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Efficiency of fertilizers under winter wheat on typical chernozem of high left – bank Forest – steppe

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The purpose. To determine efficiency of some kinds of fertilizers under winter wheat in view of after – effect of dung and fertilizers on typical chernozem of high left – bank Forest – steppe. **Methods.** Field, analytical, statistical with use of basic statistical criteria. **Results.** According to data of 2005 – 2007 tall accretions of productivity of grain of winter wheat were gained at importation of nitrogenous and phosphate fertilizers. Nitrogen in dose of 60 kg/hectare has increased productivity on 46%, phosphorus in dose of 120 kg/hectare — on 30%. Joint importation of these fertilizers in dose of N60P120 increased productivity of grain on 62%. Importation of potassium fertilizers (K_{2O}) in dose of 90 kg/hectare did not influence productivity of grain of winter wheat, but joint importation of three kinds of fertilizers ($N_{60}P_{120}K_{90}$) increased productivity on 71%. Efficiency of fertilizers in those doses on the background of after – effect of dung decreased for: Nitrogen — on 21%, phosphorus — 20, nitrogen and phosphorus — 33, full fertilizer — on 35%. After 10 years according to data of 2015 – 2017 efficiency of fertilizers on natural soil fertility decreased in comparison with 2005 – 2007. Gain of grain yield made from: nitrogen — 13%, phosphorus — 23, nitrogen and phosphorus — 22, nitrogen, phosphorus and potassium — 23%. The least gain of yield from fertilizers on the background of after – effect of dung were from: nitrogen — 11%, phosphorus — 17, nitrogen and phosphorus — 13, nitrogen, phosphorus and potassium — 17%. **Conclusions.** Efficiency is determined of some kinds of fertilizers under winter wheat for the periods of 2005 – 2007 and 2015 – 2017, and for 2 soil backgrounds — natural and after – effect of dung. The highest performance of fertilizers was fixed in 2005 – 2007 on natural background, while on the background of after – effect of dung it noticeably decreased. For the period of 2015 – 2017 efficiency of fertilizers was diminished in comparison with natural background of 2005 – 2007 due to accumulation of nutrients in soil as a result of regular importation of fertilizers under rotating crop. On the background of after – effect of dung efficiency of fertilizers was the least due to accumulation in soil of nutrients of dung and fertilizers.

***Key words**: typical chernozem, field experiment, fertilizers, winter wheat, productivity, efficiency, after – effect of dung, forest – steppe zone.*

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One of the main factors in improving the productivity of agriculture is the use of organic and mineral fertilizers. It is known that their effectiveness depends on weather and climatic conditions, soil fertility, fertilizer systems and other agro-measures. Therefore, by optimizing the fertilizer standards, these and other factors need to be taken into account. Winter wheat is the most important food crop in Ukraine. Its annual sown area is 5-6 million hectares, volumes of application of mineral fertilizers to 0.7-0.8 million tons of active substances, which should be used with the greatest economic and ecological expediency.

Analysis of recent research and publications. The issue of the influence of natural and anthropogenic factors on the yield of winter wheat was studied by many researchers in different regions of Ukraine. They paid a lot of attention to agrometeorological conditions, soil fertility, its moisture content and various agro-measures [1, 2, 3, 4]. Most studies were conducted on the effects of organic and mineral fertilizers on the winter wheat yield [5, 6]. It was established that the content of nutrients in the soil significantly influences the efficiency of mineral fertilizers, it is necessary to consider them by optimizing

the rates of mineral fertilizers [7]. Efficiency of mineral fertilizers under winter wheat is widely studied in foreign countries [8-11].

In this article, there are presented the results of field studies of the effectiveness of mineral fertilizers under winter wheat on different agricultural backgrounds.

Aim. Determine the effectiveness of certain types of mineral fertilizers for winter wheat, taking into account the effects of manure and mineral fertilizers on the chernozem typical of Forest-Steppe on the left bank.

Methods. The research was carried out in conditions of field stationary experiment, which was laid in 1990 on the chernozem typical heavy-loamy of the ISSAR State Enterprise "Experimental Farm "Donetske".

