INSTITUTE OF MICROBIOLOGY AND BIOTECHNOLOGY, REPUBLIC OF MOLDOVA

FRUNZE NINA

QUALITY AND HEALTH OF ANTHROPOGENOUS TRANSFORMED BLACK SOILS

BĂLŢI – 2019

PURPOSE OF THE INVESTIGATIONS :

AGROECOLOGICAL APPRECIATION OF CHANGES IN THE FERTILITY OF ANTHROPIC CHERNOZEMS MODIFIED IN THE REPUBLIC OF MOLDOVA AND OF THE STABILITY OF THE MICROBIENIAN COMMUNITIES FOR THE COMPARATIVE ANALYSIS OF THE QUALITY AND "HEALTH" OF SOILS

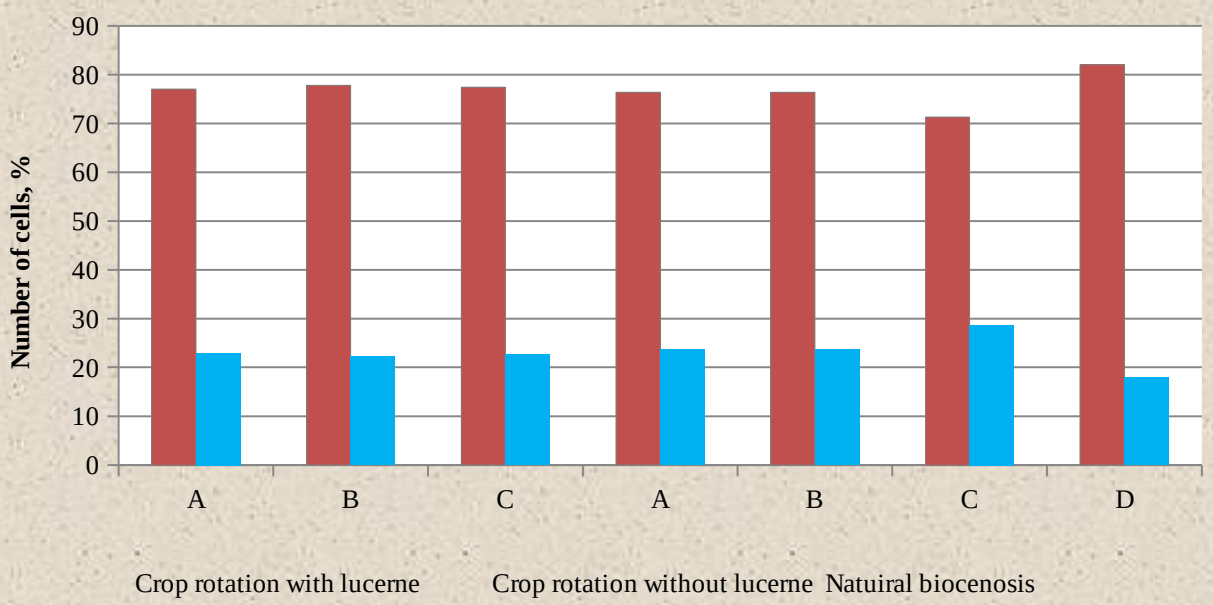
1. Content of humus and the main nutrients in the rotation of cultures furajere of typical chernosem from the Field Station of the ASM "Biotron"

Background	Humus	C		N		P_2O_5		K_2O	
	%	%	t/ha	%	t/ha	%	t/ha	%	t/ha
Crop rotation with lucerne									
The control	3,00	1,74	43,50	0,20	5,0	0,068	1,70	0,71	17,75
Mineral	3,00	1,74	43,50	0,20	5,0	0,21	5,25	0,80	20,0
Organic	3,30	1,91	43,75	0,23	5,75	0,18	4,50	0,70	17,50
Crop rotation without lucerne									
The control	2,80	1,62	40,50	0,20	5,0	0,077	1,93	0,72	18,0
Mineral	2,90	1,68	42,00	0,20	5,0	0,23	5,75	0,97	24,25
Organic	3,40	1,97	49,25	0,30	7,5	0,29	7,25	1,15	28,75

2. Number of soil bacteria: A - Field Station of ASM "Biotron"; B - Field Station of Cultures of the "Chetrosu" Agrarian University, billion. cells / g soil (X ± x).

Option	Years of research					5 years on average
	1	2	3	4	5	
A. Typical chernozem: crop rotation with lucerne						
The control	3,89±0,11	3,79±0,08	4,12±0,11	4,38±0,22	2,96±0,12	3,83±0,13
Mineral background	4,94±0,14	3,81±0,08	4,82±0,13	7,88±0,39	3,76±0,13	5,04±0,17
Organic background	4,05±0,11	3,84±0,10	5,27±0,15	5,26±0,18	5,56±0,19	4,80±0,15
Organic background*	5,41±0,19	3,96±0,07	5,97±0,16	5,13±0,12	6,04±0,24	5,30±0,16
A. Typical chernozem: crop rotation without lucerne						
The control	3,62±0,14	3,54±0,13	4,05±0,14	3,96±0,16	2,85±0,11	3,60±0,14
Mineral background	3,91±0,15	3,61±0,13	4,78±0,17	5,62±0,22	3,59±0,13	4,30±0,16
Organic background	5,32±0,17	4,35±0,14	5,02±0,18	4,16±0,10	4,19±0,16	4,61±0,15
Organic background*	5,36±0,15	6,37±0,25	5,39±0,16	3,99±0,08	5,64±0,25	5,35±0,18
A. Typical chernozem: natural biocenosis						
Forest strip	8,82±0,23	7,77±0,15	9,06±0,20	6,82±0,25	7,52±0,21	8,00±0,21
Б. Carbonatic chernozem: experimental options						
The control	3,55±0,10	4,82±0,15	3,17±0,07	3,63±0,08	4,13±0,09	3,86±0,10
$N_{60}P_{45}K_{45}$	3,68±0,09	5,13±0,15	3,52±0,08	3,74±0,10	4,12±0,09	4,04±0,10
$N_{160}P_{120}K_{90}$	3,76±0,08	5,28±0,14	3,58±0,09	3,59±0,08	4,26±0.09	4,09±0,10
The manure 12 t/ha + P_{15}	4,15±0,11	5,64±0,14	4,24±0,08	3,79±0,08	4,33±0,11	4,43±0,11
The manure 24 t/ha + P_{30}	4,18±0,09	5,92±0,17	4,44±0,14	3,81±0,09	4,83±0,13	4,64±0,12
The manure 12 t/ha + $N_{60}P_{45}K_{45}$	5,82±0,15	6,14±0,16	4,86±0,12	4,43±0,12	5,62±0,14	5,37±0,14
Virgin land	9,86±0,25	16,02±0,59	9,08±0,21	11,40±0,25	10,60±0,24	11,39±0,31

