

## **ECHIPAMENTE MODERNE PENTRI ÎNFIINȚAREA LIVEZILOR** **MODERN TECHNOLOGIES FOR ORCHARDS ESTABLISHING**

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### **Abstract**

**Necessity to adapt the orchards operations mechanizing technologies to current requirements has led to achieving new performant equipment: equipment for planting seedlings for setting orchards or nurseries and technical equipment designed to extract planting material with ball root, for replanting it in green areas, plantations and/or nursery fields.**

**Keywords:** equipment, planting.

**Cuvinte cheie:** echipamente, plantare

### **1. Introduction**

Fruit growing is and will be one of the forefront branches of agriculture. When the area of establishing the orchard is chosen, we must take into account a series of climate factors (climate and microclimate of field, soil, relief, slope) and economic factors (existing manpower, road network, water supplying sources, etc)

### **2. Materials and method**

Intensive orchards ensure big fruit productions and good conditions for mechanized maintenance operations. These plantations are placed on sloped field or small sloped fields, easily to irrigate. Density of planting depends on the type of culture, the distance between rows being of 2.5 and 6 meters, and distance between the trees in row of 0.5 and 5.5 meters, according to table 1.

#### **Plantation establishing works**

In order to set an orchard, the following stages have to be covered: field marking, holes ditching, remarking and partially filling the holes with earth and litter, choosing the planting material, trees distribution according to planting holes and trees planting.

#### **Trees planting**

The most appropriate period for planting the fruit trees is autumn (October-November), as it ensures the restoration of roots system and starting the vegetal growth early in spring, but they can be also planted early in spring (March-April); the tree should be planted at the same depth it grew in nursery, respectively with its grafting point at soil level. (fig.1) [17].

Whatever the planting period is, the planting material is submitted to two preparing operations: roots cutting and their introduction into a suspension.

For trees planting the following technologies are used:

#### **a) Ditching the holes and planting;**

The holes can be manually performed by spade (fig.2) or mechanically performed by drills (fig.3).

#### **b) Soil working in stripes (fig.4) and opening a ditch where seedlings are planted mechanically (fig.5)**

#### **c) Extracting the seedlings and replanting them (fig.6)**

#### **d)**

### **Description of equipment**

**A) The equipment for soil works for afforestation EPI (fig.7,a)**, cuts the soil and vegetal wastes (branches, brushes, roots), by means of a rotor with discs at a depth of approx. 230 mm, followed by the soil and wood fragments breaking, which were previously cut by a rotor with chisel type knives, at a width of approx. 380 mm and depth of approx. 230 mm, requirements imposed for soil preparing works, in order to replant the seedlings; the equipment in fig.7,b cuts the soil at a depth of 300 mm and width of 600 mm.

The soil between stripes will remain completely the same, not worked and covered by vegetal wastes, so that, after planting, the whole surface of forestry crop should remain covered by vegetal wastes.

By using the equipment for soil works proposed, within the operation of preparing the afforestation works, a single equipment is able to perform most part of operations, such as:

- Chopping and mincing the branches up to 12 cm diameter;
- Destroying the knobs:

- Scarifying the soil;
- Levelling the ground;
- Turning the soil by ploughing;
- Grinding and levelling the soil;
- Breaking the soil crust;
- Soil loosening and weeds destroying.

**B) Equipment for planting the forestry seedlings, EPF1 symbolized**, with a working place (fig.8,a) or two working places (fig.8,b), has a compact structure of carried type, being designed for attaching the three point hydraulic elevator.

#### **Constructive and functional parameters**

##### **C) Equipment for extracting ball root plants , EXPLANT 500**

**The technical equipment (fig. 9)** is designed to extract gardening, ornamental or orchard planting material, with ball roots, in order to replant it in green areas, plantations and/or nursery fields. At the same time, the equipment can be used for previously digging the holes where either the ball roots material or bare root material are to be replanted.

