

## INFLUENCE OF THE RESISTENCE TO PENETRATION AND SHEARING ON THE EXECUTION STEPS OF THE HOLES FOR PLANTING SAPLINGS

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**Abstract:** The present research displays the results obtained after the digging of holes for planting saplings in a previously unprepared soil, following the steps to carry them out according to some physical-mechanical properties of the soil. The research was carried out on a horizontal ground in the Forest District Iuliu Moldovan, in two forest compartments 31 C and 32 A, in a previously unprepared ground, on two types of soil: gley-soil (the muddy subtype) and alluvial soil (the vertical-gleyed subtype), and in Forest District Radna, forest compartment 74, on a brown typically luvic soil, using the Stihl BT 121 motto-borer with a 200 mm drill. The objectives of the research were to make a comparative determination, on different types of soil, of the qualitative parameters, among which the most important ones are: degree of loosening of the soil taken and left in the hole, resistance to penetration, resistance to shearing, timing of drilling holes, using the Stihl BT 121 motto-borer in order to establish its technical efficiency. In order to observe the influence which the drilling of holes has on its walls, we measured the resistance to penetration and resistance to shearing every 10 cm at a 30 cm depth, the proper depth for planting small-sized saplings, on two opposing sides, so that we could get the most probable values of these physical-mechanical properties of the soil. After taking the measures in order to establish the compaction degree of the wall and of the bottom of the hole by the borer in that interval, it was judged that in conditions of normal humidity, if the borers have sharp knives and are well conceived and executed from a technical point of view, there are no big values of the resistance to penetration which could affect the subsequent development of the saplings. The usefulness of the present paper stays in the research data collected, processed, analyzed and valorized in order to offer a pertinent study material, which could indeed be used by specialists in designing the process for obtaining, through a mechanized means, the holes for planting small-sized saplings on a horizontal ground, using the Stihl BT 121 motto-borer.

**Key words:** motto-borer, resistance to penetration, average time of drilling, degree of scattering, degree of evacuation.

### INTRODUCTION

The objectives of the research carried out were to comparatively determine on different types of soil, the qualitative parameters, among which the most important ones are: degree of loosening of the soil taken and left in the hole, resistance to penetration, resistance to shearing, time of drilling holes, using the Stihl BT 121 motto-borer in order to establish its technical efficiency.

In order to obtain pertinent results, the research was done according to a complex methodology, with a novelty character in this domain, which gave the possibility to study different technical aspects of usage of the motto-borer.

There is a general concern for introducing and extending the motto-borers for drilling holes in the sylvan field even in other countries. In our country, people tried several types of motto-borers without being extended in the production. (TUDOSOIU P., et al., 1968)

Because of the compaction, while digging holes for planting saplings, there are several phenomena of friction occurring which increase the resistance to penetration through the walls

of the hole. For the same reason, the soil offers resistance to some mechanical, exterior forces, presenting resistance to compression, shearing and penetration. (POPESCU I., DERCZENI R., 2006)

During the drilling of the holes with a motto-borer, there are two categories of friction forces. The first category is represented by the friction forces which occur among the soil particles, which come in contact with them, and the second one by the shearing forces given by the soil particles with the metallic part (the drill). (CHIRU V., *et al.*, 1963)

At the mechanized execution of holes for planting saplings, one needs to act to reduce the friction forces between the soil and the active organs, because, if on the contrary, there is registered a supplementary consumption of energy. (POPESCU I., 1984)

### MATERIAL AND METHODS

The research was carried out on a horizontal ground in the O.S. Iuliu Moldovan, in two arranged unities (parcels) 31 C and 32 A, in a previously unprepared ground, on two types of soil: gley-soil (the muddy subtype) and alluvial soil (the vertical-gleyed subtype), and in O.S. Radna, arranged unities 74, on a brown typically luvic soil, using the Stihl BT 121 motto-borer with a 200 mm drill.