3. The share of the free and adsorbed cells on the soil particles intact structure micromonolites of the typical chernozem from the Field Station of the ASM "Biotron": A – the control, B – mineral background, C – organic background, D – forest strip



4. Summary and active biomass of the typical chernozem from the Field Station of the ASM "Biotron", annual average

Option	Microbial biomass, mkg C / g soil		Share of active biomass,% from summary
	total	activate	
Crop rotation with lucerne			
The control	566 ± 13	60 ± 2	10,6
Mineral background	769 ± 20	142 ± 3	18,5
Organic background	1033 ± 18	193 ± 5	18,7
Crop rotation without lucerne			
The control	419 ± 14	41 ± 1	9,8
Mineral background	544 ± 20	82 ± 1	15,1
Organic background	919 ± 25	200 ± 3	21,8
Natural biocenosis			
Forest strip	1211 ± 20	353± 10	29,1

5. Content and reserves of the organic substance of the typical chernozem in the Balti steppe, depending on the type of agricultural use, the annual average

Option	$C_{org.}$		$C_{mic.}$		$C_{mic} : C_{opr}$, %
	%	kg/ha	kg/ha	% relative to the virgine land	
Winter wheat in crop rotation					
The control	2,73±0,084	76440	2611±73,63	45,34	3,42
$N_{60}P_{30}K_{30}$	2,89±0,088	80920	3745±100,36	55,35	4,62
Autumn wheat, permanent cultivation					
The control	2,70±0,085	75600	2572±75,36	44,66	3,40
$N_{60}P_{30}K_{30}$	3,09±0,089	86520	3176±95,60	46,94	3,67
Sugar beet in crop rotation					
The control	2,75±0,086	77000	2511±79,10	43,60	3,26
The manure 40 t/ha + $N_{60}P_{30}K_{30}$	2,82±0,089	78960	4122±130,67	60,92	5,22
Sugar beet, permanent cultivation					
The control	2,73±0,059	65520	2644±71,92	45,91	4,04
The manure 40 t/ha + $N_{60}P_{30}K_{30}$	3,35±0,072	93800	4959±134,88	73,29	5,29
Black steam, since 1964					
The control	2,62±0,089	73360	1950±52,46	33,86	2,66
$N_{60}P_{30}K_{30}$	2,37±0,081	66360	2182±49,53	32,25	3,29
Virgin land, since 1985					

6. Content and reserves of the organic substance in the typical chernozem of the furajer rotation the Center Zone, annual average

FUND	C_{org}		C_{mic}		C_{mic} : $C_{org.}$ %
	%	kg/ha	kg/ha	% relative to the virgine land	
Crop rotation with lucerne					
The control	1,74±0,049	43500	654±20,73	57,12	1,50
Mineral	1,74±0,052	43500	675±21,74	58,95	1,55
Organic	1,91±0,055	47700	1063±33,59	92,84	2,23
Crop rotation without lucerne					
The control	1,62±0,046	49500	571±18,73	49,87	1,41
Mineral	1,68±0,048	42000	615±20,23	53,71	1,46
Organic	1,86±0,054	46500	1105±35,91	96,51	2,38
Natural biocenosis					
Forest strip (since1975)	1,80±0,052	45000	1145±35,95	100	2,54

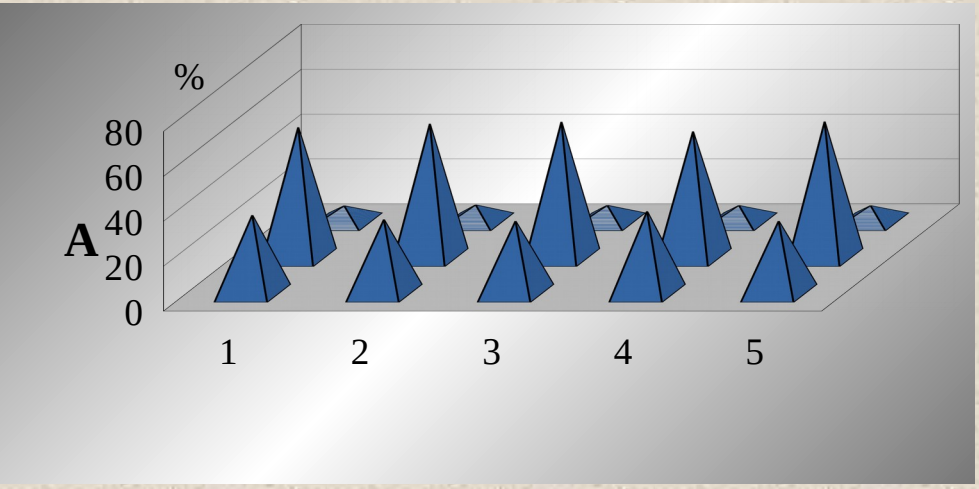
7. Amino acid content of the typical chernozem of the Field Stationary of the ASM "Biotron", mg N / kg soil

