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MODIFICATION OF SOME CHEMICAL AND PHYSIOLOGICAL CHARACTERISTICS OF REDDISH PRELUVOSOL, PRODUCED BY THE SYSTEM OF SOIL BASIC TILLAGE AND FERTILIZATION

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ABSTRACT

Chemical reaction – pH (H_2O); hydrolytic acidity (Ah); cation – exchange capacity (T); base saturation degree (V%) and soil respiration of reddish preluvosol, differently tilled and with organic or/and mineral fertilizers were determined. Among the basic tillage, the most active for growth of pH were chisel and disk. Total capacity of cationic exchange increased in unfertilised and stable manure (compost) variants, and also for the ploughing at 15 and 25 cm. Degree of base saturation had the highest value in the variants unfertilised and fertilized with stable manure compost.

Key words: soil basic tillage, plough, disk, chisel, organic and mineral fertilization, soil chemical features, soil respiration.

INTRODUCTION

Numerous researchers have demonstrated that conservation tillage is effective in improving soil physical and chemical properties (Jian et al., 2011; Madejon et al., 2009; Thomas et al., 2007; Naudin et al., 2010).

Cultivated soils are increasingly faced with agronomic or environmental risk such as higher supply of pesticides and fertilizers that can increase pollution, or compaction and erosion due to heavier machines and repeated operations (Guillaume and Daniel, 2006).

Basic tillage of soil and organic and/or mineral fertilization represent some essential components in crop management and pursue the realization of favourable conditions of plant growth and development by modification of soil physical state with some direct implications on soil physiological and chemical features of that.

The present communication has as objective the estimation of the physiological and chemical modifications of reddish preluvosol as a consequence of different modes of soil basic tillage and of organic and/or mineral fertilization.

MATERIAL AND METHODS

The researches were designed as a bifactorial experiment, of type 4 x 5, having as factor A, the basic tillage (a_1 – ploughing at 15 cm; a_2 – ploughing at 25 cm; a_3 – chisel at 30 cm; a_4 – disk at 10–12 cm) and factor B, organic and/or mineral fertilization (b_1 – unfertilized; b_2 – stable manure, sponta-neously composted, 30 t/ha/3 years; b_3 – wheat straws, 10 t/ha + N_{50}/3 years; b_4 – $N_{100}P_{70}$ – annually and b_5 – $N_{150}P_{70}$ – annually). The crop rotation was: pea, winter wheat and maize. The experiment was founded in 2000 at Didactic Experimental Station from Moara Domneasca, Ilfov county, on reddish preluvosol, having a clay loam texture and 2.17-2.64% humus (1.26-1.53 C_t%). The air temperature varied between 10.6°C and 12.6 in 2010 and precipitations, between 305 mm (2010), 444.9 mm (2002) and 823.0 mm (2005). The soil samples, for analyses, were sampled in October, 2011, from the depth 0-20 cm, after harvesting the maize crop.

The soil samples were cleaned of visible vegetal remains, fine grinded and analysed for: pH-H_2O; hydrolytic acidity (Ah m.e./ 100 g soil), total capacity of cationic exchange (T m.e./100 g soil); degree of base saturation (V%) – cited methods after Stoica et al.

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(1986) – and soil respiration potential by the device (auto supplied with oxygen) and method of Ştefanic (1989; 1994; 2006). Statistical analyses were made by multiple comparison method (Snedecor, 1968) expounded by Ştefanic (2010).

The letters which differentiate experimental variants, in tables, placed before the numbers permit the comparison between columns (A and A x B) and those after the numbers allow variant comparison in rows (B and B x A).

RESULTS AND DISCUSSION

The modification of pH, produced by soil basic tillage and of fertilizing mode, is presented in table 1.

Table 1. Influence of soil basic tillage and of organic and/or mineral fertilization on pH (H_2O) modification of reddish preluvosol from Moara Domneasca, Ilfov County

Factor B / Factor A	b_1 – unfertilized	b_2 – stable dung	b_3 – straw $+N_{50}$	b_4 – $N_{100}P_{70}$	b_{5v} – $N_{150}P_{70}$	Average A
a_1 – plough 15 cm	b 5.405 a	b 5.429 a	b 5.263 b	b 4.704 c	c 4.539 d	b 5.068
a_2 – plough 25 cm	a 5.569 a	b 5.397 b	b 5.343 b	a 4.904 b	a 4.728 c	a 5.188
a_3 – chisel 30 cm	a 5.554 a	a 5.560 a	a 5.440 b	c 4.636 c	b 4.632 c	a 5.164
a_4 – disk 10 12 cm	a 5.548 b	a 5.576 a	b 5.311 c	b 4.746 d	c 4.457 e	a 5.128
Average B	5.519 a	5.490 a	5.339 b	4.748 c	4.589 c	
LSD	A	B	B x A	A x B		
5%	0.052	0.044	0.088*	0.088*		
1%	0.079*	0.059	0.123	0.118		
0.1%	0.128	0.078*	0.173	0.156		

Figures in the same column, preceded by different letters are significantly different at P≤5%.
Figures in the same row, followed by different letters are significantly different at P≤5%.

