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The monograph describes the theoretical and practical aspects of the development of science in Ukraine and the EU countries. There are distinguished the issues on the agricultural science, physical geography, geophysics, economic and social geography, geological sciences, applied social and communicational technologies, decorative and applied arts, etc. The publication is designed for scientists, lecturers, postgraduates, students, as well as a wide range of readers.

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**THE CONTINGENCY OF AGROLANDSCAPES ACCORDING TO  
ECOLOGICAL-AGROCHEMICAL INDICES  
AND PERSPECTIVES OF SELECTING TRADITIONAL  
AGRICULTURAL CROPS IN EASTERN PODILLIA, UKRAINE**

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**Abstract.** The paper considers spatial and temporal dynamics of mobile forms of phosphorus, nitrogen, potassium, pH, and humus content in agrocoenoses soils of Eastern Podillia. The contingency of administrative districts of Vinnytsia Region is represented according to the Sorensen-Chekanovsky coefficient based on the studied ecological-agrochemical indices of agricultural lands. The compliance of ecological-agrochemical indices of Eastern Podilian soils with the optimal parameters required for the growth of priority agricultural crops are analysed by the example of the wheat, sunflower, maize and sugar beet. A joint analysis of ecological-agrochemical soil indices shows substantial dynamics of contingency coefficients of administrative districts of Vinnytsia Region. Given the ecological valence of different agricultural crops according to the proposed set of ecological and agrochemical indices, different coefficient values are recorded that indirectly reflect the degree of area suitability for the corresponding plants cultivation. From the list of traditionally grown crops, the wheat meets the greatest degree of compliance with the proposed soil indices. Next in rank come the sunflower, maize, and sugar beet, respectively. This fact should be taken into account when planning the selection of agricultural plants in the region as a whole and in an individual administrative district in particular.

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## 1. Introduction

The rational use and protection of natural resources is an important factor in the socio-economic development of the country. Environmental problems arise when natural resources are inappropriately used and economic activities are carried out without the introduction of safe production technologies. The acute environmental crisis in many regions is deepening and encompassing all large territories, and may in the future turn into a general environmental and economic catastrophe [39].

As agrolandscapes make up approximately 80% of the territory of Ukraine, the issue of ensuring the sustainability of agrolandscapes in modern conditions is an urgent problem.

In the context of the sustainable development of the state, agrolandscapes must be resistant to anthropogenic load, ensure sustainable yields at an environmentally acceptable and economically sufficient level, and must stably resist degradation processes, which is achieved by natural influences and special measures to streamline agrolandscapes [40].

In the process of reforming land relations, anthropogenic influence on agrolandscapes has increased considerably and the irrationality of land use has increased. The current difficult economic situation of business entities determines, in particular, the direction of land use for obtaining economic benefits in the short term. Thus, in large areas cultivate crops without taking into account the natural conditions and opportunities of specific land, which leads to depletion of soils [41].

Given the unsatisfactory quality of land in Ukraine, which tends to deteriorate, and the international community's focus on global environmental issues (desertification, biodiversity conservation, food security), land reform should embrace the internalisation of external effects of land use with particular use of land use [42].

The intensive use of agricultural land without proper environmental justification not only does not ensure the reproduction of soil fertility, but also causes significant disturbances in agroecosystems, leads to a deterioration of the quality of agricultural landscapes, and therefore their degradation [43].

Therefore, the task of ensuring the effective management of land resources should be considered within the broader process of landscape transformation (changing the structure of the land fund) and its negative consequences [42].

To date, agricultural production should follow the path of rational use of nature and be oriented to the effective maintenance of its adaptability, sustainability, resource-saving, environmental and environmental role and be based on the maximum use of agro-climatic resources, biological and ecological factors.

