

THE INFLUENCE OF THE SOIL TILLAGE SYSTEMS ON THE PHYSICAL PROPERTIES FROM THE FORESTRY NURSERIES

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Abstract

In this paper it was analysed the influence 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.

Key words: minimum tillage, physical properties, soil porosity.

INTRODUCTION

The machines system consists of all the machines, tools, equipment and outfit used for the mechanization of all the tillage mentioned in the technology of the production process of the forestry seedlings.

The classification of the machines system is done according to the production or technological processes which are mechanised. In practice it can be distinguished a specific machines system and a machines system common to more technological processes.

The mechanisation technology consists of an assembly of production processes, technological processes, forest tillage and operations justified from an economical and technical point of view. These should be carried on in a certain concatenation, observing some established conditions and using a well précised assembly of equipment.

Generally, a mechanisation technology from the vegetal production contains the following: soil fertilisation, soil main tillage, preparation tillage of the germination layer and the seeding, tillage of maintaining the cultures and the product gravest.

Choosing the type of machine or the equipment is a difficult problem, which requires a lot of experience because climate, relief, soil category, soil structure, humidity, physical and mechanical properties, the species for which the soil is prepared determine the type of machine which cooperate to an optimal preparation of the germination layer.

The excessive mechanisation of soil tillage is going to be replaced with minimum tillage done in only certain moments of maximum efficiency.

Through combined technical interventions achieved at the right moment it is avoided the lack of balance which can appeared in the forestry nurseries caused by the soil excessive compression. As a result the following can be mentioned: the degradation of the soil structure, the fertility reduction and the perturbation of the soil microbiological processes.

The substantiation of the unconventional soil tillage system is based on the achievement of some objectives and indicators, from which the following can be mentioned: (Gus P., 2003):

- the renunciation to ploughing done totally or periodically with the plough,
- the reduction of tillage number, totally or partially,
- keeping the vegetal remains at the surface of soil,
- avoidance erosion and preservation of soil through the creation of optimal conditions for growing and development of culture plants,
- the decrease of the production cost and the increase of net profit through the reduction of fuel consumption, and of human and mechanical work.

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 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.

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

MATERIAL AND METHODS

The results presented in this paper are obtained in the years 2005-2008 through research made in Agriș 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 analyze 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 cm³ (Da, g/cm³); 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 (mm²) 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 mathematics interpretation of these scanned images needs the following mathematical description using a matrix:

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

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.

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

No.	Nursery	The altitude, (m)	Vegetation area	Climatic province		Annual rainfall, (mm)	Type of soil
				Köppen	Stoienescu		
1	Agriş	175	Forest field	C.f.b.x.	I.B.p.2	700-800	Brown soil

RESULTS AND DISCUSSION

The minimum tillage systems influence firstly the physical characteristics, through the loosening of soil intensity from 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 loosening of soil intensity from the furrowed layer. The values of the apparent density on the depth between 0-30 cm increases 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 have lower values compared to the conventional versions, which show a higher level of soil sag, this fact should not worry because the presence of macro pores and biopores reduces the negative effect of consolidation (Țopa, D., 2007)

The description of the results for each determined parameter:

Apparent density: Analyzing 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, 47-1, 66, 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, D_a (g/cm^3)				Average values, apparent density, D_a (g/cm^3)		
Depth (cm)	Depth (cm)	Plough classical	Harrow	Average	Paraplow	Rotary harrow
0-5	0-5	1,60	1,43	1,52	1,37	1,56
5-10	5-10	1,38	1,40	1,39	1,38	1,64
10-20	10-20	1,38	1,38	1,38	1,40	1,82
20-30	20-30	1,36	1,34	1,35	1,45	1,87

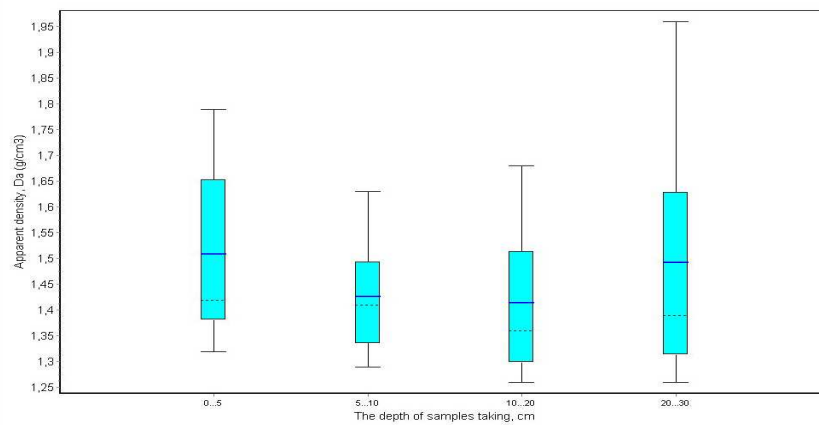


Figure 1. The box-plot diagram for the values of apparent density, D_a (g/cm^3) of furrowed and harrowed soil.