The acidification effect on soil chemical reaction was significant when mineral fertilization was applied annually in soil, which was resulted in some ions that were not adsorbed in soil (Borlan et al., 1982). The acid reaction of soil solution is given by unsaturated humic acids and other organic acids (Chiriță, 1955).

Ploughing at 15 cm (unfertilised or fertilized with stable manure) maintained pH at 5.40 and 5.43, but pH it diminished, significantly, in the other variants with mineral fertilizers. The last observation was valid for all the other variants. It may have been due to the ask alkalinity of organic matter accumulated preferentially under the row, which could have counterbalanced the acidification processes (Guillaume and Daniel, 2006). The acidification was mainly due to the mineralization of organic matter, the acidifying effect of the nitrification of added ammonium, and root exudation (Guillaume and Daniel, 2006).

Influence on hydrolytic acidity is presented in table 2.

Soil tillage by disk or by chisel, in the unfertilised variants, and also mineral fertilization determined an increase of soil hydrolytic acidity.

Influence on total capacity of cationic exchange is presented in table 3.

The basic working of soil by disk, for a long time, without fertilization, enlarged the cationic-exchange to 24.0 m.e./100 g soil. The same effect of the superficial work on increasing the soil cationic-exchange capacity was, also observed in the other variants of fertilization. Regarding the influence of fertilizing modes only at $N_{150}P_{70}$ the cation-exchange was higher for all modes of basic tillage.

Table 2. Influence of soil basic tillage and of organic and mineral fertilization on soil hydrolytic acidity (Ah - m.e./100 g soil)

Factor B / Factor A	b_1 – unfertilised	b_2 – stable dung	b_3 – straw $+N_{50}$	b_4 – $N_{100}P_{70}$	b_5 – $N_{150}P_{70}$	Average A
a_1 – plough 15 cm	b 3.50 c	c 3.35 c	b 4.09 b	b 6.13 a	c 6.42 a	c 4.70
a_2 – plough 25 cm	c 2.77 c	b 3.50 b	c 3.50 b	c 5.10 a	d 5.54 a	d 4.08
a_3 – chisel 30 cm	a 4.09 c	a 3.94 c	b 4.38 c	a 7.35 b	b 7.88 a	b 5.53
a_4 – disk 10-12 cm	a 4.23 d	a 4.09 d	a 5.25 c	a 7.73 b	a 8.95 a	a 6.05
Average B	3.648 c	3.720 c	4.304 b	6.579 b	7.197 a	
LSD	A	B	B x A	A x B		
5%	0.199*	0.242*	0.461*	0.485*		
1%	0.301	0.326	0.631	0.652		
0.1%	0.485	0.431	0.865	0.862		

Figures in the same column, preceded by different letters are significantly different at P≤5%.
Figures in the same row, followed by different letters are significantly different at P≤5%.

Table 3. Influence of soil basic tillage and of organic and mineral fertilization on soil cationic-exchange capacity (T- m.e/100 soil)

Factor B / Factor A	b_1 – unfertilized	b_2 – stable dung	b_3 – straw $+ N_{50}$	b_4 – $N_{100}P_{70}$	b_5 – $N_{150}P_{70}$	Average A
a_1 – plough 15 cm	b 22.4 b	b 21.2 c	b 22.5 b	b 25.0 a	c 24.9 a	c 23.200
a_2 – plough 25 cm	c 20.9 b	b 21.9 b	b 22.0 b	b 24.3 a	c 24.1 a	d 22.620
a_3 – chisel 30 cm	b 22.6 b	a 22.3 b	a 22.8 b	a 26.8 a	b 27.9 a	b 24.500
a_4 – disk 10-12 cm	a 24.0 c	a 23.2 c	a 23.8 c	a 27.3 b	a 29.0 a	a 25.460
Average B	22.48 c	22.13d	22.78 c	25.87 b	26.47 a	
LSD	A	B	B x A	A x B		
5%	0.29*	0.55*	1.01*	1.10*		
1%	0.45	0.74	1.37	1.48		
0.1%	0.72	0.98	1.84	1.95		

Figures in the same column, preceded by different letters are significantly different at P≤5%.
Figures in the same row, followed by different letters are significantly different at P≤5%.

