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Original Article

Influence of Soil Tillage and Organic and Mineral Fertilization Estimated by Synthetic Indicator (ISFS%) of Soil Fertility in Reddish Preluvosoil from Moara Domnească - Ilfov

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Abstract

In a long-term experiment, with different basic soil tillage and kinds of organic and/or mineral fertilization, different analyses were achieved to determine the evolution of the soil fertility status of reddish preluvosoil from the Didactic Experimental Station of Moara Domneasca-Ilfov. There was determined, in arable layer: respiration potential, cellulolyse, and Indicator of Vital Activity Potential (IVAP%) was calculated; also, catalasic potential and total amidasic and phosphatasic potentials and the Indicator of Enzymic Activity Potential (IEAP%), than, the Biological Synthetic Indicator (BSI%) was calculated. Humus content (Ct%), huminic acid content (Ch%) and pH-H_2O constitute the Chemical Synthetic Indicator (CSI%). BSI% + CSI% / 2 = SIFS% (Synthetic Indicator of Soil Fertility). Test results and their statistical processing showed that IVAP%, with certain value, the highest, was obtained where continuous were tilled with the chisel and it was fertilized with $N_{100}P_{70}$. IEAP% with maximum value was achieved in all modes of fertilization. Biological Synthetic Indicator (BIS%) shows that chisel achieved optimal biologic conditions in $N_{100}P_{70}$ variant. CSI% shows that only to chisel and disk tillage, the composted stable manure (that was in extremely low quantity) allowed higher accumulation of nutrients than when the furrow was overthrown by plowing. Synthetic Indicator of Soil Fertility (SISF%), which it refers only to the soil characteristics, shows maximal values only for superficial and loosening soil tillage, in the annual supply conditions with nitrate ammonium and superphosphate.

Keywords: IVAP %, IEAP %, BSI %, SISF %

1. Introduction

Basic work of soil and fertilization are essential components in agricultural technology, aiming to create conditions for growth and developing of plants by changing soil physical condition, which direct implications on its vital and chemical characteristics [23, 9, 18].

Relationship between soil physical condition which follows after soil tillage on vital and enzymatic processes depend on soil texture, organic carbon content and the quantity of soil organic matter introduced [14].

Viliams [26] studied the humus, in terms of microbiological, chemical and biological, and emit the theory of humus formation from vegetal remains, from other organic materials and microorganisms, living and dead, which activate or activated in this process. The influence of tillage

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types on soil properties can be evidenced by indicators, important to track the improvement of soil fertility and agricultural system sustenability assessment [11, 15, 13]. Tillage mode which minimizes interference with ground, which equilibrates balance between the decomposition of vegetable remains, humification and transformation of potential of soil fertility in its vegetable productivity is very important [22, 12]. Some authors have observed that the application of stable manure resulted in improved soil acidity [16, 5, 8, 1, 19, 25, 27, 3].

2. Material and Method

The experiment was located in 2000, in the experimental field of Agrotechnics collective of Faculty of Agriculture – USAMV Bucharest. Reddish preluvosoil from Moara Domnească - *Ilfov* is characterized by organic carbon content (Ct%) ranging from 1.22 to 1.57%, a loam-clay content and chemical reaction (pH-H_2O – 5-6).

Experiment is bifactorial with: factor A – basic tillage: (a_1- plough to 15 cm, a_2 - plough to 25 cm, a_3 - tillage with chisel to 30 cm, a_4 - tillage with disck to 10 - 12 cm) and factor B, soil fertilization (b_1 -unfertilized, b_2 - stable manure/3 years, b_3 - straw 5 t + N_{50}/3 years, b_4 - $N_{100}P_{70}$, annually, b_5 - $N_{150}P_{70}$, annually).

In order to determine the influence of tillage x fertilization mode on some pedo-biologic activities and some soil chemical characteristics, were sampled soil samples, in autumn 2011, after corn culture, from the depth of 0 - 20 cm. The samples were sifted by a sieve of 2.5 mm, and the visible remains were removed. The soil samples, with 16 - 18% humidity, were kept in plastic bags, at 4^0 - 6^0C, along of analysis time. Soil samples were analyzed according to the pedo-biological methodology [21, 22], and those chemical after [22, 23, 5, 17].

