Scientific Papers, UASVM Bucharest, Series A, Vol. LIV, 2011, ISSN 1222-5339

DYNAMICS OF PHYSICAL QUALITY INDICES OF THE TYPICAL LOW HUMIFIED CHERNOZEMS IN VARIOUS CONDITIONS OF FERTILIZATION AND SOIL PROCESSING

INA CHIRCU, MARIA MOTELICA, ECATERINA CHISLARI

State University of Moldova

Keywords: *chernozem, agrophysical indices, structural aggregative indices*

Abstract

In the studied land, a few crop variants of soybean and alfalfa were examined: in both cases there is the control variant, mineral fertilization variant ($N_{60}P_{38}K_{175}$) and organic fertilization variant with 70 t/ha farmyard manure (two times in seven years for alfalfa, and one time in seven years for soybean). Due to the fact that humidity is below the critical values for the both variants, the report between apparent density and total one presints values between 0.9-1.0 g/cm^3. The COLE values in the plowing variant (for soybean) comprise up till 16%, which implies the idea that with the plowind occurs the desagregation and soil mass dispersion processes. The higher values of Ka on the organic fertilisation variant (3.03 for soybean and 2.77 for alfalfa) says that organic fertilizers contribute to the biological processes intensification and structuring capacity conservation of the soil. Mineral fertilization is an factor of structure degradation.

INTRODUCTION

Evaluation of the physical quality of the soil involve the measurement of some soil proprieties and traits that serve as sensitive indicators to the modification of the soil functions resulted from using and managing of the soil resources. The determinations of these indicators should underpin the evaluation regarding degradation and soil pollution.

The soil physical properties have a major influence on the way of soil functioning within the ecosystem. Using various technical methods, this traits can be ameliorated so this leads to development of the soil capacity to ensure optimal conditions for plant vegetation.

The soil physical characteristics like structure, porosity, apparent density, hydrological regime, air regim and heat regime, changes depending by soil processing. The purpose of this study implies the evaluation of the dynamics of physical quality indices of the typical low humified chernnozems in various conditions of fertilization and soil processing.

MATERIAL AND METHODS

The researche included field activities and laboratory analysis.

The land research took place in the experimental field of the Microbiology and Biotechnology Institute under Academy of Science of Moldova, located in the ecological micro-district Băcioi. In the studied land, were examinated a few crop variants of soy and alfalfa: in the both cases there is the control variant, mineral fertilization variant ($N_{60}P_{38}K_{175}$) and organic fertilization variant with 70 t/ha farmyard manure (two times in seven years for alfalfa, and one time in seven years for the soybean).

For alfalfa was applied the rotation system in such way: soil plowing on 25-27 cm depth for during three years, in the fourth year the arable surface were treated with the disk about 8 -10 cm depth after what on the land were sown wheat.

The laratory analysis was performed in the laboratory LCŞ „Pedogenetic Processes" from the State University of Moldova using the classical method of examination.

RESULTS AND DISCUSSION

Within the studied object, the apparent density of the both variants (control and organic fertilization) in the arable layer, presents values from the optimal interval (1.1-1.3 g/cm^3) (Table 1). Moreover, the density values are identical for the both alfalfa and soy cultures. To note that, the total density is practicaly identical for all the variants, but presents almost equal values with the apparent density, result caused by the low humidity values (W,%) for the both variants. Therefore, the main factor which determine the values of apparent density and its dynamic in dry period and dry years is humidity. With reference to the humidity, in the variant of annual plowing, for the soybean crop, the value of humidity is bigger than in the case of rotation system on alfalfa crops. So, this justifies the affirmation from speciality literature that alfalfa crop, in virtute of a higher water utilization coeficient, leads to a higher consumption of water from the pedosphere.

The ratio between apparent density and total one presents values between 0.9-1.0 g/cm^3, this is caused by the humidity which is below the critical values in the both cases.

The extension linear coefficient (COLE) is a soil humidity function. This coefficient within the rotational system of soil processing (alfalfa) presents values under 10%. In the case of plowing variant (soybean) - COLE presents value untill 16%, and this implies the ideea that the plowing work determine the soil matter disintegration and dispersion.

As is shown in the table 1, in all the cases the total porosity presents excelente values. Almost 50% from total porosity space is occupied by aggregate porosity and characterizes an excellent pore space condition (refering to the capilar porosity). But in the same time, the experimental data shows that interaggregate porosity is about 75% from total porosity. This could be explained by the hard soil fissures caused by the pronounced water deficit. As a consequence of these fissuring processes is the intensive physical evaporation and water depletion.

The structuring process, and respectively structural - aggregative conditon, are integral indices for the dynamic of all pedogenetic elementary processes, characteristic of one or another pedogenesis type. The fertilization is one of the factors with impact on the structuring process.

Structural/aggregative component of the studied soil is included in the optimal model of the structural/aggregative condition of the chernozems, with the major part of agronomic valuable aggregates (10-0.25 mm) more that 70% for all the variants (Table 2). The boulder aggregate content (>10 mm) presents values under 30%, thing that indicate the achieving of the structural processes in autonomous regime. Techno\anthropogenetic interventions have no role in the structure modification. Also for all the variants, to note, the boulder degree is greater in the 20-40 cm layer, fact caused by the classical soil processing system that result with slightly compaction processes in the arable layer.

