Scientific Papers. Series A. Agronomy, Vol. LXI, No. 2, 2018
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

EVALUATION OF THE CELLULOLYTIC ACTIVITY DEPENDING ON SOIL TILLAGE SYSTEM AND METEOROLOGICAL CONDITIONS UNDER SUNFLOWER AGROCOENOSES

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Abstract

The aim of this work was to evaluate cellulolytic activity depending on soil tillage system, weather conditions in a long-term crop rotation under sunflower agrocoenoses. The study was carried out at the Didactic Station „Chetrosu" of the State Agrarian University of Moldova on carbonate chernozem with sandy loam texture. The cellulolytic activity was determined according to the Misustin (1978) method based on the principle of cellulose decomposition under aerobic conditions by incorporating linen tissue in the 0-30 cm soil layer. The researches has shown that soil cellulolytic activity under conservation tillage system - No-till is less with 15-20%, comparative with plowing variant during May-June period - characterized by sufficient rainfall and moderate temperatures. The July-August dry weather conditions have inhibited cellulolytic activity under conventional soil tillage from low to very low, being similar to the No-till variant, where cellulolytic activity also diminished with 10% from May-June to July-August period. The incorporation of linen tissues at different depths showed that cellulolytic activity is higher in the 20-30 cm layer and it is directly affected by the soil moisture.

Key words*: carbonate chernozem, cellulolytic activity, soil moisture, soil tillage system, weather conditions.*

INTRODUCTION

Soil - a living organism made up of countless living microscopic creatures. The number and diversity of organisms that live in soil is immeasurable - over 20 groups of species, totalizing thousands of species in terms of population size especially bacteria, fungi and algae (Berca, 2008). These microorganisms have a special role in organic material transformation.

Bacteria are the most widespread group of microorganisms ranging from several hundreds to billions in each cm^3 of soil and represent 40% of the amount of microorganisms in the soil. The most populous area of bacteria is found in the nearness (2-5 mm) of plant roots, called the rhizosphere (Girla and Cazmalî, 2013), and according Alcamo (2003) one gram of soil in the rhizosphere contains about 500,000,000 microorganisms.

About the way of nutrition, the bacteria are classified into heterotrophs and autotrophs, and by the way of oxygen use in aerobic and anaerobic. Soil fungi are predominantly aerobic heterotrophic microorganisms that prefer an acid environment, live alongside bacteria and are of great importance in the humification and ammonification process.

Actinomycetes are a form of transition from bacteria to fungi, they develop under acid to alkaline pH, have a high capacity of decomposition of organic substances (Girla and Cazmalî, 2013).

The rate and extent of cellulose degradation by microorganisms and their enzymes is dependent in part on physical and chemical parameters such as temperature, pH, O_2 supply, availability of other sources of substrate. The study of relationship between soil tillage and residue management practices and enzyme activities is important, because enzyme activities potentially may be used as indexes of soil fertility, productivity, and soil tilth and quality.

Understanding the process of cellulose decomposition and identifying the factors involved in this process in soils would be an important building block in understanding the microbiological and biochemical changes associated with tillage and residue management practices (Deng, 1994).

MATERIALS AND METHODS

The study 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 on carbonate chernozem with sandy loam texture.
The cellulolytic activity was determined in a long-term crop rotation under sunflower agrocoenoses with conventional and No-till soil tillage systems, and at different weather conditions registered during two vegetation periods (May-June and July-August of 2015-2016 crop year).
Chemical and physical soil properties were determined according to agro-ecological monitoring methods (Cerbari, 1997, 2010) in field and laboratory. The cellulolytic activity was determined according to the Misustin (1978) method based on the principle of cellulose decomposition under aerobic conditions by incorporating linen tissue in the 0-30 cm soil layer.
The results of cellulolytic activity were evaluated according to Table 1.