In this regard, agro-ecological studies, including those related to the issues of conjugacy of agro-landscapes by ecological-agrochemical parameters and prospects of selection of traditional crops, are of particular importance. The relevance of this subject is primarily determined by prospects of increasing the yield of agricultural crops through studying soil cover of agroecosystems and further selection of the crops taking into account the species tolerance. These manipulations make it possible to group agricultural lands from different areas in accordance with the total set of their studied ecological and agrochemical indices and differentiate them by their "suitability" so as to sow certain plants. Therefore, the relevance of research on this particular subject is indisputable.

The current surveys provided in different countries of the world in the field of studying ecological-agrochemical indices of soil cover, including pH [23-24; 26], nitrogen [21; 35-38], potassium [22; 29; 31-32], phosphorus [20; 28; 29; 33] and humus [25; 27; 34] are multidirectional. Many national scientists were engaged in the research of ecological and agrochemical indices, thanks to which the assessment of growing technologies [1; 6-9; 11-12], application of fertilizers [10; 13; 17; 19], forecasting of yields [11-12; 14-16; 18] and the optimal ratio of nutrients in the soil for main agricultural crops (winter wheat, sunflower, sugar beet and corn) [2-5; 10] have been made for the territory of Ukraine. However, for particular administrative districts the issues of crop selection, aimed at reducing pressure on soil and preserving nutrients, still remain poorly studied. Additionally, this subject has never been considered by the example of Eastern Podillia. Though some light has been shed on the problem by now, more detailed elaboration and search for new approaches to its solution including the methods of mathematical analysis are required.

The purpose of the paper is to establish the contingency of agrolandscapes of Eastern Podillia and to determine prospects of planting the main agricultural crops (winter wheat, sunflower, maize, sugar beet) in the region

on the basis of ecological and agrochemical indices (soil content of humus, nitrogen, phosphorus, potassium, and pH).

Objectives: to establish the contingency of agrolandscapes of Eastern Podillia in accordance with ecological and agrochemical indices; to identify the crops which are the most relevant to the proposed ecological and agrochemical soil parameters from the list of traditionally planted crops.

## **2. Material and methods**

The paper is based on the original studies carried by the authors in Eastern Podillia during 2008-2012 and 2013-2017.

Prior to sampling, the objectives and the degree of required accuracy of the expected results were determined. Samples were taken during the growing season not earlier than 2 months after fertilization. Sampling points were selected so as to avoid the influence of extraneous factors. On arable lands, cluster samples were taken at a depth of 0-10 and 15-25 cm of the arable layer. The cluster sample consisted of 20 point samples. The sample weight was not less than 1 kg. From the samples taken, visible remains of vegetation and foreign impurities were removed.

The laboratory analysis of samples included a set of proper manipulations required to determine such indices as pH, mobile forms of nitrogen, phosphorus, potassium, and humus content. To calculate pH, a soil suspension was prepared in a fivefold volume of 1 mol/L potassium chloride (KCl) solution in water. Then pH of the suspension was measured using a pH-meter. The content of organic matter in soils was assessed by the oxidometric method. The nitrogen content in the soil was evaluated using the titrimetric method.

To determine the content of phosphorus and potassium compounds in the soil, an extract was prepared (the soil sample was placed in a conical flask adding 100 cm<sup>3</sup> of the extracting solution; then the solution was stirred and remained in the vertical position for 18-20 hours). To determine the phosphorus, a reagent was added to the soil sample in a volume of 45 cm<sup>3</sup> and the photometry was carried out. The determination of potassium was carried out by flame photometry.

To analyse the results basis the Sorensen-Chekanovsky coefficient was calculated, used for further design of corresponding graphic models.



### 3. Results and discussion

#### 3.1. Agrolandscape ontogeny by ecological and agrochemical parameters within the Eastern Podillia

The area of Eastern Podillia (Vinnytsia Region) is located within the Podillia-Dnieper Territory of the forest-steppe zone of Ukraine. A significant part of Eastern Podillia is occupied by the Podilian structural-denudation upland correspondent to the slopes of the Ukrainian crystal shield that descends south-west. Podilian Upland is heavily indented by valleys of numerous small rivers and ravines. Though it does not represent a continuous plane surface, flat areas are typical for all its watercourses.

