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RESEARCH ON THE SOIL BREATHING ACTIVITY UNDER THE IMPACT OF AGRICULTURAL TECHNOLOGICAL PROCESSES

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Abstract

The biological properties of the soil are important because they are closely related to soil physico-chemical properties and plants' health. Thus, the diversity of species, their number and their functions are indicators sensitive to changes in soil properties due to agricultural practices. From a biological point of view, improving the physical and chemical properties of the soil creates favourable conditions for the activity of the microorganisms and for the growth of the plant roots. Soil breathing is one of the soil's properties, determined by the plant roots' activity and microorganisms living in the soil, an activity that is appreciated by the carbon dioxide production (CO_2 emission) from the organisms that live in the soil. The research calls into question the soil breathing process under two crops, wheat and corn, following the impact of various soil technological processes on this respiration potential, on experimental variations such as conventional tillage, superficial tilling, disc harrowing and no tillage soil. From research in the field, soil breathing rates vary significantly between major plant biomasses, suggesting that the type of vegetation influences the rate of soil respiration.

Key words*: *soil CO_2 emission, soil tillage systems, no-tillage, conventional tillage, wheat, corn

INTRODUCTION

The carbon flow from the soil into the atmosphere occurs mainly in the form of CO_2 and is the result of the soil breathing process. Soil respiration represents the combined respiration of plant roots, microorganisms and macro organisms in the soil [10]. Microorganisms and roots contribution to total soil respiration is estimated at 42% using the relationship between biomass, root and CO_2 [5]. Root breathing covers a percentage between 51% and 62% of the evolution of CO_2 emissions [3].
Under insufficient aeration conditions, the decomposition of plant debris is incomplete and bacterial activity is intense and short-lived. It is estimated that an oxygen content below 10% is the lower limit below which soil processes are affected [2]. Oxygen is necessary in conducting soil oxidation processes and in the activity of aerobic nitrifying bacteria that oxidize ammonia and convert it in nitrates.
Soil biological activity (including the enzymatic enzyme) plays an important role as it is involved in the degradation of organic matter [4].
As a result of biological activity, mainly by the decomposition of organic matter by microorganisms, the majority of CO_2 is present in the atmosphere, more than 90% of CO_2. This CO_2 content is higher in cultivated soils than in non-cultivated soils [6]. These researches have been addressed but there have been no major predictable differences in soil respiration between cultivated and non-vegetated soils, possibly due to the diversity of crops and harvesting systems included [8].

MATERIALS AND METHODS

The research was carried out on a typical chernozem soil in the Roman Plain, considered to be the soil with the most favorable properties in terms of fertility [9].
The principle of the method for determining the soil respiration potential, consists in capturing the oxygen released by

the microorganisms during the breathing process in 0.2N NaOH and titrating the NaOH excess left uncombined with 0.1N HCl in the presence of the thymolphthalein indicator 1% until it turns blue to colorless [11].

The calculation and interpretation of the results is according to the formula [1]:

CO_2 mg/100g soil d.s. = (A - B) × f × 2.2 × 5 × KU

where:

A = ml of HCl with which titration was performed on control samples (mean of 3 repeats);

B = number of ml of HCl 0.1N with which titration of each soil sample was performed;

2.2 = CO_2 equivalent in mg for 1 ml of 0.1 N HCl;

f = correction factor;

5 = the ratio coefficient of the 20 grams of soil taken in the analysis to 100 grams of soil;

KU = correction coefficient for soil humidity.

The soil humidity is expressed by:

U% = water / dry soil × 100

To determine the correction factor (f), the following relationship is used:

f = 0.019011 × 10/0.019011 × ml of HCl

The experimental results were processed by using the variance analysis, by which the limit differences (D.L.) were calculated [7].

RESULTS AND DISCUSSIONS

The potential for soil respiration, is a global indicator for assessing the soil life activity level. Soil breathing is the main pathway where CO_2 fixed by terrestrial plants returns to the atmosphere. It is estimated to be about 75 × 1,015 g C/yr, this high natural flow is likely to increase due to Earth's activity [12].

For the wheat culture (Table 1), the soil respiration potential, as a result of the various technologies applied on the typical chernozem, recorded values of 27.18 mg CO_2/100g solution , as conventional tillage through plowing (A), indicating the richest biological soil activity, followed by the variant in which the soil was worked with the chisel (C), with a breathing potential of 26.75 mg CO_2/100 g dry substance solution.

Similar results have been found by Schlesinger [12], where conventional soil tillage and temperature increase have increased the CO_2 flow in the soil without increasing the amount of organic matter in the soil.

The version tillaged alternately with the disc and the chisel (D/C) showed a good breathing potential of 23.03 mg CO_2/100g dry substance solution.

