Scientific Papers. Series A. Agronomy, Vol. LIX, 2016
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

COMPARATIVE EVALUATION OF PLASTICITY AND MICROAGGREGATES CONTENT OF CARBONATE CHERNOZEM UNDER DIFFERENT ANTHROPIC-IMPACT LEVELS

Lucia MACRII

State Agrarian University of Moldova, 44 Mircesti Str., Chisinau, Moldova

Corresponding author email: luciamacrii@yahoo.com

Abstract

Information about soil properties changes under different anthropic-impact levels is necessary for selecting appropriate sustainable soil management practices. The aim of this work was to evaluate the plasticity and water-stable microaggregates content (<0.25 mm) of soil in various agroecosystems and to show the correlations established between them. These soil properties sensitize very well biochemical and physical soil changes and can be used as diagnostical indexes. The study was conducted on carbonate chernozem at the Didactic Station "Chetrosu" of the State Agrarian University of Moldova, including long-term crop rotation agroecosystems, single-crop systems (55 years) - fallow, alfalfa, weed-free fallow and single-maize-crop system (29 years).

The researches has shown that, with anthropic-impact amplification, soil plasticity is decreasing and powder fraction (<0.25 mm) content is increasing. The best physic and physic-mechanical soil properties (water-stable microaggregates content (<0.25 mm), plasticity) were established at fallow (55 years) and the worst at weed-free-fallow (55 years), the other studied agroecosystems takes an intermediate position between these two extremes. There were established strong and medium correlations between plasticity (liquid and plastic limits) and water-stable microaggregates content (<0.25 mm) of carbonate chernozem managed under different anthropic-impact levels. Correlation coefficients and trend lines between plasticity and the water-stable microaggregates content (<0.25 mm) revealed a negative tendency because the soil plasticity decrease at the same time with the powder fraction content increasing.

Key words*: anthropic-impact level, microaggregates content, soil plasticity.*

INTRODUCTION

Accelerated soil degradation is a major ecological problem of the world. The source of this problem is closely linked to agriculture and society. The anthropic-impact level on soils is more visible and right evaluated if parallel are studding soils formed under natural conditions. Based on these researches we can see the gradual soil properties changes at a management practice to another, and implement measures that will reduce soil degradation.

Longstanding research of physic-mechanical properties of soil from Republic of Moldova, in different biogeographical zones, types of ecosystems and agroecosystems, level of human impact, including degraded and undegraded agrophysic soils, soils with various degrees of erosion, allowed the proposal to use some of physic-mechanical properties of soil (plasticity and adherence) as diagnostical indexes of complex soils degradation trends (Andriuca and Macrii, 2015). At the same time, studying aggregate stability, it is possible to quantify whether or not the management is ameliorating the natural soil properties and the land capability for agriculture. Knowing the soil structure, as an essential element of soil fertility, has a great importance because it influences not only the physical conditions aeration and food regime but also the accessibility of nutrient for plant, degradation of organically material in soil and microbiological activity (Ţopa and Jităreanu, 2007).

MATERIALS AND METHODS

The investigations was carried out at the Didactic Station "Chetrosu" of the State Agrarian University of Moldova, located in the South-East side of the Central Moldavian Plateau (46^{o} $92^{'}$ N latitude, 29^{o} $04^{'}$ E longitude and 51 m altitude above sea level) on carbonate chernozem with loamy texture. The researches

included agroecosystems with different anthropic impact levels: long-term crop rotation agroecosystems – maize, alfalfa – 1st year use; single-crop systems (55 years) - fallow, alfalfa, weed-free fallow and single-maize-crop system (29 years).

The article prezents correlations between soil plasticity (plastic and liquid limits) and water-stable microaggregates content (<0.25 mm), % g/g obteined at the soil aggregate hydrostability determination.

