of development, which can increase the potential infestation of the field with weed seeds and reduce the yield of the next crop, namely winter wheat.

Soybeans and beans – row crops, harvested relatively late, after which there was much less moisture and crop residues in the soil, which led to a significant decrease in yield compared to pure steam.

Despite the decrease in yield after these predecessors, their agronomic value in crop rotations is very important. A feature of these crops is the fixation of atmospheric nitrogen with the help of nodule bacteria that settle on the roots and its accumulation in the soil. They improve biological processes in the soil due to the favorable chemical composition of root and post-harvest residues. After harvesting, the content of phosphorus and potassium in the soil increases. Accumulated in the roots of legumes and released after their death, calcium cements the soil and improves its structure.

The lowest grain yield was formed by wheat after its placement after sunflower and corn: 3.75 and 4.01 t/ha, which is 2.17 and 1.91 t/ha lower than in the steam version, and on average compared to leguminous predecessors. at 1.07 and 0.81 t/ha. Sunflower and corn are late harvest crops, they remove a large amount of moisture and dissolved nutrients from the soil, which impairs their use by winter wheat at the beginning of the growing season in autumn and during the spring-summer period of development. In addition to the negative aspects, there are also positive factors of action of these crops in agrophytocenoses. First of all, it is a large number of crop residues that remain after harvesting. But in arid weather conditions, which were observed during the years of research, the decomposition of plant residues slowed down and their effect on the development of winter wheat plants was leveled. In the variant where the share of sunflower was 40% and this crop was used as a precursor of winter wheat (sunflower, wheat, row crops, winter rye, sunflower), received the lowest yield – 3.75 t/ha of grain.

CONCLUSIONS

The formation of elements of the structure of the winter wheat harvest was influenced by predecessors. When placing it after pure steam, the best conditions were created, which had a positive effect on the formation of productive bushiness of plants, height and structure of the ear. All these figures were the highest in the steam version.

Bean predecessors: soy peas and beans significantly improved the starting conditions for wheat plants, which contributed to better formation of vegetative mass and reproductive organs of wheat. In terms of the structure of the winter wheat harvest, these options were inferior to steam, but also had high values. The lowest indicators of crop structure elements were after sunflower and corn.

Conditions that developed after different predecessors influenced the development of winter wheat throughout the growing season. The highest yield of winter wheat was obtained in the version with pure steam. Studies have shown a significant reduction in wheat yield after its placement after legume predecessors: peas, soybeans and beans. The lowest yield was in the variants with sunflower and corn. Intensive use of sunflower crops in short-rotation crop rotations (40%) led to a significant decrease in winter wheat yield.

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