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# THE EFFECT OF CROPS AND FARMING SYSTEMS ON SOIL QUALITY

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***Abstract***

*Soil biological quality can affect key soil functions that support food production and environmental quality. The objective of this study was to determine the effects of crops and climatic conditions on soil biological quality in two contrasting agricultural cropping systems from South estern part of Romania. The experiment was bifactorial of type 2 x 4 in 3 repetitions, with A factor (farming system: $a_1$ – organic farming; $a_2$ – conventional farming system) and B (crops: $b_1$ - soybean, $b_2$ - winter wheat, $b_3$ - maize, $b_4$ - sunflower). Soil biological properties (respiration and biodegradation of celulose) were assessed at depths of 0-20 cm in 2012 during vegetation period of studied crops. Also, the chemical reaction of soil was tested. Compared to conventional system, organic farming system had greater chemical reaction of soil, high respiration and catalase activity of soil under 2012 year conditions.*

**Key words:** *organic and conventional agriculture system, soil reaction, cellulase activity of soil, soil respiration.*

## INTRODUCTION

Management practices to sustain crop yields are necessary to conserve or enhance soil quality. Thus, a difference in management practices often results differences in biological, chemical and physical soils properties which in turn results changes in functional quality of the soil (Islam and Weil, 2000).
Soil quality is the capacity of soil to maintain some key ecological functions, such as decomposition and formation of soil organic matter. Microbial processes are important for the management of farming system and improvement of soil quality. Microbial respiration of soil has received considerable attention because it can be used as a soil quality indicator and it is one important variable to quantify soil microbial activity, organic matter content and its decomposition (Araujo et al., 2008). Generally, higher values of soil respiration indicate a better quality of soil (Stefanic, 1994; Stefanic, 2006).
Cellulose is the main component of plant tissues (30-60%) and will be the most important compound with carbon in soil and water. In nature, microbial decomposition of the cellulose is greatly influenced by environmental factors such as oxidation-reduction potential, pH and assimilable nitrogen content of the soil are the most important.
In our country studies on soil microbial activity especially in organic farming system are relatively few. For those intended objective was to highlight the effect of crop and climatic conditions on soil quality in organic and conventional farming system.

## MATERIALS AND METHODS

Samples from the plow horizon (0-10 cm) of a chernozem soil from National Agricultural Research and Development Institute from Fundulea Romania were used in this experiment. The experience was bifactorial of type 2 x 4 in 3 repetitions, with A factor (farming system: $a_1$ – organic farming; $a_2$ – conventional farming system) and B (crops: $b_1$ - soybean, $b_2$ - winter wheat, $b_3$ - maize, $b_4$ - sunflower). This experience was founded in 2004, under dryland condition, on cambic chernozem, well drained, formed on loess, with 33.8% clay content and 2.8% organic matter in arable layer. The soil samples were taken in summer of 2012 and 2013 (July).
Experimental factors were: *A factor (farming system: $a_1$ – organic farming; $a_2$ – conventional*

*farming system) and B factor (crops: $b_1$ - soybean, $b_2$ - winter wheat, $b_3$ - maize, $b_4$ - sunflower).*

In the organic farming system has been practiced an 8-year rotation (wheat/soybean, corn, sunflower - alfalfa (4 years, cover crop) and work done were stubble, disking (18 cm), worked with combiner, sowing and for weeding crops two mechanical and two hand hoeing. In the conventional farming system we performed a 4-year rotation (wheat-soybean-corn-sunflower) and were conducted in addition works fertilizers and chemical treatments so: the wheat was fertilized during autumn with 80 kg to N / ha and Icedin to herbicides, soybean, corn and sunflower was fertilized with 100 kg / ha NPK complex fertilizers (15:15:15) have been treated the weed vegetation, one manual and two mechanical hoeing.

The fresh soil samples were sieved by a sieve of 2 mm, all visible plant remains were removed and then were tested for respiration, cellulose biodegradation potential (Stefanic methods 1994, 2006) and soil chemical reaction (Elena Stoica method, 1986). Cellulolytic activity is expressed in % cellulose degraded and respiration in mg $CO_2$ from 100 g dw soil

The results were statistically interpreted by multiple test (Snedecor) and by correlations. For an easer interpretation of the experimental data, the bifactorial tables were utilized. The data were grouped and significantly separated by letters; letter "a" for the higher values and for those inferior, the letter "b", 'c", etc.

