INFLUENCE OF MINIMUM TILLAGE SYSTEMS UPON THE SOIL PHYSICAL PROPERTIES AND THE REDUCTION RATIO

INFLUENȚA SISTEMULUI MINIM DE LUCRARE ASUPRA PROPRIETĂȚILOR FIZICE ŞI A GRADULUI DE MĂRUNȚIRE A SOLULUI

N. BOJA*, F. BOJA*,A. TEUŞDEA, MIHAELA CARȚIŞ****

Universitatea de Vest "Vasile Goldiş" Arad, Romania
****Universitatea din Oradea, Romania***

Abstract: *In this paper was analyzed the influences of soil tillage systems on the physical soil properties. The using of non-conventional soil tillage systems has important ecological and economical advantages. The purpose of this study was to evaluate the influence of the conventional and non-conventional soil tillage systems on some physical properties and the determination of the reduction ratio.*
The paper presents the influence of conventional plough tillage system on some physical soil properties in comparison with the alternative minimum tillage system (Para plow and rotary harrow).

Rezumat: *În această lucrare au fost analizate influenţele sistemului de lucrări asupra proprietăţilor fizice ale solului. Utilizarea sistemului de lucrări neconvenţionale are importante avantaje ecologice şi economice. Scopul acestui studiu a fost de a evalua influenţa sistemelor convenţionale şi neconvenţionale de lucrare a solului asupra unor proprietăţi fizice şi a gradului de mărunţire. Lucrarea prezintă influenţa sistemului de lucru convenţional, cu plugul clasic, asupra unor proprietăţi fizice a solului în comparaţie cu sistemul minim de lucrare neconvenţional (paraplow şi grapa rotativă).*

Key words**:** *minimum tillage, physical properties , soil porosity.*
Cuvinte cheie: *lucrări minime, proprietăţi fizice, porozitatea solului.*

INTRODUCTION

The tillage systems are applied in order to modify soil characteristics and to control the vegetation factors (water, air, heat, nutritive elements and biological activity), thus facilitating optimal conditions for the growth of plants.

Through the tillage systems there are produced the conditions for the quality performance of the other technological elements such as: the achievement at the surface of the field of conditions for seeding.

The economical efficiency of a culture is in a strong connection with the way of performance and the quality of the tillage systems.

The tillage systems determine firstly changes of the physical characteristics, which influence the chemical and the biological features of soil.

The implementation of a tillage system should be done in accordance with all the aspects which can influence that system, thus it assumes the knowledge in detail of all the elements which contribute to the increase of the soil fertility. An insufficient analysis of the way in which the soil interacts to these high requirements can have negative consequences, which are the degradation processes or even the destruction of the production capacity (HAMZA M.A. AND ANDERSON W.K. 2005).

The knowledge of the soil porosity, for example, is of the highest importance because the whole dynamics of soil depends on it, because the pores receive and offer all the mineral,

organic components and micro organisms which run in a form or another in its mass (OPREA C.V. 1960).

The tillage systems applied irrationally and most of all the classical tillage (ploughing) has determined in time a degradation of soil characteristics, the strong content decrease in organic matter and subsequently its productive potential.

The unconventional tillage of soil appeared as a necessity and alternative to the classic system having both ecological and economical advantages.

The minimum tillage systems (reduced tillage) assume the basic tillage without the return of the furrow. Taking into account the tools which are used at the basic tillage this system can have many versions, one of them is: the tillage with the paraplow and the rotary harrow.

The minimum tillage system with paraplow and rotary harrow is a polyvalent choice for the main processing and the preparation of the germinative bed, for the fields and cultures with moderate requirements of soil loosening, for the increased capacity for body of water and the possibility of doing the seeding and also for the decrease of erosion.

In this paper there are presented the obtained results regarding the influence of tillage systems method upon: apparent density, total porosity and reduction ratio.

MATERIALS AND METHOD

The results presented in this paper are obtained in the years 2005-2008 through research made in Iarac forestry nursery within The Forestry Agency Arad, paying attention to the influence of some unconventional tillage and classical tillage systems upon some physical characteristics. Samples were taken in their natural setting with metallic cylinder of 100 cm3, to determine some physical characteristics on four depths: 0-5; 5-10; 10-20; 20-30.

