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EVALUATION OF SOIL FOR COMPLIANCE WITH ORGANIC CROP PRODUCTION: SCIENTIFIC - METHODOLOGICAL APPROACHES

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Shows the scientific – methodical approaches to the evaluation of soils according to their suitability for growing organic produce. A method for evaluation of soil, based on consideration of the optimal and actual indicators of fertility and pollution. The results of testing the proposed research and methodological approaches on the example OD NULES ofUkraine "Agronomic Research Station".

Key words: organic production, soil, certification, area of organic production.

Introduction. The problem of growing high-quality agricultural products and raw materials is actual for Ukraine, because in the last decade, the area of degraded and marginal soils growing and in 2012 is was over 10 million hectares [1]. One of the ways of solving this problem is the development of organic production agricultural products as a modern system of agriculture that allows you to grow high-quality and safe products and to minimize the negative impact of agricultural technologies on the environment [2, 3].

Organic production is based on universal principles to promote biological processes in agroecosystems with maximum using of their domestic natural resources. Specific principles of organic producing is the preservation and restoration of soil fertility by the methods that optimize their biological activity, providing a balanced supply of nutrients to plants, preserve land and other natural resources what are needed to produce organic products. Taken into account the local and

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regionalecological status of areas, and providing support for plant resistance preventivemeasures by selecting appropriate species, varieties resistant to pests and diseases, appropriate crop rotation, mechanization, physical and biological methods of plant protection. One of the key issues of effective management of organic production is to define specific zones for the certification of agricultural land and the analysis of climatic conditions can ensure that organic products of standardized quality [4 – 8].The quality of crop production is influenced by environmental factors which primarily include natural (soil, temperature, precipitation, insolation, etc.) and anthropogenic (growing technology, pollution of agricultural land as a result of human activity, etc.).

In Article 23 of the Law of Ukraine "On the production and circulation of organic agricultural products and raw materials" (2013) indicated that the binding is to assess the suitability of land (soil) for the production of organic products and raw materials, as well as the establishment of zones of organic production. Today the efforts of various departments and agencies, especially the Ministry of Agrarian Policy and Food of Ukraine aimed at ensuring the implementation of the Law of Ukraine. In this regard, before the scientific community is priorities – make a scientific study ways of transition to organic production principles. One of the components of this problem is to develop techniques and methods for assessing the suitability of soils for further certification and standardized guarantee product quality. The purpose of research – development of a method of evaluation of soils for their suitability for the production of organic agricultural products (raw materials), as well as testing of the developed method as an example of a typical agricultural enterprise.

Materials and methods. Method of assessment of soils developed on the basis of systematic analysis and evaluation of agro-ecological condition by synthesizing a group of indicators characterizing the level of fertility and pollution.

Studies were conducted on the basis OD NULES of Ukraine "Agronomic Research Station" using maps farms, agrochemical certification fields and related regulations. For agronomic zoning studied economy belongs to the northern province of forest-steppe zone of typical black soil and gray forest soils. The total area of the studied enterprise– 949.8 ha and species composition following: typical

chernozemeasy- and medium loam (60.2%), meadow and meadow-chernozemic and theirwashing forms easy- and medium loam (39.1 %), and meadow soddy and meadow and their gley forms easy- and medium loam (0.7 %) (Fig. 1).

