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Results of Research on the Physical and Mechanical Properties of Potato Culture

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Abstract: The article presents research on the study of the physical and mechanical properties of potato stem and tubers, such as the tensile strength of the stem and stolon, the friction coefficient, which allows for the correct selection and justification of the installation location, the shape, and the parameters of the stem remover working element in the potato harvester.

Keywords: potato, tuber, riveting, potato harvester, rolling, sliding, stolon strength, tensile force, tuber mass, tuber radius, friction force, friction coefficient, moment of inertia, resistance moment.

When a potato bush is pulled, especially from a previously dug-out ridge and when the stem is green, a significant number of tubers are pulled out along with the stems, firmly held on the stalls. In the works of many researchers, the number of extracted tubers is about 50% or more [1,2]. Their research shows that the number of pulled-out tubers depends on the degree of ripeness of the potato. When tubers with dried stems are pulled, a small number of tubers are extracted, only about 6% by mass of the tuber harvest. With green bushes, 50 percent or more of the tubers are extracted.

Our experiments show (Table 1) that when pulling green and slightly wilted bushes, 60-70% of tubers are extracted from the dug-out ridge along with the stems. This condition of the stem during the potato harvest period is typical for Uzbekistan and other CIS countries.

Potato tubers, as shown by the practice of mechanized harvesting of potatoes, as well as a number of conducted studies, when passing through the separating organ, do not completely

separate from the stem, up to 20-30% of tubers remain after passing, for which additional devices in the stem-removing working organs are necessary.

Therefore, studying the strength of the stolon, as well as the stem, is of great interest in substantiating the parameters of the stem removal working element. The data obtained under field conditions are presented in Table 2. The work was carried out using a strain gauge device. Samples for measurements were taken from different sections of the field diagonally. Repetition - 20 times.

Table 1.Results of harrowing potato bushes before and after subsoiling

Variety	Moisture content, %		Weight of tubers (kg) removed from the soil	Weight of tubers (kg) not removed from the soil	Percentage tubers, extracted from the soil
	cotton	bolls			
Before excavation					
Lorch	88,5	18,5	0,737	0,660	52,7
Sante	70,3	16,1	0,480	1,073	30,9
After excavation					
Lorch	83,7	15,4	0,687	0,270	71,2
Sante	52,4	17,2	0,580	0,340	63,0

As can be seen from Table 2, the tearing forces of the stolon itself, as well as the stolon tearing force from the roots, are greater than the stolon tearing force.

Since when removing the cob from the combine harvester, it is necessary to pluck the tubers from the stalls, we are more interested in these data. The minimum pulling force from the stolon was 0,8-1,0 N, and the maximum was 18,0-23,2 N.

Table 2 Stolon strength in relation to various parts of the plant

Variety	Force, H								
	tubers separating from the stolon			from stolon to stolon detachment			from the roots of stolon rupture		
	avg	max	min	avg	max	min	avg	max	min
Lorch	10,3	18,0	0,8	11,7	23,0	2,0	14,6	33,5	6,0
Sante	11,1	23,2	1,0	12,2	30,0	4,0	20,8	34,0	6,0

Table 3 shows the tearing forces of the cob stem along its average diameter. However, this is not sufficient to justify the parameters of the defoliating working element. More complete data is needed, which would clarify the change in the resistance to tearing of the leaf blade stem depending on the height of the stem cross-section and, consequently, the diameter.

Table 3 The tearing forces of the potato stem along its average diameter

Variety	Average diameter, mm	Breaking forces, N		
		average	maximum	minimum
Acrob	9,8	427	493	349
Lorch	8,4	417	433	349
Victoria	8,1	343	416	271
Cardinal	6,3	235	311	189
Santa	6,9	219	291	170

Work in this direction has been carried out by a number of researchers [1,2]. We repeated these works to supplement and clarify these indicators. Figure 1 shows the curves of change in the temporary resistance of the cotton blade to tearing depending on the change in cross-sectional height. From these data, it can be seen that with increasing stem cross-section height, the temporal resistance decreases intensively, especially within the range of 0-180 mm.

Figure 2 shows the change in the amount of panicle entering the combine harvester over two meters of the machine's path. It is highly variable and averages 2,43 kg/m.

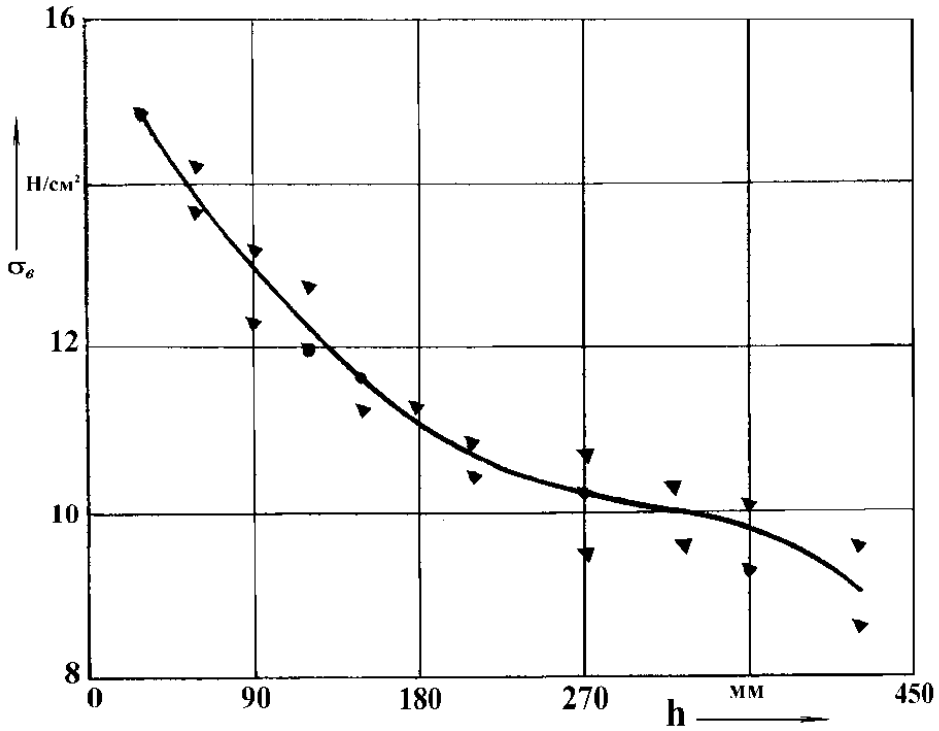

Fig.1. Change in temporary resistance to stem tearing potato shoots depending on the height of their cross-section