For each sample there were completed six repetitions (P1, P2, P3, P4, P5, P6) harvested after each technical finished work and it resulted 96 harvested samples for the determination of apparent density and 84 harvested samples for the determination of total porosity.

The physical indicators were counted based on the formulae proposed by A. Canarache. (1990).

We intend to analyse the effect of basic tillage systems – classical and unconventional systems (paraplow and rotary harrow) – upon some basic soil characteristics, with major influence upon the soil fertility and its conservation.

The following physical soil characteristics were determined: the apparent density (the method with the cylinders of 100 cm^3 (Da, g/cm^3); the total porosity (Pt, %) and the determination of the reduction ratio.

To determine reduction ratio, perpendicular pictures were taken on soil, after each finished work in six repetitions to show exactly the size of the resulted particles, which, subsequently, were scanned and processed through a proper method.

The determination of the soil reduction ratio was made after the following algorithm whose aim is to separate light coloured clumps from the rest of the image; all these digitally to a resolution of 0.03931 (mm^2) resulted from the digital photography to the dimension of 2054×1446 pixels to a resolution of 76 pixels per inch (1 inch=25.4(mm)). It is chosen the light colours surfaces because these represent the "cutting" area of the clump done by the mechanic gear and it approximates best the cross surface, and moreover the clumps dimension, where light reflects best. On the other surfaces light reflects at random and not directionally.

The mathematic interpretation of these scanned images needs the following mathematical description using a matrix:

$$Img_{i,j} = \left\{ (R,G,B)_{i,j} / i = \overline{1,nL},\ j = \overline{1,nC} \right\}$$

where: $Img_{i,j}$ is the image matrix with *nL* lines and *nC* columns,

- $(R,G,B)_{i,j}$ is a matrix element which has three values which encodes the colour of a pixel *i,j* from the image.

THE PLACE OF RESEARCH

From the climatic point of view the area where research was taken is presented in table1.

Table 1

The general characterization included in the experiment

Nrb.	Nursery	The altitude m	Vegetation area	Climatic province		Annual rainfall (mm)	Type of soil
				Köppen	Stoenescu		
1	Iarac	100	Forest steppe (of water meadow)	C.f.a.x.	I.B.p.1	500-600	erratic soil

RESULTS AND DISCUSSION

The minimum tillage systems influence firstly the physical characteristics, through the soil loosening intensity of the furrowed layer, then the chemical and biological soil characteristics. The reduction of the soil structure and the physical characteristics are the first changes induced by the tillage systems.

The minimum tillage systems through the reduction of the soil tillage and the increase of the quantity of organic matter left in the soil or at its surface contribute essentially to the renewal of the soil structure.

The minimum tillage systems and the replacement of ploughing with the paraplow and rotary harrow reduce the soil loosening intensity of the furrowed layer. The values of the apparent density on the depth between 0-30 cm grow at the minimum systems compared to the classical system.

The total porosity offer significant information about many soil characteristics. High values of the total porosity show a higher capacity of water storage, high permeability and good airing, but sometimes reduced values of the lifting power (Canarache, A., 1990).

The porosity variations, induced at the conventional and unconventional works for the soil preparation are not uniform on the profile and more they do not influence all pores categories.

Even though in the versions of the unconventional tillage systems, the total porosity had lower values compared to the conventional versions, which show a higher level of soil sag, this thing should not worry because the presence of macro pores and biopores reduces the negative effect of consolidation (Ţopa, D.,2007)

The description of the results for each determined parameter:

a) Apparent density

Analysing the results obtained in table 2, when using the classical plough and the disk harrow, it can be seen that the values of apparent density decrease together with the increase of the sample taking depth.

At the variant of preparing the soil through an unconventional system, apparent density has rising values between 1, 60-1, 71, as it can be observed in figure 2.