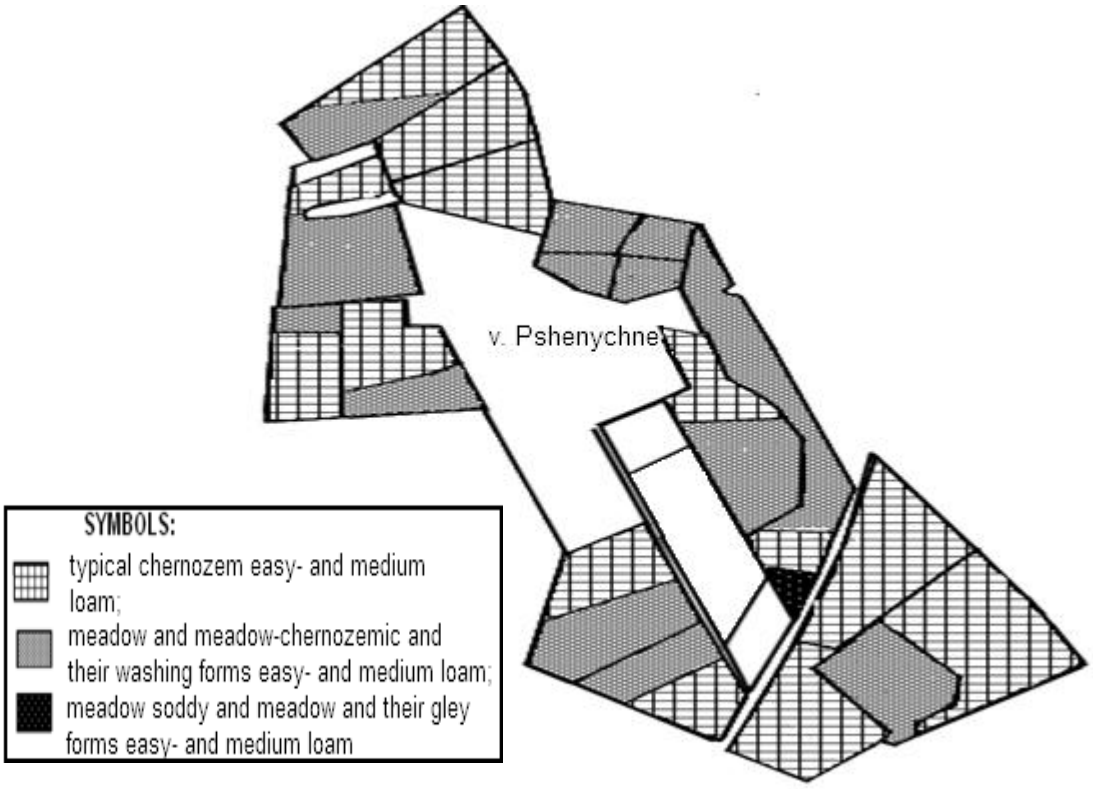

Figure 1. Maps placement of soil types in OD NULES of Ukraine "Agronomic Research Station"

As the meadow - black soil is similar in its characteristics typical black soil [9], and the area of turf and meadow soil is negligible, the assessment of soil OD NULES of Ukraine "Agronomic Research Station" was based on parameters that are optimal for typical black soil medium loam area which is the largest (Table 1).

1. The optimal parameters of typical chernozem on their suitability for organic crop production

Indicators	Options depending on the soil granulometry (physical clay content, %)
	Typical chernozem easy- and medium loam
Agrophysical indicators	
Soil density, g/cm^3	1,0 – 1,4
Productive moisture reserves (0 – 100 sm), mm	90 – 143
Agrochemical indicators	
Hydrolytic acidity, me/100 g of soil	1,5–2,8

Reverse acidy (pH saline), unit	5,4–6,8
Total exchangeable bases, me/100 g of soil	19,0 – 36,0
Humus level, %	≥3,2
Mobile nitrogen, mg/kg	32 –45
Labile phosphorus (by Machygin), mg/kg	41 – 60
Exchangeable potassium (by Machygin), mg/kg	270 – 400

Results and analysis. Analysis of scientific literature and documentation allowed us to determine that the evaluation of soils for compliance with the requirements of organic production is advisable to do the following groups of indicators:

1. Agrophysical : soil density , productive moisture reserves;

2. Agrochemical: hydrolytic acidity; reverse acidy (pH saline); total exchangeable bases; humus level; mobile nitrogen, labile phosphorus; exchangeable potassium, the content of mobile forms of trace elements (boron, manganese , cobalt, copper , zinc);

3. Soil contamination: the content of mobile forms of heavy metals (cadmium, lead, chromium, mercury), pesticide residues (DDT and its metabolites; benzene hexachloride) , the density of radioactive contamination (Cs- 137 , St- 90).

It was found that the evaluation is advisable to by comparing the actual state of reference. According to the standard necessary to take the best indicators of soil fertility according to the type of soil and its particle size distribution according to regulations: ISO 4288:2004 "Quality of soil. The passport of soils" ISO 4362:2004 "Quality of soil. Indicators of soil fertility".

We offer a valuation of soil suitability for driving organic production of agricultural products as following categories:

I– eligible (soil parameters meet the requirements of organic production, deviations from the optimum ≤ 25%);

II – conditionally suitable (soil parameters indicate the need to introduce measures to increase the level of fertility, the deviation from the optimum > 25 %);

III – unsuitable (exceeding the MAC, MAL, AL, APL and others sanitary standards for harmful substances). In that case prohibited for organic production in the subject to certification.

