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Agrochemical assessment of fertilizer systems in crop rotation of Polissia

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The purpose. To determine efficiency of fertilizer systems upon ecological and agrochemical state of soil in crop rotation of Polissia. **Methods.** Field, agrochemical, mathematical-and-statistical. **Results.** It is proved that intensity of balance of nutrients and humus completely depends on a share of organic chemistry in fertilizer system. **Conclusions.** Positive balance of humus (0,73 t/hectare) is observed at organic-and-mineral system (75% of organic and 25% of mineral fertilizers). Organic fertilizer system (dung — 50 t/hectares) ensures mid-annual balance of humus of 0,66 t/hectare. Organic-and-mineral system (50% of organic and 50% of mineral fertilizers) secures the balance of humus in norm of 0,46 t/hectare.

Key words: *fertilizer system, nitrogen, phosphorus, potassium, humus, intensity of balance.*

Formulation of the problem. In our time, the problem of protection and rational use of land is extremely relevant, both in our country and all around the world [2, 6, 9].

Constantly growing negative impact of human activity often leads to catastrophic state of the environment, which is determined primarily by the destruction and even rupture of constant interrelation in living ecosystems.

In recent years, there are significant adverse changes in the quality of soil caused by the increased intensity of the impact of anthropogenic and technological factors on land resources. Unbalanced load on all categories of land has reached a level at which there are possible catastrophic consequences not only for the whole system of nature, but also for the social sector in general. According to statistics, there is the tendency for deterioration of the quality of land fertility. In recent years, of particular concern is the rise of technological processes of water pollution and violations of chemical indicators of soil quality [1, 2].

Analysis of recent researches and publications on the subject. Under current conditions, the reliable means of restoring sustainable functioning of agro-ecosystems of Polissia area is agriculture greening. In this connection, there is the necessity for forecasting agro-ecological situation, improving the management of fertility and productivity of agrocenosis at specific soil and climatic and economic conditions on the basis of a detailed assessment of agro-ecological condition of the soil in the region [1, 7].

Agricultural ecosystems are characterized by the deteriorated ecological balance between synthesis and decomposition of organic matter, which leads to the deterioration of nutrient, water, air and other modes of soils. The greatest danger to soil of Polissia are the processes of dehumification and decalcification, the intensity of which is increasing annually.

The impact of anthropogenic factors on physical - chemical, agrochemical and agrophysical soil degradation of Ukrainian Polissia has been studied by many researchers, such as V.A. Kovda, Yu.A. Zlobyn, B.M. Myrkyn, H.A. Bulatkin, V.V. Larionov, V.V. Lisovyi, V.I. Kysil, V.V. Medvedev, R.S. Truskavetsyi et al., but this problem is still important and urgent.

Materials and Methods. The research was conducted during 2012-2014 in the stationary experiment laid at the experimental field of Zhytomyr National Agrarian and Ecological University (near Velyki Horbashi village), located in Cherniakhiv district of Zhytomyr region.

Field and laboratory studies were conducted according to conventional methods. Defining agrochemical indices was performed by the following methods: humus – according to Tiurin (GOST 26213-91); pH - potentiometrically (GOST 26483-85), hydrolytic acidity - according to Kappen in

modification of Central Research Institute of Agrochemical Maintenance of Agriculture (GOST 26212-91); nitrogen, which is easily hydrolyzed - according to Cornfield; mobile phosphorus and exchangeable potassium - according to Kirsanov (GOST 26207-91).

In determining the value of the average balance of humus in the soil, we used the formula of H.Ya. Chesniak [5].

Statistical analysis of the results of research was carried out according to the method of B.A. Dospiekhov using applied computer programs ANOVA [4].

The results of research. It was found that crops use only 50% of nitrogen in fertilizers, much of it is lost through leaching, denitrification, moves to remote forms [3, 8, 10]. However, in the biosphere exists a permanent mechanism for replenishing nitrogen because of its assimilation by microorganisms able to fix molecular nitrogen from the atmosphere.