Soil plasticity (plastic and liquid limits) were determined by Vasiliev A. method, the soil aggregate hydrostability by Savvinov wet-sieving method, both according to conventional methods used in soil science and geology (Вадюнина and Корчагина, 1986; Canarache, 1990).

The soil samples were taken from the arable and subarable layer - 0-60 cm at each 10 cm.

RESULTS AND DISCUSSIONS

The carbonate chernozem humus content of researched agroecosystems deviate in surface layer from 3.41% (in fallow) to 2.75% (in weed-free fallow), pH varies in arable and subarable layer beetwen neutral and alkaline (6.9-8.2), the sum of Ca^{++} and Mg^{++} falls within the range of 19.7-28.8 me/100 g soil. The weed-free fallow soil is highlighted with lower content of Ca^{++} and Mg^{++} (19,7-24,7 me/100g soil) compared with the other studied agroecosystems (25.4-28.8 me/100g soil).

The soil plasticity of researched objects is described by liquid and plastic limits and correspond loam variety (Table 1).

From agrotechnical aspect, the plastic limit represents the most important soil characteristics, because it simultaneously represents the upper limit of the moisture of soil physical suitability for machine tillage. Therefore, the knowledge of this plasticity limit is very important for correct and well-timed soil tillage. If at approximately equal colloid clay fraction content plastic limit values are higher, the interval of moisture suitable for tillage is wider, together with the time interval favourable for good tillage with less resistance and energy waste (Gajiè, 2005).

Soil plasticity studies revealed the highest values for liquid (38.8%) and plastic (22.4%) limits in fallow (55 years), which represent a background variant.

The soil liquid and plastic limits researches in arable and subarable layers of various agroecosystems show, that plasticity deviate more significant, among variants, in arable layer, because this one, receive the direct consequences of anthropic-impact, especially those relating to the soil tillage. With anthropic-impact amplification, the soil liquid and plastic limits is decreasing. Compare with fallow (55 years) soil plasticity, the weed-free fallow (55 years), in arable layer (0-30 cm), deviate at liquid limit with 5-9% and at plastic limit with 2-5%, other studied variants – single-alfalfa-system (55 years), single-maize-system (29 years) and crop-rotation agroecosystems (maize, alfalfa 1st year use) are placed between these extremes (fallow and weed-free fallow), so remarked deviation in arable layer (compared to fallow) do not exseed 3,6% at the liquid limit and 2.9% at the plastic limit, however a worsening trend of these indexes are notified in single-alfalfa-system (55 years). The liquid and plastic soil limits indexes of single-maize-system (29 years) compared with the crop-rotation agroecosystems soil plasticity values are higher (statistically significant), this is explained by the higher content of organic matter.

In subarable layer, liquid and plastic limit is characterized with smaller differences among researched variants, and yet, a decrease of plasticity is observed at weed-free fallow (up to 3.8% at liquid limit and up to 1.2% at plastic limit, compared with fallow). The crop rotation agroecosystems and single-maize-system, in subarable layers, recorded significant higher values (with 1.9-3.3% increase) at liquid limit, compared with fallow.

If we compare the soil plasticity between arable and subarable layer, at liquid limit, then it can be noted a slightly decrease with depth (up to 3%) in fallow and slightly increase (up to 2%) in crop-rotation agroecosystems and single-maize-system. Weed-free fallow soil show more significant increase of liquid limit (up to 5%) in subarable layer compared with arable, because of degradation. The greater the degradation of soil in arable layer the greater it differs by the soil of underlying layer.