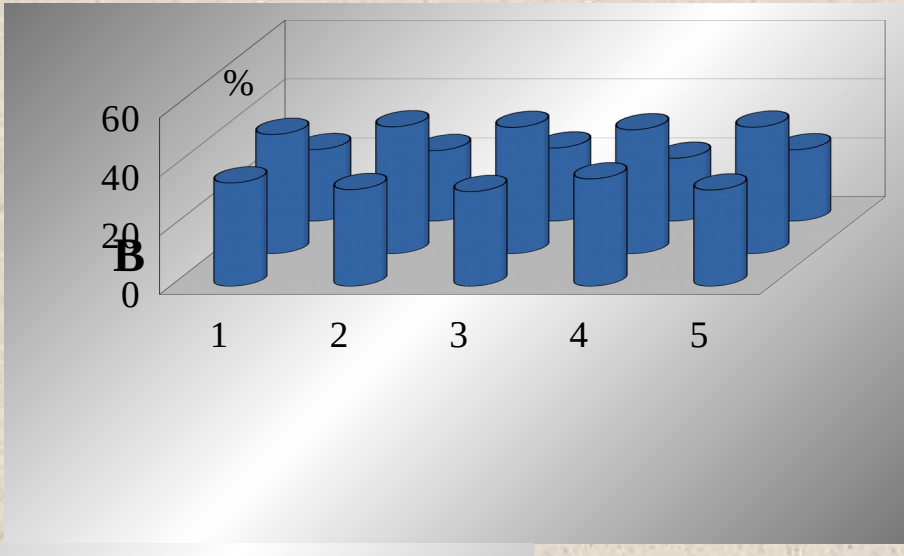
Amino acids	The control	Mineral background	Organic background	Organic background *
Aspartic	25,00±0,55	31,00±0,20	40,00±1,05	29,00±0,72
Threonine	8,00±0,15	10,00±0,08	13,00±0,27	13,00±0,25
Serine	13,00±0,21	16,00±0,34	18,00±0,24	21,00±0,34
Glutamic	19,00±0,47	24,00±0,79	34,00±0,84	23,00±0,58
Proline	7,00±0,12	11,00±0,22	12,00±0,37	17,00±0,38
Glycine	21,00±0,25	28,00±0,36	35,00±0,70	46,00±0,71
Alanin	34,00±0,42	40,00±0,67	45,00±0,83	44,00±0,96
Valine	6,00±0,09	8,00±0,20	11,00±0,27	13,00±0,39
Cystine	4,00±0,03	7,00±0,20	8,00±0,10	8,00±0,13
Methionine	2,00±0,02	2,00±0,09	2,00±0,07	2,00±0,07
Isoleucine	4,00±0,04	8,00±0,20	8,00±0,22	10,00±0,32
Leucine	5,00±0,05	12,00±0,29	13,00±0,26	16,00±0,54
Tyrozine	2,00±0,02	2,00±0,04	3,00±0,12	1,00±0,06
Phenylalanine	2,00±0,02	3,00±0,01	3,00±0,13	3,00±0,14
γ-aminobutyric	5,00±0,06	3,00±0,05	2,00±0,04	2,00±0,04
Lysine	14,00±0,11	13,00±0,19	15,00±0,23	18,00±0,32
Histidine	11,00±0,07	10,00±0,09	11,00±0,10	12,00±0,16
Arginine	16,00±0,12	25,00±0,20	29,00±0,24	38,00±0,37
Σ amino acids	197,00±3,09	252,00±4,05	301,00±8,21	317,00±7,18

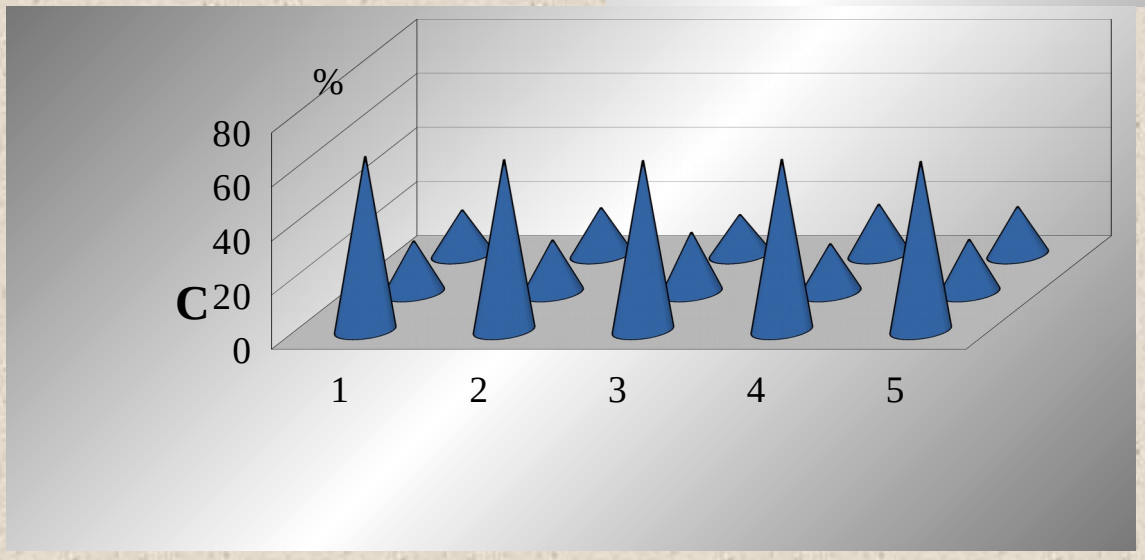
8. Physical characteristics of the amino acids from the typical chernozem of the Field Stationary of the ASM "Biotron", :

A - molecular mass; B - the length of the radical; C - the volume of the radical;