Biological and chemical indicators were calculated also, after Snedecor [20] and Ştefanic [22]. The analytic data of pedo-enzymatic tests were examined in two-way tables indicating by alphabet litter, significant groups of values that marks the separate and combined influence of experimental factors by multiple testing method Snedecor [20]. The highest values were noted with the letter **"a"**.

3. Results and Discussions

The Indicator of Vital Activity Potential include both respiration and cellulolitic activities of soil [9] and is a biological indicator to assess the overall standard of living in the soil.

From the table 1, we remark to average A, that the best tillage performed by chisel 30 cm (*a* 45.03%).

From among the 5 ways of mineral and organic fertilization, fertilization with $N_{150}P_{70}$, IPAV% reflected a more intense mineralization of organic matter (62.16 *a*).

The phenomenon was observed in [19, 7], that the increasing of nitrogen dose increased IPAV (%). Following interactions (B x A, A x B) one observes that differences exist, but these are heavily to explain in relation with the well-definite influence.

From the table 2 – the enzymatic activity, we remark to average A, that the best tillage performed by disc (*a* 8.25%) and by ploughing to 15 and 25 cm (*a* 7.70 and *a* 7.71%).

From among the 5 ways of mineral and organic fertilization, fertilization with stable manure gives the highest IEAP (%, 8.91 *a*). Soil unfertilized and that with mineral fertilization were in the second group.

In interaction of factor influences (A x B) we observe that working with disk at stable manure and straw + N_{50}, the soil had the highest enzymatic activities.

The experimental variants with disk and also $N_{150}P_{70}$ given the highest value **"a"** of IEAP%. Because the soil biological properties are extremely sensitive they may be considered, ones of suitable indicators of soil fertility, completing the soil physical and chemical information [2].

From the table 3 – with BSI (%), one sees that factor A (average) have influenced negative only by ploughing at 25 cm. Factor B (average) influenced positive by fertilization with $N_{150}P_{70}$.

The influences of plought at 25 cm and $N_{150}P_{70}$ are a consequence of very little quantities of supplying with organic fertilizers and a stimulation of humus mineralization. Those were observed also in cambic chernozem from Fundulea [24].

The table 4 – with CSI points out that (average A), the tillage did not influenced on chemical characteristics of the soil. Factor B (average) influenced positive by fertilization with stable manure.

Pursuing the combined influence of factors (AxB) one observes that the plough at 15 cm the higst value is on applying 10 t/ha stable manure, CSI % diminished in variants mineral fertilized.

Factorial analyses (A, B, AB and BA) although reveal some modifications in vital processes in soil and in pedo-enzymatic activity do not permit, easy and simple interpretation and conclusions about the best way of soil fertility increase by the mode of tillage and fertilization.

Table 1. Influence of soil tillage and fertilization expressed by IVAP (%)

Factor A \ Factor B	b_1– unfertilized	b_2–stable manuare	b_3-Straw +N_{50}	b_4 – $N_{100}P_{70}$	b_5 – $N_{150}P_{70}$	Average A
a_1–plough 15 cm	a 29.31 d	a 30.47 d	b 33.91 c	b 40.63 b	a 70.31 a	b 40.93
a_2-plough 25 cm	b 22.31 d	b 27.07 c	d 23.32 d	c 33.40 b	c 41.06 a	c 29.43
a_3–chisel 30 cm	a 26.82 d	a 30.09 c	c 27.48 c	a 74.98 a	b 65.82 b	a 45.03
a_4–disc 10-12 cm	a 28.15 d	b 26.21 d	a 39.15 c	b 42.81 b	a 71.47 a	b 41.56
Average B	26.65 d	28.46 c	30.96 c	47.95 b	62.16 a	
DL P	A	B	B x A	A x B		
5%	1.559*	1.326	2.661*	2.651*		
1%	2.362	1.782	3.697	3.565		
0.1%	3.796	2.357*	5.194	4.715		

Table 2. Influence of the type of tillage and fertilization on soil enzymatic activity expressed by IEAP(%)