The soil cover of Vinnytsia Region has been formed under the impact of a temperate continental climate characterized by fluctuations in the annual temperature regime within 7-9 °C, annual solar radiation at the level of 4300-4400 MJ/m<sup>2</sup>, precipitation in the range of 569-639 mm, and a humidity factor of 1.8.

The main soil-forming rocks are loess and loess-like loam, which granulometric composition varies from light loam in the north to medium loam in the centre and heavy loam in the south of the area. Their characteristic feature is low humus content and sufficiently high thickness of the humus horizon.

Vinnytsia Region is dominated by grey forest soils – 50.5% and chernozems – 42.1%. The podzolized grey and dark grey soils, podzolized chernozems are the most fertile. They contain 3.5-5.5% of humus and occupy 1.7% of Eastern Podillia.

The land resources of Vinnytsia Region consist of 2,649.2 thousand hectares, including 76.1% (2,016.5 thousand ha) of agricultural lands and 13.3% (379.1 thousand ha) of forests. The rest is occupied by developed lands (4%), open swampy areas (1.1%), open areas without vegetation cover or with insignificant vegetation cover (0.9%), and others (1.9%).

According to the results of the laboratory analysis of soil samples of the studied agrocoenoses of Eastern Podillia, the dynamics of the corresponding ecological-agrochemical indices (Table 1) was found, showing the spatial-temporal heterogeneity of values of pH, mobile forms of nitrogen, phosphorus, potassium, and humus content.

Comparison of average indices for the proposed time intervals (2008-2012 and 2013-2017), taking into account the administrative-ter-

ritorial division of the Vinnytsia Region, indicates that the values of pH ( $\bar{x}=5.6$ ) and humus content ( $\bar{x}=2.7\%$ ) remains at the same level, though the range of their dynamics is slightly different. Thus, in the period from 2008 to 2012, the minimum pH was equaled to 5.1, maximum – 6.2; in 2012-2017 the minimum pH was 5.0, maximum – 6.3. The minimum value of humus in 2008-2012 was 1.84%, maximum – 3.89%. Next five years (2013-2017) showed that the h—umus content varied from 1.9% to 3.75%.

The average values of mobile forms of nitrogen, potassium and phosphorus differ between the studied periods showing a clearly expressed decreasing trend in 2008-2012 (mobile forms of nitrogen  $\bar{x}=79.0$  mg/kg, phosphorus  $\bar{x}=79.7$  mg/kg, potassium  $\bar{x}=99.5$  mg/kg) and increasing in 2013-2017 (mobile forms of nitrogen  $\bar{x}=82.0$  mg/kg, phosphorus  $\bar{x}=3.5$  mg/kg, potassium  $\bar{x}=109.9$  mg/kg).

In 2012-2017 the maximum of average nitrogen values was recorded in Koziatyn District ( $\bar{x}=111.0$  mg/kg), minimum – in Zhmerynka District ( $\bar{x}=64.0$  mg/kg); the minimum values of phosphorus were found in Chernivtsi District ( $\bar{x}=54.0$  mg/kg), maximum – in Orativ District ( $\bar{x}=110.0$  mg/kg); potassium content ranged from 77.0 mg/kg (Lypovets District) to 146.0 mg/kg (Kryzhopil District).

Results of the cluster analysis according to the Sorensen-Chekanovsky quantitative coefficient allow distinguishing the districts of Eastern Podillia into 5 groups based on the average values (pH, content of mobile forms of potassium, nitrogen, phosphorus and humus), which dynamics has been monitored over 5 years from 2008 to 2012. Each of these groups includes the districts as follows:

- Bar, Sharhorod, Bershada, Illintsi, Orativ, and Teplyk;
- Haisyn, Zhmerynka, Tomashpil, Nemyriv, and Lityn;
- Vinnytsia, Kalynivka, Lypovets, Koziatyn, Khmilnyk, and Pohrebyshche;
- Kryzhopil, Trostianets, Yampil, Tyvriv, Tulchyn;
- Mohyliv-Podilskyi, Chechelnyk, Murovano-Kurylivetskyi, Pishchanka, and Chernivtsi, shown by a dendrite in Figure 1.