#### **TECHNICAL CHARACTERISTICS**

- type of equipment	- carried, behind the tractor
- <b>power of tractor in aggregate</b>	- <b>45 HP</b>
- driving system	- hydraulic
- working hydraulic pressure	-120 bar
- transport height	-280 mm
- max. height of lifting the earth ball from the soil	-220 mm
- shape of ball performed	- troncated cone
- ball's dimensions:	
- upper diameter	-500 mm
- lower diameter	-320 mm
- height	-500 mm
- variation coefficient of ball's dimensions	-1.47-2.94 %
- degree of preserving ball shape and integrity	-94.5-96.2 %
- crown damaging level	-1.2-1.8 %
- working capacity per shift	-approx. 108 plants
- fuel consumption for 100 plants extracted	- 26 l
- coefficient of operational reliability	- 0.95
- equipment mass	-approx. 700 kg.

### **3. Results and discussions**

#### **A) Equipment for working the soil**

The working qualitative indexes determined by measurements or calculation during the laboratory-field testd, have been obtained on levelled ground, at 2.5 km/h rolling speed, rotor rotation  $n_r=780 \text{ min}^{-1}$ , tractor power 150 HP, are shown in *table 3* [16].

#### **B) Equipment for planting forestry seedlings, EPF1symbolized**

Values determined after planting depth tests can be easily identified in diagram in *fig. 10*, for traction force, in *table 4*, for necessary power, in *table 5* and for fuel consumption in *table 6* [15].

Graphics for traction force have been drawn for two average speeds, because the speeds for tests 1 and 2 are very closed.

### **4. Conclusions**

Following the experimental research with seedlings planted equipment EPF1, in aggregate with 80HP tractor, following conclusions have been reached:

#### **Traction force:**

- in plowing and disking field before planting: 3.2 tf
- in disking field before planting: 3.8tf
- in plowing field autumn: 3.4 tf

#### **Necessary power:**

- in plowing and disking field before planting: 20.58 kW
- in disking field before planting. 25.59 kW
- in plowing field autumn: 22.16 kW

Use of such equipment in new technologies of establishment intensive and super-intensive orchards will solve one of the real needs of Romanian horticulture and equipment production in the country will create new jobs and reduce the cost price. Using mechanized planting technology leads to:

- ✓ lower fuel consumption by approx. 20%;
- ✓ reduce labor requirements by approx. 35%;
- ✓ reduction physical effort 10 times compared to the situation where planting is done manually;
- ✓ possibility to increase worked surface with the same labor; promote compliance with the optimum planting periods, affecting output growth.

## 5. References

- [1] Ministry of Water, Forest and Environment Protection-1999. *Developing strategy of forestry in Romania during 2000-2020*.
- [2] Chiriță.C. Și colab.-1977. *Forestry stations*. Academy publishing House.
- [3] Giurăscu C. C.-1975. *History of Romanian forest since old times up to present*. Ceres București Publishing.
- [4] Giurgiu V.-1988. *Arranging forests with multiple functions*. Ceres București Publishing
- [5] Jantsch Erich-1972. *Tehnological forecasting in perspective*. OECD. Scientific Publishing, București.
- [6] Milescu I, Alexe A. –1969. *Forests in the world*. Agroforestry Publishing, 33 p.
- [7] Popescu G., Pătrășcoiu Nicolae-2004. *Forest and man* Nord Carta Suceava Publishing.
- [8] Ministry of Forestry-1987. *Technical guide for compositions, schemes and technologies of forest restoration* Agricultural Propaganda Publishing.
- [9] Institut für Forstwissenschaften Eberswalde-DDR. 1988. *Forstpflanzenanzucht/Walderneuerung in der DDR*.
- [10] Eng.A.Sbârnac, Ph.D. Eng. A. Iana.-1966. *Class of forestry works mechanization machines*. Agricultural Propaganda Publishing .
- [11] Ilie Popescu.-1984. *Mechanization of forestry works*. Ceres Publishing.
- [12] Ioan Damian. –1976. *Afforestations –1978*. Didactic and Pedagogical Publishing.
- [13] \*\*\**Technical norms on afforesting compositions,, schemes and technologies* Ministry of Water, Forest and Environment Protection .
- [14] I. Popescu, S.C. Popescu(2000)- *Mechanization of forestry works*, TRANSILVANIA Brașov University Publishing.
- [15] \*\*\*(2005) – *Researches on promoting innovative mechanizing techniques within afforesting technologies*, INMA –București, Financing Contract no 17 from 03.10.2005.
- [16] Ph.D. Eng.Ciupercă Radu, Eng. Ciurel Gica, Eng. Mircea Radu - INMA București *Innovative technology for working the soil for afforestation*.
- [17] Dragoș Șerban *How to plant fruit trees (11 July 2009)*

## Tables and figures

Table 1.

