STUDY OF THE WORKING PROCESS OF THE ACTIVE PARTS OF AN EQUIPMENT FOR EXTRACTION PLANTS WITH ROOT BALL, EXPLANT 500

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Abstract

In the production of wooden seedlings (fruit trees or shrubs and ornamental trees), the high exploitation of the biological potential of plants and use of effective methods and techniques, are the main ways to increase production both quantitatively and qualitatively.
An important part, in terms of labor consumption, in work technologies in nurseries, it have putting out of seedlings, in order to its transplantation or deliverys for planting.
The working principle of the machinery and tehnical equipment for extraction plants with root ball is based on penetration into the soil of the active working parts (spades), cutting the soil ball and extracting it together with the plant (tree saplings, tree, shrub), in a view to transplantation. From constructive point of view, penetration into the soil of the active working parts is ensured by means of some double acting hydraulic cylinders, the penetration force beeing linear and directly proportional to the pressure in the hydraulic system. From analysis of the results obtained in the tests, was noted the fact that the resistance to penetration of the soil in which we worked, determined over the depth of penetration in the soil of the active parts (spades) of the equipment increase directly proportional to the depth of penetration and inversely proportional with soil moisture.
Increasing the efficiency of the penetration force into the soil, of the active working parts (spades) is achieved by providing a hydraulic pulsating force (with shocks) through a hydraulic control and operated device, with shocks. Hydraulic operation with shocks can be used as needed,- in heavy soils with high penetration resistance.

Key words: Root ball, spades, tree saplings, shrubs, penetration force

To obtain saplings of adequate quality, in terms of economical efficiency, both regarding saplings for fruit growing sector and for arranging urban green areas or forestry plantations, in nurseries a series of works are performed to maintenance the crop. An important part, in terms of labor consumption, in work technologies in nurseries, it has putting out of saplings, in order to its transplantation or deliverys for planting.

MATERIAL AND METHOD

The technical equipment, EXPLANT 500 (fig.1) is meant to extract dendro-horticol planting material, ornamental or fruit bearing, medium - sized and large, with root ball, from nurseries and/or forestry plantations, in order to transplant them in green areas, plantations and/or growing fields from nurseries. Also, the machine can be used to anticipated digging of holes, where follows to make transplanting, either of planting material (saplings) extracted with root ball or saplings with bare root (without soil bale).

Actuating the active working parts is achieved by the machinery`s own hydraulic system, actuated by the tractor from the unit.The main parts of the equipment are:

The guide frame (*1*) is a construction of steel profiles, welded, which serves to support all the other parts of the machinery.

The sliding body (*2*) is a welded body provided with guide rollers that bear the entire assembly of spades and ensure its vertical movement.

Spade`s support arms (*3*) are in number two and provide support to the two lateral spades. The support arms are articulated on the sliding body so that to allow "opening" and "closing" the two lateral spades in order to embrace the plant to be extracted.

The spades (*4*) are in number three: one central and two lateral. The spades are made of steel and have a cylindrical shape with four sharp edges to cut both soil and roots of the plant to be extracted. The spades are mounted so that to go into the soil inclined (about 15°) to ensure the achievement of a truncated cone-shaped bale of soil.

Guide of spades (*5*) - ensure movement of the spades and their correct positioning so that the bale of soil have truncated -cone shape.

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Hydraulic pump (*6*) is PRD-117D type, with volume of 3.25 cm3/rot, and a maximum pressure of 200 bar, ensuring actuating of all hydraulic cylinders of the machinery with a view to cut the soil and lift the plant with the root ball. Actuating the hydraulic pump is realised by the final transmission of the 45 HP tractor, being adopted an innovative technical solution that makes the object of a patent application.

Oil tank (*7*) is a welded construction made of iron sheet, it has a capacity of approximately 20 l and it is equipped with filtering system of the recirculated oil in the hydraulic system.

Distributor (*8*) is a manual distributor with 5 sectors, modular, and which ensures three positions: lifting, lowering and neutral.

Hydraulic cylinders for actuating the spades (*9*) are in number three, one for each spade and ensure spades` penetration into the soil. Cylinders are ø 50x500 type , and they are equipped with the possibility of fastening on the sliding body.