Table 1. Values of cellulolytic activity on chernozems (Misustin, 1978)

Index level	Cellulolytic activity
Very low	< 36
Low	36-52
Middle	52-68
Great	68-84
Very great	> 84

RESULTS AND DISCUSSIONS

The carbonate chernozem of researched agroecosystem is characterized by the sub-moderate humus content (2.4% in 0-30 cm soil layer), the sum of Ca^{++} and Mg^{++} in arable layer is about 22.0 mg/100 g soil. Carbonates are present throughout the profile, ranging from 1% in the upper layer to 8% at a depth of 110-120 cm. Soil reaction is slightly alkaline.
Soil tillage lead to physical properties change, creating in some cases favourable conditions for microorganism's activity. With the purpose to follow soil cellulolytic activity at different conditions, this one was studied under conventional (Tillage) and No-till soil tillage systems (Tables 2 and 4) at different weather conditions registered during two vegetation periods - May-June and July-August of 2015-2016 crop year (Figure 2). Also, it was researched cellulolytic activity depending on depth and tissue layout toward roots of sunflower plants (Tables 2 and 4, Figure 1).

Table 2. Cellulolytic activity (%) depending on soil tillage system, May-June 2016

Depth, cm	Tissue location	Tissue breaking, % to the initial mass	Average	Index level
Tillage				
0-10	On the row	46.7	46.5	Low
	Between the rows	45.4		
	On the row	47.3		
10-20	On the row	51.1	49.2	Low
	Between the row	47.4		
	On the row	49.2		
20-30	On the row	53.2	50.7	Low
	Between the rows	48.9		
	On the row	50.0		
No-till				
0-10	On the row	29.2	31.1	Very low
	Between the rows	30.6		
	On the row	33.4		
10-20	On the row	30.0	30.1	Very low
	Between the rows	28.6		
	On the row	31.8		
20-30	On the row	33.0	32.7	Very low
	Between the rows	30.2		
	On the row	34.8		

According to the data, the cellulolytic activity under sunflower agrocoenoses during May-June period for Tillage variant varies within the limits of 47-51% in 0-30 cm soil layer, and for No-till variant is lesser - 31-33%.

Table 3. Physical soil conditions under sunflower agrocoenoses, May 2016

Depth, cm	Moisture, %		Bulk density, g/cm^3		Penetration resistance, kgf/cm^2	
	Tillage	No-till	Tillage	No-till	Tillage	No-till
0-10	17.7	16.8	1.18	1.35	5.1	15.0
10-20	18.2	16.8	1.20	1.37	9.7	17.5
20-30	19.0	17.1	1.29	1.34	16.3	20.8
30-40	18.9	19.5	1.26	1.33	14.7	18.0
40-50	20.7	18.9	1.28	1.18	16.3	18.9

Table 4. Cellulolytic activity (%) depending on soil tillage system, July-August 2016

Depth, cm	Tissue location	Tissue breaking, % to the initial mass	Average	Index level
Tillage				
0-10	On the row	24.2	23.4	Very low
	Between the rows	20.9		
	On the row	25.1		
10-20	On the row	26.0	24.5	Very low
	Between the rows	21.4		
	On the row	26.1		
20-30	On the row	26.9	25.4	Very low
	Between the rows	22.3		
	On the row	26.9		
No-till				
0-10	On the row	22.8	20.8	Very low
	Between the rows	19.6		
	On the row	20.1		
10-20	On the row	23.3	23.9	Very low
	Between the rows	22.6		
	On the row	25.8		
20-30	On the row	26.9	25.1	Very low
	Between the rows	23.3		
	On the row	25.2		

Some physical soil properties (moisture, bulk density, penetration resistance), determined in May, show that on Tillage variant soil moisture is higher by 1-2%, comparative with No-till variant, and the bulk density and penetration resistance data indicates a more afforested settlement of the arable layer on tilled variant (Table 3). These better physical conditions (moisture, O_2 supply) explain the cause of a higher cellulolytic activity on Tillage.