Table 1. The influence of anthropic-impact level on soil plasticity

Plasticity, %	Layer, cm		Single-crop agroecosystems				Crop rotation agroecosystems	
			Fallow (55 years)	Alfalfa (55 years)	Weed-free fallow (55 years)	Maize (29 years)	Maize	Alfalfa 1st year use
Liquid limit	0-30	min	34.9	32.8	29.5	34.7	34.3	33.8
		max	38.8	35.2	30.3	36.4	35.4	35.8
	30-60	min	34.3	35.0	30.5	37.6	37.3	36.2
		max	35.6	35.4	35.1	38.3	38.2	37.4
$DL_{0.05} = 0.3$								
Plastic limit	0-30	min	19.5	18.8	17.6	19.5	19.0	19.0
		max	22.4	19.6	17.8	19.7	19.6	19.5
	30-60	min	19.1	18.6	17.9	19.4	19.7	19.0
		max	20.3	18.8	19.3	19.7	19.8	19.6
$DL_{0.05} = 0.6$								

Soil plastic limit of studied objects, show the same tendency between moistures in arable and subarable layers, only differences are smaller.

The soil changes at diverse management practices may be pointed out and by studying aggregate stability. Therea are shown the microaggregates content (<0.25 mm) obtained at wet-sieving (Figure 1). The chart analysis show a perfect view of slowly increase of microaggregates content (<0.25 mm) in fallow (55 years) from above (27.3%) to beneath layers (58.0% at 50-60 cm deph). This natural microaggregates content distribution it is reversed in agroecosystems. The weed-free fallow (55 year) is a system with the most dispersed soil phase – the content of microaggregates (<0.25 mm) at wet-sieving corisponde to 92.5% at 0-20 cm depth and 89.9% at 20-40 cm depth, and only at 50-60 cm depth the content of microaggregates decrease to 60.9%.

The intensive soil tillage without organic matter incorporation and lack of any vegetation leads to extremal degradation with complete destruction of soil solid phase.

The crop rotation-agroecosystems and single-maize-system (29 years) don't differ among them by the microaggregates content, that it's placed between 64.4-72.3% in arable layer and 51-7-64.1% in subarable layer.

The single-alfalfa-system (55 years) doesn't contribute completly at the building of stabile aggregates, having the same position as crop-rotation agroecosystems. It was noticed that at 50-60 cm depth, regardless of anthropic-impact level, the content of microaggregates don't differ significantly among variants (51.7-64.1%).

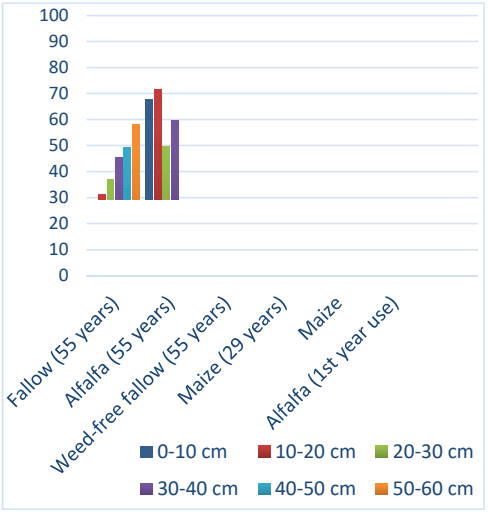

Figure 1. The influence of anthropic-impact level on the soil' microaggregates content (<0.25 mm), % g/g (wet-sieving)

There were established correlations between limits of soil plasticity and microaggregates content (<0.25 mm) for soil managed under single-crop-systems (55 years) and crop-rotation agroecosystems plus single-maize-system (29 years) (Figures 2, 3, 4, and 5). The analysis of trend lines found that soil plasticity diminishes with microaggregates content increasing. The both properties are related to soil particles behaviour in contact with water, what explain in complex physic-chemical soil state. The r - coefficient values show that were established strong correlations, with exception of medium one-between plastic limit and water-stable microaggregates content (<0.25 mm) of soil used under crop rotation agroecosystems and single-maize-system, but statistically authentic.