Variants: 1 – the control; 2 - mineral fertilizers; 3 - organic fertilizers; 4 - organic fertilizers + vegetable debris + siderates; 5 - virgin land

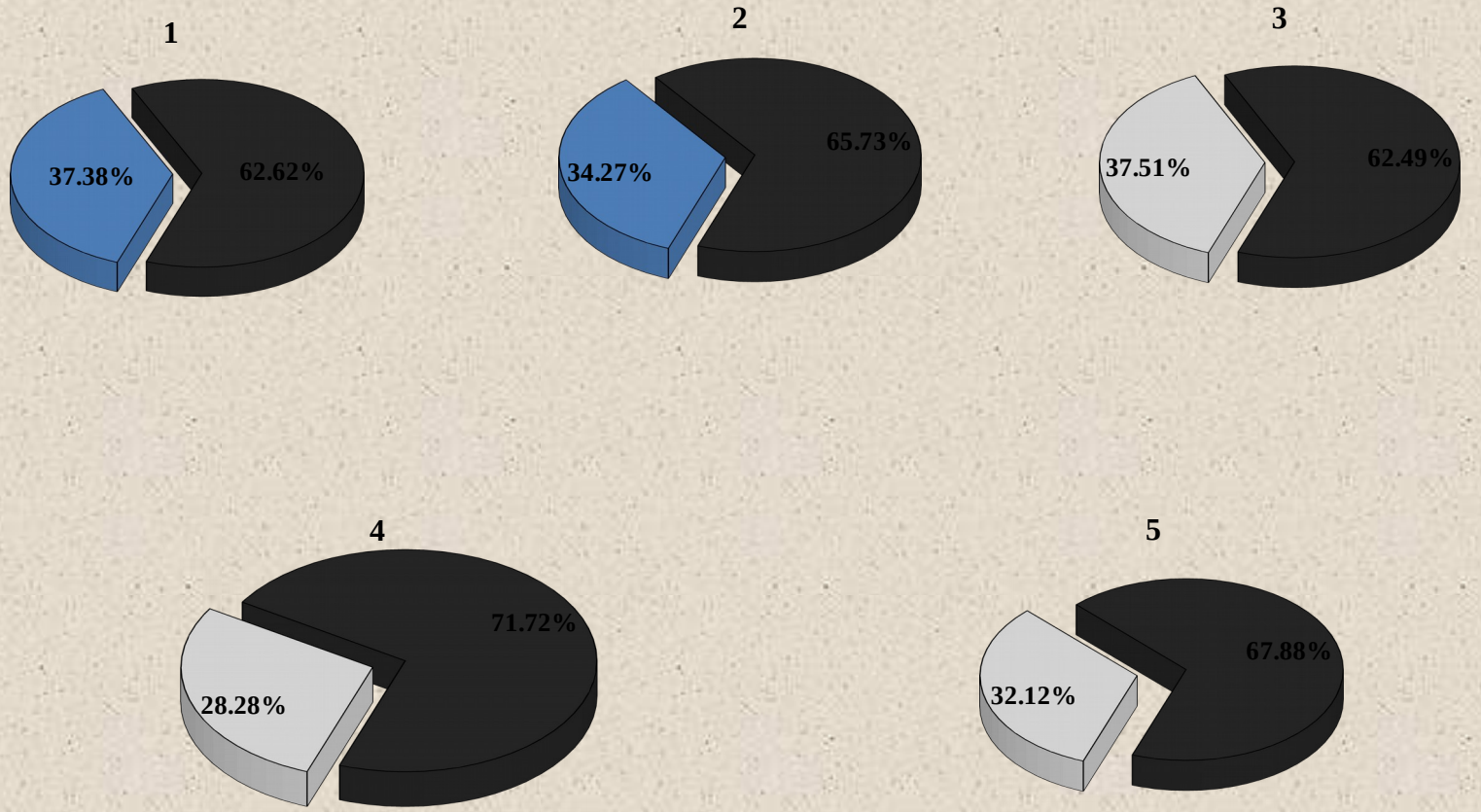






9. The share of amino acids in the typical chernozem of the Field Stationary of the ASM "Biotron", which have the ionized R-group:

1 – the control; 2 - mineral fertilizers; 3 - organic fertilizers; 4 - organic fertilizers + siderates + vegetable residues; 5 - virgin land



10. The total nitrogen content and of its component fractions from the typical chernozem of the "Biotron" Field Stationary, the annual average

Background	N_{total}			NH_4^+	NO_3^-	Amino acid nitrogen	
	%	t/ha	% compared to humus	%		%.	% compared to humus
Crop rotation with lucerne							
The control	0,20	4,60	8,00	0,0006	0,0058	0,03	1,2
Mineral	0,20	4,60	8,00	0,0006	0,0067	0,03	1,2
Organic	0,23	5,29	7,67	0,0006	0,0086	0,05	1,7
Crop rotation without lucerne							
The control	0,20	4,60	8,00	0,0005	0,0054	0,02	0,8
Mineral	0,2	4,6	7,69	0,0006	0,0056	0,03	1,2
Organic	0,3	6,9	10,35	0,0006	0,0070	0,03	!,0
Forest strip							
Natural	0,22	5,06	7,07	0,0011	0,0008	0,07	2,3

11. The intensity of the emission of CO_2 by the microbial communities of the typical and carbonatic chernozem from the Field Station of the ASM "Biotron" at the growth of the plants in permanent culture and crop rotation

