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ECOLOGICAL AND AGROCHEMICAL INDECES OF SOD-PODZOLIC SOILS IN THE AREA OF TECHNOGENIC LOAD OF MODERN PIG COMPLEXES

Мета. **Проведення імпактної локальної оцінки вразливості дерново-підзолистого ґрунту сільської селітебної території у зоні впливу сучасних свинокомплексів та обґрунтування шляхів реабілітації території з порушенням екологічної рівноваги.** ***Методи.*** **Агрохімічні (обмінна кислотність, рухомі сполуки калію та фосфору, сума поглинутих основ, ємність поглинання ґрунту, гідролітична кислотність, ступінь насиченості ґрунту, фракційний склад ґрунтових фосфатів), спектрометричні (визначення вмісту важких металів у ґрунті), біометричні (визначення середніх величин та їх похибок).** ***Результати.*** **Проведено агрохімічне дослідження проб ґрунту в межах санітарно-захисної зони свинокомплексу та поза нею.** ***Висновки.*** **Сформована інформаційна база еколого-агрохімічних показників дерново-підзолистого ґрунту в зоні техногенного навантаження сучасних свинокомплексів. На основі отриманих даних будуть розроблятися науково обґрунтовані шляхи зниження техногенного навантаження на навколишнє середовище сучасних свинокомплексів в умовах промивного режиму дерново-підзолистого ґрунту зони Полісся.**

Ключові слова: ґрунт, свинокомплекс, екологічна рівновага, рухомий калій, рухомий фосфор, нітрити, важкі метали, допустимі рівні.

The transition of agriculture to an intensive way of development has led to the emergence of powerful livestock complexes with a stable high output. The main feature of such companies is the high concentration of animals in restricted areas, which inevitably generates a number of environmental problems in these areas. The territories that are in the zone of influence of such companies are subject to intense action connected with pollution of natural environments due to the emission of pollutants into the atmosphere, dumping them into water sources and the formation of a large amount of organic waste, which are located mainly on the arable land of these farms [1].

Despite the considerable amount of work done over this problem, a number of issues remains to be resolved, which require further research. The issues of the uncontrolled introduction of non-sprinkler manure in rural settlements in the soils with a high infiltration rate and high levels of soil contamination and contamination of surface waters due to uncontrolled storage of livestock effluent are not adequately covered for today. Ignoring the environmental principles of agricultural production inevitably accelerates the ecological destruction of land resources, reduces the ecological and economic efficiency of agrarian production [2].

Purpose of researches. Conducting an effective local assessment of the vulnerability of sod-podzolic soils of rural residential areas in the zone of influence of modern pig farms and to substantiate ways of rehabilitation of the territory with a violation of the ecological balance.

Material and methods of research. The information base for research serves modern pig farms with a production capacity of 6.0 and 25.0 thousand units, located on the territory of Grozyno village, Korosten district of Zhytomyr region. The total area of the first complex is approximately 5.5 hectares. On the eastern side of the complex there are experimental fields of the Institute of Agriculture Polissya of the National Academy of Agricultural Sciences, from other sides - limited byy agricultural lands and buildings of economic use. From the western side of the pig farm there is a river of local significance Siniavka. The distance to the nearest residential buildings is 440 m. The second complex occupies 16 hectares and is located at a distance of 1000 m from residential buildings.

For research, samples of soil are selected on the territory located in the zone of influence of pig farms. Selected plots are in the same geomorphological and hydrological conditions. Samples were selected in May-early June 2017. For the agrochemical characteristics of the soils, mixed samples were taken at the depth of the arable layer. The points for

the sampling of individual samples were at a different distance from the location of the pig farms, in fields where non-sprinkler pus was introduced directly as fertilizer (sites No. 1-30) [3].

The following indicators were determined in the soil: exchange acidity - at pH - meter; mobile compounds of phosphorus and potassium - according to Kirsanov (National Standard of Ukraine 4115-2002); alkaline hydrolyzed nitrogen - by the Cornfield method, nitrate nitrogen (N-NO3) - using Griss reagent. The sum of the absorbed bases (S), the absorption capacity of the soil (T), the degree of soil saturation with the bases (V%), and the hydrolytic acidity (Ng) [4] were determined.

The group composition of phosphates was determined by the method of F.V. Chirikova (1947) (variant Shkonda, 1952). The method is based on repeated soil treatment with appropriate solvents and obtaining selective extracts [5].