Table 1. The potential for soil respiration under the influence of soil cultivation on wheat crop, mg CO2/100g dry substance solution

Soil processing method	The potential for soil respiration		Difference mg CO_2/100g dry substance solution	Meaning
	Mg CO_2/100g soluţion d/s	%		
Annual plowing (A)	27.18	100	Mt	
No-tillage (N)	18.96	69.75	- 8.22	0
Disc/Chisel (D/C)	23.03	84.73	- 4.15	-
Annual Disc (D)	12.61	46.39	- 14.57	000
Annual Chisel (C)	26.75	98.41	- 0.43	-
$Dl_{5\%}$ = 5.89; $Dl_{1\%}$ = 8.57; $Dl_{0.1\%}$ =12.87				

*DL - the limit difference (variance analysis method)
Source: own research.

Compared with the conventional version (A), considered as the control variant, the version with the yearly disc (D) recorded the lowest soil biological activity (12.61 mg CO_2/100g dry substance solution), the difference being statistically very significant negative, followed by the version in which it was directly sown in untreated land with statistically assured, significantly negative values of 18.96 mg CO_2/100g dry substance solution (Fig.1).

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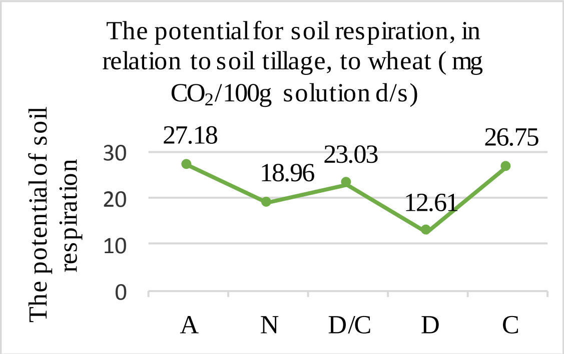

Fig. 1. The potential for soil respiration in wheat crop, mg CO_2/100g dry substance solution
Source: own research and design.

In this context, researches conducted by Raich in 2000 [8], and quoted by Guş [6], indicate the same increased values of the breathing potential in the classic system (81.3 g/m3) and the lowest values at direct sowing (5.9 g/m3).

In corn culture, a more intense biological activity is recorded in the soil compared to wheat culture (table).

In the version where the soil was alternatively processed with the disc/chisel (D/C), there is the richest biological activity in the soil, where it reaches 57.14 mg CO2/100g dry substance solution, followed by the version where the soil was processed by plowing with furrow turning (50.42 mg CO_2/100g dry substance solution) and yearly chisel version (C), where the values reach 47.37 mg CO_2/100g solution.

Table 2. Breathing potential under the influence of soil cultivation on corn crop, mg CO_2/100g dry substance solution

Soil processing method	The potential for soil respiration		Difference mg CO_2/100g dry substance solution
	mg CO_2/100g soluţion d/s	%	
Annual plowing (A)	50.42	100	Mt
No-tillage (N)	30.09	59.67	- 20.33
Disc/Chisel (D/C)	57.14	113.32	6.72
Annual Disc (D)	46.36	91.94	- 4.06
Annual Chisel (C)	47.37	93.95	- 3.05
$Dl_{5\%}$ = 15.88; $Dl_{1\%}$ = 23.09; $Dl_{0.1\%}$ =34.64			

*DL - the limit difference (variance analysis method)
Source: own research.

In the case of the yearly disc (D), the soil breathing potential has high values, close to the other reduced soil tillage versions, which is 46.36 mg CO_2/100g active substance solution (Fig 2).

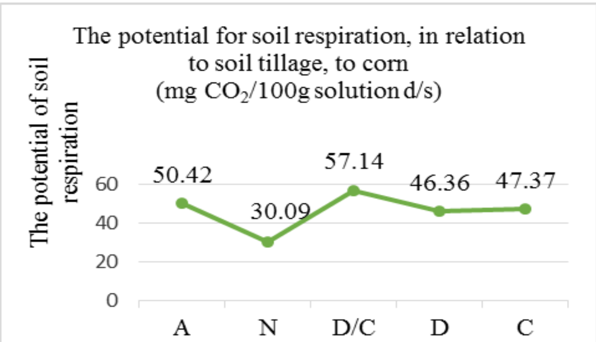

Fig. 2. The potential for soil respiration in corn culture, mg CO_2/100g dry substance solution
Source: own research and design.

As with wheat crops, the lowest biological activity in the soil was recorded as seeded in no tillage soil (N) where they have the value of 30.09 mg CO_2/100g dry substance solution, but here this value is higher than the conventional tillage version of the wheat crop, the difference being significantly negative, changes observed by the Rustad, due to the different use of soil technological works [10].

CONCLUSIONS

The soil's breathing potential was higher in the case of plowing (A) and lower in the no tillage soil, with no soil intervention (N) or only by superficial tilling (D), or disk tillage soil, for the wheat culture.

In wheat culture, the weakest biological activity, with regard to the potential for soil respiration, is recorded in the year round superficial tilling (12.61 mg CO_2/100g dry substance solution), which drops by 50%

versus the conventional version (27.18 mg CO_2/100g dry substance solution).

In corn culture, the potential for soil respiration values were higher than wheat crops. For corn, the smallest value of soil breathing potential was recorded in direct seed sowing, with the highest value being recorded in the plowed version.

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