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CONTENT

AGRICULTURAL SCIENCES

GEOLOGICAL AND MINERALOGICAL SCIENCES

TECHNICAL SCIENCES

CHEMISTRY SCIENCES

FORMATION OF PRODUCTIVITY OF WINTER WHEAT CROPS DEPENDING ON AGROTECHNICAL METHODS OF TILLAGE

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Abstract

Following the correct technology of winter wheat production and grain storage, you can get a high economic effect of the activity.

Wheat is one of the first crops that were cultivated many years ago. And until now it deservedly occupies a leading place in the ranking of food products in about 50 countries around the world. Ukraine is also on this list, and in addition is a major producer and exporter of this cereal crop.

In Ukraine, wheat is considered one of the main food crops. It is used to make a valuable and cult product for Ukrainians - bread, so national economic importance of grain is difficult to underestimate. Quality bakery products determines the composition of grain. Among other grains, winter wheat contains a high percentage of protein, which reaches up to 15%, depending on the production technology and variety. In addition, the grain is rich in carbohydrates and other important trace elements..[1].

Among the crops grown in Ukraine, winter wheat is the leader in terms of sown area. And every year, despite the bad seasons and weather vagaries, the hectares of grain continue to remain at a stable level. So, for the 2020 harvest, 6400000 hectares of this winter crop were sown in Ukraine, which is 0.6% less than last year's figure. This relative stability is provided by the correct and modern technology of growing winter wheat, through which you can get a high result in agriculture.

The determining factor of production, regardless of the region of Ukraine is the technology of growing winter wheat. It acts as a guide for the agronomist at all stages of the production process. In accordance with the selected technological scheme, all operations in the field, from preparation for sowing to harvesting, are carried out. Producers choose the growing technology themselves according to the natural and climatic characteristics and capabilities of the farm..[2].

Keywords: yield, typical chernozem, winter wheat, structure, tillage, fertilizers.

Tillage is one of the main measures to optimize its properties (water-physical, biological, agrochemical), restore fertility, control phytosanitary condition, protect against erosion. Soil treatment methods that are adapted to the soil-climatic conditions and requirements of crop rotation have a positive impact on soil productivity.[3].

According to a number of authors (A. Mikhailovsky, E.V. Gerasimenko, V.M. Kaliberda, 1960; L.A. Shedei, R.V. Akimova, 2009), in the Forest-steppe conditions the most effective system of cultivation in crop rotations is combined, which combines deep loosening without turning the layer, surface cultivation and plowing [2, 3], which increases the productivity of the rotation.[4].

In experiments O.V. Pikovskoi, I.V. Prysyazhnyuk found that flat tillage is an effective means of improving the agrophysical parameters of chernozemcompared to traditional plowing. [5].

In turn, changes in the content of humus cannot but affect the yield of crops grown. However, the limiting factor of influence on the yield and quality of the crop is the fertilizer.

Mineral nutrition of plants is improved by applying scientifically proven doses of fertilizers. Fertilizer application in amounts exceeding the physiological need of plants does not lead to a further increase in yield and is accompanied by a deterioration in product quality [6].

The aim of our research is to establish the nature of the influence of the main tillage measures depending on the background nutrition on the yield of winter wheat and their economic efficiency in the grain-parrow crop rotation in the Right-Bank Forest-steppe of Ukraine.

The research was conducted during 2015-2016. In the conditions of the Right-Bank Forest-steppe of Ukraine on chernozem typical light loam Pogrebyshchansky agro-soil area in a grain-propagation rotation with alternating crops: clean fallow, winter wheat, sugar beet, barley.

Crop rotation deployed in space, the area of fields - 2.3 hectares, the area of finishing options - 2010 m2, fertilized background - 1643 m2.

The object of the research were tillage systems, namely:

1) classic tillage - disk flaking at a depth of 6-8 cm + plowing at 28-30 cm (LDG-10, PLN-3,35)

2) shallow tillage at a depth of 28-30 cm (PG-3-100)

3) surface cultivation at 10-12 cm (BDT-7).