In order to determine the content of heavy metals in soil, the method of atomic absorption spectrometry on "Quantum - 2A" spectrometer was used.

Digital material is processed by the methods of variation statistics [3].

Results of research. The investigated arable soils are characterized by a near neutral reaction of the medium, an average degree of content of organic matter (2.1%) and high - moving potassium, as well as a very high concentration of mobile phosphorus compounds. According to the latest data, the share of such soils (with a very high level of P2O5) in the structure of

1. Agrarian and chemical characteristics of sod-podzolic sandy soils

Lot No.	Organic substance, %	pH_{KCl}	P_2O_5	K_2O	S	$H_г$	T	V, %
			by Kirsanov, mg/kg		mg-eq./100 g			
1	1,1	4,9	700	22	22,2	2,2	24,4	91,0
2	2,8	5,2	1 805	110	29,9	5,3	35,2	84,9
3	2,1	6,0	2 427	120	24,4	1,9	26,3	92,8
4	2,6	5,8	4 720	137	28,0	4,1	32,1	87,2
6	2,3	5,7	2 340	200	29,2	2,9	32,1	91,0
13	2,0	5,7	720	39	7,6	2,0	9,6	79,2
14	1,8	6,4	1 975	45	29,0	1,0	30,0	96,7
15	1,5	5,3	1 257	306	8,0	2,3	10,3	77,7
16	1,6	5,7	1 137	46	8,2	1,3	9,5	86,3
17	1,1	4,9	1 390	72	7,2	2,2	9,4	76,6
18	1,5	5,4	762	120	26,2	1,8	28,0	93,6
19	1,5	5,0	1 375	51	8,2	2,7	10,9	75,2
20	1,7	5,4	2 360	28	10,2	2,4	12,6	81,0
21	1,4	5,7	860	44	8,6	1,5	10,1	85,1
22	1,6	5,3	1 077	82	23,4	1,9	25,3	92,5
23	2,2	5,1	1 840	52	20,6	2,5	23,1	89,2
27	2,2	5,3	1 750	48	11,8	2,8	14,6	80,8
28	1,4	5,4	407	134	8,6	1,5	10,1	85,1
29	1,0	5,4	613	289	9,0	1,5	10,5	85,7
30	1,5	5,2	530	180	4,4	2,4	6,8	64,7

2. Agrochemical characteristics of sod-podzolic loamy soils

Lot No.	Organic substance, %	pH$_{KCl}$	P_2O_5	K_2O	S	$H_г$	T	V, %
			by Kirsanov, mg/kg		mg-eq./100 г			
5	2,3	5,5	2 137	52	16,8	3,1	19,9	84,4
7	2,3	5,3	937	84	6,9	2,9	9,8	70,4
8	2,1	5,9	2 443	165	13,1	2,3	15,4	85,1
9	2,8	5,4	3 015	181	4,5	3,7	8,2	54,9
10	1,8	5,4	2 230	449	30,8	2,4	33,2	92,8
11	1,7	5,2	1 008	58	5,0	2,8	7,8	64,1
12	1,6	5,0	810	84	5,4	2,9	8,3	65,1
24	1,7	6,0	1 851	62	10,1	1,4	11,5	87,8
25	1,1	-	-	-	22,2	2,2	24,4	91,0
26	1,6	5,2	1 585	118	15,8	4,3	20,1	78,6

arable areas is 12%, and 49% - soil with high and high content of phosphorus. 51% of investigated areas (51.4 hectares), including 42% (42.0 hectares), and 9% (9.4 hectares) of arable soils, are in particular need of liming Introduction of limestone materials (Table 1, 2).

A small amount of mobile potassium in soils is associated with the high removal of this element by cultivated crops and its low content in used organic fertilizers. On the contrary, the accumulation of phosphorus in the studied soils is due to the relatively low demand for plants in it at sufficiently high levels in pork manure.

Analyzing the presented results, first of all, it should be noted that very high level of soil saturation with mobile forms of phosphorus, determined in 0,2n HCl, exceeds the established concepts of high level of soil P2O5 in 5-10 times. The content of mobile forms of phosphorus in relation to gross reserves varies within 33-50% and exceeds the similar indicator for sod-podzolic soils of Zhytomyr region to 15% in loamy and 4-12% in sandy loam. The variability of this indicator is quite high: on the soils of light-loamy it is 25-27%, and on sandy soils is approaching 50%.