Table 2

The influence of the tillage system upon soil physical properties - apparent density

Average values, apparent density, Da (g/cm^3)			
Depth (cm)	**Plough clasical**	**Harrow**	**Average**
0-5	1,44	1,43	**1,43**
5-10	1,37	1,41	**1,39**
10-20	1,35	1,40	**1,37**
20-30	1,38	1,38	**1,38**

Average values, apparent density, Da (g/cm^3)			
Depth (cm)	**Paraplow**	**Rotary harrow**	**Average**
0-5	1,64	1,56	**1,60**
5-10	1,57	1,64	**1,61**
10-20	1,56	1,82	**1,69**
20-30	1,56	1,87	**1,71**

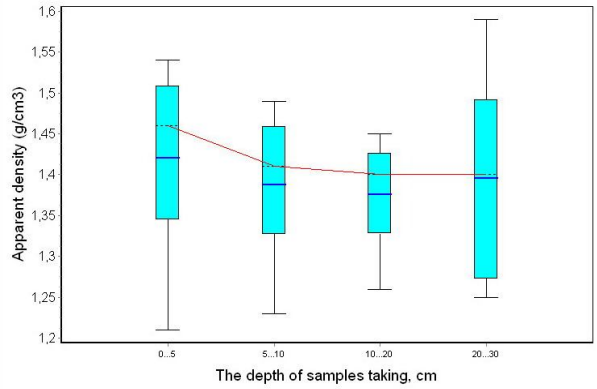

Figure.1. The box-plot diagram for the values of apparent density, Da (g/cm^3) of furrowed and harrowed soil

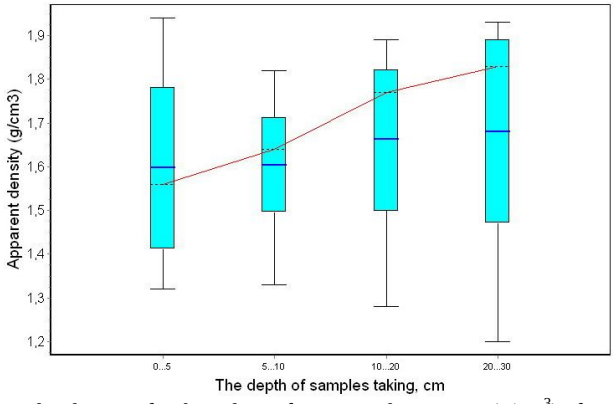

Figure.2. The box-plot diagram for the values of apparent density, Da (g/cm^3) of paraplow and rotary harrow

b) Total porosity

Analysing the average resulted values from table 3, depending on the used tillage system, it can be noticed that total porosity in the case of the classical system has increasing values together with the increase of depth and in the case of the unconventional system the soil porosity has decreased values.

Table 3

The influence of the tillage system upon soil physical properties - total porosity

Average values, total porosity, Pt (%)			
Depth (cm)	**Plough classical**	**Harrow**	**Average**
0-5	46,22	46,85	**46,54**
5-10	46,75	47,05	**46,90**
10-20	50,07	48,21	**49,14**
20-30	48,71	48,82	**48,76**

Average values, total porosity, Pt (%)			
Depth (cm)	**Paraplow**	**Rotary harrow**	**Average**
0-5	39,44	42,27	**40,86**
5-10	41,91	39,10	**40,50**
10-20	42,26	32,47	**37,37**
20-30	42,36	30,79	**36,57**

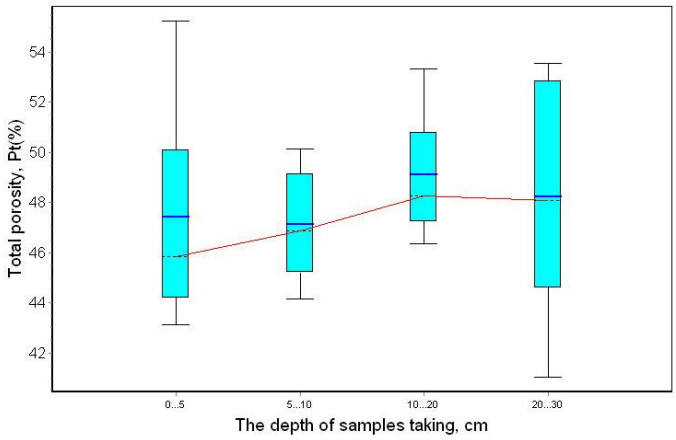

Figure3. Box-plot diagram for the values of the total porosity, Pt (%) of furrowed and harrowed soil