Fruit growing	Distance between rows (m)	Distance in row (m)
Apple tree	2.5...6	0.8...5
Pear tree	3.5...5	1.5...4.5
Plum tree	5...6	3.5...4.5
Apricot tree	5...6	3.5...5.5
Peach tree	4.5...5.5	3...4
Cherry tree	5...7	4...5.5
Sour cherry tree	4...6	2...4.5
Currant tree	2.8...3	1...1.2
Raspberry tree	2.5	0.5
Blackberry tree	2.5	1.5...1.8
Nut tree	4...5	3...3.5

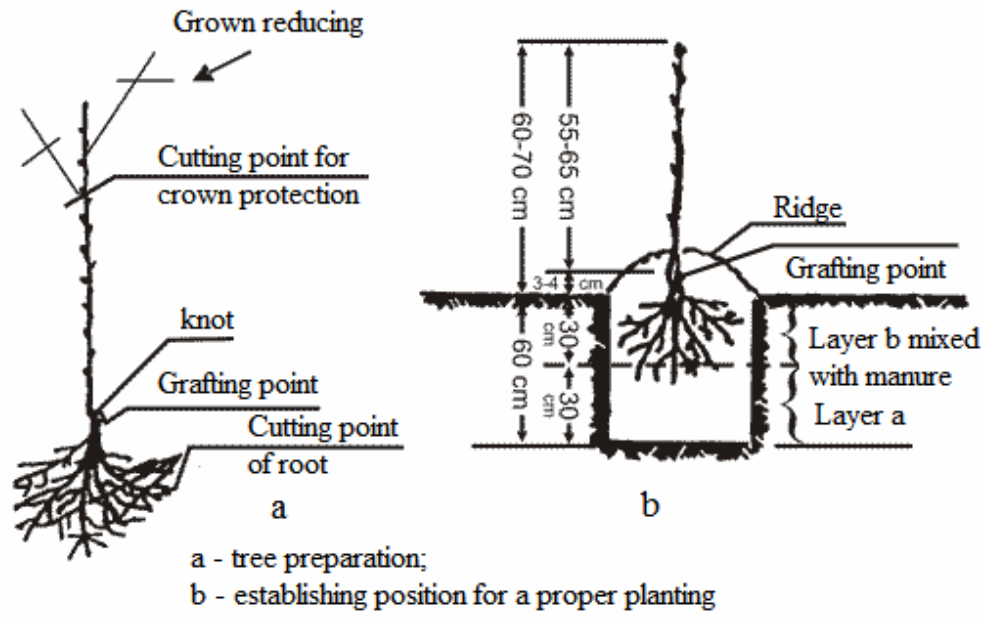


Fig. 1. Correct planting



Fig. 2. Manually digging



Fig. 3. Mechanically digging



Fig. 4. Soil working in stripes



Fig. 5. Planting



Fig. 6. Equipment for extracting seedlings



a)



b)

Fig. 7. Equipment for working the soil



a)



b)

Fig. 8. Equipment for planting forestry seedlings EPF1 during the work

Table 2. Constructive and functional parameters of equipment EPF1

Den. No	Parameter	M.U.	Value
1	Type of machine		carried
2	Number of planting sections	Pcs.	1
3	Working depth	cm	30
4	Working speed	km/h	0.2-3
5	Theoretical planting distances between seedlings in row, for 1, 2, 3, 4, 6 planting arms	mm	500, 750, 1000, 1500, 3000



Fig. 9. Equipment explant 500

Table 3 [16]

Index name	Symbol	MU	Value
Average working depth	$a_{med}$	mm	227.5
Average working width	$B_m$	mm	377.5
Index of variation of working depth/width	$V_a$	%	2,2/1,.
Soil breakage: - fractions under 1 cm - fractions between 1...5 cm - fractions over 5 cm		%	96.5 2.5 1.0
Soil mincing degree	$G_{ms}$	%	97.5
Soil levelling degree	$G_{ns}$	%	98.5
Level of vegetal waste destroying	$G_{dv}$	%	98.8

