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Influence Of Mesh Surface Parameters In A Mechanical Cotton Seed Cleaning Unit On Cleaning Efficiency

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Abstract

The article presents the results of experimental studies carried out on both the existing and improved Mechanical seed (cotton seed) cleaning cleaners installed in the Cotton seed sorting unit unit, aimed at increasing the cleaning efficiency of cotton seeds. Analysis of the obtained results showed that the mass of 1000 seeds increased by 1,3–1,4 g, the impurity level decreased by 0,22–0,31%, and mechanical damage was reduced to 0,2%.

Keywords: Cotton seeds, cleaning, sorting, agregat (unit), efficiency, impurity, regulation.

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Introduction

Cotton yield, as well as the quality and quantity of fiber and cotton products obtained during processing, largely depend on the quality characteristics of seed cotton. Therefore, the preparation of high-quality seed cotton is considered one of the pressing issues [1, 2].

In existing technological processes, after the processing of seed cotton, seeds are obtained that differ in physiological maturity, density, and the weight of 1000 seeds. These characteristics reduce the germination energy of the seeds and lead to delayed and uneven crop

maturation. The characteristics of seeds include their shape, size, weight, hairiness, the strength of the seed coat, and friction coefficients [3, 4].

At cotton processing enterprises, during the drying, cleaning, ginning, and linting processes of raw cotton, seed cotton is subjected to a certain degree of mechanical damage and contamination. The presence of damaged seeds, mineral and organic impurities, and empty seeds in seed cotton reduces the probability of full germination. Therefore, the sorting and cleaning processes of seed cotton are among the most important technological stages and serve as a guarantee for obtaining high yields [5, 6].

In the technological sequence of seed preparation, initially, fuzzy (linted) seed cotton passes through a sorting and cleaning process using the Cotton seed sorting unit+Mechanical seed (cotton seed) cleaning pneumatic-mechanical method. During this process, the seed fraction is first separated by air, after which the selected fuzzy seed cotton is cleaned from impurities using an Mechanical seed (cotton seed) cleaning -type mechanical seed cleaning device (Fig. 1).

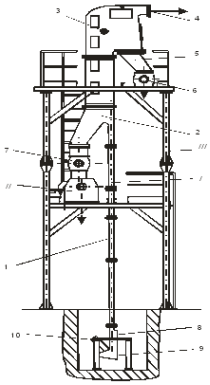

Figure 1. Cotton seed sorting unit-type fuzzy seed cotton sorting and cleaning unit.

Figure 2. Process of determining the optimal mesh surface of the seed cotton cleaner.

1 – pneumatic pipe; 2 – separation chamber; 3 – separator; 4 – branch pipe; 5 – technical fraction collection chamber; 6, 7 – vacuum valves; 8 – inlet branch pipe; 9 – air flow regulating slot; 10 – seed inlet tray; II – Mechanical seed (cotton seed) cleaning -type mechanical seed cleaning device.

The residual lint content of the seeds delivered to the seed preparation workshop ranges from 8.5 to 10.0%. Due to this lint content,

the separation of organic and inorganic impurities contained in the seed mass is a complex process. The main working elements of the Mechanical seed (cotton seed) cleaning -type seed cleaning machine are a slatted drum and a mesh surface. The cleaning process is carried out as the seeds pass over the mesh surface under the action of the slatted drum, resulting in the removal of impurities.

Long-term observations and analyses have shown that, due to design shortcomings of the currently used mechanical seed cleaner, the cleaning efficiency of the equipment remains low. It is known that the dimensions of the mesh surface and the arrangement pattern of its отверстия significantly affect the cleaning process. Therefore, the influence of the arrangement of mesh surface openings in the Mechanical seed (cotton seed) cleaning -type mechanical seed cleaner on the separation of impurities from the seed mass was investigated.

Experimental studies demonstrated that optimal results in impurity separation were achieved when the mesh openings were arranged in a herringbone pattern at an angle of 45°. Based on this finding, an improved mesh surface for the mechanical seed cleaner was designed, and its effect on the seed cleaning process was investigated (Fig. 2).

The experiments were conducted on the Cotton seed sorting unit using both the standard Mechanical seed (cotton seed) cleaning and the improved Mechanical seed (cotton seed) cleaning, with Namangan-77 selection variety seed cotton (R-3 generation), in three replications. Laboratory analyses were carried out in the laboratory of the seed preparation workshop. The initial seed parameters were as follows: lint content – 8.8%, impurity content – 0.8%, mechanically damaged seeds – 3.8%, moisture content – 7.5%, and the mass of 1000 seeds – 97.6 g. The experimental results are presented in the table below.

Table 1. Comparative Performance of the Cotton Seed Sorting Unit with Conventional and Improved Mechanical Cleaning Systems

Cotton seed indicators.	Cotton seed sorting unit with the currently operating Mechanical seed (cotton seed) cleaning	Improved Mechanical seed (cotton seed) cleaning integrated into the Cotton seed sorting unit.	Difference. +,-

	Experimental repetition (replication of the experiment)			Arithmetic mean value.	Experimental replication.			Arithmetic mean value.	
	1	2	3		1	2	3		
1	2	3	4	5	6	7	8	9	10
Productivity: 2500 kg/h.									
Mass of 1000 cotton seeds, g.	100,0	100,8	100,6	100,5	102,0	101,8	101,6	101,8	+1,3
Impurity level.	0,70	0,67	0,72	0,70	0,5	0,48	0,47	0,48	-0,22
Mechanical damage	4,2	4,0	4,0	4,1	3,8	4,0	4,0	3,9	-0,2
Productivity: 3000 kg/h.									
Mass of 1000 cotton seeds, g	100,0	99,8	100,2	100,0	101,8	101,0	101,2	101,4	+1,4
Impurity	0,70	0,68	0,60	0,66	0,44	0,25	0,36	0,35	-0,31
Mechanical damage	4,0	4,3	4,0	4,1	4,0	4,0	4,0	4,0	-0,1

The results of the conducted experiments and studies showed that the Cotton seed sorting unit equipped with the improved Mechanical seed (cotton seed) cleaning has higher efficiency compared to the existing unit, with its productivity increased to 2500–3000 kg/h. At the same time, the quality indicators of seed cotton improved: the mass of 1000 seeds increased to 1.3–1.4 g, the impurity level decreased to 0.22–0.31%, and mechanical damage was reduced to 0.2%. These positive results were achieved by selecting the optimal configuration of the mesh surface

openings in the Mechanical seed (cotton seed) cleaning mechanical seed cotton cleaning device.

In our future research, the cleaning efficiency will be further investigated by replacing the mixing working part of the fuzzy seed cotton cleaner with a newly designed drum that ensures a loosening process of the seed cotton.

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