The sod-podzolic soils responded to the prolonged introduction of organic fertilizers, usually by increasing the amount of organophosphates - 3-4 times in comparison with the soil without fertilizing (Table 3). In sandy soils with less pronounced buffering force and the ability to accumulate mineral forms of phosphorus, the relative content of organophosphates for the introduction of organic fertilizers increases to 35% of gross reserves. The fact that sorption of phosphorus in sod-podzolic soils occurs mainly due to the phosphates of iron and aluminum, according to A.I. Kalinin (1975, 1985), A.Yu. Kudeiarova (1995), I.M. Khmelinin (1984), etc. [6]. In our studies, we have obtained similar results: the content of phosphorus semi-oxide is about 70% of the amount of mineral phosphorus. At the same time for the fraction of alumina and iron-phosphates marked minimum variability of the characteristic, which is expressed by coefficients of variation in 5-20%. Soil nutrition with liquid pork pus contributed to a decrease in the fraction fraction Al-P and Fe-P (Table 4).

The proportion of calcium phosphates as a result of the long-term application of pumice manure to light-loamy sod-podzolic soils increased up to 42%, and up to 35% of the amount of mineral phosphates in the sandy loam. The reason for such a phenomenon may be temporary excessive moisture conditions, which are formed on loose-loamy soils with a binomial profile enriched with a mule in combination with sand particles. As a result, in these soils, along with the elemental soil processes of pseudosuppression, signs of malting appear, which stimulate the formation of iron phosphates to

3. Fraction composition of soil phosphates by systematic application of pig manure

Soil	Saturation with fertilizers, t/ha	Indices	P_2O_5 by Kirsanov, mg/kg	$P_{min.}$, mg/kg	Fractions P_2O_5, mg/kg			
					Loosebound	Al - P	Fe - P	Ca - P
Sandy	0	M ± m	208 ± 72	875	43	203	463	166
		n	7	5	5	5	5	5
		lim	740 ÷ 1800	1346 ÷ 2603	63 ÷ 343	454 ÷ 470	663 ÷ 1000	166 ÷ 790
	200	M ± m	1213 ± 440	1983 ± 413	202 ± 113	475 ± 19	821 ± 138	485 ± 254
		V, %	44,9	25,7	69,3	5,0	20,4	64,3
Loamy	0	M ± m	219 ± 44	823	35	180	370	238
		n	14	6	6	6	6	6
		lim	960 ÷ 1470	1831 ÷ 2480	98 ÷ 304	288 ÷ 466	770 ÷ 945	538 ÷ 874
	200	M ± m	1143 ± 283	2091 ± 281	208 ± 84	351 ± 79	850 ± 70	681 ± 140
		V, %	24,7	15,9	49,4	26,0	9,8	24,3

4. Phosphate condition of soil with a systematic application of organic fertilizers

Type fertilizer	Saturation with fertilizers, t/ha	$P_{вал.}$, mg/kg	$P_{org.}$		$P_{min.}$		Al-P + Fe-P				Ca – P	
			mg/kg	% к $P_{вал.}$	mg/kg	% к $P_{вал.}$	mg/kg	% к $P_{вал.}$	% к P_{min}	mg/kg	% к $P_{вал.}$	% к P_{min}
Sod-podzolic loamy												
Pig manure	0	1 372	347	25,3	823	60,0	550	40,1	66,8	273	19,9	33,2
	200	3 382	969	28,7	2 091	61,8	1 201	35,5	57,4	889	26,3	42,5
Sod-podzolic sandy												
Pig manure	0	1 231	329	26,7	650	52,8	441	35,8	67,8	209	17,0	32,2
	200	3 908	1 355	34,6	1 983	50,7	1 296	33,2	65,4	687	17,6	34,6

the detriment of calcium phosphates. The content of organophosphates for the systematic introduction of liquid pork manure increases slightly and mainly on the sandy soils.

The most important problem that accompanies the operation of such large enterprises is the recycling and utilization of livestock effluent, which is often solved by their use as meliorants.

At the moment, it should be kept in mind that in the recycled waste, impurity elements (heavy metals) may be present at elevated concentrations as compared with their presence in the soil. Consequently, the monitoring of the content of heavy metals in the environment is a prerequisite for the existence of these territories.