The scheme of variants of experiment includes 15 variants from which eight are chosen: 1 - without fertilizers (control), 2 – N_{60}, 3 – P_{120}, 4 – K_{90}, 5 – $N_{60}P_{120}$, 6 – $N_{60}K_{90}$, 7 – $P_{120}K_{90}$, 8 – $N_{60}P_{120}K_{90}$. Winter wheat was grown after black fallow for the period of 2005-2007 and 2015-2017 respectively, according to a crop rotation.

Efficiency of mineral fertilizers was investigated on two agricultural backgrouns - natural and aftereffect of manure. Accounting of the yield was carried out using a Sampo harvester.

Research results. According to the data of 2005-2007, high efficiency of mineral fertilizers under winter wheat was established on a natural agricultural background. The application of nitrogen in the norm - 60 kg/ha increased the yield of winter wheat by 46%, phosphorus in the norm of 120 kg/ha - by 30%, and the application of both nitrogen and phosphorus ($N_{60}P_{120}$) - by 62% (Table 1).

The application of potassium fertilizers did not affect the yield of winter wheat, but the introduction of complete mineral fertilizers in the norm $N_{60}P_{120}K_{90}$ increased yield by 71%.

Table 1 – Effect of fertilizers on yield of winter wheat grains for 2005-2007 (background – natural)

№ of a variant	Norm of fertilizers, kg/ha of active substance			Grain yield, t/ha				Increment of the yield	
	N	P	K	2005	2006	2007	Average	t/ha	%
1	0	0	0	4.85	1.99	1.96	2.93	–	–
2	60	0	0	6.50	3.18	3.18	4.29	1.36	46
3	0	120	0	5.56	2.88	2.99	3.81	0.88	30
4	0	0	90	4.88	1.93	1.99	2.93	0	0
5	60	120	0	6.31	3.92	4.00	4.74	1.81	62
6	60	0	90	6.30	3.23	3.23	4.25	1.32	45
7	0	120	90	5.57	2.96	3.00	3.94	1.01	35
8	60	120	90	6.91	4.01	4.11	5.01	2.08	71
HIP, t/ha				0.59	0.31	0.60			
P, %				3.4	3.5	7.0			

fficiency of mineral fertilizer application in the same norms under background of aftereffect of manure decreased in 2 times: nitrogen - 21%, phosphorus - 20%, nitrogen and phosphorus - 33% (Table 2). Potassium fertilizers also did not work, and the combined application of nitrogen, phosphorus and potassium increased yield by 35%. The decrease of the efficiency of mineral fertilizers is due to the inflow of nutrients to the soil with manure. During the first rotation period, which finished in 2002, manure was applied at 100 t/ha: sunflower - 30 t/ha, sugar beet - 40 t/ha, corn for grain - 30 t/ha. For the second rotation 30 t/ha of sunflower was applied. For the period of 2005-2007, 130 t/ha of manure or 650 kg/ha of nitrogen, 325 kg/ha of P_2O_5 and 780 kg/ha of K_2O were applied in the soil, which resulted in a decrease in the efficiency of mineral fertilizers.

Table 2 – Effect of fertilizers on yield of winter wheat grains for 2005-2007 (background – aftereffect of manure)

№ of a variant	Norm of fertilizers, kg/ha of active substance			Grain yield, t/ha				Increment of the yield	
	N	P	K	2005	2006	2007	Average	t/ha	%
1	0	0	0	5.90	2.90	2.63	3.81	–	–
2	60	0	0	6.93	3.71	3.24	4.63	0.82	21
3	0	120	0	6.77	3.65	3.25	4.56	0.75	20
4	0	0	90	6.16	2.89	2.49	3.85	0.04	1
5	60	120	0	7.04	4.15	3.98	5.06	1.25	33
6	60	0	90	6.94	3.61	3.59	4.71	0.90	24
7	0	120	90	6.97	3.54	3.25	4.59	0.78	20
8	60	120	90	7.14	4.25	4.07	5.15	1.34	35
HIP, t/ha				0.87	0.41	0.57			
P, %				4.4	3.9	5.9			

After 10 years for 2015-2017 according to crop rotation we continued to study the effectiveness of the same norms of mineral fertilizers.