The cooperation of agricultural ecosystems in cluster blocks is dictated not only by agrotechnology of agricultural land cultivation, but also by their geographical location, which is represented by a map compiled according to the results of cluster division of agricultural habitats.

The dynamics of this spectrum of chemical indices shows a relative instability in time (Figure 2). It should be taken into account when devel-

oping identical approaches to the agricultural crop growing technique in regions with similar ecological-agrochemical indicators so as to differentiate them in time, taking into consideration the dynamic rate of transformation of qualitative and quantitative soil indices. Thus, the averaged monitoring results for 2013-2017, based on the above-mentioned ecological-agrochemical soil indices, demonstrate a different picture of the contingency of administrative districts of the Eastern Podillia, reflected not only in numerical changes of the Sorensen-Chekanovsky coefficient but also in different graphic principle of the relationships between the administrative-territorial units of the study area.

**3.2. Prospects for the selection of traditional crops within the Eastern Podillia, taking into account their ecological tolerance to a given set of agrochemical soil parameters**

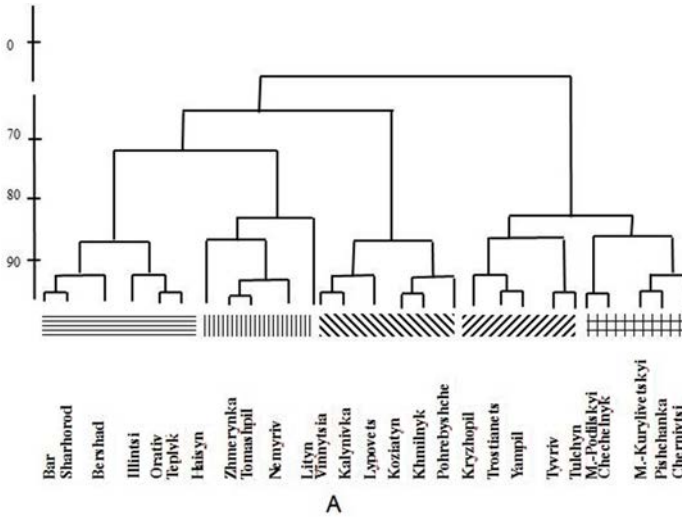
Analysis of the literature data [1-5; 8; 12] with descriptions of optimal variation limits of the ecological-agrochemical indices discussed above for the traditional crops of Eastern Podillia allowed establishing that for the winter wheat the most suitable are the soil acidity limits at the level of 6.3-7.5 ( $\bar{x}$  = 6.9), for mobile forms of potassium – from 100 to 130 mg/kg ( $\bar{x}$  = 115 mg/kg), nitrogen – 85 mg/kg, phosphorus – 110-140 mg/kg ( $\bar{x}$  = 125 mg/kg), humus – about 4%.

When comparing the averages of the optimal limits for the winter wheat cultivation with the actual values obtained during monitoring studies of ecological-agrochemical soil indices in Eastern Podillia for 2013-2017 (Table 1), it can be noted that the values of the Sorensen-Chekanovsky coefficients vary from 78 to 93% (Figure 3). It suggests the good prospects of growing this crop in the region (taking into account the values of the studied soil indices and not taking into account other ecological-agrochemical indices and other environmental factors of the study area). The optimal ratio of the established ecological-agrochemical indices and the averages of optimal limits for the winter wheat cultivation were recorded in Teplyk (92%), Bar, Orativ and Khmilnyk districts (91% each). Lityn, Murovano-Kurylivetskyi (78% each), Chernivtsi, Mohyliv-Podilskyi (79% each) and Lypovets (80%) districts had the least coefficient value and were, correspondingly, less suitable for the winter wheat cultivation according to the ecological-agrochemical indices.

