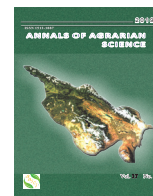




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# Laboratory studies of the physicommechanical properties in the cane stem

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### A B S T R A C T

The article considers the research results of the physicommechanical properties in the wild plants, particularly in cane. The experiments have been conducted through special testing devices, as a result of which it has been disclosed that per the height of the stem the proportional and strength (fatigue) limits, as well as the modulus of elasticity fall down, while the relative deformations rise up. The experimental results have been introduced through a table and diagrams.

**Keywords:** Wild plants, Physicommechanical properties, Stem pull-out, Elasticity, Deformation, Special testing.

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### Introduction

There are multiple factors affecting the cutting process of the plants stems and they are mainly related to the physicommechanical properties of the stem in the cutting plant, which are factually taken into account when designing the cutting apparatus. The values of the stem height, its thickness, resistance during the cutting process, the threshold pressure and strain in the cutting plant, as well as the knowledge and analyses of other properties are necessary to estimate the strength of individual units in the cutting apparatus and the main geometric parameters in the blade. As a result of the force exerted by the blade, considerable pressure appears between the blade and the cutting material, which results in the destruction of the connections between individual parts of the material.

The phenomenon related to the changes of physicommechanical properties in the stem is based on the restrictions of the strains and the size of deformation variation depending on the effect of the blade speed, humidity of the environment, on the thickness of the stem in the cutting plant, etc. [1, 2].

In the accomplished works [3, 4], the investigations of the physicommechanical properties of the plants have shown that throughout the process of stems' pull-out only elastic deformation (there is no plastic deformation) takes place before their cutting; the directly proportional relationship between the drag force and deformations holds up, while the limits of strength and proportion overlap. Nevertheless, the diagrams designed as a result of the investigations conducted by the academician A.P. Tarverdyan [5, 6] have enabled to clearly enhance the differences between the limits of strength and proportion. As a result of pulling out the samples, plastic deformation together with the elastic one is generated and the directly proportional relationship between the cutting force and deformation fails to keep up until the cutting moment. Also it has been shown [5, 6] that from the lower stem part of the cutting plant upwards the proportional and strength (fatigue) limits, as well as the elasticity modulus are reduced, while the deformation increases.

## Materials and Methods

In order to describe the mechanical properties four parameters have been identified: proportional limit ( $\sigma_r$ ), elastic deformation ( $\varepsilon_r$ ), endurance (fatigue) limit ( $\sigma_e$ ), plastic deformation ( $\varepsilon_e$ ) and modulus of elasticity (E).



**Fig. 1.** *The general view of the device for testing the samples made from the cane stem*

150 mm length and 2-3 mm width have been prepared which have been experimented through the methodology and machine developed and recommended by A.P. Tarverdyan. Metallic rings have been adhered to both ends of the stem with special glue (würth), which are intended for fastening the samples in the handles (Fig.2). The choice of the width in the samples (2-3 mm) depends on the need to reduce the cutting force down to the value in case of which the sticking connection by glue and the obtainment of verified measurement data are simultaneously ensured for the determination of the mechanical properties of the sample and for the design of the deformation diagrams.



**Fig. 2.** *Experimented samples of the cane*

The stem properties of the thick-stemmed crops and wild plants are subjected to huge changes parallel to the plants height, which apparently causes some problems during the cutting process.

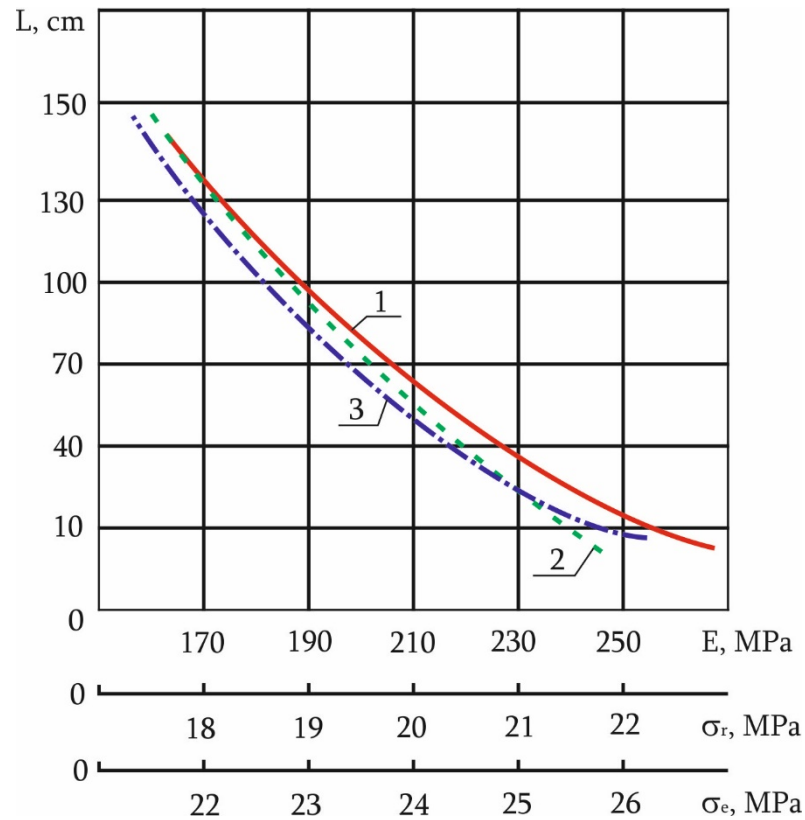
The experiments on pulling out the stems of the plants, particularly those of the canes have been conducted on the machine of PTM-3 series (Fig. 1). It should be mentioned that the mentioned machine has been subjected to some structural changes by the academician A.P. Tarverdyan in order to eliminate the existing shortcomings (damage of the stem samples in the handles and slipping out of the stems through them), which enable to gain verified measurement data [5, 6]. Taking into account that our observations concern the cane stem cutting process in the water medium with vibro-cutting principle, it is relevant to implement the experiments in the 3<sup>rd</sup> inter-node from the lower part of the cane stem. Strata/samples with

