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THE INFLUENCE OF SOIL TILLAGE: ORGANIC AND MINERAL FERTILIZATION WITH DIFFERENT FORMS OF ORGANIC CARBON IN REDDISH PRELUVOSOIL FROM THE SOUTH OF ROMANIA

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Soil samples were collected at 0-20 cm depth in autumn 2011, after the harvesting of corn, in the experiment field at Moara Doamnească- ILFOV. The experiment was bi-factorial. The factor A, soil tillage: a1-plowing to 15 cm (A15); a2 - plowing at 25 cm (A25); a3 - chisel at 30 cm (C30) and a4 - disc 10-12cm (D10-12); factor B, fertilization type with graduations: b1 - N0; b2 - 10 t /ha stable manure; b3 - 5 t straw / ha + N50; b4 -N100P70 and b5 - N150P70. It was determined the influence of different forms of organic carbon in reddish preluvosoil. This experiment shows that the tillage carried out with chisel at 30 cm and disc at 10-12 cm favored the growth of different forms of organic carbon from the reddish preluvosoil and led to an improvement in quality. The most favorable fertilization that emerged from the analysis was organic fertilization and organo-mineral fertilization.

Key words: organic carbon, soil tillage, C/N, extractable carbon.

INTRODUCTION

Loose state of agricultural soil is the first prerequisite condition for seedbed to drain excess water from precipitation and achieve the optimal ratio between air and water, creating well-oxygenated environment for seed germination, root development and aerobic activity of the micro-population. Both depth and how the overthrowing of furrow were investigated, especially in the attention of agricultural production outcame, quality of tillage and fuel consumption. But not only that, as the depletion of oil reserves, it was necessary to reduce the costs of basic work and seedbed preparation, increase of productivity fields, but also to avoid possible degradation of soil fertility by side effects of chemical fertilizers of managed soil. A summary of accumulated knowledge concerning fertility status of soils under the influence of tillage has been published by[13]. That was at the base of the concepts underlying current agriculture: biodynamic, sustainable organic or organic in the late twentieth and early twenty-first century[19].

In Romania, the first scientific research on the influence of tillage on some soil chemical properties were made in Agronomic Research Institute of Romania – ICAR Bucharest and its experimental stations. The results were published in the decades 3 and 4 of the last century[23,20,15].

Such work continued to be carried out in Romania after 1962, Research Institute for Cereals and Industrial Plants and its experimental stations. Particular attention was paid to the influence produced on the biological and biochemical properties of soils in long-term experiments[29,28,21,30,27].

The main objective of crop fertilization is to achieve high yields and quality[10]. However, application of mineral fertilization can affect cyclical biological processes of the soil. Twentieth century with conflicting conclusions, usually gave crop response to nitrogen fertilization involves increases in CO_2 fixation in the soil and hence the large production of roots[33]. This increase leads to returning crop residues in the soil[25,34], which are considered the main control factor of soil organic matter in agro-ecosystem[24].

Table 1
Combined influence of different tillage systems and fertilization on soil organic matter (O.M) content from Moara Domneasca-ILFOV

Factor B / Factor A	b_1– unfertilized	b_2–stable manure 10t/ha	b_3-5 t/ha Straw +N_{50}	b_4 – $N_{100}P_{70}$	b_5–$N_{150}P_{70}$	Average A
a_1–plough 15 cm	a 2.53 a	c 2.54 a	b 2.53 a	a 2.66 a	a 2.67 a	b 2.58
a_2-plough 25 cm	b 2.08 c	c 2.61 a	c 2.25 b	b 2.34 b	b 2.42 a	c 2.34
a_3–chisel 30 cm	a 2.60 b	a 3.41 a	b 2.47 b	a 2.63 b	a 2.63 b	a 2.75
a_4–disc 10-12 cm	a 2.45 d	b 3.04 b	a 3.25 a	a 2.55 c	a 2.69 c	a 2.80
Average B	2.41 c	2.90 a	2.62 b	2.55 b	2.60 b	
DL P	**A**	**B**	**B x A**	**A x B**		
5%	0.063	0.073	0.139	0.146		
1%	0.096	0.098	0.192*	0.196*		
0.1%	0.155*	0.130*	0.263	0.260		