The technical characteristics of the motto-borer used in our research are given in Table 1, and its photography appears in Figure 1.



Figure 1 Stihl BT 121 motto-borer Motoburghiul Stihl BT 121, ([www.stihl.ro](http://www.stihl.ro))

Table 1

Technical data of the Stihl BT 121 motto-borer ([www.stihl.ro](http://www.stihl.ro))

Cylindrical capacity	30,8 cm <sup>3</sup>
Weight	9,4 kg
Power	1,3/1,8 kW/CP
Level of vibrations left/right	2,2/2,5 m/s <sup>2</sup>
Speed of rotation	190 1/min
Level of acoustic pressure	103,0 dB(A)
Level of acoustic pressure	109,0 dB(A)

The present research displays the results obtained after the digging of holes for planting saplings in a previously unprepared soil, taking into consideration the following aspects: time needed to dig holes according to some physical-mechanical properties of the soil, degree of aeration of the soil taken out and left in the hole.

The physical-mechanical properties were determined by using the method of cylinders with a constant volume of 100 cm<sup>3</sup>, carrying out five repetitions at different depth, from 10 to 10 cm until the depth of 30 cm. The determination of the resistance to penetration was made

with the aid of a penetrometer and that of the resistance to shearing was made with the aid of the equipment for shearing through rotation.

The methods of analysis and interpretation of the results as well as the work procedure for the determination of the physical – mechanical properties are those indicated in the specialized literature. (CANARACHE A., et al., 1990)

In order to observe the influences which the digging of holes have on their walls, we measured the resistance to penetration and the resistance to shearing on the holes' walls from 10 to 10 cm until the depth of 30 cm, on two opposing sides, so as to get the most probable values for these physical-mechanical properties of the soil, depth sufficient enough for the planting of small-sized saplings. The placement of samples for the resistance to penetration and shearing on the walls of the holes is given in Figure 2.

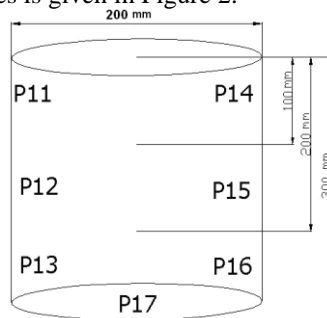


Figure 2 Placement of samples for the resistance to penetration and shearing on the walls of the holes

In order to accomplish the objectives we have dug 50 holes for each type of soil chosen for the experiment, placed on a horizontal ground, previously unprepared, using the Stihl BT 121 motto-borer with a 200 mm drill.

## RESULTS AND DISCUSSIONS

To establish the quality of the work carried out with the Stihl BT 121 motto-borer with a 200 mm drill, we made the following measurements:

- Degree of aeration of the soil taken and left in the hole,
- Resistance to penetration and shearing of the walls and of the bottom of the hole,
- Average time for the digging of a hole,

### a) Physical properties

The state of aeration of the processed soil and in the natural setting can be expressed through specific issues: apparent density and total porosity. (POPESCU I., 2006)

The three types of soil on which the research was carried out are: gley-soil (the muddy subtype), alluvial soil (the vertical-gleyed subtype), and a brown typically luvic soil. The physical properties determined during the execution of the holes like the granulometry of the soil are presented with average values in Table 2 and 3.

Table 2

Average values of the physical properties of the soil analyzed			
Depth of prelevation of the sample, cm	Natural humidity, %	Apparent density, g/cm <sup>3</sup>	Total porosity, %
SOIL 1: GLEYSOIL – MUDDY (u.a. 31 C, O.S. IULIU MOLDOVAN)			
0-10	24.11	1.62	37.89
10-20	22.73	1.69	37.43
20-30	20.09	1.72	36.45
SOIL 2: ALLUVIALSOIL– VERTICAL GLEYED (u.a. 32 A, , O.S. I. MOLDOVAN)			
0-10	20.75	1.70	36.97
10-20	19.46	1.75	35.73
20-30	17.38	1.73	35.19
SOIL 3: BROWN TYPICALLY LUVIC (u.a. 74, , O.S. RADNA)			
0-10	22.43	1.69	37.43
10-20	21.10	1.71	36.31
20-30	18.74	1.73	36.09