Lifting hydraulic cylinder (*10*) provides vertical movement of the sliding body (*2*) achieving thus lay on the soil of the spades` assembly, and, after "cutting " the soil bale, lifting it to the desired height. A Ø63x1000 cylinder is used.

Hydraulic cylinder for actuating spades` support arms (*11*) is a cylinder ø 40x250 and it ensures opening and closing movement of the two lateral spades so they can be positioned around the tree to be extracted.

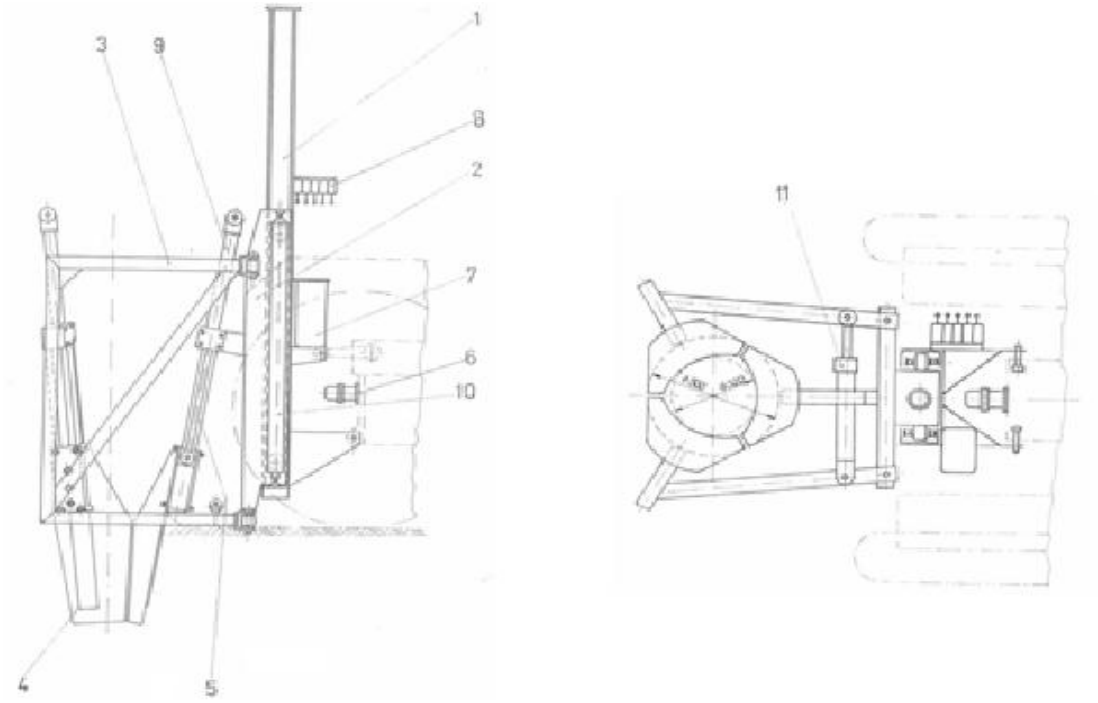

Figure 1 **Constructive scheme of the equipment to extract plants with root ball EXPLANT 500**

Working process of the equipment (fig.2) consists of the following phases:

Phase I. With spades (*4*) lifted upright, with the sliding body (*2*) near to the ground and the spades` support arms *(3*) wide open, by maneuvering the tractor, the equipment is positioned near the plant to be extracted, so that the three spades to be at equal distance from stem.

Phase II. Lateral spades approaches the plant by actuating the cylinder (11) and it is commanded descending of the sliding body *(*2) simultaneously with actuating the cylinder (10) until the tractor is supported on the spades supports.

Phase III. Spades (4) are pushed in the soil by actuating the cylinders (*9*) successively, starting with the central spade, obtaining roots` cutting, and cutting lateral sides of the soil bale.

Phase IV. By actuating the cylinder (10) is ordered lifting of the sliding body (*2*) together with spades` assembly, and thus are performed extraction and lifting of the root ball plant above the ground. Cutting the vertical roots and cutting the lower part of the bale is achieved by pulling up.

Phase V. By wide opening of the lateral spades, with the cylinder (11), the root ball is released, and it can be putted down on the ground, in baskets for local handling or for packaging and loading in vehicles.