Figures in the same column, preceded by different letters are significantly different at P≤0.05
Figures in the same row, followed by different letters are significantly different at P≤0.05

Table 2
Combinated influence of basic soil tillage system and organic / mineral fertilization on C/N modification of reddish preluvosoil from Moara Domnească – Ilfov

Factor B / Factor A	b_1– unfertilized	b_2–stable dung 10t/ha	b_3-5 t/ha Straw +N_{50}	b_4 – $N_{100}P_{70}$	b_5–$N_{150}P_{70}$	Average A
a_1–plough 15 cm	a 10.27 a	c 9.83 a	A 9.62 b	a 9.99 a	a 9.56 b	a 9.86
a_2-plough 25 cm	c 8.64 c	b 10.50a	B 9.01 b	b 9.04 b	a 9.64 b	b 9.37
a_3–chisel 30 cm	b 9.58 b	a 12.13a	B 9.20 b	b 9.19 b	a 9.36 b	a 9.89
a_4–disc 10-12 cm	c 8.63 b	b 10.03a	a 10.19 a	c 8.53 b	b 8.94 b	b 9.27
Average B	9.28 b	10.62 a	9.51 b	9.19 b	9.38 b	
DL P	**A**	**B**	**B x A**	**A x B**		
5%	0.276	0.314	0.602*	0.628*		
1%	0.418*	0.422*	0.826	0.845		
0.1%	0.671	0.559	1.136	1.117		

Figures in the same column, preceded by different letters are significantly different at P≤0.05
Figures in the same row, followed by different letters are significantly different at P≤0.05

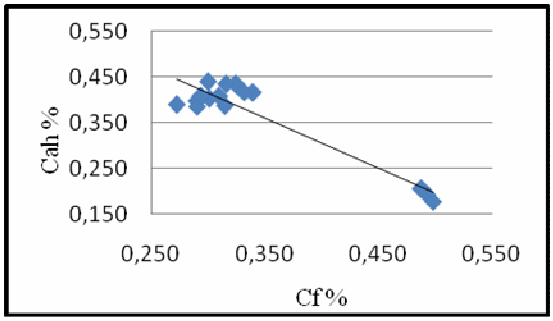
Table 3
Influence of basic soil tillage and organic / mineral fertilization on extractable carbon modification on reddish preluvosol from Moara Domnească – Ilfov

Factor B / Factor A	b_1– unfertilized	b_2–stable dung 10 t/ha	b_3-5 t/ha Straw +N_{50}	b_4 – $N_{100}P_{70}$	b_5–$N_{150}P_{70}$	Average A
a_1–plough 15 cm	b 0.677 b	b 0.700 a	b 0.753 a	b 0.737 a	c 0.683 b	b 0.710
a_2-plough 25 cm	b 0.663 a	b 0.667 a	c 0.643 a	c 0.630 a	c 0.643 a	c 0.649
a_3–chisel 30 cm	b 0.683 b	a 0.713 a	b 0.737 a	b 0.737 a	b 0.760 a	b 0.726
a_4–disc 10-12 cm	a 0.743 b	a 0.770 b	a 0.853 a	a 0.800 a	a 0.837 a	a 0.801
Average B	0.692 b	0.713 a	0.747 a	0.726 a	0.731 a	
DL P	**A**	**B**	**B x A**	**A x B**		
5%	0.0100	0.0229	0.0417	0.0458		
1%	0.0151	0.0308	0.0564*	0.0616*		
0.1%	0.0243*	0.0407*	0.0755	0.0815		

Figures in the same column, preceded by different letters are significantly different at P≤0.05
Figures in the same row, followed by different letters are significantly different at P≤0.05