Option	Humus, %	3 year average		
		mg CO_2/100 g soil/h	mg CO_2/h/g carbon	Total share of breath intensity,%
Carbonatic chernozem : corn, permanent cultivation				
The control	2,435±0,05	5,70±0,17	2,34±0,07	41
Maize vegetable scrap 8,5 t/ha	2,497±0,07	6,58±0,18	2,64±0,07	40
Maize vegetable scrap 8,5 t/ha + $N_{68}P_{45}K_{45}$	2,492±0,06	7,32±0,21	2,94±0,08	40
$N_{135}P_{90}K_{90}$	2,457±0,07	7,24±0,20	2,95±0,08	41
Maize vegetable scrap 25 t/ha	2,511±0,08	7,53±0,22	2,99±0,09	40
Carbonatic chernozem: black steam, permanent				
The control	2,387±0,06	5,42±0,16	2,27±0,07	42
Maize vegetable scrap 8,5 t/ha	2,422±0,08	5,71±0,17	2,36±0,07	41
Maize vegetable scrap 8,5 t/ha + $N_{68}P_{45}K_{45}$	2,465±0,07	6,63±0,19	2,69±0,03	41
$N_{135}P_{90}K_{90}$	2,437±0,06	6,65±0,02	2,73±0,08	41
Maize vegetable scrap 25 t/ha	2,502±0,08	6,92±0,19	2,77±0,08	40
Typical chernozem: crop rotation with lucerne				
The control	3,00±0,09	4,21±0,12	1,40±0,04	33
Mineral fertilizers	3,00±0,10	5,41±0,15	1,80±0,05	33
Organic fertilizers	3,30±0,09	5,63±0,16	1,71±0,04	30
Organic fertilizers + vegetable scrap + siderates	3,40±0,09	6,21±0,18	1,83±0,04	29
Typical chernozem: crop rotation without lucerne				
The control	2,80±0,08	3,95±0,11	1,41±0,04	36
Mineral fertilizers	2,90±0,10	4,94±0,14	1,70±0,05	34
Organic fertilizers	3,20±0,09	6,10±0,18	1,91±0,06	31
Organic fertilizers + vegetable scrap + siderates	3,10±0,08	7,17±0,22	2,31±0,07	32
Typical chernozem: natural biocenosis				
Forest strip	3,11±0,11	13,70±0,37	4,40±0,12	32

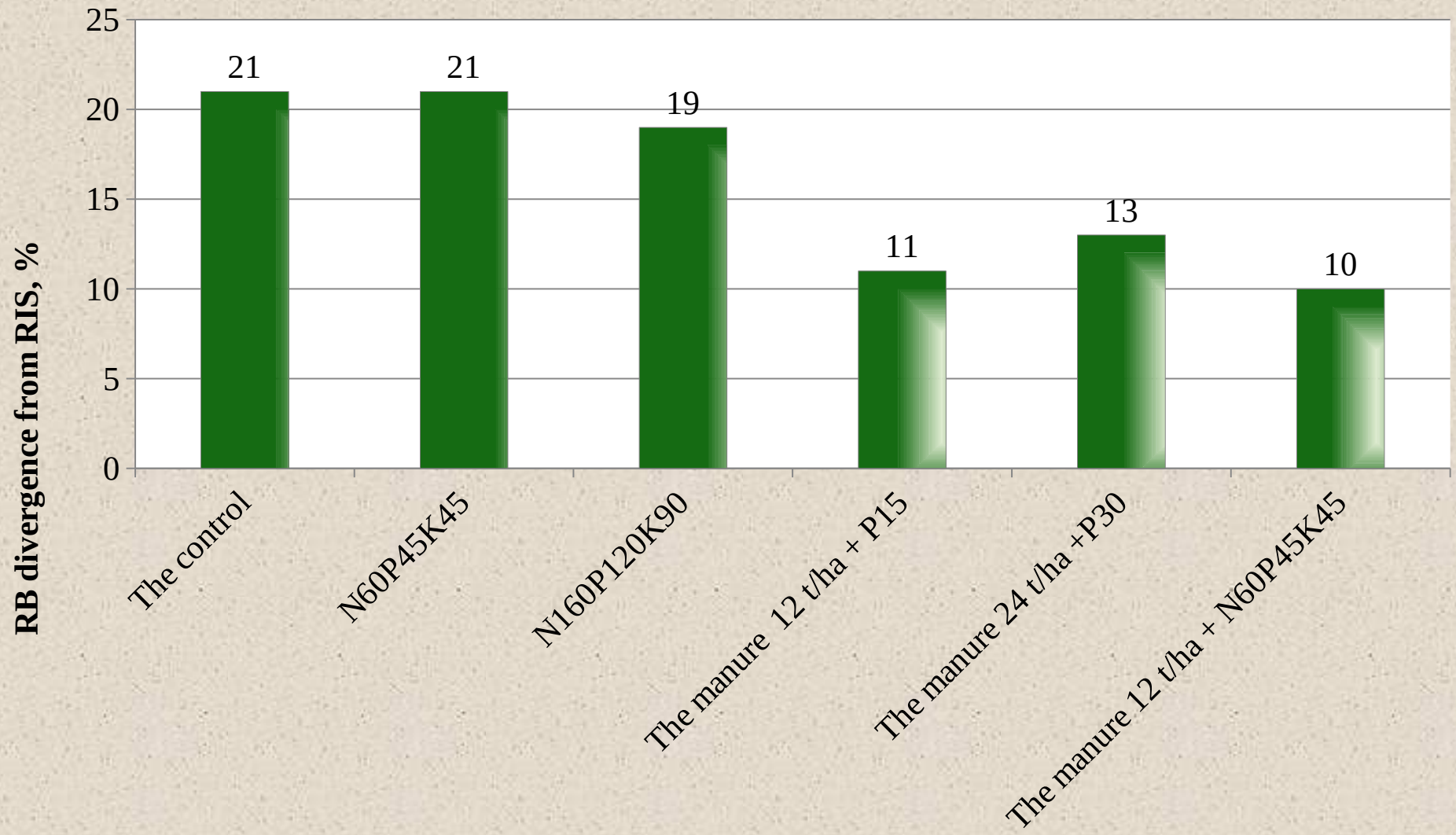
12. Emission CO_2, content and balance of humus from the carbonate chernozem of the Field Cultures Stationary of the "Chetrosu" Agrarian University under different conditions of agricultural use