## RESULTS AND DISCUSSIONS

### 1. Climatic conditions

In 2012 average of monthly temperatures in the growing season of crops were above the annual average, on average 1.9°C. There was a deficit of rainfall in the early part of the growing season, followed in May of precipitation that exceeded the normal of the zone and again a deficit of rainfall in June, insufficient to meet water needs of crops (Table 1).

Table 1. Average temperature (°C) and monthly distribution of rain fall (mm) during the crop vegetation period Fundulea, 2012

| **Month** | **March** | **April** | **May** | **June** | **Average** |
|---|---|---|---|---|---|
| Temperature 2012 | 5.5 | 14.2 | 18 | 23.3 | 15.3 |
| *Multi-annual average* | *4.7* | *11.1* | *16.9* | *20.7* | 13.4 |
| Differences | 0.8 | 3.1 | 1.1 | 2.6 | 1.9 |
| Rainfall | 4.8 | 35.1 | 159.5 | 20.7 | 55.0 |
| *Multi-annual average* | 37.6 | 44.1 | 60.5 | 71.8 | 53.5 |
| Differences | -32.8 | -9.0 | 99.0 | -51.1 | 1.5 |

### 2. Soil chemical reaction

The results obtained showed a very significant influence of the farming system, crop and its interaction on the soil reaction. The chemical reaction of the soil had lower values in conventional farming system (5.86) than the organic farming system as a whole is observed a higher pH (6.02) (Table 2).

Table 2. The influence of the agricultural farming system and crops on soil chemical reaction ($pH-H_2O$)

| **Farming system (Factor A)** | **Crop (Factor B)** | | | | **Average(A)** |
|---|---|---|---|---|---|
| | **$b_1$ soybean** | **$b_2$ winter wheat** | **$b_3$ maize** | **$b_4$ sunflower** | |
| $a_1$- organic farming | a 6.06 a | a 6.15 a | a 6.01 b | a 5.87 c | a 6.02 |
| $a_2$- conventional farming | b 5.87 a | b 5.93 a | b 5.81 b | a 5.84 a | b 5.86 |
| Average (B) | 5.97 b | 6.04 a | 5.91 b | 5.85 c | |
| Factors | **A** | **B** | **B*A** | **A*B** | |
| LF 5% | 0.012 | 0.034 | 0.042 | 0.048 | |
| LF 1% | 0.028 | 0.047 | 0.061 | 0.067 | |
| LF 0.1% | 0.088* | 0.067* | 0.093* | 0.094* | |

At the average of crops (factor B), one observes the influence of factor B on chemical reaction of soil. Variant winter wheat crop is framed in the group „a” with the highest values of pH (6.15) under organic farming and then diminishes in conventional farming system (5.93). The increase of pH, could be explained by the a large amount of plant debris which improve soil pH by the decomposition of the protein to ammonium (Table 2).

## 3. Cellulolytic activity

Cellulolytic activity in chernozem soil was positive influenced by the farming system. In organic farming system the soil cellulolytic activity was more intense (4.13) compared to conventional farming system (2.39). One possible explanation could be the use of fertilizers in the conventional farming system. Fertilizers reduce soil cellulolytic activity (Feliang Fan et al., 2012).

Very significant differences are due to the crops, too. Thus, we note a synergistic effect, in organic farming the degradation processes of organic cellulose were more active in the corn crop as compared to crop wheat while in the conventional farming the highest values were in wheat crop and the lower in corn crop (Table 3).

Table 3. The influence of the agricultural farming system and crops on soil cellulolytic activity

| Farming system (Factor A) | Crop (Factor B) | | | | Average(A) |
|---|---|---|---|---|---|
| | $b_1$ soybean | $b_2$ winter wheat | $b_3$ maize | $b_4$ sunflower | |
| $a_1$- organic farming | a 4.72 b | a 2.64 d | a 5.70 a | a 3.44 c | a 4.13 |
| $a_2$- conventional farming | b 2.64 b | a 3.76 a | b 1.40 c | b 1.76 c | b 2.39 |
| Average (B) | *3.68* | *3.20* | *3.55* | *2.60* | |
| Factors | **A** | **B** | **B*A** | **A*B** | |
| LF 5% | 1.842 | 0.597 | 1.579 | 0.844 | |
| LF 1% | 4.249 | 0.837 | 3.304 | 1.183 | |
| LF 0.1% | 13.530 | 1.183 | 9.590 | 1.672 | |

Stefanic et al., (1994, 2011) show that cellulolytic potential is a sensitive test to assess the improvement of living conditions in soil and highlights the effect of soil tillage, chemical and organic fertilization and the climate conditions on this indicator.