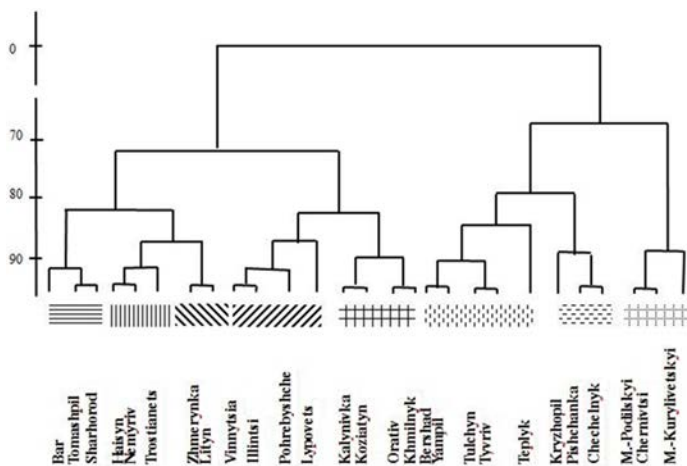
**Ecological-agrochemical soil indices of agroecosystems in Eastern Podillia**

Table 1

Districts	2008-2012						2013-2017								
	Average value			Average value			Average value			Average value					
	pH <sub>Cl</sub> or pH <sub>H<sub>2</sub>O</sub>	P <sub>2</sub> O <sub>5</sub> mg/kg	N mg/kg	K <sub>2</sub> O mg/kg	humus, %	pH <sub>Cl</sub> or pH <sub>H<sub>2</sub>O</sub>	P <sub>2</sub> O <sub>5</sub> mg/kg	N mg/kg	K <sub>2</sub> O mg/kg	humus, %	pH <sub>Cl</sub> or pH <sub>H<sub>2</sub>O</sub>	P <sub>2</sub> O <sub>5</sub> mg/kg	N mg/kg	K <sub>2</sub> O mg/kg	humus, %
Bar	5.3±0.4	87±7.2	70±6.1	104±9.2	1.92±0.1	5.3±0.4	96±8.3	69±5.6	119±9.2	1.96±0.1	5.3±0.4	96±8.3	69±5.6	119±9.2	1.96±0.1
Bershad	5.6±0.38	78±6.7	95±8.3	112±9.9	2.91±0.1	5.6±0.4	81±7.1	82±7.1	124±9.3	2.78±0.2	5.6±0.4	81±7.1	82±7.1	124±9.3	2.78±0.2
Vynnytsia	5.4±0.42	95±8.3	96±8.3	74±6.1	2.63±0.2	5.4±0.4	94±8.2	77±6.4	88±7.5	2.72±0.2	5.4±0.4	94±8.2	77±6.4	88±7.5	2.72±0.2
Haisyn	5.4±0.41	73±6.4	80±7.1	88±7.5	1.84±0.2	5.3±0.4	76±6.3	82±7.1	99±8.8	2.24±0.2	5.3±0.4	76±6.3	82±7.1	99±8.8	2.24±0.2
Zhmerynka	5.2±0.39	76±6.5	69±5.6	88±7.5	1.84±0.1	5.1±0.4	84±7.2	64±6.3	99±8.8	1.90±0.1	5.1±0.4	84±7.2	64±6.3	99±8.8	1.90±0.1
Illintsi	5.7±0.45	93±8.3	90±8.1	86±7.3	2.80±0.2	5.6±0.4	88±7.3	76±6.5	85±7.4	2.81±0.2	5.6±0.4	88±7.3	76±6.5	85±7.4	2.81±0.2
Kalynivka	5.8±0.48	98±8.7	99±8.4	75±6.3	3.50±0.3	5.9±0.5	100±9.8	98±8.5	83±7.2	3.52±0.3	5.9±0.5	100±9.8	98±8.5	83±7.2	3.52±0.3
Koziatyn	6.2±0.51	100±9	92±8.1	70±6.1	3.78±0.3	6.2±0.5	109±9.9	111±9.9	78±6.5	3.78±0.3	6.2±0.5	109±9.9	111±9.9	78±6.5	3.78±0.3
Kryzhopil	5.8±0.48	76±6.5	65±5.4	132±10.3	2.70±0.2	5.8±0.4	84±7.2	92±8.1	146±10.2	2.66±0.2	5.8±0.4	84±7.2	92±8.1	146±10.2	2.66±0.2
Lypovets	6.0±0.5	95±8.7	105±9.3	78±6.3	3.89±0.3	6.0±0.5	85±7.3	93±8.2	77±6.4	3.85±0.3	6.0±0.5	85±7.3	93±8.2	77±6.4	3.85±0.3
Lityn	5.5±0.41	78±6.5	71±6.1	73±6.2	2.06±0.2	5.4±0.4	76±6.3	70±6.1	79±6.7	2.02±0.1	5.4±0.4	76±6.3	70±6.1	79±6.7	2.02±0.1
