AgroLife Scientific Journal - Volume 3, Number 1, 2014
ISSN 2285-5718; ISSN CD-ROM 2285-5726; ISSN ONLINE 2286-0126; ISSN-L 2285-5718

INFLUENCE OF SOME PLANT SPECIES AND SOIL TILLAGE UPON THE FERTILIZATION OF CHROMIC LUVISOL IN THE ROMANIAN PLAIN

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Abstract

Crop plant and basic tillage can influence soil fertility. Grown in the same place after three years, crop plant determines an annual influence that may be modified in the following year. Basic tillage strongly influences the arable horizon, especially when it is repeated several years later. The paper presents our attempts to determine both plant influences in crop rotation and the basic soil loosening maintained unchanged for 12 years. Laboratory analysis was performed in order to determine the effect of chemical, biological and pedo-enzymical influences on 0-20 cm depth of the chromic luvisol horizon where the middle term experiment was placed at Moara Domneasca - Ilfov. Results were statistically analyzed by the multiple comparison method (Snedecor, 1965). The steady conclusions show that the temporary influence of the plant cultivated in a three-year crop rotation, must be ignored. Ploughing and disking by repeated loosening (for 12 years) produced a better state of fertility in comparison with permanent chiselling.

Keywords: *pH (H_2O), humus, cellulolyse, total pedo-amidase, total pedo-phosphatase.*

INTRODUCTION

Crop establishment pre-supposes basic tillage for adequate seedbed preparation. In the technical history of this type of farming concerns, ploughing was and still is the basic work, irrespective of the time of year. Basic tillage must ensure suitable soil loosening at a certain depth, in order to facilitate the incorporation of stubble, organic manures and even mineral fertilizes, amendments of any kind into the soil, and provide the best retention of the water resulting from precipitations, weed control etc. The question of ploughing depth occurred in the past, and still persists in modern times; however, towards the end of the 20th century, the ‘no-till’ technology was recommended for economic reasons and based on scientific arguments; this resulted in the complete elimination of ploughing that was replaced with other operations (for example, plant-waste mulching) and new technical means, among which the ‘minimum tillage’ strategy which introduced chiseling as the basic work for loosening the superficial soil layer and hardpan destruction.

In Romania, the first scientific publications concerning soil tillage supported the extension of the ‘dry farming’ strategy which is highly appreciated in agricultural practice, because it is based on both animal and mechanical traction, low consumption of fossil energy, good maintenance of the soil physical characteristics, and weed control (Săndoiu and Enicov, 1940; Staicu, 1938; Sandoiu et al., 1942, 1947; Stratula and Ionescu, 1965; Rusu et al., 2009; Marin et al., 2012; Dinca et al., 2013). As examples of worldwide literature, we mention (Pfeiffer, 1938; Carter, 1986; Laford et al., 1992; Balota et al., 2003) whose books present the loose status of the superficial soil layer, the microflora, micro and mesofauna responsible for both organic matter mineralization and aerobic humification. In the past few years, industry provided agriculture with some ploughs and tractors capable to plough deeply and very deeply, which undoubtedly play a role in certain specific agricultural cases, such as the physical improvement of soil, together with other obligatory agrotechnical measures, such as top quality organic fertilization, aerobic composts, etc.

Our paper presents the results of complex chemical, physiological and pedo-enzymical research performed in a new conception of analysis and interpretation. This presents the effect of the influence factors (plant species and basic tillage) by the change in some characteristic parameters of soil fertility that allows farmers to choose the basic loosening mode for chromic luvisol, in order to reduce its negative effects on soil fertility.