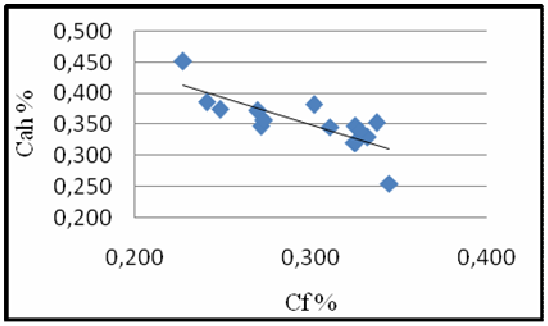
The main objective of crop fertilization is to achieve high yields and quality[10]. However, application of mineral fertilization can affect cyclical biological processes of the soil. Twentieth century with conflicting conclusions, usually gave crop response to nitrogen fertilization involves increases in CO_2 fixation in the soil and hence the large production of roots[33]. This increase leads to returning crop residues in the soil[25,34], which are considered the main control factor of soil organic matter in agro-ecosystem[24].

Correlations between carbon, in humic and carbon in fulvic acids, from tillaged and fertilized soil



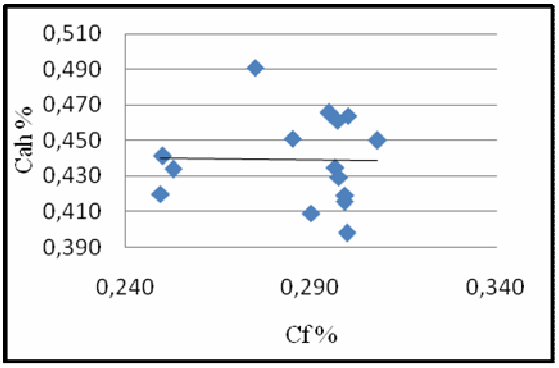
a_1*FB

Fig. 1. Ploughing at 15cm.



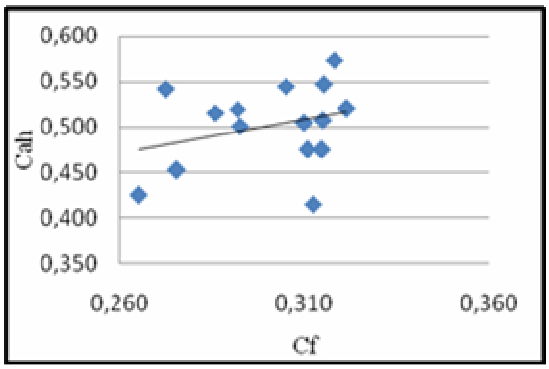
a_2*FB

Fig. 2. Ploughing at 25 cm.



a_1*FB

Fig. 3. Worked with chisel at 30 cm.



a_2*FB

Fig. 4. Worked with disc at 10-12 cm.

Table 4

Correlations between soil carbon, in humic and fulvic acids, under different tillages

Variance	Regression Equation	R^2	r	Signification
a_1*F_B	y = -1,091x+0,741	0,881	0,939	**
a_2*F_B	y = -0,864x +0,680	0,621	0,788	**
a_3*F_B	y = -0,023x+0,445	0,000	0,000	
a_4*F_B	y = 0,719x + 0,285	0,085	0,291	
n = 15				
DL P	5%	0,497		
	1%	0,623		

Changes in the soil organic carbon and total nitrogen are largely responsible for the physical, chemical and biological soil properties [26,10] and have great influence on crop productivity and environmental quality[17]. Nitrogen fertilization affect the increase of organic carbon content and total nitrogen in soil by increasing biomass production .

tefanic[30] shows that soil organic nitrogen content is higher in variants ploughed at 15 cm (Nt% = 0.163) and 20 cm (Nt% = 0.168) and lower plowing to 30 cm. The explanation lies in the speed of synthesis and mineralization of humus and organic matter provided by stubble in agronomic conditions applied. Papacostea[11] stated that a soil with good productivity to maintain its fertility level, as reserves of humus, must be maintained by adding organic matter.