Mohyliv-Podilskyi	5.5±0.44	65±5.2	79±6.5	127±10.2	2.57±0.2	5.5±0.4	55±4.2	75±6.3	130±10.2	2.58±0.2	5.5±0.4	55±4.2	75±6.3	130±10.2	2.58±0.2
Murovano-Kurylivskiy	5.3±0.41	62±5.1	74±6.2	127±10.2	1.89±0.1	5.3±0.4	59±4.6	65±5.4	140±10.3	2.00±0.1	5.3±0.4	59±4.6	65±5.4	140±10.3	2.00±0.1
Nemyriv	5.3±0.41	71±6.0	69±5.8	96±8.3	2.26±0.2	5.3±0.4	74±6.2	78±6.5	101±9.1	2.18±0.1	5.3±0.4	74±6.2	78±6.5	101±9.1	2.18±0.1
Orativ	5.7±0.45	86±7.3	77±6.3	89±7.5	3.29±0.3	5.8±0.5	110±9.9	91±8.1	96±8.4	3.28±0.2	5.8±0.5	110±9.9	91±8.1	96±8.4	3.28±0.2
Pishchanka	6.0±0.51	62±5.1	73±6.2	124±10.2	2.86±0.2	5.9±0.5	69±5.6	83±7.2	136±10.3	2.88±0.2	5.9±0.5	69±5.6	83±7.2	136±10.3	2.88±0.2
Pohrebyshche	5.8±0.47	88±7.4	92±8.1	69±5.4	2.98±0.3	5.7±0.4	96±8.2	83±7.2	79±6.6	3.10±0.2	5.7±0.4	96±8.2	83±7.2	79±6.6	3.10±0.2
Teplyk	5.6±0.43	85±7.3	78±6.6	96±8.3	2.80±0.2	5.5±0.4	86±8.2	91±8.1	117±9.3	2.80±0.2	5.5±0.4	86±8.2	91±8.1	117±9.3	2.80±0.2
Tyryriv	5.1±0.4	73±6.1	60±5.1	111±10.1	2.16±0.2	5.0±0.4	83±7.1	71±6.1	116±9.3	2.12±0.1	5.0±0.4	83±7.1	71±6.1	116±9.3	2.12±0.1
Tomashpil	5.7±0.45	76±6.3	74±6.2	93±8.1	2.00±0.1	5.6±0.4	81±7.1	82±7.1	105±9.1	1.90±0.1	5.6±0.4	81±7.1	82±7.1	105±9.1	1.90±0.1
Trostianets	5.3±0.41	78±6.4	69±5.8	113±10.1	2.52±0.2	5.3±0.4	86±7.3	78±6.5	135±10.2	2.63±0.2	5.3±0.4	86±7.3	78±6.5	135±10.2	2.63±0.2
Tulchyn	5.3±0.41	67±5.3	68±5.7	109±10.0	2.38±0.2	5.2±0.4	77±6.4	76±6.4	131±10.2	2.40±0.1	5.2±0.4	77±6.4	76±6.4	131±10.2	2.40±0.1
Khmelnitskiy	6.2±0.5	100±9	93±8.1	78±6.3	3.74±0.3	6.3±0.5	108±9.2	102±9.1	93±8.2	3.76±0.3	6.3±0.5	108±9.2	102±9.1	93±8.2	3.76±0.3
Chernivtsi	5.6±0.46	61±5.0	77±6.4	119±10.1	2.74±0.3	5.5±0.4	54±5.2	76±6.4	132±10.2	2.84±0.2	5.5±0.4	54±5.2	76±6.4	132±10.2	2.84±0.2
Chechelnyk	5.9±0.47	69±5.4	74±6.2	127±10.2	3.14±0.3	5.8±0.5	65±5.3	84±7.3	132±10.2	3.00±0.2	5.8±0.5	65±5.3	84±7.3	132±10.2	3.00±0.2
Sharhorod	5.6±0.45	85±7.2	82±7.1	109±10.1	2.05±0.1	5.4±0.4	81±7.1	65±5.3	117±9.6	2.10±0.1	5.4±0.4	81±7.1	65±5.3	117±9.6	2.10±0.1
Yampil	6.2±0.51	77±6.3	68±5.4	120±10.2	3.10±0.2	6.2±0.5	87±7.4	88±7.5	131±10.2	3.20±0.2	6.2±0.5	87±7.4	88±7.5	131±10.2	3.20±0.2