The relationship between chemical soil reaction and cellulolytic activity was significant positive for conventional farming system (r = 0.75**) and non significant for organic farming system (r = - 0.11), (Figure 1), which can be explained by the low values of pH and the use of mineral fertilization in conventional farming system.

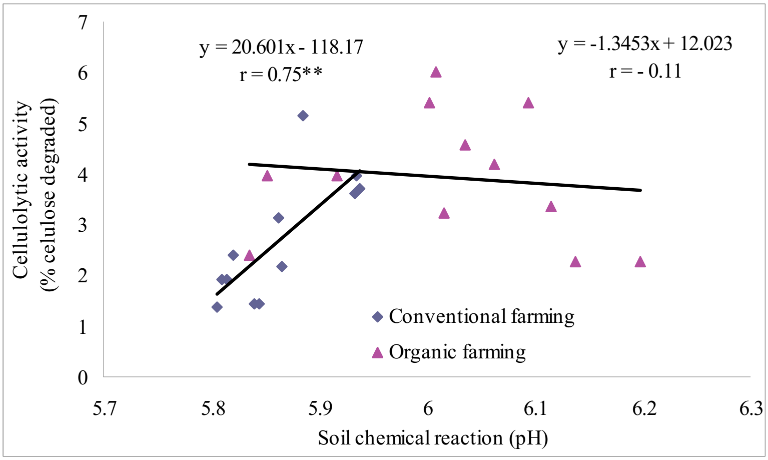


Figure 1. The relationship between soil chemical reaction and cellulolytic activity in organic and conventional farming systems

Cellulase activity in agricultural soils is affected by a number of factors.
These include temperature, pH, and oxygen from the soil, the chemical structure of the organic mattter and its location in the soil profile, the quality of organic matter from plant debris, nutrients from the soil and trace elements from fungicides (Arinze and Yubedee, 2000).

**4. The soil respiration**

The soil respiration, under 2012 year condition, was very significant influenced by the farming system and by the interaction between farming system and crop (Table 4).
In organic farming system soil respiration values were higher (48.64) as conventional farming system (42.87), suggesting a more rapid decomposition of organic debris (Table 5).

Table 4. Analyses of variance for soil respiration

| Source of variance | Sum of squaers | LF | Mean square | F values and signification |
|---|---|---|---|---|
| Farming system (Factor A) | 197.626 | 1 | 197.626 | 122.10*** |
| ErorrA | 3.237 | 2 | 1.618 | |
| Crop (Factor B) | 48.371 | 3 | 16.123 | 2.59 NS |
| Interaction A*B | 85.457 | 3 | 28.485 | 4.577** |
| Erorr B | 74.67 | 12 | 6.223 | |

***significant at < 0.001 level of probability; **significant at < 0.01 level of probability

Table 5. The influence of farming system and culture on soil respiration (mg $CO_2$/100 g dm soil)

| Farming system (Factor A) | Crop (Factor B) | | | | Average(A) |
|---|---|---|---|---|---|
| | $b_1$ soybean | $b_2$ winter wheat | $b_3$ maize | $b_4$ sunflower | |
| $a_1$- organic farming | a 51.17 a | a 44.20 b | a 51.96 a | a 47.22 b | *a 48.64* |
| $a_2$- conventional farming | b 41.16 a | a 43.99 a | b 43.71 a | a 42.62 a | *b 42.87* |
| Average (B) | *46.17* | *44.09* | *47.83* | *44.92* | |
| Factors | **A** | **B** | **B*A** | **A*B** | |
| LF 5% | 2.227 | 3.137 | 4.227 | 4.437 | |
| LF 1% | 5.136 | 4.398 | 6.483 | 6.220 | |
| LF 0.1% | 16.353 | 6.217 | 11.672 | 8.792 | |

Decreased of the soil respiration indicates that there is a small amount of organic matter or aerobic microbial activity in soil. Other comparisons of conventional and organic system have also reported increased soil microbial respiration under organic management (Glover at al., 2000). A higher soil respiration, in the organic farming system, is an indicative of high biological activity, suggesting rapid decomposition of organic residues that make nutrient available for plant growth (Swezy at al., 1998). Also there is the assumption that under global warming due to the increase of $CO_2$, increases root biomass which in turn leads to increased of the soil microbial activity (Lipson et al., 2005).