Option	Humus, %	The balance of humus, %	CO_2	
			mg/100 g soil/h	mg/g C
Permanent cultivation				
Black steam	2,40	-0,40	4,22±0,10	1,76±0,04
Black steam + mineral fertilizers	2,43	-0,37	6,75±0,19	2,78±0,08
Sunflower	2,50	-0,30	10,13±0,30	4,05±0,12
Sunflower + mineral fertilizers	2,51	-0,29	15,94±0,52	6,35±0,20
Autumn wheat	2,50	-0,30	8,79±0,21	3,52±0,08
Autumn wheat + mineral fertilizers	2,53	-0,37	11,78±0,31	4,66±0,12
Corn	2,60	-0,20	7,24±0,19	2,78±0,07
Corn + mineral fertilizers	2,62	-0,18	14,30±0,43	5,46±0,17
Virgin land, 50 years	3,11	+0,31	13,37±0,27	4,30±0,09
Crop rotation				
The control	2,75	-0,05	3,10±0,06	1,13±0,02
$N_{68}P_{45}K_{45}$	2,79	-0,01	5,33±0,12	1,91±0,04
$N_{135}P_{90}K_{90}$	2,89	+0,09	5,91±0,12	2,04±0,04
The manure 20 t/ha	2,85	+0,05	4,80±0,09	1,68±0,03
The manure 40 t/ha	3,14	+0,34	4,92±0,09	1,57±0,03
The manure 20 t/ha + $N_{68}P_{45}K_{45}$	2,92	+0,12	4,70±0,07	1,61±0,03

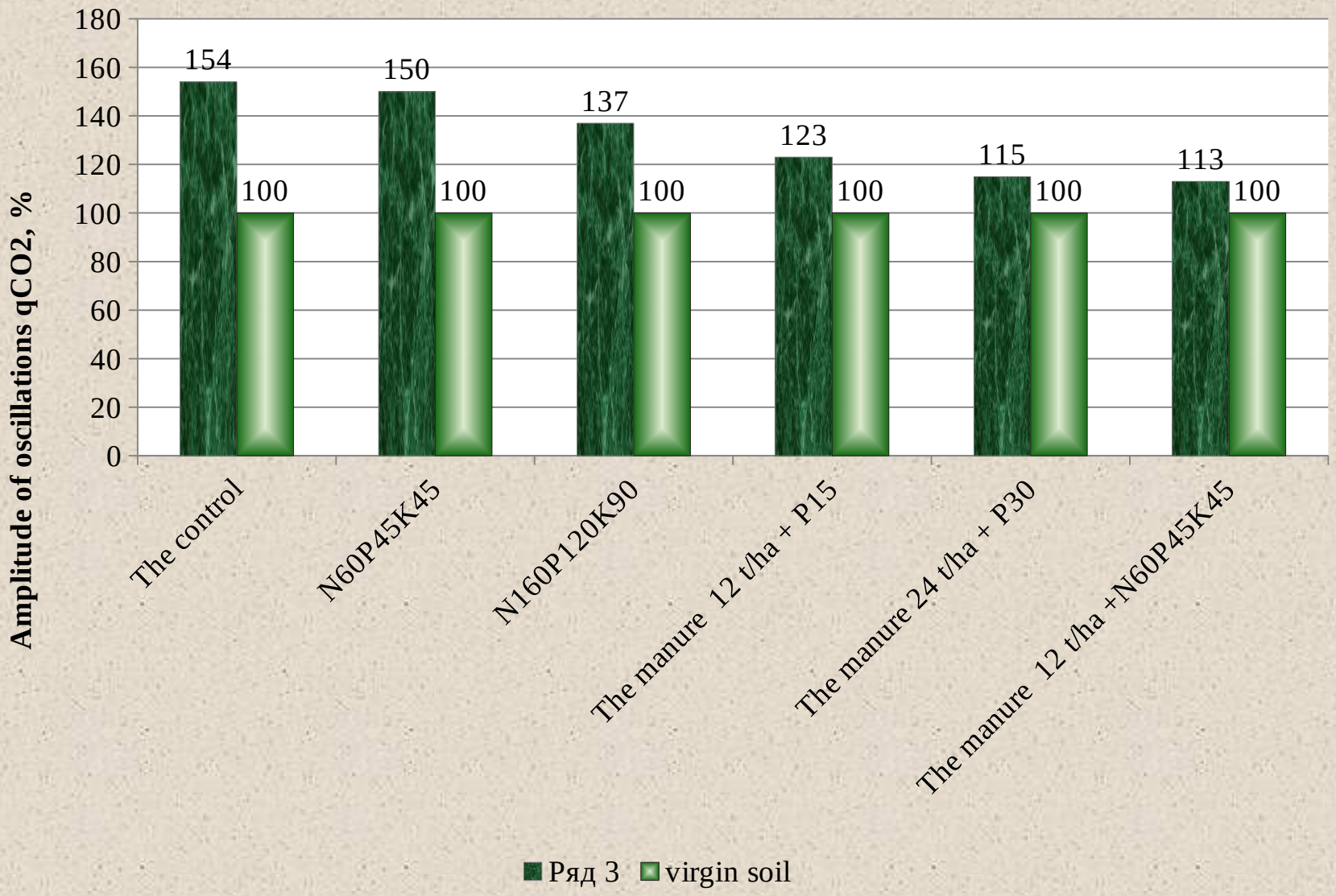
13. Seasonal dynamics of the respiratory indices of the microbial communities in the carbonate chernozem of the Field Cultures Stationary of the UA "Chetrosu", the vegetation period of the year 2007