The researches has shown that soil cellulolytic activity under conservation tillage system - No-till is less with 15-20%, comparative with plowing variant during May-June period - characterized by sufficient rainfall (monthly precipitation was higher than multiannual average) and moderate temperatures (16.5-22.1°C) (Figure 2).

The July-August dry weather conditions (precipitations much lower than multiannual average) have inhibited cellulolytic activity under conventional soil tillage from low (47-51%) to very low (23-25%), being similar to the No-till variant (21-25%) where cellulolytic activity also diminished with 10% from May-June to July-August period.

The most populous area of microorganisms is near of plant roots. This explains better decomposition of tissues located on rows, comparative to that located between rows (Figure 1).

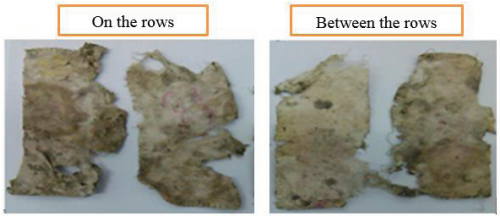

Figure 1. Cellulolytic activity depending on tissue location in sunflower agrocoenoses

Data obtained in both variants (Tillage and No-till) during two vegetation periods reveals that microorganisms activity grows slightly - with 2-5% from surface soil layer (0-10 cm) to 20-30 cm soil layer. This is due to soil moisture increasing with depth.

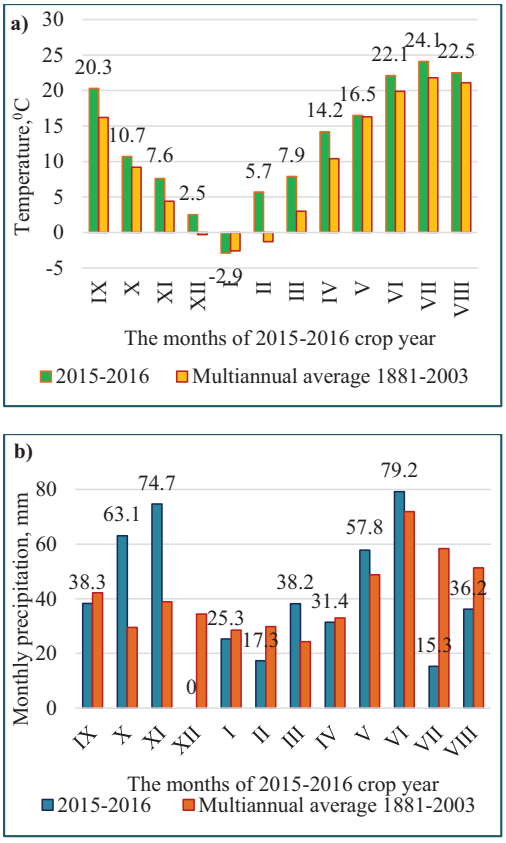

Figure 2. Meteorological conditions of 2015-2016 crop year, DES „Chetrosu": a) Temperature; b) Precipitation

CONCLUSIONS

Soil cellulolytic activity under conservation tillage system - No-till was less with 15-20%, comparative with plowing variant during May-June period - characterized by sufficient rainfall and moderate temperatures. The July-August dry weather conditions have inhibited cellulolytic activity under conventional soil tillage from low (47-51%) to very low (23-25%), being similar to the No-till variant (21-25%), where cellulolytic activity also diminished with 10% from May-June to July-August period.

The incorporation of linen tissues at different depths showed that cellulolytic activity is higher in the 20-30 cm layer and it is directly affected by the soil moisture.

The most populous area of microorganisms is near of plant roots. The better decomposition of tissues occurred on rows, comparative to that located between rows.

Cellulolytic activity is influenced by soil moisture, O_2 supply, soil tillage system, weather conditions and other factors that act directly and indirectly on microorganisms in the soil.

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