Table 3

Depth of prelevation of the sample	Sand		Dust		Clay
	Coarse	Fine	I	II	
SOIL 1: GLEYSOIL – MUDDY (u.a. 31 C, , O.S. IULIU MOLDOVAN)					
0-10	0.74	36.04	16.94	16.94	29.54
10-20	2.34	45.44	12.54	12.54	27.34
20-30	1.84	39.34	16.54	13.84	28.64
SOIL 2: ALLUVIALSOIL– VERTICAL GLEYED (u.a. 32 A, O.S. I. MOLDOVAN)					
0-10	1.74	39.04	14.54	24.24	20.64
10-20	1.84	37.54	14.14	23.04	23.84
20-30	2.44	39.54	14.54	18.54	25.24
SOIL 3: BROWN TYPICALLY LUVIC (u.a. 74, , O.S. RADNA)					
0-10	1.24	37.54	15.74	20.59	25.09
10-20	2.09	41.49	13.34	17.79	25.59
20-30	2.14	39.44	15.54	16.19	26.94

**b<sub>1</sub>) Resistance to penetration**

The results of the research carried out, (POPESCU I., MIHAI S., 1966) demonstrate that the resistance to compression and cutting of the soil increase while the humidity of the soil is reduced to under 14% and goes even lower while its humidity increases to values over 28%.

In the situations in which the humidity is reduced under the minimum threshold shown, the active organs of the equipment take out clods and the aggregates are being highly stressed, which leads to the increase of specific consumption for materials (gas and metal). If humidity goes above the threshold of 28%, the soil begins to lose its organs. Consequently, it is recommended that the mechanic execution of the holes for planting to be done when its humidity is found in an optimal state (18-24%). (POPESCU I., POPESCU S., 2000)

Another important aspect is related to the resistance to penetration in connection with the study of the development and penetration in the soil of the root system of the saplings. The experimental research shows that at values under 10-15 kgf/cm<sup>2</sup> the resistance to

penetration does not influence negatively the penetration in the soil of the roots, while at values over 35-50 kgf/cm<sup>2</sup> it is almost null. (RUSU T., et al., 2007)

The values obtained are given in a graphic in Figure 3 to 5.