The following fertilizer system was used in the studied crop rotation:

1) No fertilizer background;

2) N60P60K60 + 30 kg N (locally in the phase of tillering of winter wheat).

3) N60P60K60 + 30 kg N (locally in the phase of bush formation of winter wheat) and 15 kg N (foliar application in the phase of winter wheat entering the tube). Repetition of the experiment was three times.

Agrotechnics in the experiment, excluding the methods of main tillage, was basic for the lysotepe zone and was conducted in accordance with the method of

field experiment (V.F. Moiseychenko, V.O. Yeshchenko).

The soil cover of the experimental plot is represented by black clay loam of heavy granulometric composition, thickness of the humus horizon - 25-45 cm, medium supply of mobile forms of nitrogen and potassium, weak supply of phosphorus, the amount of absorbed bases - 38-42 mg-eq. per 100 g of soil, pH 4.6-4.9.

Structural analysis - by the method of trial sheaves according to the method [1]. Winter wheat yield accounting was carried out by direct harvesting method.

Statistical analysis of experimental data was carried out by dispersion and correlation-regression methods.

The results of the research found that on average for 2015-2016. The method of main treatment influenced the wintering of plants. Thus, the number of plants per square meter in the flat tillage was 228 pieces, which is 20 pieces or 9.4% more compared to the classical tillage, which included disk flaking in combination with plowing (Table 1). This is explained by more preferable formation of agrophysical soil parameters for winter wheat plants on the variants with flat tillage than with classical tillage, which is confirmed by scientific papers [5].

On the variants with the classical way of cultivation the number of stems with an ear per square meter was 470 units, with surface cultivation - 456 units, and with flat-row - 456 units, which is more by 14 and 28 units, respectively.

The combination of the fertilizer system together with the way of the main tillage had a positive effect on the formation of the parameters of the yield structure of winter wheat. So, compared to the control variant the number of plants increased by 56-87 units / M2, the total stems - by 92-126 units / M2, stems with an ear - by 99-136 units / M2, the ear length - by 0.4 1.9 cm, grain weight per ear - by 0.02-0.29 g, weight of 1000 grains - by 0.5-3.6 g.

Table 1

Effect of tillage methods and fertilizer systems on the formation of winter wheat yield structure parameters, 2015-2016rr.

The method of basic tillage	Background	Quantity, pcs / m2			Weight 1000, g	ear	
		plants	stems				
			total	with an ear		Length, cm	Mass grain, g
Disk peeling + plowing for 28-30 cm	Неудобрений	167	441	387	38,7	8,2	1,03
	$N_{60}P_{60}K_{60}$+ N_{30}	223	538	499	39,2	8,6	1,05
	$N_{60}P_{60}K_{60}$+ N_{30}+ N_{15}	236	541	523	40,5	10	1,14
Flat-cut tillage to a depth of 28-30 cm	Неудобрений	199	447	407	39,6	8,7	1,0
	$N_{60}P_{60}K_{60}$+ N_{30}	232	533	503	40,4	9,9	1,15
	$N_{60}P_{60}K_{60}$+ N_{30}+ N_{15}	254	567	541	42,3	10,1	1,17
Surface tillage to a depth of 10-12 cm	Неудобрений	161	433	373	38,4	7,4	1,02
	$N_{60}P_{60}K_{60}$+ N_{30}	230	533	486	38,4	8	1,32
	$N_{60}P_{60}K_{60}$+ N_{30}+ N_{15}	232	539	509	39,5	8,2	1,07

Methods of main tillage combined with fertilizer had a significant impact on winter wheat yield (Table 2).

Table 2.

Effect of the methods of main tillage and fertilizers on winter wheat yield, (average for 2015-2016).