MATERIALS AND METHODS

The field experiment was established on chromic luvisol at the Moara Domneasca research centre in 2000. The three-year crop rotation had the following influence factors: **A** (a_1 - peas; a_2 - winter wheat and a_3 - maize) and **B,** annually: (b_1 - ploughing to 25 cm; b_2 - loosening with chisel to 20 cm and b_3 - loosening with disk to 10-12 cm). All soil loosening works were performed in autumn for all crops. Soil samples were collected the same day with Egenér drill from the parcels of all plants at 0-20 cm depth, simultaneously with maize harvesting. For each soil sample, a part was sieved (2-2.5 mm) in order to remove visible organic waste, then air-dried quickly; another part was introduced into a thin plastic bag, well closed to maintain humidity at room temperature for a month, in order to stabilize microbial processes, then temperature was decreased to 4-7^{0}C until the analysis was performed. We performed the following analyses: humidity; chemical reaction of soil (pH-H_2O) by the electrometric method, and humus content (Ct%) by spectrophotometrical method (Graham, 1950; Salfeld, 1974); cellulolyse (Vostrov and Petrova, 1961); total pedo-phosphatase (Ştefanic et al., 1965; 1971; Irimescu and Ştefanic, 1998) and total pedo-amidase (Ştefanic and Gheorghiţă, 2008). All results were transformed into percentage (compared with the Maximal Estimated Value (MEV=100 – determined according to the data obtained by Ştefanic, 1994, for each test) and in accordance with the Numerical Taxonomy Method. To transform the analytical results into primary indicators and finally into the Complex Indicator of Soil Fertility (CISF%), the results (in repetition) were calculated as percentage from MEV for each test; then we calculated the mean of the percentages resulted from analysis. The changes in the soil characteristics resulted from the influence of the cited experimental factors were assessed by using the multiple test recommended by Snedecor (1965). The Maximum Empirical Value (MEV) is indicated under Table 2 (Gheorghita et al., 2008).

RESULTS AND DISKUSSIONS

Table 1 presents the chemical, physiological and pedo-enzymical analyses necessary to evaluate the effect of human intervention on soil fertility. Each analysed character was subject to variance analysis and were statistically differentiated by letters using LDP 0.1% (presented at the bottom of table).

Table 1. Data (in three replications) from laboratory analyses were introduced to evaluate the chemical, physiological and pedo-enzymical features, influenced by basic works for loosening agricultural soil (after 12 years of application) in a three-year crop rotation (peas, winter wheat and maize)

Experimental variants A / B		pH (H_2O)	Humus (Ct%)	Cellulolyse (mg cellulose)	Pedo-amidase mg NH_4^+ / 100 g soil	Pedo-phosphatase mg P / 100 g soil
a_1- peas	b_1- A_{25}	c 5.53	b 1.55	a 3.78	c 0.067	c 0.335
	b_2- C_{20}	c 5.47	b 1.52	b 3.48	b 0.187	c 0.547
	b_3- D_{10-12}	b 5.67	a 1.80	a 5.22	b 0.143	c 0.635
a_2-winter wheat	b_1- A_{25}	b 5.62	c 1.40	b 1.40	a 0.210	a 1.670
	b_2- C_{20}	d 5.42	c 1.39	b 3.40	a 0.310	b 1.255
	b_3- D_{10-12}	c 5.55	b 1.57	b 1.56	b 0.107	c 0.460
a_3-maize	b_1- A_{25}	a 5.75	d 1.21	c 1.14	c 0.067	d 0.230
	b_2- C_{20}	a 5.71	b 1.49	b 2.46	a 0.290	c 0.235
	b_3- D_{10-12}	a 5.77	a 1.68	a 4.50	b 0.167	c 0.550
LSD 0.1%		**0.086**	**0.144**	**1.569**	**0.1178**	**0.3395**

*A_{25} - ploughing to 25 cm, C_{20} - with chisel to 20 cm, D_{10-12} - with disk to 10-12 cm

In table 2, the results of the chemical, physiological and pedo-enzymical analyses transformed into percentage from VEM are presented in three replications (necessary to calculate their arithmetic means).

Table 2. Change in percentages (primary indicators) of the results (in three replications) presented in Table 1

Experimental variants A / B		pH (H_2O)	Humus (Ct%)	Cellulolyse (mg cellulose)	Pedo-amidase mg NH_4^+ / 100 g soil	Pedo-phosphatase mg P / 100 g soil	Average CISF %
a_1- peas	b_1- A_{25}	66.63	36.47	31.50	0.82	1.42	**a 27.37**
	b_2- C_{20}	65.90	35.76	29.00	0.93	2.19	**b 26.76**
	b_3- D_{10-12}	68.31	42.35	30.25	0.71	0.57	**a 28.44**
a_2-winter wheat	b_1- A_{25}	67.71	32.94	11.67	1.05	0.84	**c 22.84**
	b_2- C_{20}	65.30	32.71	12.33	1.55	1.24	**c 22.63**
	b_3- D_{10-12}	66.87	36.94	13.00	1.30	0.43	**c 23.73**
a_3-maize	b_1- A_{25}	69.28	28.47	29.00	0.33	0.27	**b 25.47**
	b_2- C_{20}	68.80	35.06	20.50	1.45	1.16	**b 25.39**
	b_3- D_{10-12}	69.52	39.53	37.50	0.83	0.67	**a 29.61**
MEV		8.3	4.25	12	20	25	

For example: The results in table 3 are transformed into percentages from VEM, as follows: experimental results for pH (H_2O) = **5.53;** VEM for pH (H_2O) = **8.3** (excepting the base-saturated soils) **5.53 : 8.3** *x* **100 = 66.63 %** (primary indicator). In (Table 3), the values of the Complex Indicator of Soil Fertility (CISF %) presented in (Table 2), were factorially grouped. The factor A mean (separate influence of the plant grown in 2012) and the factor B mean (separate influence of the basic mode of soil tillage for the same period of 12 years) were statistically grouped. Thus, we found that the plant species determined no significant influence (in 2012), but the factor B had a negative influence by repeated chiseling at 20 cm in depth.

