

ASPECTS REGARDING THE SOIL COMPACTION IN THE FORESTRY NURSERIES: REQUIREMENTS, MEANS, TECHNOLOGY

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Abstract

The research in cause has as a purpose the identification of the technical means of optimal mechanisation used in the forest nurseries, which are meant to lead to an decrease degree of compaction, a rise of the qualitative level of the processing.

The purpose of the research is scientifically motivated through the necessity of introducing new tools for the execution of the works implied for soil preparation about activity settlement.

Soil compaction assumes volume compression of the soil under the action of external factors. As solid particles can not be compressed, the air pockets between them reduce and therefore through compaction the dimensions of the pores is modified, their distribution and also the soil durability. The degree of compaction of the soil can be estimated thru apparent density, total porosity and degree of settling.

The researches were made in the forest nursery of Iosasel, following the influence of the tillage system over the soil bearing. The tillage systems that were applied were classic system (classical plough + 2X disks) and a minimal system (paraplow + rotary harrow).

Key words: compaction, compression degree, technical work, tillage system

In the last decades, an enormous quantity of energy was spent at a global level to reduce the negative influences of the soil compaction caused by the influence of the anthropogenic activities. This research is justified in the context of the existence of some compressed soils, with weak aeration and weak development of the root of the forestry saplings.

Together with the action of climatic nature, the soil, as a system, suffers from the influences of mechanical nature, related on one hand to the tillage process and, on the other hand, to the passing of equipments. According to the characteristics of the tools used and of the exploitation conditions, the first ones are extremely diverse, being conceived to fragmentize and break up the superior part of the soil. The passing of the equipments represents another way of destroying the texture of the soil, and to favour the apparition of the compaction phenomenon, at some point, in unfavourable climatic conditions, imposed by the cultural calendar.

The soil compaction occurs at a certain degree of soil deformation. This fact can be noticed in the mass of the soil through the diminution of the structural pores, and thus the structural aggregates take the form of continuous facies.

The soil degradation is influenced by a series of factors of mechanical, physicochemical

and biological nature. The numerous and inappropriate mechanical works contribute to the destruction of the soil structure. (Rusu, T., Guș, P., 2007).

The soil structure and, implicitly, the properties which derive from it, represent both a morphological index, characterizing different genetic types of soil, and an agronomic index, determining, in an indirect way, its fertility. The agronomic value of the structure is given by its influence on the settlement, of the rule of water and air. (Popescu, I., 1984).

The degradation consists in the elongation and flattening of the aggregates, the apparition of the edges and corners, through a stocky settlement, the increase of the ratio of dusty material which, through the rain action, forms mud and passes through different states of plasticity, to finally harden and crack. (Boja, N., et al., 2009).

The ground compaction in the forestry nurseries is characterized by the increase of the apparent density, the reduction of the total porosity, of the hydraulic conductivity and of the air permeability. These modifications influence the air and water mobility in the soil.

MATERIAL AND METHOD

The research has been carried out in the Iosășel forestry nursery and consisted in the

observation of the influence of the systems of soil processing on the state of settlement. The processing systems applied were: classical tillage system (plough and disc 2X) and minimum tillage system (paraplow and rotary harrow).

There were taken samples in the natural settlement with metallic cylinders of 100 cm³, in order to determine the physical properties at three levels in depth; for each sample, the sampling was repeated six times, after the execution of each technical work.

The degree of novelty consists in the fact that the settlement of the soil could be characterized with the aid of some physical-mechanical properties at different depth levels of sampling and after the execution of each technical work, by observing at the same time the influence of the system of preparation of the soil on the compaction.

The soil compaction has as an effect the growth of the apparent density and the reduction of porosity and of the index of pores. (Boja, N., et al., 2009).

RESULTS AND DISCUSSIONS

The apparent density is one of the main indicators of the settlement of the soil and also one of the determining factors of some of the properties of the soil. High values of the apparent density signify the decrease of the capacity to retain water, of the permeability, of aeration and the increase of the mechanical resistance opposed by the soil at works and moreover at the penetration of the roots; low apparent density can reduce sometimes the bearing, making difficult the traffic and the

execution of the processing works of the germination bed.