**Figure 1. Graphic (A) and cartographic (B) models of contingency of administrative districts of Vinnytsia Region according to the Sorensen-Chekanovsky coefficient based on the studied ecological-agrochemical soil indices of agrocoenoses (2008-2012)**



A



B

Figure 2. Graphic (A) and cartographic (B) models of contingency of administrative districts of Vinnytsia Region according to the Sorensen-Chekanovsky coefficient based on the studied ecological-agrochemical soil indices of agrocoenoses (2013-2017)

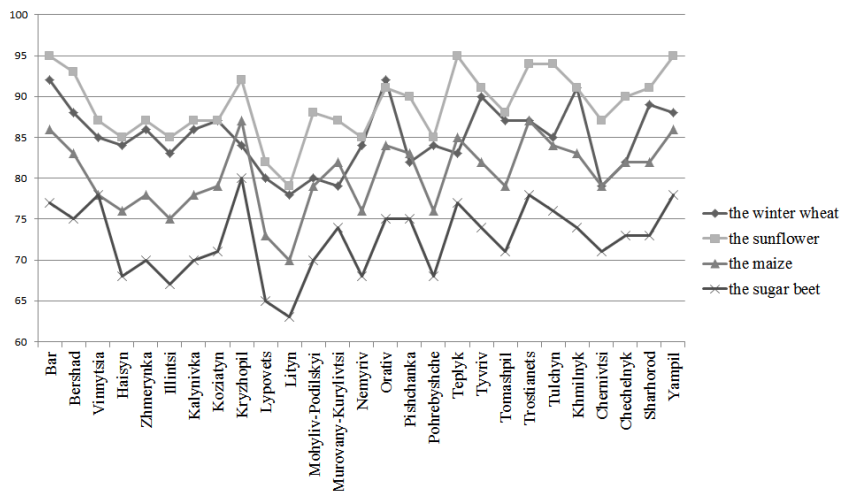
For the sunflower, soil acidity at the level of 6-6.8 ( $\bar{x}$  = 6.4) are the most suitable, the content of mobile forms of potassium – from 120 to 140 mg/kg ( $\bar{x}$  = 130 mg/kg), phosphorus – 100-110 mg/kg ( $\bar{x}$  = 105 mg/kg), humus content should be at the level of 3.5% [14-15].