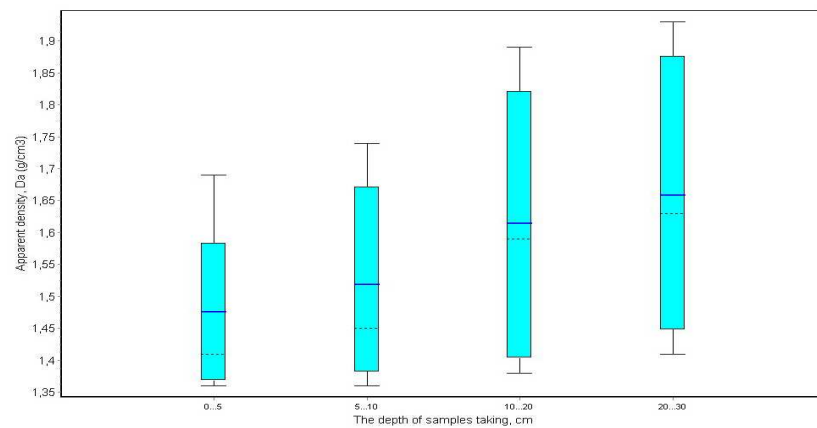


Figure 2. The box-plot diagram for the values of apparent density, D_a (g/cm^3) of paraplow and rotary harrow

Table 3

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

Average values, total porosity, Pt (%)				Average values, total porosity, Pt (%)		
Depth (cm)	Depth (cm)	Plough classical	Harrow	Average	Paraplow	Rotary harrow
0-5	0-5	40,82	47,05	43,94	49,30	42,27
5-10	5-10	49,02	48,21	48,62	48,89	39,10
10-20	10-20	49,03	48,82	48,93	48,05	32,47
20-30	20-30	50,12	49,98	50,05	46,41	30,79

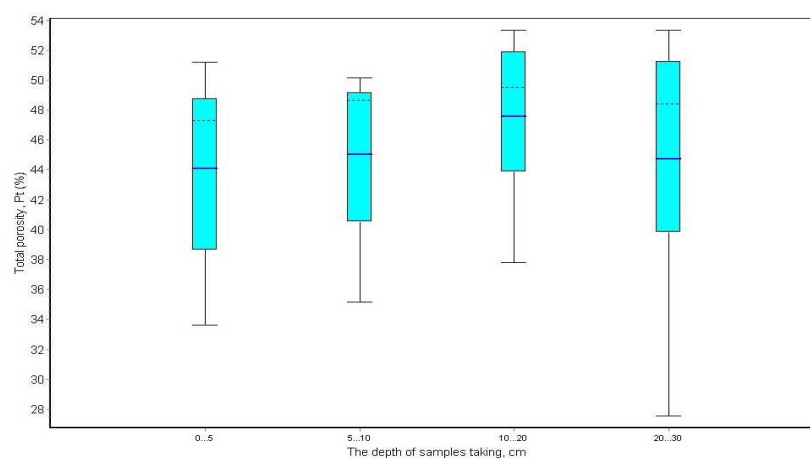


Figure 3. Box-plot diagram for the values of the total porosity, Pt (%) of furrowed and harrowed soil

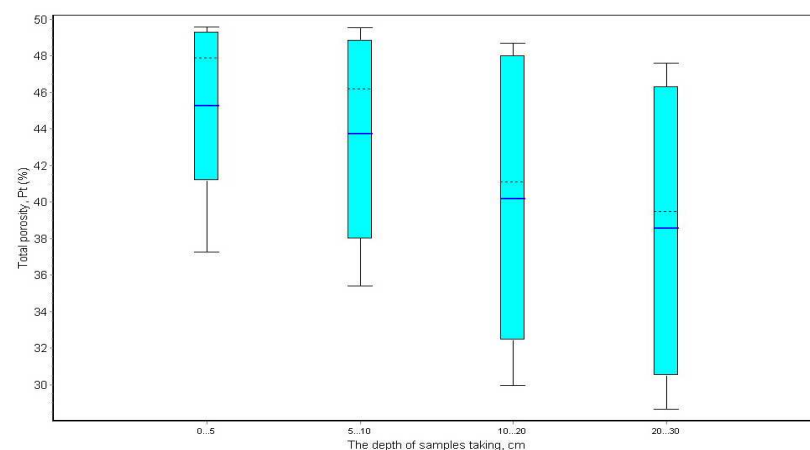


Figure 4. Box-plot diagram for the values of the total porosity, Pt (%) of paraplow and rotary harrow

Total porosity: Analyzing 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.

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.

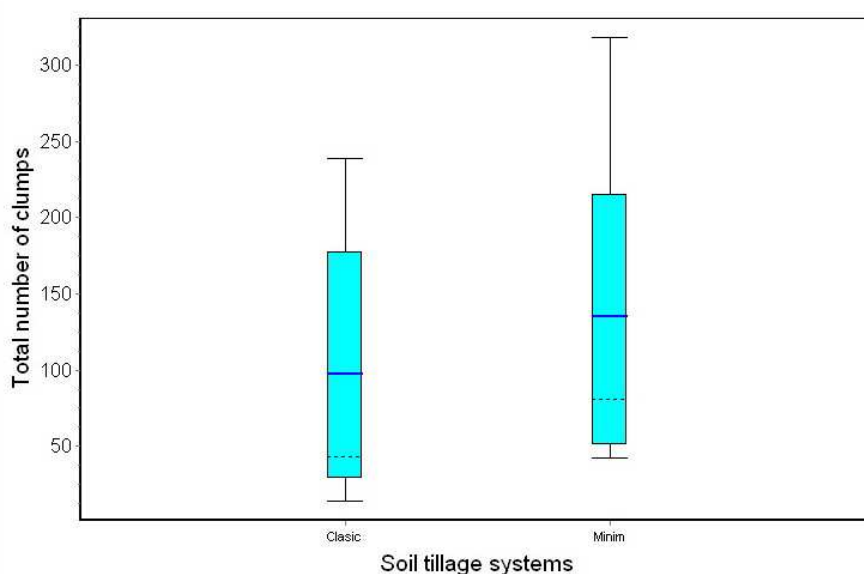


Figure 5. Box-plot diagram for the values of reduction ratio depending on soil tillage systems

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).

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