Characteristics of test conditions for the EXPLANT 500 are presented in table1.

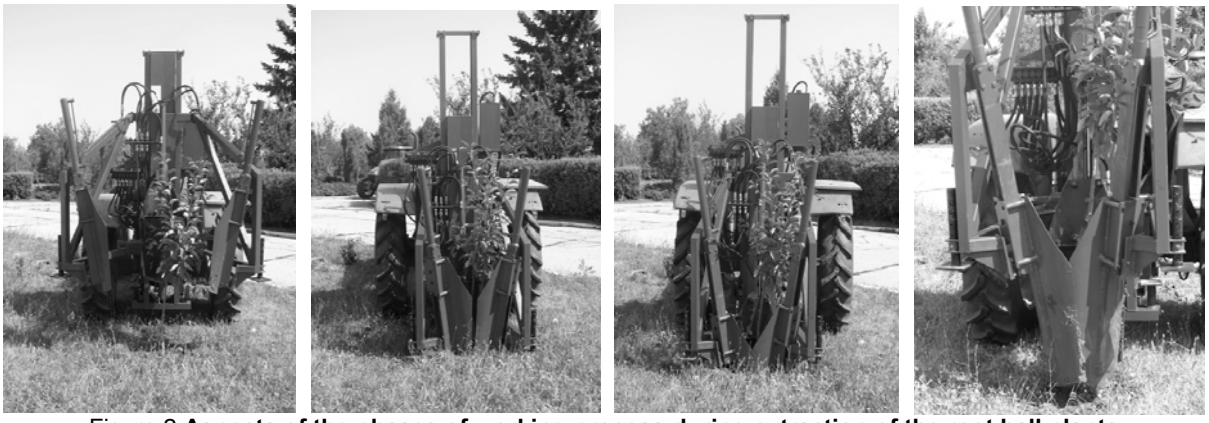

Figure 2 **Aspects of the phases of working process during extraction of the root ball plants**

Table 1

Characteristics of test conditions

Characteristics	U.M	Work performed		
		Extract ornamental trees	Extract fruit trees	Digging holes
Plants characteristics :				
- Species	-	Thuja	Apple+pear	-
- heigh	cm	150-200	130-160	-
- stem diameter(at 10 cm above the ground)	cm	2.5-4.0	2.0-3.0	-
- tree crown diameter	cm	120-140	80-100	-
Soil characteristics				
- soil conditions	-	Tillage	Tillage	fallow
- soil type	-	clayey-sandy	clayey	clayey
- penetration resistance :				
- 0-10 cm	kPa	1200	1300	1400
- 10-20 cm	kPa	2200	2400	2600
- 20- 30 cm	kPa	3000	3500	4000
- 30-40 cm	kPa	3800	over 4500	over 4500
- 40-50 cm	kPa	Over 4500	-	-
- soil moisture in layer :				
- 0-10 cm	%	16.2	17.6	18.7
- 10-20 cm	%	18.7	22.3	23.1
- 20- 30 cm	%	15.1	19.0	20.4
- 30-40 cm	%	12.3	14.2	16.8
- 40-50 cm	%	10.9	11.4	12.3
Land characteristics:				
- Inclination	Grade	0-3	0-3	0-4
- preliminary tillage	-	deep plowing and annual maintenace works	deep plowing and annual maintenace works	-
- height of unevenness	cm/ml	4	3	6

Determination of soil resistance to penetration was made with a penetrometer Spectrum Technologies SC 900, accuracy class + / - 1.25 cm and + / - 103kPa, and the soil moisture was determined with a moisture-meter Spectrum Technologies TDR 300 with accuracy class + / - 3.0%

RESULTS AND DISCUSSIONS

From constructive point of view, penetration into the soil of the active working parts is ensured by means of some double acting hydraulic cylinders, the penetration force beeing linear and directly proportional to the pressure in the hydraulic system.

From the analysis of working conditions characteristics in testing EXPLANT 500, it is noted the fact that the penetration resistance of soil in which we worked determined over the depth of penetration into the soil of the active parts (spades) of the equipment (*fig.3 and 4*) had relatively high values, these increasing directly proportional to the depth of penetration and inversely proportional with soil moisture.