This paper aims to recommend the best tillage and organic and chemical fertilization in terms organic matter content, the C/N ratio, and carbon fractions in reddish preluvosoil from Moara Doamneasca- ILFOV.

MATERIAL AND METHODS

Following the climate observation from Moara Doamneasca- ILFOV interval between 1961-2010, it is noted that the mean temperature ranged between 12-13^0, and the mean of annual air temperature is between 10-11^{0}C. Mean annual precipitation falls in the range 600-700 mm, and aridity index (IDM) has values between 29-30.

Soil samples were collected at 0-20 cm depth in autumn 2011 after harvesting corn in an experimental field from Moara Domneasca –ILFOV and were prepared by the method [14,4]. Analyses were performed in the laboratory of soil biology, Soil Sciences Department, which belongs to U.S.A.M.V Bucharest.

Experimental field has in rotation: pea, winter wheat and mays. Every crop has the same soil tillage and chemical fertilization for 11 years. Organic and organo-mineral fertilization were applied only to the maize crop. The total nitrogen content was determined by Kjeldahl method[6].

Determination of soil organic carbon (Ct%) was performed according to the methods of [18,9]. Analysis of soil organic matter was determined by computing the relationship: O.M = Ct% * 1,724. Extractable soil carbon, huminic and fulvic acids were determined by [7]. Statistical processing of the experimental results was made using the method [22, 1, 32, 2].

RESULTS AND DISCUSSIONS

Combined influence of different tillages and fertilization on soil organic matter content

The influence of tillage on fertilization average in Table 1 showed that the chisel and disk tillage favored increasing soil organic matter content, forming the group "a" of variants. It is possible that these variants may have decreased the intensity of mineralization of humus and microflora attacking mostly plant residues.

In variants plowing at 15 cm and plowing at 25 cm mineralization increased by turning the furrow, which led to a decrease in soil organic matter. The influence of organic and mineral fertilization on media of different tillage systems is an increase in soil organic matter content. Mineral fertilization variants were placed in group "**b**". At unfertilized variant, from year 2000, there is a decrease in soil organic matter (enclosed in group "**c**"). This is due to the smaller amount of plant remaining in the soil after harvest. According to the variant tillaged with chisel at 30 cm and fertilized with 10t/ha manure, led to an increase in soil organic matter content, having a value of 3.41%, followed by tillage with the disc, due to fertilization with manure or application of 5 t/ha straw + N_{50}. The lowest organic matter content was recorded at 25 cm plowing without fertilization by a value of 2.08% (MO).

Combined influence of different soil tillage systems and fertilization on C / N ratio

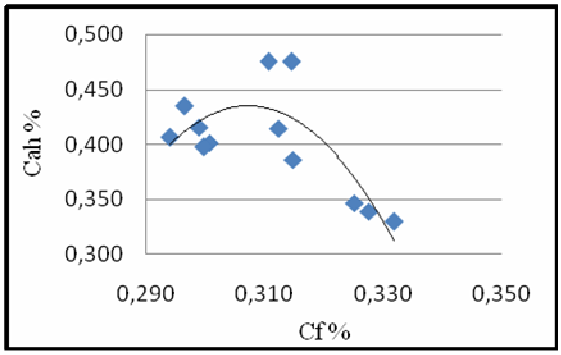
Table 2 shows the influence of tillage on average fertilization. It is observed that C/N ratio changed statistically. The highest values of the ratio were recorded in group "**a**", with the variant worked with chisel at 30cm, having a value of 9.89 and at variance 15 cm with a value of 9.86 due to lower mineralization of humus and weak soil aeration. The variants worked with disc, plough at 25 cm were placed in group "**b**", with values of 9.37 and 9.27 respectively.