Factor A \ Factor B	b_1– unfertilized	b_2–stable manuare	b_3-Straw +N_{50}	b_4 – $N_{100}P_{70}$	b_5–$N_{150}P_{70}$	Average A
a_1–plough 15 cm	a 9.94 a	b 8.44 a	a 8.02 b	a 9.07 a	c 3.05 c	a 7.70
a_2-plough 25 cm	b 7.24 a	c 6.62 b	a 8.47 a	a 8.82 a	a 7.41 a	a 7.71
a_3–chisel 30 cm	b 7.62 b	a 10.07 a	c 5.07 c	b 3.96 c	b 5.65 c	b 6.47
a_4–disc 10-12 cm	c 5.27 c	a 10.53 a	a 8.90 a	a 8.78 a	a 7.76 b	a 8.25
Average B	7.52 b	8.91 a	7.61 b	7.66 b	5.97 c	
DL P	A	B	B x A	A x B		
5%	0.595*	0.967*	1.792*	1.934*		
1%	0.902	1.300	2.437	2.601		
0.1%	1.449	1.720	3.292	3.439		

Table 3. Influence of the type of tillage and fertilization on soil biological activity, expressed by BSI (%)

Factor A \ Factor B	b_1– unfertilized	b_2–stable manuare	b_3-Straw +N_{50}	b_4 – $N_{100}P_{70}$	b_5–$N_{150}P_{70}$	Average A
a_1–plough 15 cm	a 19.63 c	a 19.45 c	b 20.96 c	b 24.85 b	b 36.68 a	a 24.31
a_2-plough 25 cm	c 14.78 d	b 16.84 c	c 15.89 d	c 21.11 b	c 24.23 a	b 18.57
a_3–chisel 30 cm	b 17.22 d	a 20.08 c	c 16.27 d	a 39.47 a	b 35.73 b	a 25.75
a_4–disc 10-12 cm	b 16.71 c	a 18.37 c	a 24.02 b	b 25.79 b	a 39.62 a	a 24.90
Average B	17.08 d	18.69 c	19.29 c	27.80 b	34.07 a	
DL P	A	B	B x A	A x B		
5%	0.961	0.736	1.510	1.471		
1%	1.457*	0.989*	2.110*	1.978*		
0.1%	2.341	1.308	2.991	2.616		

Table 4. Assessing the influence of the type of tillage and fertilization on the Chemical Synthetic Indicator CSI (%)

Factor A \ Factor B	b_1– unfertilized	b_2–stable manuare	b_3-Straw +N_{50}	b_4 – $N_{100}P_{70}$	B_5–$N_{150}P_{70}$	Average A
a_1–plough 15 cm	a 57.44 a	b 58.05 a	b 57.52 a	a 52.50 d	a 53.58 c	a 55.82
a_2-plough 25 cm	a 58.40 a	b 58.11 a	b 57.04 b	a 52.40 c	b 50.67 d	a 55.33
a_3–chisel 30 cm	a 57.56 b	a 60.09 a	b 57.65 b	b 50.87 c	b 51.15 c	a 55.47
a_4–disc 10-12 cm	a 58.23 b	a 60.22 a	a 58.90 b	a 51.84 c	c 49.62 d	a 55.76
Average B	57.91 b	59.12 a	57.78 b	51.90 c	51.26 c	
DL P	A	B	B x A	A x B		
5%	0.402	0.347	0.695	0.694		
1%	0.609*	0.467*	0.965*	0.934*		
0.1%	0.980	0.617	1.354	1.235		

Therefore we appeal to interpretation of all indicators, monofactorial presented in table 5, applying multiple test, after Snedecor [20] and Ştefanic [21], for establishing the experimental variances which gave the best variants of the soil fertility indicators, remarked after 11 years of stationary experimentation. From the data of table 5, it can see that the Indicator of Vital Activity Potential (IVAP%), with the best value (marked with **"a"**) was obtained where always worked with chisel and was mineral fertilized with $N_{100}P_{70}$. Indicator of Enzyme Potential Activity (IEAP%), with maximum value **"a",** was performed in all modes of fertilization. Biological Synthetic Indicator (BSI%), which is the arithmetic average of the two biological indicators (IVAP% and IEAP%), shows that working with chisel, achieved optimal effect by chemical moderate fertilization with $N_{100}P_{70}$. Chemical Synthetic Indicator (CSI%) shows that the largest accumulation of nutrients were made equally to chisel with stable manure and disk with stable manure.