From table 2 we can see that the content of aggregate >10 mm is lower on the organic fertilization variant than for witness variant, regularity characteristic for the both crops. Moreover, the content of aggregate <0.25 mm is lower on the organic fertilization variant than mineral fertilization. These data implies the idea that the organic fertilizers are an stabilizing factor of the structure. More Intensive spraying of the structural-aggregative compound (with the highest content of aggregate <0.25 mm) is observed on the mineral fertilization variant ($N_{60}P_{38}K_{175}$). Therefore, we can conclude that the systematic application of the mineral fertilizers leads to the structure dispersion either under K cation influence or indirectly as a result of partial decalcification of the adsorbtiv complex. In the favor of this conclusion comes also the agronomically valuable aggregates (10-0.25mm), with a lower content on the mineral fertilisation variant than on the witness variant. Analyzed in terms of hydrostability, the aggregative - structural component shows the clear growth trend of aggregation and hydro stability. The content of hydrostable macroaggregates varies between %-75% (for soybean) and 65%-78% (for alfalfa). Values higher than 80% is noticed in the 0-10 cm layer.

One integrator parameter of the soil structuring is the structuring coefficient (Ka).

In the study experience the structuring capacity remains on a higher level, fact resulted from the structuring coefficient between the values 2-4. From the same table, is proved that the structuring potential occurs in equal proportions in the witness and mineral fertilisation variant. Therefore, the higher values of Ka on the organic fertilisation variant (3.03 for soybean and 2.77 for alfalfa) says that organic fertilizers contribute to the biological processes intensification and structuring capacity conservation of the soil.

To assess all the processes what influence the structural aggregate size, were used the degree of structure crushing (GMS). A more intense structure crushing is found on the mineral fertilization variant, compared with the witness variant. Here the GMS values are over 60%. And again is confirming the above statement that the mineral fertilization is an factor of structure degradation. The most pronounced process of structure crushing is in the variant of clasical system of soil processing (soybean), when the GMS values is even 67%.

In favor of this conclusion are also the lower values of the medium weighted diameter (DMP) on the mineral fertilization variant, comparing with the witness variant. Higher values of DMP we notice in the 20-40 cm layer for all the variants, because of the higher boulder degree in this layer, as a result of clasical system of soil processing.

CONCLUSIONS

1. Agricultural use and fertilization implies characteristics and particular dynamic of the physical quality indices, which, assigna specific agricultural trait to the typical low humified chernozems.

REFERENCES

1. Canarache A.,1990. *Fizica solurilor agricole.*
2. Jigău Gh., 2009. *Geneza şi fizica solurilor.*
3. Jigău Gh., T. Nagacevschi, 2006. *Ghid al disciplinei Fizica Solului.*

Table 1

Agrophysical indices

		Soybean									Alfalfa								
Variant	***Depth, cm***	***W, %***	***ρ_b, g/cm^3***	***ρ_t, g/cm^3***	***ρ_b/ρ_t, g/cm^3***	***COLE %***	E_t	E_a	$E_{\sum agr}$	E_{ia}	***W, %***	***ρ_b, g/cm^3***	***ρ_t, g/cm^3***	***ρ_b/ρ_t, g/cm^3***	***COLE, %***	E_t	E_a	$E_{\sum agr}$	E_{ia}
Control	0-10	3.94	1.07	1.12	0.95	4.32	59	24.5	13.8	44.7	5.38	1.03	1.09	0.94	5.49	63	25.0	12.5	51.2
	10-20	10.74	1.06	1.17	0.90	10.64	60	26.0	14.2	45.8	7.41	1.14	1.22	0.92	7.26	56	26.5	16.6	39.5
	20-30	13.41	1.12	1.27	0.87	13.71	57	28.1	16.8	40.0	8.38	1.17	1.26	0.92	7.94	56	24.1	14.3	41.6
	30-40	14.37	1.21	1.38	0.87	14.00	53	22.5	14.1	39.1	8.82	1.18	1.28	0.91	9.02	53	25.1	15.7	37.9
	Average	***10.61***	***1.11***	***1.23***	***0.89***	***10.66***	***57***	***25.3***	***14.7***	***42.4***	***7.49***	***1.13***	***1.21***	***0.92***	***7.42***	***57***	***25.2***	***14.8***	***42.6***
$N_{60}P_{38}K_{175}$	0-10	3.57	1.17	1.21	0.96	3.11	55	25.9	15.9	39.0	4.17	1.04	1.08	0.96	4.69	61	25.1	13.2	48.1
	10-20	10.68	1.12	1.23	0.90	10.41	57	25.5	14.9	42.0	7.71	1.12	1.21	0.92	8.04	56	29.3	14.5	42.2
	20-30	12.20	1.09	1.21	0.90	12.63	59	27.1	15.4	43.1	8.76	1.15	1.24	0.93	8.10	55	27.7	17.4	38.4
	30-40	13.03	1.17	1.32	0.88	12.16	56	24.3	14.1	41.9	9.85	1.11	1.25	0.88	10.02	57	25.7	15.0	42.2
	Average	***9.87***	***1.13***	***1.24***	***0.91***	***9.57***	***57***	***25.7***	***15.1***	***41.5***	***7.62***	***1.10***	***1.19***	***0.92***	***7.71***	***57***	***27.0***	***15.0***	***42.7***
Organic 1 / 7 years 70 t/ha	0-10	7.61	1.05	1.14	0.91	8.85	60	27.1	15.4	44.3	5.00	1.11	1.17	0.94	5.09	57	25.1	14.6	42.8
	10-20	14.55	1.01	1.15	0.87	14.14	60	26.8	14.6	45.7	8.55	1.11	1.21	0.91	8.40	58	25.6	15.2	42.9
	20-30	16.06	1.08	1.25	0.85	15.79	58	27.6	16.0	42.3	8.70	1.10	1.19	0.92	8.08	57	27.9	17.2	41.0
	30-40	15.49	1.14	1.34	0.86	14.97	55	24.2	14.4	40.8	8.84	1.11	1.24	0.89	8.42	56	23.0	12.9	44.2
	Average	***13.42***	***1.07***	***1.22***	***0.87***	***13.43***	***58***	***26.4***	***15.1***	***43.3***	***7.77***	***1.11***	***1.20***	***0.91***	***7.49***	***57***	***26.4***	***14.9***	***42.7***