According to the influence of soil fertilization on different soil tillages, it is observe that on application of 10 t/ha of stable manure, C/N ratio recorded a value of 10.62 which was placed in group "**a**"; other values of fertilization variants were fited in group "**b**" due to accumulation of Ct%. According to the influence of combined factors ,it is observe that tillage to 15 cm and unfertilized variant recorded the highest value of C/N ratio (10.27), probably due to Nt% content depletion of the soil. At 25 cm plowing, the application of manure led to a value of 10.50 but plowing at 30 cm and application of 10t/ha stable manure recorded the highest value of C/N ratio in the experiment (12.13). The lowest C/N value was recorded at the variance tilled with disc at 10–12 cm and unfertilized variant with a value of 8.63 followed by unfertilized variant and ploughing A25 (8.64).

Combined influence of different tillage systems and fertilization on extractable carbon content

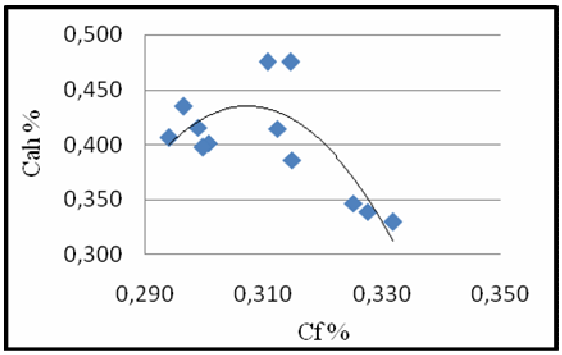
According to the influence soil tillage system on media fertilization, it observes that the highest value of extractable carbon is at tillage executed with the disc (0.801%), followed by work carried out with the chisel and plowing at 15 cm (A15) respectively. Both are in group "**b**" with a value of 0.649%.

According to the influence of media fertilization on soil tillage systems, there is a difference between the fertilized variants and unfertilized one due to the application of mineral and organic fertilizers.



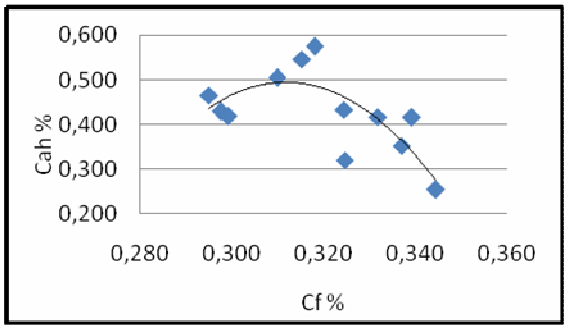
*b1*FA*

Fig. 5. unfertilized.



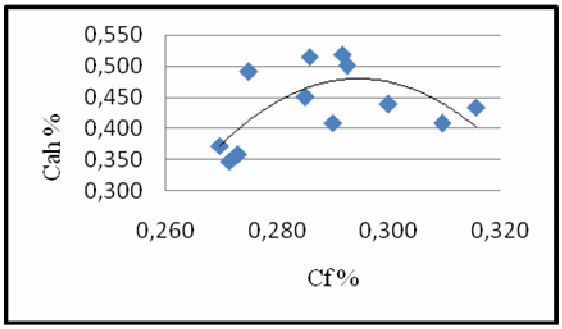
*b2*FA*

Fig. 6. At 10 t/ha stable manure.



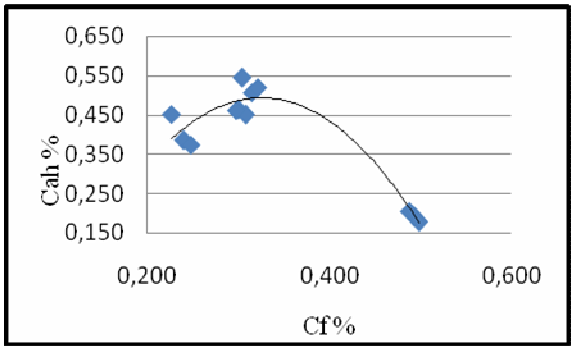
b_3*F_A

Fig. 7. 5 t/ha straw + N_{50}.



b_4*F_A

Fig. 8. $N_{100}P_{70.}$



*b5*FA*

Fig. 9. $N_{150}P_{70}$.