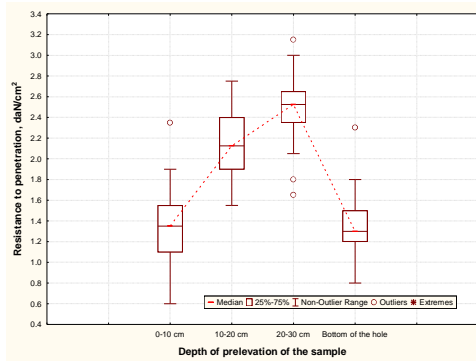


Figure 3 Variance of resistance to penetration for soil 1

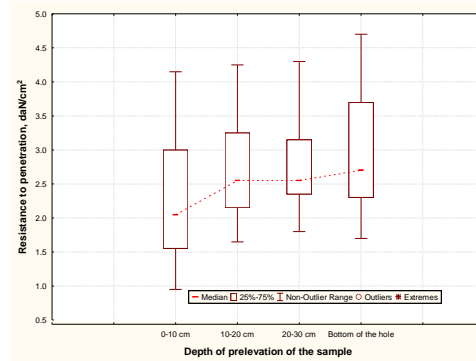


Figure 4 Variance of resistance to penetration for soil 2

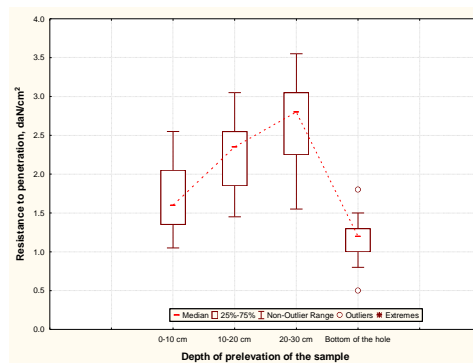


Figure 5. Variance of resistance to penetration for soil 3

**b<sub>2</sub>) Resistance to shearing**

The problem of determining the resistance to cutting of the grounds represents a very special practical importance, because the excessive deformation and the breaking of the crop of land are produced because of the overcoming of this resistance by the effective and tangential efforts which appear inside the ground. (KRUCH J., et al., 2002) The representation of these values under a graphical form is given in Fig. 6 to 8.

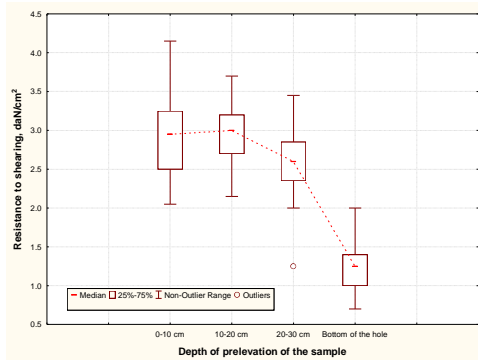


Figure 6 Variance of resistance to shearing for soil 1

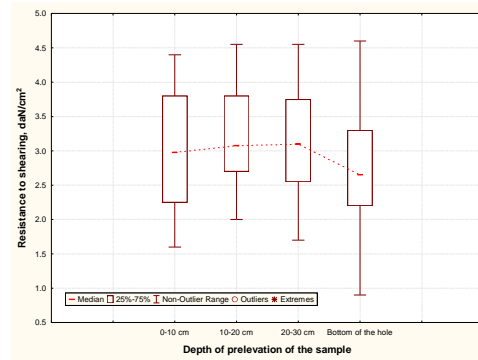


Figure 7 Variance of resistance to shearing for soil 2

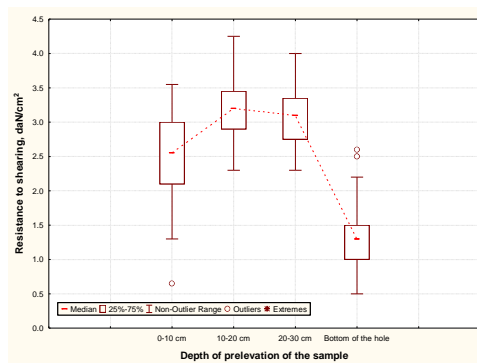


Figure 8. Variance of resistance to shearing for soil 3

**c) Duration of drilling**

In order to establish the economic efficiency of the Stihl BT 121 motto-borer, at the boring of the holes for planting, we registered the number of drilled holes for each variant of work and established the average time of execution of a hole for every type of soil included in the experiment.

We can notice the enormous periods of execution for the holes in the 2nd soil, this fact being easily explainable because in this case we observed a more frequent presence of the roots, but also of the parental material and, in addition, bigger values of the resistance to penetration in comparison with the other types of soil which were included in the experiment.

The variation of duration of drilling are given in Figure 9.

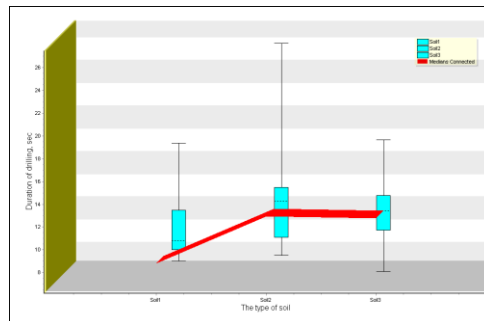


Figure 9. Variance of duration of drilling

### CONCLUSIONS

From all of the above, we can infer the following conclusions regarding the qualities and the behavior of the Stihl BT 121 motto-borer with a 200 mm drill in the sylvan field of activity, on a horizontal ground:

- Analyzing the granulometric composition of the two types of soil included in the experiment, we can say that the fact that the soils present a sand-dust-clay-like composition, also mentioning that the quotas of participation of the fraction “dust” in the 32 A parcel (2<sup>nd</sup> soil) is by far superior to the same fraction from the other parcels. Thus, we can explain the average time of execution of the hole as being bigger in this parcel than in the rest of the parcels included in the experiment.
- In the pedological conditions of these three parcels included in the experiment the average time of execution of the holes are: 9.95 sec. for the 1st type of soil (gley-soil- the muddy subtype), for the 2nd type of soil (alluvial soil - the vertical-gleyed subtype) the average time was 13.30 sec, while for the 3rd soil (brown typically luvic soil) the average time was 12.87 sec for the 200 mm drill.
- After taking all the measurements for establishing the degree of compaction of the wall and bottom of the hole by the motto-borer during the work, it was inferred that in condition of normal humidity, if the motto-borers have sharp knives and are well conceived and executed from a technical point of view, do not register big values of resistance to penetration which could affect the ulterior development of the saplings.
- During the research, it was inferred that the wall of the hole is also compacted because of the wearing out of the spires of the helicoidal transporter or of the knife placed at the base of the last spire. Another possible cause for compaction occurs when the active diameter of the motto-borers’ knife is cut because of the wearing out, which can lead to the exaggerate compaction of the walls or of the bottom of the hole.
- The small values of the resistance to penetration and shearing were obtained also because of the optimal values of the soil humidity during the drilling of the holes, these values oscillating between 19.20 % and 22.31 %.

### BIBLIOGRAPHY

1. CANARACHE A., and colab., 1990, Tutorial for the study of the soil on the spot and in the laboratory, Publishing House Agro-Silvică, Bucharest.
2. CHIRU V., DUDA A., POPESCU I., 1963, Research Regarding the Mechanized Plantation in the Mountain Region, The Polytechnic Institute, Faculty of Sylviculture, Braşov, Sci. VI: 287-298.
3. KRUCH J., POPESCU I., DERCZENI R., 2002, Geotechniques with Elements of Amelioration of Setting Soils, University of Transylvania Printing Press, Braşov.
4. POPESCU I., MIHAI S., 1966, Research Regarding the Mechanization of Soil Preparations of the Ground for the Forestation in the Hill Region, The Polytechnic Institute, Faculty of Sylviculture, Braşov, Sci. IX: 63-73.
5. POPESCU I., 1984, Mechanization of the forestry processing, Publishing House Ceres, Bucharest;
6. POPESCU I., POPESCU S., 2000, Mechanization of Forestry Works, University of

- Transylvania Printing Press, Braşov.
7. POPESCU I., DERCZENI R., 2006, Technical Means and Procedures to Dig Holes with Protecting Cavities for the Saplings, Proceedings of the Biennial International Symposium, Forest and Sustainable Development, Braşov, Sci: 153-158.
  8. POPESCU I., 2006, Technological Variants of Mechanization for Digging Holes for Planting Saplings in Cavities, Proceedings of the Biennial International Symposium, Forest and Sustainable Development, Braşov, Sci: 159-164.
  9. RUSU T., PAULETTE LAURA, CACOVEAN H., TURCU V., 2007, Physics, Hydro-physics, Chemistry and Respiration of the Soil- Research Methods, Risoprint Printing Press, Cluj-Napoca.
  10. TUDOSOIU P., IANA A., CADARIU GH., GRĂDINĂ C., IACOB I., NEGOESCU N., MIHĂILĂ I., MARINESCU V., 1968, Portable Borer for Digging Planting Holes, Technical Research Center for the Forestry Economy, Bucharest.
  11. \*\*\* [www.stihl.ro](http://www.stihl.ro).