The method of basic tillage	Background	Yield, t / ha	Increase in yield	
			t / ha	%
Disk peeling + plowing for 28-30 cm	No fertilizers	2,96	-	-
	$N_{60}P_{60}K_{60}$+ N_{30}	3,83	0,87	29,4
	$N_{60}P_{60}K_{60}$+ N_{30}+ N_{15}	3,91	0,95	32,1
Flat-cut tillage to a depth of 28-30 cm	No fertilizers	2,95	-0,01	-0,3
	$N_{60}P_{60}K_{60}$+ N_{30}	3,89	0,93	31,4
	$N_{60}P_{60}K_{60}$+ N_{30}+ N_{15}	3,94	0,98	33,1
Surface tillage to a depth of 10-12 cm	No fertilizers	2,45	-0,51	-17,2
	$N_{60}P_{60}K_{60}$+ N_{30}	3,32	0,36	12,2
	$N_{60}P_{60}K_{60}$+ N_{30}+ N_{15}	3,48	0,52	17,6
HIP_{05}, т/га, 2014-2015 pp. 0,054-0,073				

Note: Fertilizer rates are average per 1 hectare of sward area.

Thus, the application of the total mineral fertilizer N60P60K60 in combination with topical application of N30 in the phase of complete tillering of plants, yield increased to 3.82-3.89 t / ha, which is higher compared with uncomfortable plots by 0.39-0.93t / ha. Increasing nitrogen nutrition by N15 foliar in the phase of emergence of winter wheat tube led to an increase in grain yield of winter wheat in 3.48-3.94 t / ha, which is more by 0.52-0.98 t / ha compared to the control.

The highest yield of winter wheat on average for 2015-2016.was noted on the background of classical and flat tillage with the application of full mineral fertilizers with a local application of N30 and top-up N15 (respectively, 3.91 and 3.94 t / ha). The yield increase in these two variants was respectively 0.95 and 0.98 t /

ha. Additional introduction of mineral nitrogen increased the formation of active carbohydrates in plants due to which the level of winter wheat grain yield per unit area increased, which is confirmed by the works of V. Khodanitsky and O. Khodanitsky [6].

The lowest productivity of land was noted on the unfertilized background of surface tillage at a depth of 10-12 cm and amounted to 2.45 t / ha.

Along with quantitative assessment there are also qualitative indicators to assess the effectiveness of tillage methods, as they also affect the economics and effectiveness of the above methods. After all, the chemical composition of wheat grain includes all the necessary elements for adequate nutrition: proteins, carbohydrates, fats, enzymes, vitamins and minerals. The most important component of the wheat grain is protein, the content of which can vary from 11 to 20%. All the most important life processes in the human body are associated with proteins. Protein cannot be replaced by other substances. The most important component in wheat grain is gluten protein.

Gluten content is also one of the main criteria and elements for assessing the quality of grain in bakeries, which in our studies varied depending on the method of basic treatment and the amount of fertilizer applied, which agrees with the studies [7].

The studied variants were evaluated by the content of gluten, vitreousness, IDC index and protein in winter wheat grain (Table 3).

The fertilizer system was more effective at flat treatment, so it had good result of qualitative indices of winter wheat, and the difference in comparison with the control variant was: for gluten content 9,0-10,6%, for vitreousness index 13,9-24,0 %, for protein content 3,31-3,5%. Winter wheat grain corresponded to III class by all indicators. It should be noted that the disc husking combined with plowing at 28-30 cm protein content was the highest among the variants of combined fertilizer N60P60K60 + N30 + N15 and amounted to 12.99%, which is higher than the surface treatment by 0.06% and flat tillage by 0.47%.

On the variants with the use of surface tillage, which were studied in the experiments of the fertilizer system had a positive effect on the qualitative characteristics of winter wheat grain, and the difference in comparison with the natural agrochemical background was: for the gluten content 5,6-5,8%, for the vitreous index 11 7-23,0%, for the protein content 3,22-3,91%. Grain by all indicators corresponded to III class.