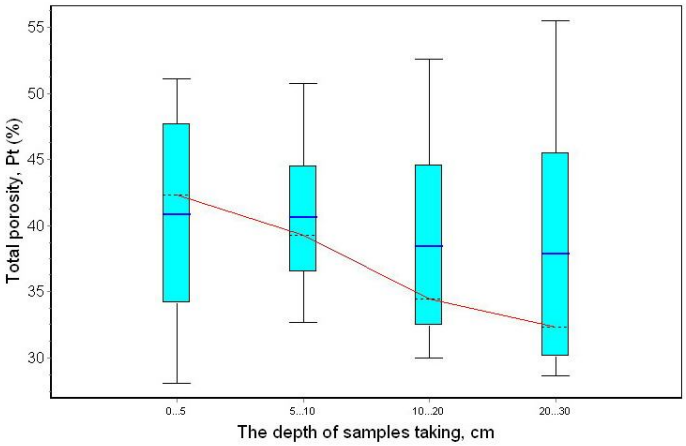

Figure4. Box-plot diagram for the values of the total porosity, Pt (%) of paraplow and rotary harrow

c) Reduction ratio

The graphic presentation of reduction ratio comparatively to the tillage systems variant is shown in picture 5 and it can be observed that the unconventional variant offers a much higher reduction ratio than in the case of the classical variant.

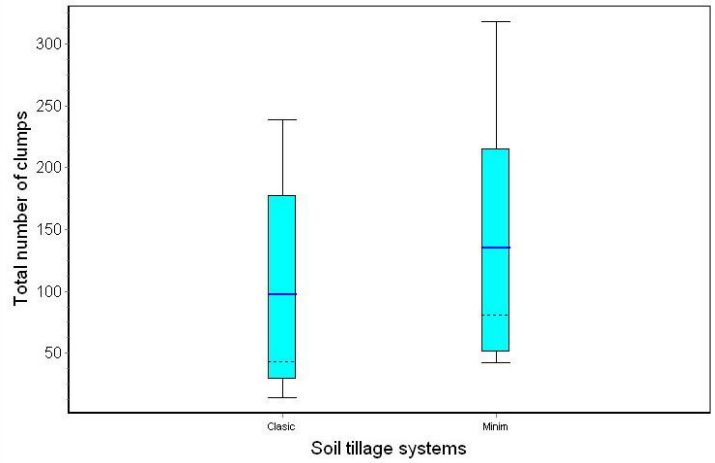

Figure5. Box-plot diagram for the values of reduction ratio depending on soil tillage systems

CONCLUSIONS

The complete mechanization of the investigations from the nurseries is a decisive condition in this action of exploitation the biological potential of plants, for the introduction of new technologies, for making easier the physical work, for considerable increase of work efficiency and for the substantial reduction of production costs.

Taking into account the results obtained after the determination of the physical characteristics many conclusions can be taken as the following: apparent density, in the classical variant of soil tillage systems has decreasing values while at the conventional variant it has increasing values together with the rise of the sample taking depth; the soil porosity can be damaged seriously due to the deficient application of the soil tillage systems.

The tillage systems influence the soil physical characteristics and the reduction ratio both through the classical ploughing technology and the conservative technology.

The reduction ratio changes significantly due to the tillage systems, so at the minimum tillage systems (paraplow and rotary harrow) the level of reduction ratio is much more increased compared to the classical system (plough and dragged).

LITERATURE

1. CANARACHE A., et. al.., "*Îndrumător pentru studiul solului pe teren şi în laborator*", Ed. Agro-Silvică, Bucureşti, 1990.
2. GUŞ P., RUSU T., STANILA S., "*Lucrările neconvenţionale ale solului şi sistema de maşini*", Ed. Risoprint, Cluj-Napoca, 2003.
3. HAMZA M.A. and ANDERSON W. K., „*Soil compaction in cropping systems: A review of the nature, causes and possible solutions. Soi land Tillage Research*", vol. 82 issue 2, pg. 121-145. 2005
4. OPREA C.V., „*Pedologie*" Ed. Agro-silvică, de stat, Bucureşti, 1960.
5. POPESCU I., "*Mecanizarea lucrărilor silvice*", Ed. Ceres, Bucureşti, 1984.
6. RUSU T., GUŞ P., " *Compactarea solurilor – procese şi consecinţe"*, Ed. Risoprint, Cluj-Napoca, 2007.
7. ŢOPA D., JITĂREANU G., „Influenţa sistemelor de lucrare a solului asupra categoriilor de porozitate la cultura grâului de toamnă", Compactarea solurilor – procese şi consecinţe, Ed. Risoprint, Cluj-Napoca, 2007.