Table 5

Correlations between soil carbon, in huminic and fulvic acids, under different soil fertilization

Variance	Regression Equation	R^2	η	Signification
b_1*F_A	$y = -34{,}52x^2+18{,}07x-1{,}924$	0,554	0,744	*
b_2*F_A	$y = -200{,}8x^2+123{,}4x-18{,}52$	0,639	0,799	**
b_3*F_A	$y = -201{,}8x^2+125{,}9x-19{,}4$	0,549	0,741	*
b_4*F_A	$y = -174{,}0x^2+102{,}5x+14{,}63$	0,453	0,673	*
b_5*F_A	$y = -10{,}71x^2+6{,}988x-0{,}647$	0,923	0,960	**
n = 12				
DL P	5%	0,671		
	1%	0,775		

According to the influence of interaction factors, it observes that the highest value of extractable carbon was obtained at the work done with the disc and fertilized with 5t/ha straw+N_{50} and the lowest value obtained at work done with plough at 25 cm and fertilized with $N_{100}P_{70.}$

Following the data in Table 4 and in Figures 1 and 2, there is a significant correlation between carbon from humic and fulvic acids, in soil tillaged with furrow return.

In tillage systems without furrow overthrowing, there is no significant correlation exceeding two factors analyzed (Figs. 3 and 4), which can be explained by the higher amount of total organic carbon in the soil and is still undergoing decomposition.

Following the data in Table 5 and Figures 5–9 there is a significant correlation between carbon, from humic and fulvic acids, in soil fertilized with 10 t/ha stable manure and application of $N_{150}P_{70}$ dose. Explanation of distinct significant correlation from the application of stable manure is that organic matter was introduced. Explanation distinct significant correlation from the application N150P70 dose may be due to intense mineralization of organic matter but with negative effect on CO_2 release into the atmosphere.

CONCLUSIONS

1. Tillage with chisel at 30 cm and with disk at 10–12 cm favoured the increase of humidified organic material content in soil with values of 2.75% and 2.80% respectively.

2. The application of 10 t/ha/3 years stable manure favoured the increase of humidified organic material content in soil at a value of 2.90%.

3. The most adequate soil tillage system in reference to organic material content remained in the soil after 11 years of experimentation was at work done with the chisel at 30 cm in combination with organic fertilization with 10 t/ha – 3 years stable manure with humidified organic material value of 3.41%.

4. Soil tillage with plow at 25 cm and tillage system with disc at 10–12 cm favoured the significant reduction of C/N content ratio.

5. The most adequate soil tillage system in reference to C/N ratio after 11years of experimentation was tillage done with plough at 25 cm and tillage done with chisel at 30 cm in combination with unfertilized variance with 5 t/ha/3 years wheat straw+$N_{50.}$

6. Soil tillage system with the chisel at 30 cm and with disc at 10–12cm favored the increase in soil extractable carbon content with values of 0.72% and 0.80% respectively.

7. The application of 10 t/ha/3 years stable manure and wheat straw 5 t/ha/3 years nitrogen favoured soil extractable carbon content, having 0.71% and 0.75 % respectively.

8. The most adequate soil tillage in reference to extractable carbon content after 11 years of experimentation was work done with chisel at 30 cm in combination with organic fertilization with organic material values of 0.71% and 0.81%.

9. The most adequate fertilization system was organic fertilization with 10 t/ha stable manure and 5t/ha straw+N_{50} which determined humus content increase as it is shown in the result analysis, through the reduction of C/N ratio in the work done with chisel at 30 cm.

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