Option	Perioada	BR		SIR		qCO_2	The amplitude of qCO_2 compared to the virgin land, units (mkg C-CO_2/ мg $C_{мmic}$/ h)
		mkg C-CO_2/g soil/h	% to the virgin land	mkgC-CO_2/ g soil/h	% to the virgin land	mkg C-CO_2/ mg C_{mic}/ h	
The control	the spring the summer the autumn mediate	0,84±0,019 0,59±0,016 0,70±0,026 0,71±0,020	61	12,40±0,41 7,74±0,22 10,61±0,43 10,25±0,35	40	3,07	1,08 (1,99-3,07)
$N_{60}P_{45}K_{45}$	the spring the summer the autumn mediate	0,86±0,020 0,60±0,017 0,70±0,026 0,72±0,021	62	12,89±0,44 8,11±0,24 11,06±0,44 10,69±0,37	41	2,99	1,00 (1,99-2,99)
$N_{160}P_{120}K_{90}$	the spring the summer the autumn mediate	0,98±0,030 0,68±0,018 0,74±0,028 0,80±0,025	69	15,40±0,48 11,23±0,29 12,35±0,49 12,99±0,42	50	2,73	0,74 (1,99-2,73)
The manure 12 t/ha + P_{15}	the spring the summer the autumn mediate	1,06±0,033 0,80±0,019 0,96±0,036 0,94±0,029	81	19,48±0,63 14,55±0,35 17,42±0,70 17,15±0,56	70	2,44	0,45 (1,99-2,44)
The manure 24 t/ha + P_{30}	the spring the summer the autumn mediate	1,08±0,034 0,82±0,020 0,98±0,038 0,96±0,031	83	20,26±0,66 16,44±0,42 17,62±0,72 18,11±0,60	70	2,28	0,29 (1,99-2,28)
The manure12 t/ha + $N_{60}P_{45}K_{45}$	the spring the summer the autumn mediate	1,16±0,037 0,89±0,023 1,01±0,039 1,02±0,033	88	22,44±0,76 18,00±0,49 20,12±0,83 20,19±0,69	78	2,25	0,26 (1,99-2,25)
The virgin land,	the spring the summer	1,46±0,051 0,94±0,025		28,44±0,97 23,66±0,66			

14. The relative size of the RB from the experimental variants compared to the RIS of the carbonate chernozem from the Field Cultures Stationary of the Agrarian University "Chetrosu" tor the vegetation period of 2007, % compared to the standard soil virgin land.

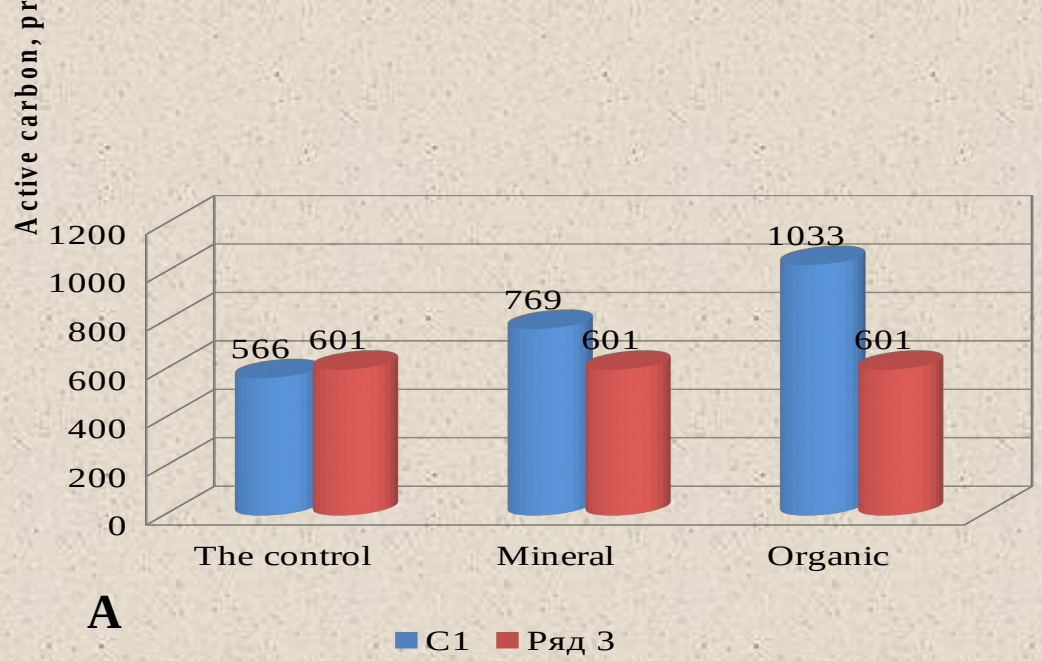


15. The relative deviation of qCO_2 in the arable soil and that of the virgin land of the carbonate chernosem from the Field Cultures Stationary of the Agrarian University "Chetrosu" during the vegetation period of 2007