Comparison of the data of the level of heavy metals in the studied soils with the norms (maximum permissible concentration) showed that the content of gross forms of investigated elements below the MPC, except for cadmium and zinc. Excess of cadmium content is noted at 9 sites (2, 7, 8, 9, 11, 12, 13, 14, 26) and varies from 0.51 to 0.64 mg/kg (greater than PC by 2-28%) Zinc content above the normative requirements is observed only in the seventh section and is 61.14 mg/kg. The total area of land disadvantaged by these elements was 19.8 hectares, or 19.7% of the total area of arable land.

The maximum content of lead in the soil is only 6.92 mg/kg (22% of PC), copper - 15.98 (65% of PC), cadmium 13.79 mg/kg (14% of PC).

The content of the moving forms of heavy metals in the studied soils as a whole is also within the norms of the maximum permissible concentration, with the exception of zinc - the excess of PC is observed at the 4th site and is 27.84 mg/kg (the area of the contaminated surface is 1.1% of the total area arable land).

Agroecological survey data were processed using nonparametric statistics, resulting in a correlation between the total content of certain ecotoxicants. This fact is another confirmation that all of the listed pollutants have one source of origin - organic meliorants widely used in the surveyed area.

It is believed that in non contaminated soils, the share of moving forms of heavy

metals from their gross content is 5-20% [7], and in the turf podzolic we studied it was 6-30%. The results of calculations show that zinc is prone to the greatest variability, the coefficient of variation of the share of moving forms of which amounted to an average of 83%, which is the result of unpredictable level of pollution for this element. At the same time, the share of rolling forms of zinc increased in comparison with the background value of 6,3 times on sandy soils and 9,6 times on light-loamy soils.

CONCLUSIONS

Utilization of large volumes of manure drains on the land adjacent to pig farms has led to changes in agro-chemical parameters of arable soils. At the same time, there is a violation of the ratio of nutrients in the direction of explicit increase in the proportion of mobile phosphorus.

Prolonged application of organic fertilizers leads to a general increase in the content of mobile phosphorus compounds, while the relative content of organic and mineral phosphate groups does not increase or increases slightly, fluctuating within the limits of 27-35% and 50-62%, according to the gross reserves of phosphorus. The replenishment of rifle-bound phosphates on soddy-podzolic light-loamy soils occurs mainly due to the fraction of calcium phosphates, on sandy soils - at the expense of phosphates of aluminum or iron.

The agro-ecological state of the investigated soils on the content of heavy metals should be assessed as satisfactory, since the concentration of pollutants in general does not exceed PC. However, the indicator of total pollution indicates negative trends in the accumulation of heavy metals in the soil.

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ОСНОВНІ ГАЛУЗЕВІ МОДЕЛІ РЕАЛІЗАЦІЇ АГРОРЕСУРСНОГО ПОТЕНЦІАЛУ ДЕРНОВО-ПІДЗОЛИСТОГО ГРУНТУ

Розробник – Інститут сільського господарства Полісся НААН, автори: Кочик Г.М., Мельничук А.О., Кучер Г.А.

Грунтово-кліматичні умови зони Полісся мають свої особливості у формуванні структури посівів та визначенні спеціалізації. В представленій таблиці наведені варіанти найефективніших систем удобрення, які забезпечують запровадження моделей вузької спеціалізації виробництва в умовах Полісся. При моделюванні умов прийнята зерно-просапна сівозміна.

Найефективнішою виявилася традиційна органо-мінеральна система удобрення (Гній+NPK+Сидерація), яка забезпечує підвищення продуктивності с.-г. культур порівняно з неудобреним фоном більш як на 70%, що відповідає рослинницько-тваринницькій спеціалізації. Ця система удобрення може забезпечувати урожайність культур сівозміни: пшениці озимої - 4,0 т/га, кукурудзи – 5,8 т/га, картоплі - 32 т/га, люпину – 3,6 т/га.

Додаткову інформацію можна отримати, звернувшись за адресою:
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Спеціалізація	Система удобрення
1. Рослинницька	Контроль - (без добрив) Сидерація Мінеральні добрива – N68P64K86 Мінеральні добрива (NPK) + сидерація Мінеральні добрива (NPK) + вапнування
2. Змішана рослинницько-тваринницька	Гній 10т/га сівозмінної площі або 1 ум. гол./га Гній 10 т/га сівозмінної площі + мінеральні добрива (NPK) Гній 10 т/га сівозмінної площі + мінеральні добрива (NPK) + сидерація
3. Тваринницька	Гній 20 т/га сівозмінної площі або 2 ум. гол./га