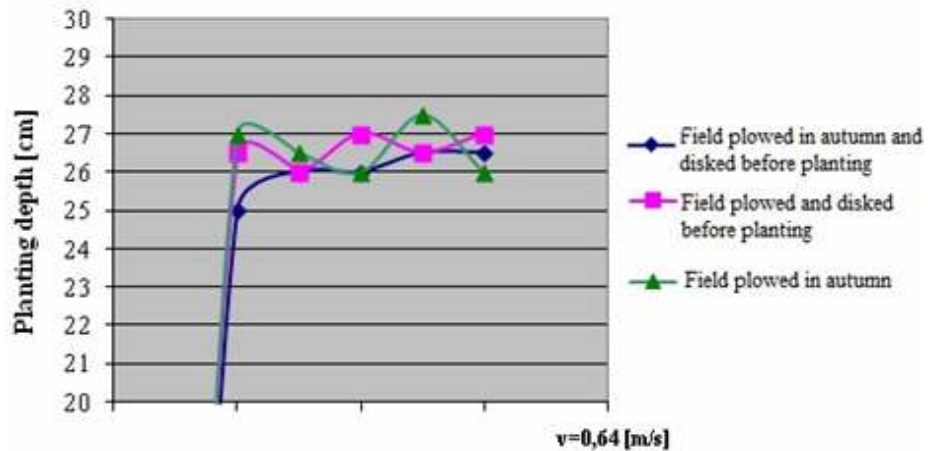


Fig. 10. Planting depth – reddish-brown soil

**Table 4. Traction strength values depending on processing filed status**

Den. no.	Field type and processing status	Average traction force (kN)	Average speed (m/s)
1	Reddish brown - Plowing and diking before planting	30.5693	0.428
2	Reddish brown - Plowing and diking before planting	33.96176	0.600
3	Reddish brown - Plowing and diking before planting	32.67131	0.630
4	Reddish brown - Disking before planting	38.94232	0.421
5	Reddish brown - Disking before planting	38.68545	0.605
6	Reddish brown - Disking before planting	36.68399	0.641
7	Reddish brown - Plowing in autumn	37.42543	0.442
8	Reddish brown - Plowing in autumn	34.14915	0.610
9	Reddish brown - Plowing in autumn	38.85483	0.646

**Table 5. Traction force values depending on processing filed status**

Den. no.	Field type and processing status	Average traction force (N)	Average speed (m/s)	Average necessary power (kW)
1	Reddish brown - Plowing and diking before planting	30569.3	0.428	12.472274
2	Reddish brown - Plowing and diking before planting	33.961,76	0.600	20.377056
3	Reddish brown - Plowing and diking before planting	32671.31	0.630	20.582925
4	Reddish brown - Disking before planting	38942.32	0.421	16.394716
5	Reddish brown - Disking before planting	38685.45	0.605	25.597115
6	Reddish brown - Disking before planting	36683.99	0.641	23.514437
7	Reddish brown - Plowing in autumn	37425.43	0.442	16.54204
8	Reddish brown - Plowing in autumn	34149.15	0.610	22.162798
9	Reddish brown - Plowing in autumn	38854.83	0.646	25.10022

**Table 6. Fuel consumption values per hour and hectare**

Den. no.	Field type and status	Fuel consumption per hour (l/h)	Fuel consumption per hectare (l/ha)	Average speed (m/s)	Average necessary power (kW)
1	Reddish brown - Plowing and diking before planting	6.5	22.1180	0.428	12.4722
2	Reddish brown - Plowing and diking before planting	7.2	16.2	0.600	20.3770
3	Reddish brown - Plowing and diking before planting	7.3	15.9180	0.630	20.5829
4	Reddish brown - Disking before planting	7.5	24,6875	0.421	16.3947
5	Reddish brown - Disking before planting	7.8	16.7916	0.605	25.5971
6	Reddish brown - Disking before planting	7.5	16.25	0.641	23.5144
7	Reddish brown - Plowing in autumn	6.5	20.4027	0.442	16.5420
8	Reddish brown - Plowing in autumn	8.2	16.9694	0.610	22.1627
9	Reddish brown - Plowing in autumn	7.8	16.3583	0.646	25.1002