Table 2

		Soybean								Alfalfa							
Variant	***Depth, cm***	***structural aggregative indices***			***structure hydrostability indices***		***medium weighted diameter DMP***	***degree of structure crushing GMS***	***structuring coefficient Ka***	***structural aggregative indices***			***structure hydrostability indices***		***medium weighted diameter DMP***	***degree of structure crushing GMS***	***structuring coefficient Ka***
		>10 mm	***10-0.25 mm***	***<0.25 mm***	***10-0.25 mm***	***<0.25 mm***				***>10 mm***	***10-0.25 mm***	***<0.25 mm***	***10-0.25 mm***	***<0.25 mm***			
Witness	0-10	15.2	70.4	14.4	91.3	8.7	3.74	72.4	2.37	9.2	68.4	22.4	3.0	7.0	3.10	78.2	2.16
	10-20	19.8	71.8	8.4	67.8	32.2	4.66	62.2	2.54	20.2	67.8	12.0	66.0	34.0	4.70	61.8	2.10
	20-30	25.2	70.4	4.4	67.4	32.6	5.48	51.8	2.37	21.8	69.8	8.4	68.0	32.0	5.24	54.2	2.31
	30-40	17.0	82.8	0.2	71.8	28.2	5.04	52.8	4.81	14.8	74.8	10.4	78.2	21.8	4.62	60.8	.96
	Average	***19.3***	***73.8***	***6.9***	***74.6***	***25.4***	***4.74***	***59.8***	***2.81***	***16.5***	***70.2***	***13.3***	***76.3***	***23.7***	***4.42***	***63.8***	***2.35***
$N_{60}P_{38}K_{175}$	0-10	6.8	68.6	24.6	83.4	16.6	2.76	83.6	2.18	4.8	73.4	21.8	89.2	10.8	2.42	84.0	2.75
	10-20	16.8	74.0	9.2	77.6	22.4	4.60	65.0	2.84	24.4	62.6	13.0	75.4	24.6	5.06	57.0	1.67
	20-30	17.6	77.0	5.4	53.8	46.2	4.84	60.0	3.34	18.0	69.2	12.8	64.2	35.8	4.72	60.8	2.24
	30-40	19.8	71.6	8.6	79.2	20.8	4.88	59.6	2.52	19.6	71.8	8.6	84.6	15.4	4.98	57.8	2.54
	Average	***15.2***	***72.8***	***12.0***	***73.5***	***26.5***	***4.28***	***67.1***	***2.67***	***16.7***	***69.3***	***14.0***	***78.4***	***21.6***	***4.30***	***64.9***	***2.25***
Organic 1 / 7 years 70 t/ha	0-10	10.8	75.0	14.2	89.8	10.2	3.58	74.0	3.00	8.4	75.0	16.6	93.6	6.4	3.32	76.8	3.00
	10-20	13.8	78.0	8.2	67.4	32.6	4.56	63.4	3.54	18.2	69.6	12.2	56.4	43.6	4.38	64.8	2.28
	20-30	21.2	74.2	4.6	62.0	38.0	5.34	55.2	2.87	22.4	69.0	8.6	52.0	8.0	5.28	53.8	2.22
	30-40	20.2	73.8	6.0	81.6	18.4	5.16	56.0	2.81	13.0	80.4	6.6	61.6	38.6	4.90	58.6	4.10
	Average	***16.5***	***75.2***	***8.3***	***75.2***	***24.8***	***4.66***	***62.2***	***3.03***	***15.5***	***73.5***	***11.0***	***65.9***	***34.1***	***4.48***	***63.5***	***2.77***

Soil Structural - aggregative component