Table 1. Average nitrogen balance in the soil-plant system depending on the fertilization system, the average for the 2012-2014 biennium, kg/ha

Balance sheet	Fertilization system *					
	1	2	3	4	5	6
Admission:						
With organic fertilizers: manure	-	200.0	100.0	150.0	-	-
straw	101.5	120.8	132.4	134.9	123.5	137.9
green manure	-	-	-	-	84	-
With mineral fertilizers	-	-	60.0	30.0	-	120.0
With seeds and atmospheric condensation	47.0	47.0	47.0	47.0	47.0	47.0
Symbiotic nitrogen fixation	151.0	156.0	177.0	159.0	158.0	178.0
Non-symbiotic nitrogen fixation	6.0	6.0	6.0	6.0	6.0	6.0
Total	305.5	529,8	522.4	526.9	418.5	488.9
Costs:						
Economic losses	264,4	304.1	337.2	330.3	300.6	339.8
Losses due to leaching	8.0	8.0	8.0	8.0	8.0	8.0
Gaseous losses (15% of administration of fertilizer with nitrogen)	-	-	9.0	5.3	-	18.0
Total	272.4	312.1	354,2	343.6	308.6	365.8
Balance, ±	33.1	217.7	168.2	183.3	109.9	123.1
Balance intensity	112	170	147	153	136	134

***Note:** 1. Biological control; 2. Organic System (manure 50 t/ha); 3. Organic and mineral system (manure 25 t/ha + $N_{25}R_{20}K_{35}$); 4. Organic and mineral system (manure 37,5 t/ha + $N_{12,5}R_{10}K_{17,5}$); 5. Organic system (green manure – 12 t/ha); 6. Mineral System ($N_{50}R_{40}K_{70}$)

Biological control leads to a neutral balance trends due to the inclusion of straw as a fertilizer. This is confirmed by the results of calculation of nitrogen balance in crop rotation (112%) for 3 years of studies (Table 1). Based on our research, the intensity of balance is entirely dependent on the proportion of organic in the fertilizer system. The higher proportion of organic matter, the greater the intensity of nitrogen balance was observed. In this regard, our system of fertilization in regard of the intensity of restoring agro-ecosystems can be compared in the following way: mineral system ($N_{50}P_{40}K_{70}$) 134% - organic system (green manure 12 t/ha) 136% - organic-mineral system (50% manure and 50% of mineral fertilizers) 147% - organic-mineral system (75% manure and 25% of mineral fertilizers) 153 - organic system (50 t/ha of manure) 170%.

Table 2. The average balance of phosphorus in the soil-plant system depending on the fertilization system, the average for the 2012-2014 biennium, kg/ha

Balance sheet	Fertilization system *					
	1	2	3	4	5	6
Admission:						
With organic fertilizers: manure	-	100	50	75	-	-
straw	49	58.6	64.2	65.6	59.9	66.9
green manure	-	-	-	-	32	-
With mineral fertilizers	-	-	50	25	-	100
With seeds and atmospheric condensation	14.2	14.2	14.2	14.2	14.2	14.2
Total	63.2	172.8	178.4	179.8	106.1	181.1
Costs:	-	-	-	-	-	-
Economic losses	99.2	115.6	127.8	126.4	114.1	129
Total	99.2	115.6	127.8	126.4	114.1	129
Balance, ±	-36	57.2	50.6	53.4	-8	52.1
Balance intensity	64	149	140	142	93	140

***Note:** 1. Biological control; 2. Organic System (manure 50 t/ha); 3. Organic and mineral system (manure 25 t/ha + $N_{25}R_{20}K_{35}$); 4. Organic and mineral system (manure 37,5 t/ha + $N_{12,5}R_{10}K_{17,5}$); 5. Organic system (green manure – 12 t/ha); 6. Mineral System ($N_{50}R_{40}K_{70}$)

Based on our calculations (Table 2), the greatest balance intensity was observed for organic systems (manure 50 t / ha) and organic-mineral system (75% of manure and 25% of mineral fertilizers), which was 149 - 142 kg / ha, respectively, more at 133-119% than at biological control. In addition, there is a satisfactory result for organic-mineral system (50% of manure and 50% of mineral fertilizers) and mineral system ($N_{50}R_{40}K_{70}$) - 140 kg / ha, 118% more, than at biological control. For organic system (green manure - 12t / ha) balance intensity increased by 45% compared with biological control.