It was noted that to ensure the necessary size of the root ball is necessary increasing the penetration force of the spades into the soil. Since the maximum penetration force in soil is limited by construction of the equipment EXPLANT 500 was chosen a hidraulyc control device with hydraulic shocks that provides increased

efficiency of soil penetration force by providing of a pulsating hydraulic force.

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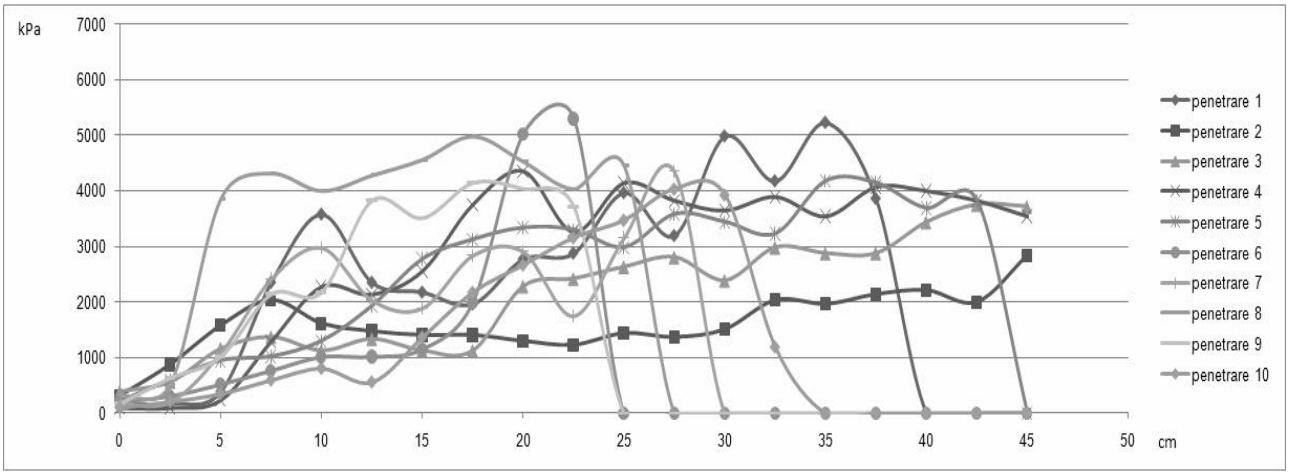