Acceptable level (concentration) of contaminants should be determined according to the following regulations: SanPiN 2264-80 "Maximum allowable concentrations of chemicals in the soil (MAC)"; SanPiN 4266-87 "Guidance on the degree of danger of soil contamination by chemicals"; DSanPiN 2.2.7.029-99 "Hygienic requirements for industrial waste management and hazard class definitions for public health"; DSanPiN 8.8.1.2.3.4-000-2001 "Permissible dose, concentration, number and levels of pesticides in agricultural raw materials , food products, the air of the working area, air, water reservoirs, soil" , ISO 4944:2008 "Setting allowable concentrations of pollutants"from 01.01.2009 , ISO 7244:2011 "Quality of soil. Special raw area. General requirements".

By using the above scientific and methodological approaches have been defined parameters suitability main soil types (most common in Ukraine), to conduct organic farming organic crop production: sod podzolized (automorphic), sod podzolized gley, sod podzolized gley, sod-podzolizednongley forms easy- and medium loam, sod-gley podlized, sod-podzolic gley, clear-gray forest , gray forest , dark-gray podzolized, podzolized chernozem, chernozemic typical soil, southern chernozemic soil, podzolized soildark chestnut soil and chestnut soils. [10]

Testing of the developed method was carried out on the example of agricultural enterprises NULES of Ukraine "Agronomic Research Station". Evaluation was carried out by the results of agrochemical certification in 2012.

Suitability of soil management requirements of organic production was determined by comparing the actual values of the regulations for the main agrophysical and agrochemical parameters (humus content , soil reaction solution, the amount of absorbed bases, basic macro- and micronutrients (boron , manganese , sulfur , copper , zinc, cobalt) , pollution of soils containing heavy metals (cadmium and lead) , radionuclides (cesium -137 and strontium -90) and pesticide residues). The evaluation of soil NULES of Ukraine regarding their compliance with organic production of agricultural crop production are presented in Tables 2 - 4.

The evaluation results showed that the contents of humus and soil pH management are suitable for organic crop production as the average humus content is high (4.86 %), while the average pH was within 7.49. In terms of the amount absorbed bases (Ca + Mg) 63% soil farms do not meet the requirements of organic production and related to partially fit. In terms of provision of basic plant nutrients such as nitrogen and phosphorus soil NULES of Ukraine "Agronomic Research Station" is suitable for the production of organic agricultural products and/or raw materials, while the contents of exchangeable potassium – partially fit (Table 2).

2. The evaluation of soil OD NULES of Ukraine "Agronomic Research Station" for compliance with organic crop production by major agrophysical and agrochemical indicators