Influence on base saturation degree is presented in table 4.

Soil base saturation degree (V%) is a synthetic index which includes T and S values and can express the degree of soil saturation with cations. The ploughing at 15 cm and 25 cm (in unfertilised variant) have had the maximum degree of saturation with bases (80.9 and 84.3) while a minimum was observed in the variants: chisel 30 cm and disk 10-12 cm. We think that by ploughing, a part of leached cations are returned towards soil surface. By applying stable manure the cations are retained in the first 20 cm of soil, more than in the variants fertilized with mineral fertilizers.

Influence of soil base tillage and of organic and/or mineral fertilization on the soil respiration potential

Soil respiration potential is a general vital indicator. In the table 5 one observes that in variant, ploughed to 15 cm and without fertilizer, soil respiration had a high level. The application of stable manure (10 t/ha/3 years) and also of straw (5 t/ha/3 years) was in very too small quantities to determine an important effect. In the variant with $N_{150}P_{70}$, given in soil annually, the influence on increasing soil respiration potential was important.

Table 4. Influence of soil base tillage and of organic and mineral fertilization on the soil base saturation degree (V%)

Factor B / Factor A	b_1 – unfertilized	b_2 – stable dung	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 80.9 a	a 80.6 a	b 77.0 b	b 65.7 c	b 63.1 d	b 73.440
a_2 – plough 25 cm	a 84.3 a	a 80.3 b	a 80.5 b	a 72.2 c	a 68.5 d	a 77.153
a_3 – chisel 30 cm	b 77.1 a	b 77.8 a	b 75.3 b	c 59.6 c	c 57.9 d	c 69.533
a_4 – disk 10-12 cm	b 77.8 a	b 77.8 a	c 70.3 b	d 57.7 c	d 47.0 d	d 66.120
Average B	80.03 a	79.11 b	75.77 c	63.79 d	59.11 e	
LSD	A	B	B x A	A x B		
5%	0.82*	0.97*	1.85*	1.94*		
1%	1.25	1.30	2.54	2.61		
0.1%	2.01	1.73	3.49	3.45		

Figures in the same column, preceded by different letters are significantly different at P≤5%.
Figures in the same row, followed by different letters are significantly different at P≤5%.

Table 5. Influence of soil base tillage and of organic and/or mineral fertilization on the soil respiration activity of reddish preluvosol (mg CO_2/100 g soil)

Factor B / Factor A	b_1 – unfertilized	b_2 – stable dung	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 26.627 b	b 22.433 c	a 22.317 c	a 28.267 b	b 32.280 a	a 26.385
a_2 – plough 25 cm	b 22.960 b	c 17.640 d	a 21.630 b	c 20.300 c	b 29.620 a	b 22.430
a_3 – chisel 30 cm	b 21.630 c	a 25.177 b	a 22.293 c	a 30.950 a	c 21.630 c	a 24.336
a_4 – disk 10-12 cm	b 22.960 b	c 19.413 d	a 22.630 c	b 24.953 b	a 35.607 a	a 25.113
Average B	23.544 c	21.166 e	22.218 d	26.118 b	29.784 a	
LSD	A	B	B x A	A x B		
5%	1.777	0.756	1.897	1.513		
1%	2.692*	1.017*	2.742*	2.034*		
0.1%	4.327	1.345	4.109	2.690		

Figures in the same column, preceded by different letters are significantly different at P≤5%.
Figures in the same row, followed by different letters are significantly different at P≤5%.

CONCLUSIONS

Between soil base ploughings, only ploughing that to 15 cm, very little diminished the pH (H2O), but the mineral fertilization (N100P70 and N150P70) increased strongly the acidity.

Soil hydrolytic acidity increased in the variants tilled by chisel or disk; fertilization with mineral fertilizers determined an important increase of Ah, between 5.10 m.e. and 8.95 m.e./100 g soil.

The ploughing to 15 cm or 25 cm increased soil base saturation degree (V%), probably by bringing the cations leached in depth, to the superior soil layer.

The soil characteristics, in all experimental variants, indicated the necessity of liming for determining an increase of soil vitality.

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