Table 5. Assessing the influence of the type of tillage and fertilization on the Synthetic Indicator of Soil Fertility SISF (%)

Basic loosening ways of soil and fertilization with organic and mineral manures	IVAP %	IEAP %	BSI %	CSI %	SISF %
a1- plough 15 cm					
b1–unfertilized	29.31 *d*	9.94 ***a***	19.63 *d*	57.44 *c*	38.54 *e*
b2-stable manuare	30.47 *d*	8.44 *b*	19.45 *d*	58.05 *b*	38.75 *e*
b3-straw + N_{50}	33.91 *e*	8.02 *b*	20.96 *d*	57.52 *c*	39.24 *d*
b4-$N_{100}P_{70}$	40.63 *d*	9.07 ***a***	24.85 *c*	52.50 *e*	38.67 *e*
b5-$N_{150}P_{70}$	70.31 *b*	3.05 *d*	36.68 *b*	53.58 *d*	45.13 ***a***
a2- plough 25 cm					
b1–unfertilized	22.31 *f*	7.24 *b*	14.78 *f*	58.40 *b*	36.59 *f*
b2-stable manuare	27.07 *e*	6.62 *b*	16.84 *e*	58.11 *b*	37.48 *f*
b3-straw + N_{50}	23.32 *f*	8.47 *b*	15.89 *e*	57.04 *c*	36.47 *g*
b4-$N_{100}P_{70}$	33.40 *d*	8.82 ***a***	21.11 *d*	52.40 *d*	36.75 *f*
b5-$N_{150}P_{70}$	41.06 *d*	7.41 *b*	24.23 *c*	50.67 *f*	37.45 *f*
a3-chisel 30 cm					
b1–unfertilized	26.82 *e*	7.62 *b*	17.22 *e*	57.56 *c*	37.39 *f*
b2-stable manuare	30.09 *d*	10.07 ***a***	20.08 *d*	60.09 ***a***	40.09 *d*
b3-straw + N_{50}	27.48 *e*	5.07 *c*	16.27 *e*	57.65 *c*	36.96 *f*
b4-$N_{100}P_{70}$	74.98 ***a***	3.96 *c*	39.47 ***a***	50.87 *f*	45.17 ***a***
b5-$N_{150}P_{70}$	65.82 *c*	5.65 *c*	35.73 *b*	51.15 *f*	43.44 *b*
a4-disk 10-12 cm					
b1–unfertilized	28.15 *e*	5.27 *c*	16.71 *e*	58.23 *b*	37.47 *f*
b2-stable manuare	26.21 *e*	10.53 ***a***	18.37 *e*	60.22 ***a***	39.29 *d*
b3-straw + N_{50}	39.15 *e*	8.90 ***a***	24.02 *c*	58.90 *b*	41.46 *c*
b4-$N_{100}P_{70}$	42.81 *d*	8.78 ***a***	25.79 *c*	51.84 *e*	38.81 *e*
b5-$N_{150}P_{70}$	71.47 *b*	7.76 *b*	39.62 ***a***	49.62 *g*	44.62 ***a***
DL P% 0.1	*4.71*	*DLP 5% 1.93*	*2.62*	*1.23*	*0.90*

Finally, the Synthetic Indicator of Soil Fertility (SISF%), is the average of BSI% and CSI%, meeting all the complex tests (table 5). This indicator shoes that maximum values, obtained only by superficial soil loosening works and annual supply with mineral fertilizers $N_{150}P_{70}$ and at chisel 30 cm with $N_{100}P_{70}$.

4. Conclusions

Of all modes of basic works, for loosening the reddish preluvosoil from Moara Domnească – *Ilfov*, deep ploughing to 25 cm proved that influenced negatively the vital processes (respiration and cellulolyse) in soil and that can be attributed to the dilution of humus content, brought to the surface and intens mineralization by raising more vigorous, in the early years of experimentation.

Organic fertilization (stable manure 10 t/ha /3 years or wheat straw, 5 t/ha + N_{50}/3 years) was made with very small doses, and did not cause the expected positive influence on soil fertility status.

Mineral manures (nitrogen and phosphorus), having available, annually, organic matter from stubble, have stimulated the development of life processes and pedo-enzymatic activity, obvious signal of nutrient deficiencies for soil microflora.

The Synthetic Indicator of Soil Fertility (%) shoes that maximum values are obtained only by superficial soil loosening works at chisel and annual supply with $N_{100}P_{70}$ and stable manuare/3 years.

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