Two of the 27 administrative districts of Vinnitsia Region mentioned in the list showed the highest degree of similarity of ecological-agrochemical indices of the sunflower vegetation. These are Yampil and Bar districts for which the Sorensen-Chekanovsky quantitative coefficients make up 95%. Close to these values are Trostianets, Teplyk (94% each), Bershad, Tulchyn (93% each), Kryzhopil (92%), Orativ, Sharhorod, Khmilnyk, Tyvriv (91%), Chechelnyk, Pishchanka (90% each) districts, with percentages varying from 90 to 95%. The range from 85 to 90% is recorded for Mohyliv-Podilskyi, Tomashpil (88% each), Murovano-Kurylivetskyi, Koziatyn, Kalynivka, Zhmerynka, Vinnytsia, Chernivtsi (87% each), Nemyriv, Illintsi, Haisyn, Pohrebyshche (85% each) districts. The less optimal set of the studied ecological-agrochemical indices for the sunflower is found in Lypovets (82%) and Lityn (79%) districts (Figure 3).

For the maize, according to the literature data, the variation range of the pH, content of mobile forms of potassium, phosphorus and humus should be kept within 6.0-7.0 ( $\bar{x}$  = 6.5), 130-150 mg/kg ( $\bar{x}$  = 140 mg/kg), 140-150 mg/kg ( $\bar{x}$  = 145 mg/kg), 3-4% ( $\bar{x}$  = 3.5%), respectively [9-11; 13]. Moreover, any changes in the thresholds of the given set of indices inevitably lead to changes in the Sorensen-Chekanovsky coefficients, which, in this case, have the lower limit of 71% and the upper limit of 87% (Figure 3).

The sugar beet requires soil acidity within 7.0-7.5 ( $\bar{x}$  = 7.3), the content of mobile forms of potassium – 160-180 mg/kg ( $\bar{x}$  = 170 mg/kg), phosphorus – 160-180 mg/kg ( $\bar{x}$  = 170 mg/kg) and humus – 3.5% [16-19].

In accordance with the performed calculations, the threshold values of the indices are set at the level of 63-80%. The values in Lityn, Lypovets, Illintsi, Haisyn, Pohrebyshche, Nemyriv, Zhmerynka and Kalynivka districts range between 63-70%; Mohyliv-Podilskyi, Koziatyn, Chernivtsi, Tomashpil, Sharhorod, Chechelnyk, Murovano-Kurylivetskyi, Tyvriv, Bershad, Khmelnyk, Pishchanka, Tulchin, Orativ, Bar, Teplyk, Vinnitsia, Yampil, Trostianets and Kryzhopil shows the coefficient value from 71 to 80% (Figure 3).



**Figure 3. Compatibility of ecological-agrochemical soil indices of Eastern Podillia with the optimal indices required for the winter wheat, the sunflower, the maize, the sugar cultivation (2013-2017)**

#### 4. Conclusions

The dynamics of pH, mobile forms of nitrogen, phosphorus and potassium, as well as humus content in the soils of agrocoenoses of Eastern Podillia is determined by spatial and temporal coordinates. A joint analysis of the ecological-agrochemical soil indices shows a significant dynamics of the coefficients of contingency of administrative districts of Vinnitsia region.

Given the ecological valence of different agricultural crops according to the proposed set of ecological-agrochemical indices, the different coefficient values are recorded that indirectly reflects the degree of area suitability for the corresponding crops cultivation. Thus, from the list of traditionally grown crops, the wheat is identified as the most compatible with the proposed ecological-agrochemical soil indices. Next in rank come the sunflower, maize and sugar beet, respectively. This fact that should be taken into account when planning the agricultural plant selection in the region as a whole and in an individual administrative district in particular.



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