## Results and Analysis

The average values for the changes of physicomechanical properties of the stem material in the plant studied by our research group are introduced in the table below, while the diagrams of the stem pullout are introduced in Figures 3,4.

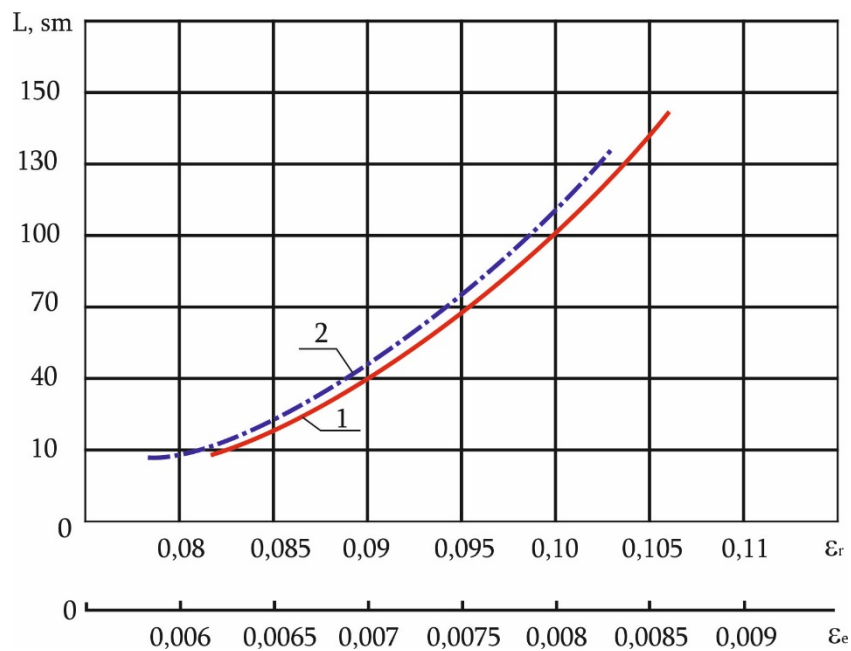
**Table.** Indicators describing the physicomechanical properties of the cane stem

Indicators describing the mechanical properties  The height of the sample location from the root node (cm)	Proportional limit, $\sigma_r$ [MPa]	Elastic deformation, $\varepsilon_r$	Modulus of elasticity, E [MPa]	Strength (Fatigue) limit, $\sigma_e$ [MPa]	Plastic deformation, $\varepsilon_e$
10	21.6	0.083	260	25.9	0.0061
40	20.4	0.09	226	24.5	0.0068
70	19.6	0.095	206	23.5	0.0074
100	18.8	0.1	188	22.6	0.0078
130	18.2	0.104	175	21.8	0.0083



**Fig. 3.** Diagrams of the changes of mechanical properties in the cane stem per its height.

1- Modulus of elasticity ( $E$ ), 2- Proportional limit ( $\sigma_r$ ), 3- Strength/Fatigue limit ( $\sigma_e$ )



**Fig. 4.** Diagrams of the deformation changes in the cane stem per its height.

1- Elastic deformation ( $\epsilon_r$ ), 2- Plastic deformation ( $\epsilon_e$ ).

The laboratory experiments of the studies on physicomachanical properties of the cane have testified that the updated device and developed methodology enabled to adjust the indices of the physicomachanical properties in the cane substance. The data received by our research group differ from those commonly found in literature [7] in 1.5-2 times, which surely will give an opportunity to adjust the geometric and kinematic parameters in the blades of cutting apparatus.

## Conclusion

1. The methodology and updated devices applied during the laboratory studies of physicomachanical properties in the cane stem have enabled to significantly adjust (in 1.5-2 times) the indicators of the physicomachanical properties.
2. As a result of investigations it has been found out that the indices of the strength in the stem material fall down per the plant height, while the deformation indices grow up.
3. Based on the concise analyses of the laboratory trials on the cane stem it can be inferred that the acquired results enable to adjust the kinematic and geometric parameters of the operating parts in the cutting apparatus.

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