Table 3. Estimation of the changes produced (by Complex Indicator of Soil Fertility - CISF%), on average, by cultivated plants (factor A) or by mode of basic tillage (factor B), in the twelfth year of application

Factors A / B	After pea	After winter wheat	After maize	Factor B - average
b_1-A $_{25\ cm}$	27.37	26.76	28.44	a 27.52
b_2- C $_{20\ cm}$	22.84	22.63	23.71	b 23.06
b_3- $D_{10-12\ cm}$	25.47	25.39	29.61	a 26.82
Factor A –average	25.23 a	24.92 a	27.25 a	2.81
LSD % 0.1	Insignificant			

The table includes also, average of factors A and B, in the interest of farmer to be able to decide how must cultivate the soil. One observes that by plowing or disking, the stubbles, by organic matter incorporated in soil, stimulated the vitality and activity of pedo-enzymes. All these characteristics of the soil are expressed by CISF%.

The interaction effect of experimental factors and possibility of a better interpretation of the quality of human interventions on fertility status of chromic luvisol, after 12 years, are presented in Table 4. They ought to observe that after winter wheat, the basic soil work was grouped with letter **c** (the smallest CISF% of the whole experiment).

The table also includes the columns of (average influence of factors A and B so that the farmer can decide how he must cultivate the soil. We notice that, by plowing or disking, the organic matter provided by the stubble incorporated in the soil stimulated the vitality and activity of pedo-enzymes and chemical fertilizers. All these characteristics of the soil are expressed by CISF%.

Table 4 presents the effect of the interaction between the experimental factors and the possibility of a better interpretation of the quality of human intervention on the fertility of chromic luvisol after 12 years. It should be noted that, after winter wheat, basic tillage was grouped under letter **c** (the smallest CISF% from all experiment).

The basic works for loosening the superficial layer of chromic luvisol must be associated with the incorporation of stubble, green manures, plant waste, farmyard manure, different composts, etc., into the soil. Therefore, when we choose the tillage method, we must bear in mind that the purpose of the chisel is to destroy the hardpan.

Table 4. Soil fertility modification after 12 years of crop rotation influence and different basic tillage

Plant cultivated in 2012 (A)	Basic tillage (B)	Interaction A x B
Peas	$A_{25\ cm}$	**a** 27.37
	$C_{20\ cm}$	**b** 26.76
	$D_{10\text{-}12\ cm}$	**a** 28.44
Winter wheat	$A_{25\ cm}$	**c** 22.84
	$C_{20\ cm}$	**c** 22.63
	$D_{10\text{-}12\ cm}$	**c** 23.71
Maize	$A_{25\ cm}$	**b** 25.47
	$C_{20\ cm}$	**b** 25.39
	$D_{10\text{-}12\ cm}$	**a** 29.61

LSD 0.1%=2.81

Plowing and, to some extent, disking are suitable for incorporating stubble and other organic manures into the soil and, last but not least, improve the physical, chemical and vital soil features.

CONCLUSIONS

Disking ($D_{10\text{-}12\ cm}$) produced the best conditions in the 0-20 cm horizon, both for pea grown after maize and for maize grown after winter wheat. Plowing to 25 cm depth presented the same results; however, it was more expensive and determined the sinking of the hardpan.

Weed control by burying the weed seeds more deeply was illusory since, by deep ploughing the following year, they were brought to the surface again; thus, they contributed to the expansion of the weed species that had escaped from herbicide treatment.

Although the experiment also referred to a possible influence of the cultivated plant, a possible action could be detected as influence exerted only in the crop year, as the experiment was organized in rotation for a period of 12 years and the specific influence disappeared.

Also, according to the chemical and biological analysis methods, in order to eliminate the climate influence and the dynamics of the various processes that occur in soil, soil sampling was performed the same day from all parcels, after maize harvesting, and the samples were kept at room temperature in order to obtain a specific balance comparable for all soil samples.

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