Table 3. Average balance of potassium in the soil-plant system depending on the fertilization system, the average for the 2012-2014 biennium, kg/ha

Balance sheet	Fertilization system*					
	1	2	3	4	5	6
Admission:						
With organic fertilizers: manure		250	125	187.5		
straw	154.3	185	202.4	207.3	189.1	211
green manure					43.6	
With mineral fertilizers			125	62.5		250
With seeds and atmospheric condensation	34	34	34	34	34	34
Total	188.3	469	486.4	491.3	266.7	495
Costs:						
Economic losses	230.1	269.5	297.8	294.5	262.2	298.9
Losses due to leaching	9	9	9	9	9	9
Total	239.1	278.5	306,8	303.5	271.2	307.9
Balance, ±	-50.8	190.5	179.6	187,8	-4.5	187.1
Balance intensity	79	168	159	162	98	161

***Note:** 1. Biological control; 2. Organic System (manure 50 t/ha); 3. Organic and mineral system (manure 25 t/ha + $N_{25}R_{20}K_{35}$); 4. Organic and mineral system (manure 37,5 t/ha + $N_{12,5}R_{10}K_{17,5}$); 5. Organic system (green manure – 12 t/ha); 6. Mineral System ($N_{50}R_{40}K_{70}$)

Calculations of potassium balance (Table 3) showed that only organic and organic-mineral systems provide its positive balance at 159-168% respectively. Use of green manure and straw only as the fertilizer does not provide accumulation of this element in the soil. For mineral fertilizer system, this figure has doubled compared with biological control, because of the arrival of "extra potassium" with the straw. Otherwise, the balance would be at the level of biological control.

The analysis of our study provides that a positive balance of humus (0.73 t/ha) was observed in organic-mineral system (75% of manure and 25% of mineral fertilizers) (table 4). Organic system is slightly inferior (manure 50 t/ha) providing the average balance of humus 0,66 t/ha and organic-mineral system (50% of manure and 50% of mineral fertilizers) in which the balance of humus was 0.46 t/ha.

Table 4. The average balance of humus depending on the fertilizer system, t/ha

Fertilization systems	The reserves of humus in the plow layer (0,2 m)	Loss of humus			Proceeds of humus			Balance
		Total	Including due to		Total	Including due to		
			mineralization	leaching		plant remains	Organic fertilizers	
1	3.64	6.22	6,13	0.09	3.63	0.81	2.82	-2.59
2	3.64	8,47	8.38	0.09	9.13	0.90	8.23	0.66
3	3.64	9.22	9.13	0.09	9,68	2.00	7.68	0.46
4	3.64	9,71	9.62	0.09	9,44	1.96	7.48	0.73
5	3.64	7.04	6.95	0.09	6.85	0.90	5.95	-0.19
6	3.64	8.83	8.74	0.09	5.07	2.01	3.06	-3.76

***Note:** 1. Biological control; 2. Organic System (manure 50 t/ha); 3. Organic and mineral system (manure 25 t/ha + $N_{25}R_{20}K_{35}$); 4. Organic and mineral system (manure 37,5 t/ha + $N_{12,5}R_{10}K_{17,5}$); 5. Organic system (green manure – 12 t/ha); 6. Mineral System ($N_{50}R_{40}K_{70}$)

Adding organic fertilizers in the form of straw and green manure (12 t/ha of green mass) did not provide for the replenishment of humus and its deficit for the year amounted to 0.19 t/ha. For mineral system ($N_{50}R_{40}K_{70}$) deficit of humus in the crop rotation was the highest and amounted to 3.76 t/ha, which indicates a significant degradation processes taking place in the soil with its intensive use. This is confirmed by the known position that high humus mineralization occurs in growing cultivated crops. In biological control slightly lower deficit of humus was observed - 2.59 t/ha.

Conclusions.

The intensity of the balance of the results of our research is fully dependent on the proportion of organic matter in the fertilization system. The higher proportion of organic matter, the greater the intensity of nitrogen balance was observed. The best balance of intensity was observed for organic (manure 50 t/ha) and organic-mineral systems (75% of organic and 25% of mineral fertilizers), for N - 170-153 kg/ha, for P_2O_5 - 149-142 kg/ha for K_2O - 168-162 kg/ha respectively.

The positive balance of humus (0.73 t/ha) was observed in the organic-mineral system (75% of organic and 25% of mineral fertilizers). Organic system is slightly inferior (manure 50 t/ha) providing the

average balance of humus 0,66 t/ha and organic-mineral system (50% of organic and 50% of mineral fertilizers) in which the balance of humus was 0.46 t/ha.

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