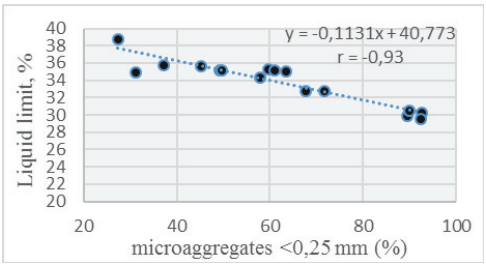

Figure 2. Correlations between soil liquid limit and microaggregates content (wet sieving) under single-crop-systems (55 years)

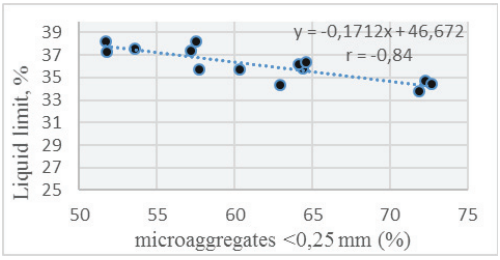

Figure 3. Correlations between soil liquid limit and microaggregates content (wet sieving) under crop-rotation agroecosystems and single-maize-system (29 years)

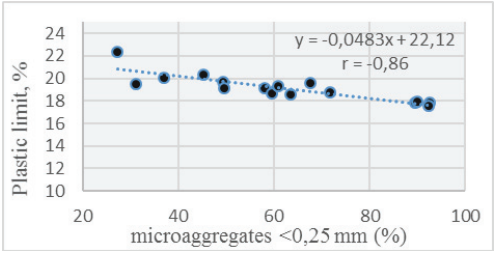

Figure 4. Correlations between soil plastic limit and microaggregates content (wet sieving) under single-crop-systems (55 years)

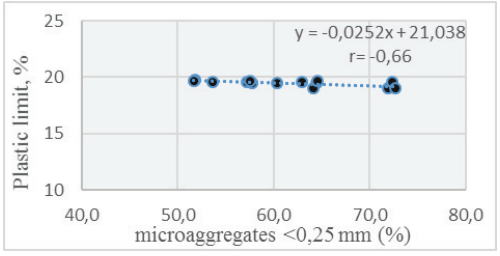

Figure 5. Correlations between soil plastic limit and microaggregates content (wet sieving) under crop-rotation agroecosystems and single-maize-system (29 years)

CONCLUSIONS

The anthropic-impact level on soils is more visible and right evaluated if parallel are studding soils formed under natural conditions.

The best physic and physic-mechanical soil properties (water-stable microaggregates content (<0.25 mm), plasticity) were established at fallow (55 years) and the worst at weed-free-fallow (55 years), the other agroecosystems takes an intermediate position between these two extremes.

With anthropic-impact amplification soil plasticity is decreasing and powder fraction (<0.25 mm) content is increasing more significantly in arable layer.

There were established strong and medium correlations between plasticity (liquid and plastic limits) and water-stable microaggregates content (<0.25 mm) of carbonate chernozem managed under different anthropic-impact levels.

Correlation coefficients and trend lines between plasticity (liquid and plastic limits) and the water-stable microaggregates content (<0,25 mm) revealed a negative tendency, because the soil plasticity decrease at the same time with the powder fraction content increasing.

REFERENCES

Andriucă V., Macrii L., 2015. Physic-mechanical idexes and using in evaluation of anthropical soil degradation degree. Agrarian Science No. 2, State Agrarian University of Moldova Publishing House, Chisinau, 12-18.

Canarache A., 1990. Fizica solurilor agricole. Editura Ceres, Bucuresti, 268 p.

Gajiè B., 2005. Plasticity of pseudogley soils in UB Communuty. Journal of Agricultural Science Vol. 50, No 2, 153-159.

Ţopa D., Jităreanu G., 2007. The modification of macrostructural hydrostability degree caused by different tillage systems at winter wheat. Scientific papers "Agronomy series" Vol. 50. Ion Ionescu de la Brad Publishing House, Iasi, 324-328.

Вадюнина А.Ф.. Корчагина З.А., 1986. Методы исследования физических свойств почв. Агропромиздат, Москва, 416 с.