In the natural background for 2015-2017, the effectiveness of mineral fertilizers decreased compared with the same background for 2005-2007. This decrease is due to the accumulation of nutrients in the soil because of the systematic application of mineral fertilizers under crops of crop rotation (Table 3).

Nitrogen fertilizers in the norm of 60 kg/ha increased the yield of wheat of winter wheat by 13%, phosphorus in the norm of 120 kg/ha P_2O_5 - by 23%, potassium did not affect the value of yield.

Table 3 – Effect of fertilizers on yield of winter wheat grains for 2015-2017 (background – natural)

№ of a variant	Norm of fertilizers, kg/ha of active substance			Grain yield, t/ha				Increment of the yield	
	N	P	K	2015	2016	2017	Average	t/ha	%
1	0	0	0	6.07	4.77	5.72	5.52	–	–
2	60	0	0	6.66	5.72	6.35	6.24	0.72	13
3	0	120	0	6.94	6.08	7.32	6.78	1.26	23
4	0	0	90	6.13	4.59	5.46	5.39	0.01	0
5	60	120	0	6.74	5.74	7.67	6.72	1.20	22
6	60	0	90	6.60	5.68	6.58	6.29	0.77	14
7	0	120	90	6.67	5.54	7.24	6.48	0.96	17
8	60	120	90	6.99	5.76	7.62	6.79	1.27	23
HIP, t/ha				0.51	0.53	0.62			
P, %				2.7	3.3	3.1			

For 26 years (1990-2016) mineral nutrients were added to the soil: nitrogen - 2610 kg/ha, phosphorus (P_2O_5) - 2490 kg/ha, potassium (K_2O) - 2160 kg/ha. Plants completely do not use nutrients, their share remains in the soil and affects yields in the aftereffect.

The lowest efficiency of mineral fertilizers was established for 2015-2017 against the aftereffect of manure (Table 4). For this period, 230 t/ha of manure and mineral fertilizers were applied: nitrogen - 2610 kg/ha, phosphorus (P_2O_5) - 2490 kg/ha, potassium (K_2O) - 2160 kg/ha. The norm of nitrogen 60 kg/ha increased the yield of winter wheat by 11%, phosphorus (P_{120}) by 17%, both nitrogen and phosphorus ($N_{60}P_{120}$) by 13%, and nitrogen, phosphorus and potassium ($N_{60}P_{120}K_{90}$) by 17%.

Table 4 – Effect of fertilizers on yield of winter wheat grains for 2015-2017 (background – aftereffect of manure)

№ of a variant	Norm of fertilizers, kg/ha of active substance			Grain yield, t/ha				Increment of the yield	
	N	P	K	2015	2016	2017	Average	t/ha	%
1	0	0	0	6.04	5.49	5.97	5,83	–	–
2	60	0	0	6.56	6.02	6.91	6.50	0.67	11
3	0	120	0	6.55	6.26	7.58	6.80	0.97	17
4	0	0	90	5.84	5.60	6.08	5.84	0.01	0
5	60	120	0	6.58	5.99	7.11	6.56	0.73	13
6	60	0	90	6.57	6.24	6.97	6.59	0.76	13
7	0	120	90	6.62	5.98	6.89	6.50	0.67	11
8	60	120	90	6.55	6.24	7.60	6.80	0.97	17
HIP, t/ha				0.49	0.42	0.90			
P, %				2.6	2.4	4.5			

The application of potassium fertilizers without nitrogen and phosphorus did not affect the grain yield of winter wheat, regardless of agricultural backgrounds.

Conclusions

It was determined the effectiveness of certain types of fertilizers under winter wheat for the two periods - 2005-2007 and 2015-2017 and on two agricultural backgrounds - natural and aftereffect of manure. The highest efficiency of mineral fertilizers was established during the period of 2005-2007 on the natural background, and it decreased on the background of the aftereffect of manure. For the period 2015-2017, fertilizer efficiency significantly decreased compared to the natural background of 2005-2007, which is explained by the accumulation of nutrients in the soil due to the systematic application of mineral fertilizers under crops of crop rotation. Against the aftereffect of manure, the efficiency of mineral fertilizers is lowest due to accumulation of nutrients in manure and mineral fertilizers in the soil.

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