The porosity (the lacunar space) registers higher values while the content of the soil grows in organic matter and offers some important indications in relation with some of the properties of the soil. Thus, high values indicate a high capacity to retain water.

The absolute values of the apparent density or of the total porosity cannot be interpreted accordingly in order to appreciate the state of settlement of the soil, because their practical significance is very different from soil to soil according to their texture.

The determination of the settlement of the soil is well taken by using a synthetic indicator which shows that the compression level and the deficit of total porosity are met. The indicator which includes the apparent density (total porosity) and takes into account the soil texture is the compression degree. (Rusu, T., Guș, P., 2007).

Apart from its significance as general indicator of its state of settlement, the compression degree practically reflects the state of breaking up and compression of the soil.

The results of the research are presented though average values according to the physical-mechanical factor analyzed, for the three sampling depths as it follows: the apparent density in *table 1*, the total porosity in *table 2*, and the compression degree in *table 3*. The graphic representations of these values appear in *figures 1-3*.

Table 1
Average values of the apparent density in comparison with the sampling depth and the technical works done

Apparent density		0-10	10-20	20-30
Witness sample		1.77	1.73	1.72
Classical tillage	classical plough	1.6	1.38	1.38
	2X disks	1.39	1.44	1.56
Minimum tillage	paraplow	1.37	1.38	1.4
	rotary harrow	1.56	1.64	1.82

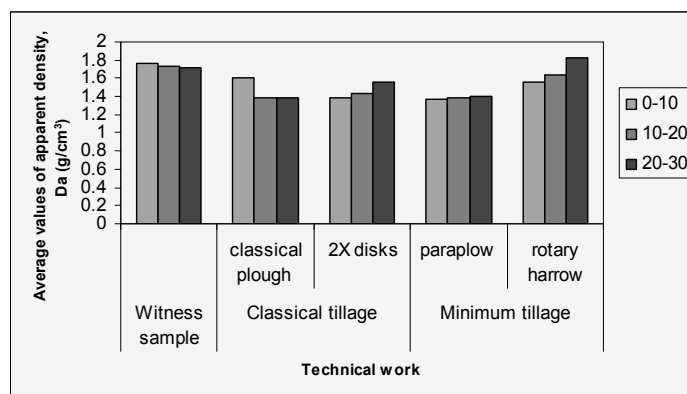


Figure 1 Variation of the apparent density with the sampling depth and the tillage system of the soil

Table 2

Average values of the total porosity in comparison with the sampling depth and the technical works done

Total porosity		0-10	10-20	20-30
Witness sample		34.33	36.08	36.34
Classical tillage	classical plough	40.82	49.02	49.03
	2X disks	48.49	46.52	42.21
Minimum tillage	paraplow	49.3	48.89	48.05
	rotary harrow	42.27	39.1	32.47