# of field	Indicators											
	Humus level, %		pH of soil		Total exchangeable bases, me/100 g of soil		Mobile nitrogen, mg/kg		Labile phosphorus, mg/kg		Exchangeable potassium, mg/kg	
	v.*	%**	v.	%	v.	%	v.	%	v.	%	v.	%
First field of crop rotation												
1	3,60	+12,5	7,41	+9,0	18,69	-1,6	129,99	+306	124,01	+202	83,88	-69
2	5,34	+66,9	7,45	+9,6	17,61	-7,3	133,17	+316	117,75	+187	97,84	-64
3	4,18	+30,6	7,39	+8,7	20,52	+8,0	115,28	+260	100,40	+145	74,78	-72
4	5,86	+83,1	7,43	+9,3	19,38	+2,0	166,80	+421	98,01	+139	73,52	-73
5	4,99	+55,9	7,37	+8,4	19,97	+5,1	137,79	+331	118,07	+188	58,39	-78
6	5,02	+56,9	7,42	+9,1	19,70	+3,7	145,60	+355	89,65	+119	68,92	-74
7	4,87	+52,2	7,27	+6,9	18,90	-0,5	108,00	+238	181,33	+342	161,83	-40
8	4,87	+52,2	7,50	+10,3	23,10	+21,6	156,80	+390	113,85	+178	65,54	-76
9	4,72	+47,5	7,68	+13,0	16,60	-12,6	154,00	+381	142,25	+247	141,75	-48
Total	4,84	+51,3	7,43	+9,3	19,39	+2,1	138,17	+332	121,34	+196	90,09	-67
Secondfield of crop rotation												
1	5,58	+74,38	7,66	+12,7	17,10	-10,0	155,40	+386	81,52	+99	59,58	-78
2	5,80	+81,25	7,70	+13,2	18,60	-2,1	154,00	+381	73,25	+79	60,42	-78
3	5,41	+69,06	7,58	+11,5	21,40	+12,6	142,80	+346	74,21	+81	66,55	-75
4	4,50	+40,63	7,67	+12,8	18,60	-2,1	140,00	+338	63,41	+55	61,29	-77
5	3,89	+21,56	7,60	+11,8	22,52	+18,5	137,20	+329	70,99	+73	67,88	-75
6	4,50	+40,63	7,60	+11,8	21,60	+13,7	131,60	+311	101,20	+147	47,84	-82
7	4,82	+50,63	7,64	+12,4	17,66	-7,1	132,80	+315	191,33	+367	135,37	-50
Total	4,92	+53,75	7,63	+12,2	19,55	+2,9	142,49	+345	93,27	+127	71,58	-73
Outside the crop rotation												
1	5,61	+75,31	7,67	+12,8	16,70	-12,1	165,20	+416	108,35	+164	70,37	-74
2	5,41	+69,06	7,70	+13,2	16,10	-15,3	165,20	+416	103,40	+152	59,74	-78
Total	5,50	+71,88	7,68	+13,0	16,37	-13,8	165,20	+416	105,66	+158	64,59	-76
Garden	3,62	+13,13	7,62	+12,1	16,90	-11,1	78,40	+145	107,66	+163	40,38	-85
Vegeta-ble	4,31	+34,69	7,67	+12,8	16,90	-11,1	112,0	+250	124,30	+203	72,50	-73
Total	4,86	+51,88	7,49	+10,2	19,32	+1,7	138,87	+334	113,48	+177	83,94	-69

* - actual value;

** - departure from optimum, %

Assessment of trace elements in soils economy showed that the contents of boron and manganese all soil management is partially fit for organic production, and for sulfur content of 25% - 75%, and suitable - not suitable for production oforganicagricultural products and / or raw materials. The content of trace elements such as copper, zinc and cobalt is within the MPC as the soil on these indicators OD NULES of Ukraine "Agronomic Research Station" meets the requirements of organic production (Table 3).

3. Evaluation of soil OD NULES of Ukraine "Agronomic Research Station" for compliance with organic crop production over the content of micro – elements, mg/kg

# of field	Micro – elements											
	B		**Mn**		**S**		**Cu**		**Zn**		**Co**	
	v.*	%**	v.	%	v.	%	v.	MAC***	v.	MAC	ф.	MAC
First field of crop rotation												
1	0,50	-83	20,03	-90	10,70	+78	0,23	3,0	0,26	23,0	0,06	5,0
2	0,58	-81	33,62	-83	8,32	+39	0,17		0,29		0,09	
3	0,50	-83	31,91	-84	7,99	+33	0,17		0,30		0,05	
4	0,64	-79	42,69	-79	9,00	+50	0,15		0,47		0,15	
5	0,63	-79	36,46	-82	4,92	-18	0,18		0,26		0,12	
6	0,90	-70	38,61	-81	4,80	-20	0,14		0,22		0,14	
7	0,70	-77	26,73	-87	3,20	-47	0,13		0,24		0,16	
8	0,60	-80	38,61	-81	4,70	-22	0,14		0,27		0,26	
9	0,60	-80	38,94	-81	5,60	-7	0,19		0,35		0,14	
Total	0,63	-79	34,34	-83	6,46	+8	0,17		0,29		0,13	
Second field of crop rotation												
1	0,68	-77	62,70	-69	5,90	-2	0,10	3,0	0,70	23,0	0,57	5,0
2	0,60	-80	47,85	-76	2,90	-52	0,10		0,57		0,34	
3	0,60	-80	31,35	-84	14,8	+147	0,09		0,27		0,35	
4	0,50	-83	42,24	-79	9,60	+60	0,12		0,50		0,27	
5	0,53	-82	34,98	-83	9,71	+62	0,12		0,25		0,19	
6	0,50	-83	28,05	-86	3,70	-38	0,11		0,24		0,18	
7	0,57	-81	33,38	-83	3,74	-38	0,18		0,26		0,14	
Total	0,58	-81	41,7	-79	7,72	+29	0,12		0,41		0,32	
Outside the crop rotation												
1	0,60	-80	36,0	-82	3,60	-40	0,16	3,0	0,21	23,0	0,10	5,0
2	0,60	-80	25,1	-87	4,50	-25	0,15		0,20		0,05	
Total	0,60	-80	30,1	-85	4,09	-32	0,15		0,20		0,07	
Garden	0,50	-83	24,1	-88	4,30	-28	0,13		0,21		0,20	
Vegeta-ble	0,70	-77	39,3	-80	4,80	-20	0,14		0,41		0,14	
Total	0,62	-79	36,	-82	6,71	+12	0,15		0,32		0,18	

* - actual value;
** - departure from optimum, %
***- MAC – maximum allowable concentration.