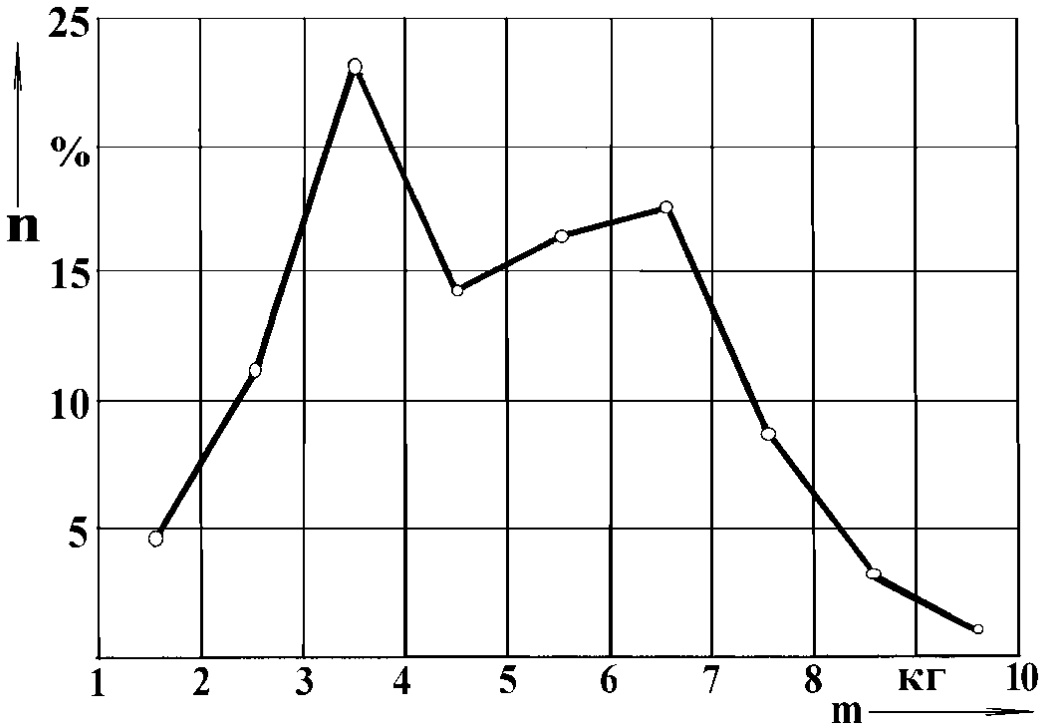

Fig.2. Variable distribution curve of incoming in a combine harvester (m) on two meters of the machine's path.

Thus, when designing stem-removing working parts that operate on the principle of pulling or detaching from the stems, it is necessary to strive for the stems to be grasped as close as possible to the base and root. In this case, there is a full guarantee that stems will not fall off.

The density and friction coefficient of tubers and cobs are also necessary for analyzing and calculating the parameters of the cob removal working body. Based on numerous studies [1], the density of the tubers can be taken as 648 kg/m^3, and the stem as 133 kg/m^3.

The results of experiments conducted according to the existing methodology [3] to determine the friction coefficients of potato stem and tubers on various surfaces are presented in Table 4.

From the data presented in the table. 4 it follows that the coefficient of friction of both tubers and cobs on all the studied friction surfaces at rest is 1,5 times greater than during movement. With an increase in the sliding speed, a noticeable decrease in the friction coefficients occurred.

Table 4 Coefficients of friction of tubers and cobs on various surfaces (pressure - own weight)

Elements	Determin-ation condition	Friction surface	Scmove-ment growth, m/s.	Coefficients of friction.		
				mini-mal	maxi-mal	average
Peace	Stump	Processed steel	-	0,71	0,80	0,76
		Soil	-	0,98	1,03	1,00
	Movement	Processed steel	1,6 2,4 3,2	0,53 0,51 0,45	0,59 0,58 0,57	0,54 0,55 0,54
		Rubber layer of conveyor belt	3,2	0,42	0,51	0,46
		Soil	3,2	0,43	0,51	0,46
Branch	Stump	Processed steel	-	0,47	0,74	0,57
		Rubber layer of conveyor belt	-	0,71	0,93	0,80
		Soil	-	0,67	0,96	0,80
	Movement	Processed steel	1,2 2,4 3,2	0,60 0,63 0,55	0,84 0,76 0,68	0,73 0,71 0,63
		Rubber layer of conveyor belt	3,2	0,42	0,49	0,45

The highest friction coefficient was obtained between the tuber and the soil, and the lowest was obtained between the tuber and the rubber layer of the conveyor belt, as well as between the cob and the rubber layer of the conveyor belt. For calculation, the coefficient of friction of the tuber with steel can be taken within the range of 0,5-0,6, with the rubber layer of the conveyor – 0,4-0,5, and for the cob - respectively – 0,6-0,7 and 0,4-0,5.

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