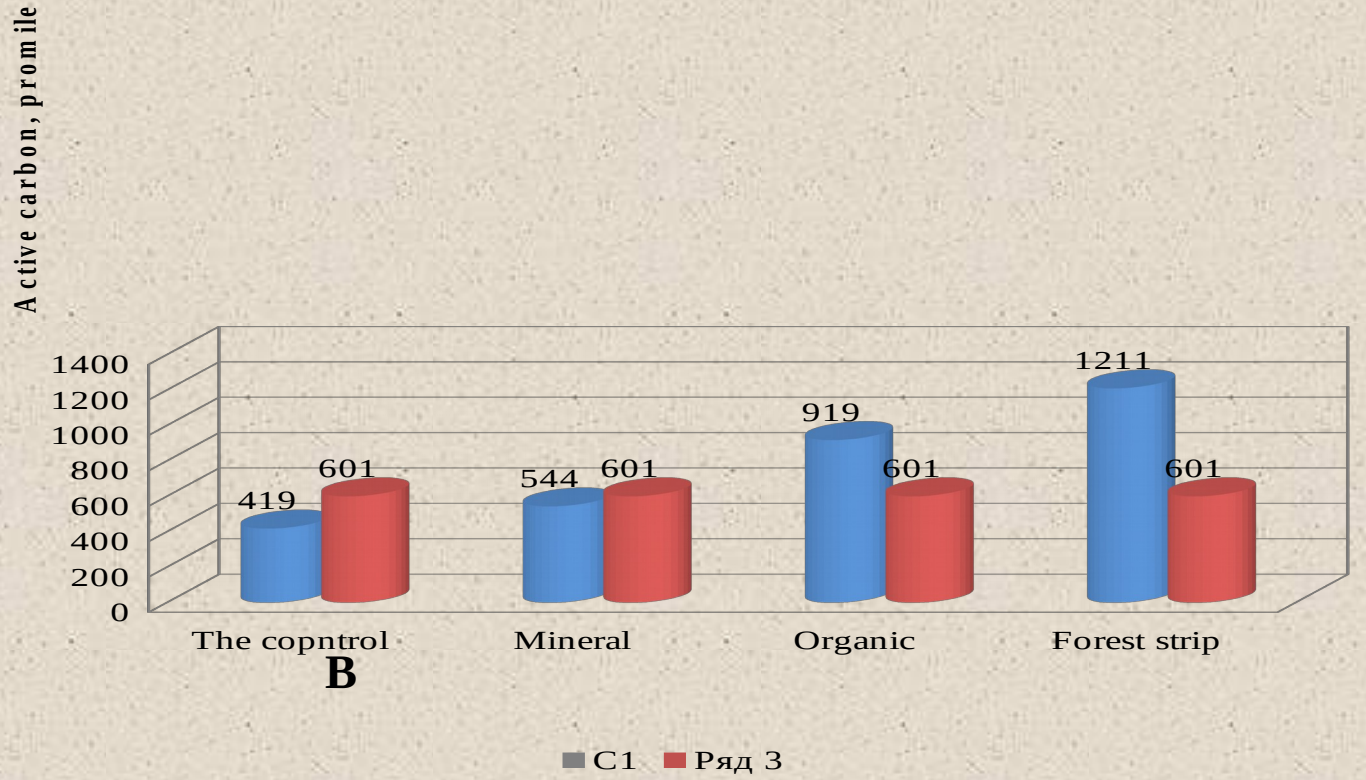


16. Content to active carbon of the typical chernosem , according to the soil health "assessment" system of Kornell University, USA (Field Station of the ASM “Biotron”)

A – Crop rotation with lucerne
B – Crop rotation without lucerne
C1- experimental variants;
C2 - carbon of the standard variant
;



A



B

Conclusions:

1. It has been established that the studied chernozem contains a large number of cells, but they present a stress state. Although most microbes showed reliable signs of viability, the specificity of the cell location suggests the probability of an insignificant vital activity of the edaphic microorganisms under the conditions of agriculturally transformed soils.

2. The in situ study revealed that most are adsorbed on soil particles, and about 1/3 were free cells, of which 67.19-90.34% were associated in aggregates of 2-3 free cells and only 32, 81-9.56% remained free .

3. The microbial biomass content rises to 252-1222 µg C / g in the soil poor in organic matter and 931-3866 µg C / g in the soil rich in organic matter. The microbial carbon reserys made up about 571-1145 kg C / ha in the Central Zone and 2511-6766 kg C / ha in the Northern Region. These values coonstituiend to 0.95-2.54% of organic matter in the soils of the Central area of the republic and, respectively, 2.94 - 8.14% in the soils of the North area.

4. The structure of living matter 62.78-79.45% consists of the eukaryotic component. The metabolically active part of the microbial community in the soil of the natural ecosystem is about 1/3 of the total quantity (average 29.1%), and in arables analogues - 9.8 - 21.8%. The tendency of living matter to function both in arable soils and in the soil of natural biocenosis is negative.

5. The typical chernozeme in Moldova has a significant amino acid content (197 t- 317 mg N / kg soil, which is 8-11% of the total nitrogen of similar chernozems). However, in the anthropic soil are synthesized by 3-7% biomoleculle more than the virgin soil. Therefore, it is possible that the smallest amount of amino acids in anthropogenic variants may be partially explained by their immediate use, while a larger amount in natural soil is retained and stored.

6. Nitrogen reserves representing 0.2% - 0.3%, decrease as a result of the long-term use of agricultural technologies, as does carbon. The lowest proportion is the ammonium fraction (0.20-0.5%). The proportion of nitrate fraction was relatively higher (7.3-14.3 times) In the arable variantes: its values exceeded those of the natural fund 13 times. A significant part was formed by the fraction of nitrogen AA: 10.0-31.0% in relation to crude nitrogen and 0.80-2.30% in relation to humus.

7. Long-term exploitation of the soil has significantly altered soil respiration and its structure. The average values of the basal respiration are higher on average by 10-21% than the RIS and it becomes deeper, reflecting a discrepancy between the RB and RIS ratios, caused by the prolonged influence of the anthropogenic factors. This situation characterizes the condition of the microbial communities as stressful, and its amplitude (13-54%) - the degree of stress.

8. Soil health indicators have revealed that its main components - organic, mineral and living matter - have undergone significant changes, making the soil very vulnerable. The saturation of chernozem studied with nutrients does not satisfy the proportional ratios that characterize their satisfactory combination in humus. The situation is aggravated not only by the lack or excess of nutrients, but also by the fact that the phenomenon itself can make these and many other macro and microelements inaccessible. Therefore, the "health" of Moldovan chernozems transformed anthropically requires not only a careful attitude from the producers, but also a well thought out legislative base from the state for their protection and protection.