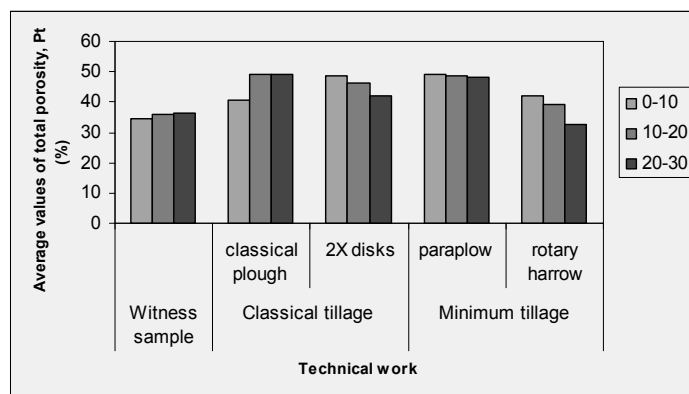
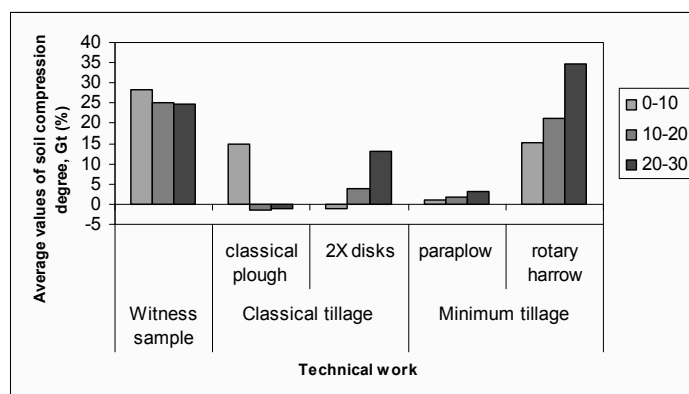
**Figure 2 Variation of the total porosity with the sampling depth and the tillage system of the soil**

Table 3

Average values of the compression degree in comparison with the sampling depth and the technical works done

Soil compression degree		0-10	10-20	20-30
Witness sample		28.35	25.04	24.86
Classical tillage	classical plough	14.8	-1.36	-1.14
	2X disks	-1.19	3.81	12.91
Minimum tillage	paraplow	1.03	1.61	3.24
	rotary harrow	15.13	21.33	34.61

**Figure 3 Variation of the compression degree with the sampling depth and the tillage system of the soil**

In certain situations, the elimination of the soil compaction is difficult to be carried out, but it is possible to minimize it through the proper soil management. It is easier to avoid the compaction rather than to eliminate it after its installation, because the correction measures can be expensive and can not totally solve the problem (Boja, N. et al., 2009).

Measures to prevent the soil compaction:

- The reduction of the traffic on the field because it represents the main cause of compaction;
- The reduction of the works applied on the soil through the usage of different minimum systems together with an

efficient management of the vegetal remains;

- The usage of equipments of small weight and of the small and medium-seized tractors;
- The usage of tyres with big outer surface and radial section which operate at a low pressure, leaves behind a wider, vaster and more stable rut due to the better distribution of the pressure on the soil.

The mechanical processing of the soil through traditional and modern methods is currently put under question due to the high energy consumption and the continuous degradation of the arable horizon through erosion and excessive compaction.

The soil processing in the classical tillage system leads to an excessive break-up through repeated interventions, leaving it without vegetal remains through the reversal of the clods in the ploughing process, thus being strongly eroded under the action of the water and wind.

Worldwide, there is the tendency to replace the classical tillage system of the soil, through the extension of the minimum work system, method recommended both from the point of view of the preservation of the soil and for the reduction of energy consumption.

In our country, the extension of these systems of soil processing in the forestry nurseries is slow because of the lack of unitary strategies to

sustain the technology, the lack of unitary strategies to correspond to the biological requirements of each culture, the lack of specialized knowledge related to the new system.

In order to establish the co-relational dependence between the indicator and the sampling depth, through the analysis of the carriage, two equations were used as it follows: a linear one and a second degree polynomial.

The element of statistical nature which determined the choice of the corresponding curve was the coefficient of determination R^2 . In all cases, the coefficient of determination for the second degree polynomial was higher than that corresponding for the right line.

In order to quantify the co-relational dependences between the physical-mechanical properties in dependence with the working depth and the tillage systems, and also of the witness sample, a second degree polynomial curve was accepted, like

$$y = ax^2 + bx + c, \quad (1)$$

in which:

y represents the physical-mechanical indicator researched,

x - the sampling depth, in cm.

The concrete results obtained were gathered in *table 4* to which it was also added the value of the coefficient of determination R^2 , whose values are presented in *table 5*.