Soil respiration was not affected by soil reaction, the correlations between them were insignificant in both farming systems (Figure 2). The most important factors affecting soil respiration are soil temperature, soil moisture, quality, quantity of organic carbon and soil texture (Tripathi et al., 2011).
Between cellulolytic potential and soil respiration there are significantly distinct correlation (r = 0.79**) in organic farming system and low in conventional farming systems (r = 0.32) (Figure 3). Cellulolytic potential was highest in the organic system, and this likely is the mechanistic link to the greatest cumulative respiration observed in this farming system.

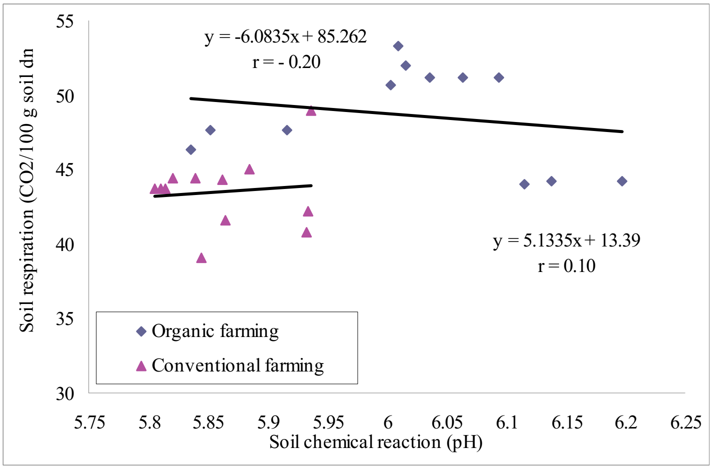


Figure 2. Relationship between soil chemical reaction and soil respiration in organic and conventional systems

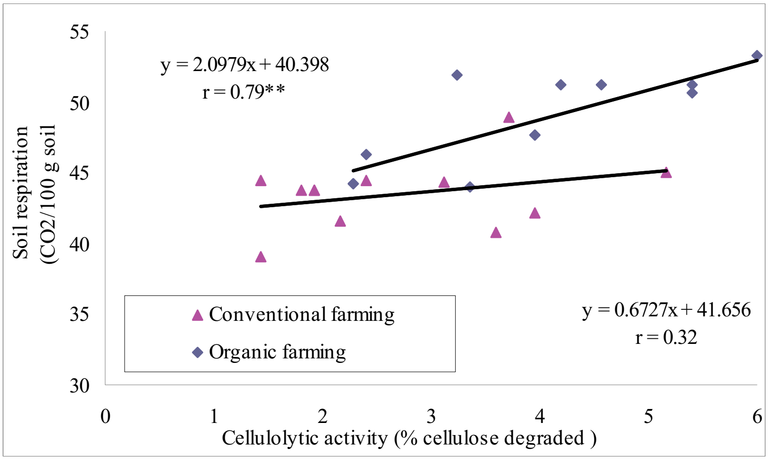


Figure 3. Relationship between cellulolytic potential and soil respiration in organic and conventional systems

## CONCLUSIONS

The culture and management system have produced some rapid changes in soil properties as soil chemical reaction and soil microbial activity measured by soil respiration and cellolityc activity. Our results showed that the conventional farming practices resulted in lower soil reaction and this was correlated with cellulolytic potential of the soil. Wheat had the most obvious effect on soil chemical reaction.

The cellulolytic activity was highest in the organic system and lowest in the conventional system.

Soil respiration was stimulated by farming system practiced and by ineraction between culture and farming system. Cellulolytic potential was highest in the organic system, and this correlated with soil respiration.

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