The content of pollutants, including heavy metals (cadmium and lead), residues of pesticides (DDT and its metabolites, hexachloran) and radioactive elements (cesium-137, strontium-90) is within the maximum allowable concentration, and

other standards, and soils OD NULES of Ukraine "Agronomic research Station" refer to fit on organic production of organic crop production (Table 4).

4. Evaluation of soil OD NULES of Ukraine "Agronomic Research Station" for compliance with organic crop production over the content of harmful substances

# of field	Heavy metals				Pesticide residues				Radioactive elements			
	Cadmium, mg/kg		Lead, mg/kg		DDT and its metabolites, mg/kg		Benzene hexachloride, mg/kg		Cs-137, Ki/km^2		St-90, Ki/km^2	
	v.	MAC**	v.	MAC	v.	MAC	v.	MAC	v.	MAC	v.	MAC
First field of crop rotation												
1	0,01	3,0	0,14	32,0	0,004	0,1	0,0059	0,1	0,0807	1,0	0,012	0,02
2	0,02		0,12		0,004		0,0055		0,1228		0,004	
3	0,02		0,12		0,003		0,0043		0,1190		0,007	
4	0,01		0,12		0,003		0,0059		0,1301		0,005	
5	0,03		0,10		0,004		0,0064		0,0911		0,004	
6	0,02		0,04		0,003		0,0069		0,0658		0,007	
7	0,02		0,04		0,003		0,0070		0,1490		0,007	
8	0,02		0,07		0,003		0,0072		0,1160		0,007	
9	0,02		0,14		0,003		0,0053		0,1220		0,008	
Total	0,02		0,10		0,004		0,0072		0,1490		0,013	
Second field of crop rotation												
1	0,01	3,0	0,35	32,0	0,003	0,1	0,0060	0,1	0,0974	1,0	0,005	0,02
2	0,01		0,30		0,004		0,0059		0,1330		0,013	
3	0,05		0,22		0,003		0,0067		0,1200		0,006	
4	0,02		0,16		0,003		0,0048		0,1120		0,002	
5	0,02		0,18		0,004		0,0063		0,1320		0,004	
6	0,03		0,12		0,002		0,0042		0,1390		0,017	
7	0,02		0,11		0,004		0,0065		0,1100		0,001	
Total	0,02		0,21		0,004		0,0067		0,1390		0,017	
Outside the crop rotation												
1	0,03	3,0	0,21	32,0	0,002	0,1	0,0069	0,1	0,0248	1,0	0,002	0,02
2	0,02		0,19		0,002		0,0072		0,1410		0,003	
Total	0,02		0,20		0,002		0,0072		0,1410		0,003	
Garden	0,02		0,21		0,004		0,0053		0,1270		0,009	
Vegeta-ble	0,02		0,20		0,004		0,0057		0,0951		0,007	
Total	0,02		0,13		0,004		0,0072		0,1490		0,017	

* - actual value;

**- MAC – maximum allowable concentration.

Conclusions. The main goal of organic farming is to guarantee the quality of products (raw materials), which can achieve only if compliance requirements for optimal soil fertility indicators and pollution. Evaluation of soil in terms of their compliance with organic production is advisable to step right on farms in three groups of indicators: agrophysical, agricultural chemistry, toxicology. Within these groups should be carried out the valuation with the establishment of the following categories: I – eligible (soil parameters meet the requirements of organic production,

deviations from the optimum ≤ 25%); II – conditionally suitable (soil parameters indicate the need to introduce measures to increase the level of fertility, the deviation from the optimum > 25 %); III – unsuitable (exceeding the MAC, MAL, AL, APL and others sanitary standards for harmful substances).

The approach that is proposed takes into account the different types of soil and pollution by harmful substances and will receive a guarantee of organic agricultural products (raw materials) standardized quality.

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