Table 3

Effect of tillage methods and fertilizers on the quality properties of winter wheat grain, 2015-2016

The method of basic tillage	Background	Gluten content, %	Glassiness,%	IDC indicator	White,%
Disk peeling + plowing for 28-30 cm	Unfertilized	17,9	41,2	81	9,02
	$N_{60}P_{60}K_{60}+ N_{30}$	23,9	53,8	78	12,34
	$N_{60}P_{60}K_{60}+ N_{30}+ N_{15}$	25,4	63,4	63	12,99
Flat-cut tillage to a depth of 28-30 cm	Unfertilized	19,2	45,1	78	10,42
	$N_{60}P_{60}K_{60}+ N_{30}$	26,9	55,1	75	12,33
	$N_{60}P_{60}K_{60}+ N_{30}+ N_{15}$	28,5	65,2	61	12,52
Surface tillage to a depth of 10-12 cm	Unfertilized	17,2	40,9	83	9,19
	$N_{60}P_{60}K_{60}+ N_{30}$	23,5	52,9	78	12,24
	$N_{60}P_{60}K_{60}+ N_{30}+ N_{15}$	23,7	64,2	64	12,93

On all systems of fertilization the maximum content of crude gluten 25,4-28,5%, vitreousness 45,1-65,2% and protein 10,42-12,52% was noted on the variants with the use of flat tillage at the depth of 28-30 cm.

The minimum indicators were noted on the variants with the application of surface tillage to the depth of 10-12 cm.

So, the fertilizer system in combination with the method of tillage has positively influenced the quality of winter wheat grain, increasing in comparison with the natural agrochemical background: the content of gluten - by 3,4-9,3%, vitreousness - by 10,0-23,2%, protein content - by 1,91-3,98%. On the fertilized variants winter wheat grain in all respects corresponded to III class, and the maximum values of grain quality indicators were obtained on the variants with the flat method of tillage.

Economic efficiency of the main tillage measures in the rotation, which was studied in Table 4.

In all variants of experience application of fertilizers due to their high cost increased production costs almost twice than in the backgrounds without fertilizers, which was reflected in the cost of production.

However, comparing the fertilized backgrounds of nutrition, we can conclude that the cost of grain of winter wheat with flat-cut tillage is 269-281 hryvnia lower than with the classical treatment. The use of fertilizers increased the cost of winter wheat grain, which led to a decrease in the level of profitability. The highest level of profitability was noted on the variants without fertilizers and was: at the flat tillage - 109,4%, at the classical tillage - 95,2%, at the surface tillage -76,2%.

Table 4.

Cost-effectiveness of tillage methods depending on nutrition background, 2015-2016

Indicators	Disk peeling + plowing for 28-30 cm			Flat cutting			Surface treatment		
	not fertilized.	$NPK+N_{30}$	$NPK+N_{30}+N_{15}$	not fertilized	$NPK+N_{30}$	$NPK+N_{30}+N_{15}$	not fertilized	$NPK+N_{30}$	$NPK+N_{30}+N_{15}$
Yield, t / ha	2,96	3,83	3,91	2,95	3,89	3,94	2,45	3,32	3,48
allowance	0	0,87	0,95	-0,01	0,93	0,98	-0,51	0,36	0,52
The cost of the harvest from 1 hectare, thousand UAH	7400	9575	9775	7375	9725	9850	6125	8300	8700
incl. allowances	0	2175	2375	-25	2325	2450	-1275	900	1300
Production costs per 1 ha, UAH	3790	6855	7012	3521	6587	6731	3476	6541	6892
Cost of production, UAH / t	1300	1810	1814	1211	1711	1727	1419	1970	1980
Net income from 1 ha, UAH	3610	2720	2763	3854	3138	3119	2649	1759	1808
Profitability level,%	95,2	39,7	39,4	109,4	47,6	46,3	76,2	26,9	26,2

Thus, the flat tillage combined with fertilization contributes to an increase in the level of profitability by 7.9% relative to the classical system of tillage. Therefore, in intensive farming as the most effective technologies for growing crops in crop rotations should be used technologies that would be based on a systematic minimum tillage, and in the shortest possible time and at minimal cost can provide a significant increase in fertility and productivity of black earth, primarily due to the strengthening of directional exchange of substances and energy in the system "soil-plant".

On the basis of the above stated in the grain-parrow crop rotation with alternation of crops: bare fallow, winter wheat, sugar beet, barley we can say that under the winter wheat is advisable to carry out flat tillage to a depth of 28-30 cm. Of the options is advisable to use the fertilizer N60P60K60 + N30 + N15, which provides a high yield of 3.94t / ha with a gluten content of 28.5% and protein 12.33%.

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