Table 4

Equations of regression determined in comparison with the physical-mechanical properties analyzed and the sampling depth

The depth of taking	Equations of regression		
	Apparent density	Total porosity	Soil compression degree
0-10	$y = 0.065x^2 - 0.455x + 2.188$	$y = -2.4214x^2 + 16.965x + 18.784$	$y = 5.2507x^2 - 35.525x + 60.442$
20-30	$y = 0.0786x^2 - 0.4894x + 2.118$	$y = -2.8993x^2 + 17.987x + 21.854$	$y = 6.0621x^2 - 36.818x + 53.856$
20-30	$y = 0.0843x^2 - 0.4837x + 2.1$	$y = -3.1343x^2 + 17.934x + 22.296$	$y = 6.5014x^2 - 36.621x + 53.242$

Table 5

Values of the coefficient of determination R^2 , obtained in comparison with the physical-mechanical properties analyzed and the sampling depth

The depth of taking	Coefficient of determination R^2		
	Apparent density	Total porosity	Soil compression degree
0-10	0.9365	0.9411	0.9466
20-30	0.8629	0.8523	0.8720
20-30	0.6957	0.6971	0.7332

CONCLUSIONS

From the compression degree, observed during the soil tillage, the following conclusions can be inferred.

During the experimental cycle, the values of the compression degree at a depth of 0 -30 cm indicate a weakly or moderately fragmentized soil, vaguely or moderately compressed.

The values of the compression degree registered in the classical tillage system are by far superior to the sample (undisloquated soil), where high values of this indicator were obtained.

If taking into consideration the coefficient of variation, all the primary data belong to inhomogeneous amounts both in the case of the witness sample and in that of the data obtained after the preparation of the germination bed in the

classical tillage system and in the minimum tillage system.

By interpreting the values of the compression degree of the soil processed in a classical tillage system, as compared to the witness sample, it can be concluded that the soil is much more compressed than in the case of the sample, even if, in the classical tillage system the number of equipments which pass on the same surface is greater. (Boja N., et al., 2008)

In the case of the harrow, as it appears in the literature of specialty and in the data obtained in our experiment, the particles of the processed soil are much more uniform and their spacing is much more homogenous. Under this state, the compression degree will be systematically positive.

As it results from the analysis of values of the coefficient of determination shown in *table 5*, as compared to the physical-mechanical properties and the sampling depth, one can make the following affirmations: the higher apparent density is taken at the working of the soil with the harrow, while the lowest value appears in the case of the classical tillage system when processing the soil with a plough; globally, the minimum tillage system has a value between that of the witness sample and of the classical tillage system, because the number of the equipments and the passing is much more reduced as compared to the classical one; regarding the total porosity, the sampling depth has a much more influence for the minimum tillage system as compared to the classical system; the compression degree is less influenced by the sampling depth in the classical system than in the minimum system;

The process of soil compaction due to natural factors appears under the form of some genetic consolidated horizons. The situations which lead to the occurrence of the phenomenon of soil compaction are divided between the action of natural and anthropogenic factors.

During the action of the wheeling system of the tractors and the agricultural equipments on the soil, it is subjected to some mechanical efforts, which, through their action, make it shift laterally (refulation), vertically (compression) and horizontally (shear). The effect of the compression is transmitted in the layers of the soil in all directions, under the form of a pressure, and thus their propagation is insignificant at depths greater than 80 cm.

The physical characteristics like: apparent density, total porosity and compression degree

modify according to the soil works. The modification of these properties is hard to notice (except for the compression degree) during a year because the soil has the tendency, in normal conditions, to get back to the initial state and to estompe the negative effects which appeared after the impact produced by its processing with mechanical means. Several research show that in a long period of time, the evolution of the physical properties in a certain direction takes place at a slow rhythm, after a short period of time when they start to stabilize.

This research attempted to emphasize the fact that the process of compaction plays a negative role on the physical-mechanical properties both in the classical and minimum tillage system. In the case of the minimum tillage system, the state of compaction of the soil is expected to reduce considerably in at least one year, without doing activities of fragmentations.

An important role in the soil compaction is also played by the agricultural equipments, through their weight and traffic.

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