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The "Engineer" publishes the most significant results of scientific and applied research carried out in universities of transport profile, as well as other higher educational institutions, research institutes, and centers of the Republic of Uzbekistan and foreign countries.

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Types of machines and units for extraction of trees and shrubs

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Abstract: This article analyzes the structure, operating principle, technical indicators, and efficiency of PZU-1, KOP-2, and Tree Spade machines for digging tree and shrub seedlings along with their roots. Based on a comparative analysis of the machines, the advantages and disadvantages of each unit and the optimal conditions for their use were determined. The results of the study show that the hydraulic Tree Spade is the most efficient technique for large trees, while PZU-1 and KOP-2 are economically acceptable for small and medium-sized seedlings.

Keywords: planting, PZU-1, KOP-2, Tree Spade, rootstock, landscaping technique, hydraulic knife

1. Introduction

In recent years, the policy of urban planning, ecology, and landscaping has become more active, and the demand for technologies for transplanting large-scale tree and shrub seedlings while preserving them has increased significantly. Manual methods do not meet modern requirements, as this process causes significant damage to the root system, low productivity, and makes it impossible to transplant a large number of seedlings simultaneously.

Therefore, in world and domestic practice, special machines and units for removing seedlings with complete preservation of root spaces are widely implemented. They have several advantages:

- reduces labor costs by 6-10 times;
- transplanted trees the concealment coefficient increases to 70-95% ;
- time is saved and the seedling growing cycle is reduced;
- it becomes possible to systematically move large green arrays.

Techniques such as PZU-1, KOP-2, and Tree Spade are based on various geometric and technological principles, each of which yields high efficiency under specific conditions. They differ from each other in the shape of the blades, the composition of the hydraulic system, the depth of transplantation, the degree of preservation of soil well stability, and labor productivity.

This article covers a comparative analysis of these techniques, their operating principles, advantages and disadvantages, as well as areas of application from a scientific and practical point of view.

2. Research methodology

The research was conducted on the basis of the following methods: Literature analysis. Local and foreign sources on equipment used in forestry and park services were studied. PZU-1, KOP-2, and the Tree Spade series were compared for the following parameters:

- working depth (cm),
- soil diameter (cm/mm),
- number and geometry of knives,
- hydraulic/mechanical type,
- Seedling productivity per hour,
- energy consumption,
- probability of root damage.

Practical observations were conducted. The operation of these units was observed at agricultural and landscaping enterprises.

3. Results and Discussion

Table 1

Comparative table of equipment

Indicator	PZU-1	KOP-2	Tree Spade (4-6 blade)
Depth of work	25-40 cm	35-60 cm	60-120 cm
Soil pit diameter	20-35 cm	30-50 cm	80-160 cm
Number of knives	1 (spatel)	2 rotating knives	4-6 cone knives
Knife geometry	Spade-shaped, rectilinear	Symmetric arc	Carousel-type conical
Performance	80-120 seedlings/hour	50-80 seedlings/hour	20-40 trees/hour
Management	Mechanic	Mechanical-semi-automatic	Fully hydraulic
Fitness to a large tree	No	Finite	Very high
Efficiency	65-75%	70-80%	85-95%
Area of application	Water lily, black paper, fruit seedlings	Shrubs and small trees	Large park trees

Advantages and disadvantages
PZU-1
Benefits:
•simple construction, inexpensive;
•easy maintenance;

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•Very convenient for small and medium-sized seedlings.

Disadvantages:

•soil composition is unstable;

•the upper part of the root is damaged more;

•Not suitable for large trees.

KOP-2

Benefits:

•thanks to the rotating knife, the soil composition is formed better;

•ideal for scattered shrubs and small trees in park and landscape design;

•The working depth is higher than that of PZU-1.

Disadvantages:

•there is a possibility of sliver deformation;

•non-hydraulic requires force;

•If the soil is hard, the quality of the soil decreases.

Tree Spade

Benefits:

•preserves 90-95% of the root cavity intact;

•the only effective technology suitable for transplanting large trees;

•low power consumption due to the hydraulic system;

•The survival rate of the transplanted trees is highest.

Disadvantages:

•the price is too high;

•constant maintenance of the hydraulic system is required;

•requires a large tractor or special chassis.

Analysis shows that in the process of using equipment, the main factors are seedling size, soil moisture, soil hardness, and transplanting distance. On this basis:

•Tree Spade optimal for parks, large invertebrate trees, large green areas;

•KOP-2 most effective for decorative shrubs and seedlings with a small diameter of 3-8 cm;

•PZU-1 economically the cheapest and convenient for small farms.

The selection of these units under appropriate conditions significantly increases the survival rate of transplanted trees.

4. Conclusion

Studies have shown that the correct choice of equipment for the effective transplantation of tree and shrub seedlings is a decisive factor. The mechanical PZU-1 unit is economically optimal for small and medium-sized seedlings, while the KOP-2 type is highly effective in transplanting decorative shrubs in park farms.

And for the safe transplantation of large trees, the unique advantage of a hydraulic conical blade Tree Spade is that it preserves the root system of the tree practically up to 90%.

The study confirms that:

- correctly selected machines significantly reduce labor costs;
- increases labor productivity by 3-5 times;
- significantly increases the concealment coefficient of transplanted trees.

In the conditions of Uzbekistan, the localization, modification, and development of energy-saving options for these units will provide significant economic benefits.

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