Figure 3 **Variation of penetration resistance over the working depth**

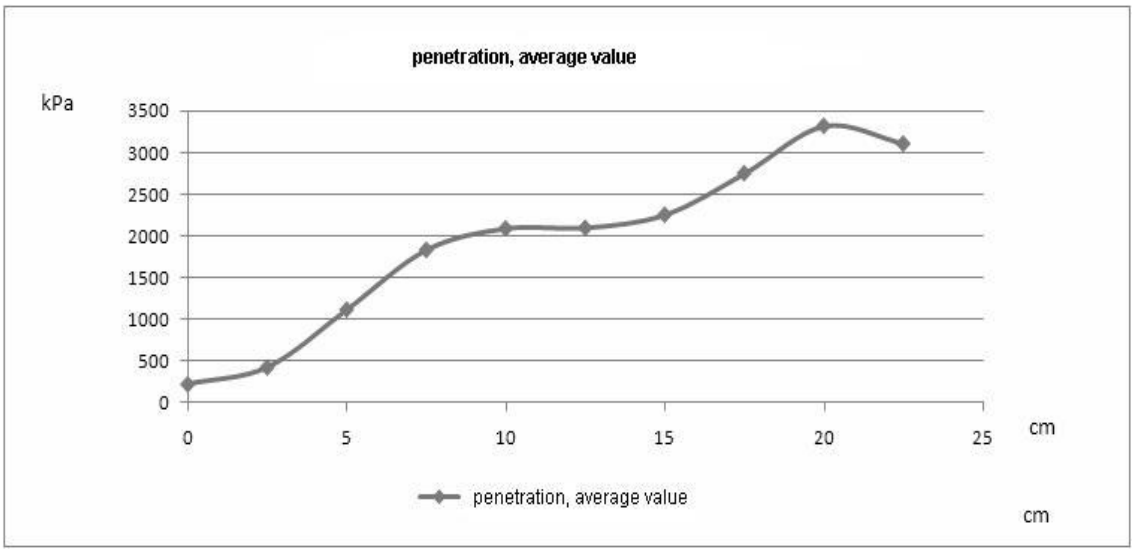

Figure 4 **Variation of average resistance to penetration over working depth**

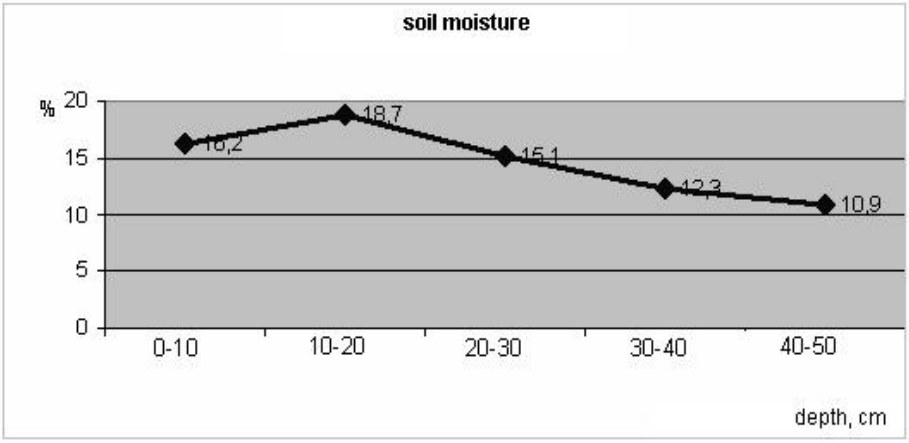

Figure 5 **Variation of soil moisture over working depth**

The technical solution adopted for the hydraulic control device with shocks *(fig. 6*) is characterized in that the electric hydraulic distributor, DHE, voluntarily ordered by electronic control unit, ECU, produces transformation of the linear force obtained by sending oil from reservoir R, at the pressure provided by the P pump through the manually distributors, DHM, in a hydraulic pulsating force that through the pipes, C, and double acting hydraulic cylinder, Ch, is transmitted to the spade, S.

The hydraulic actuating with shocks can be used as needed, in heavy soils with high penetration resistance, shocks` frequency beeing adjustable trough the electronic control unit.

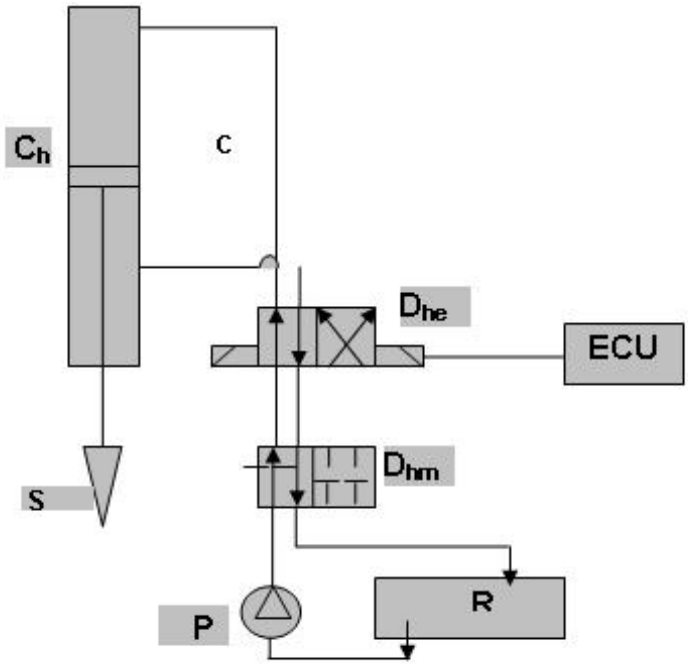

Figure 6 **The scheme of the actuating and control hydraulic device, with shocks**

CONCLUSIONS

From experiments it follows that:

The soil resistance to penetration is directly proportional to the depth of penetration and inversely proportional to soil moisture.

Penetration force of spades into the soil, is linear and directly proportional to the pressure in the hydraulic system, which makes that, under heavy soils conditions, the spades penetration depth into the soil to be limited;

Increasing efficiency of penetration force of spades into the soil, it is made by ensuring of a pulsating hydraulic force, thus ensuring the necessary working depth.

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