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INVESTIGATING THE EFFECT OF STRUCTURAL PARAMETERS OF THE MESH SURFACE ON CLEANING EFFICIENCY IN MECHANICAL COTTON SEED CLEANING UNITS

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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.

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

Introduction

Cotton yield, as well as the quality and quantity of fiber and cotton products obtained during processing, are largely determined by the quality characteristics of seed cotton. Therefore, the production of high-quality seed cotton is regarded as one of the most important issues in the industry [1, 2].

In current technological processes, seed cotton processing results in seeds that vary in physiological maturity, density, and the weight of 1000 seeds. These

variations negatively affect seed germination energy and cause delayed and non-uniform crop maturation. The main characteristics of seeds include their shape, size, mass, surface hairiness, the strength of the seed coat, and friction coefficients [3, 4].

At cotton processing enterprises, during the drying, cleaning, ginning, and linting operations, raw seed cotton is exposed to a certain level of mechanical damage and contamination. The presence of damaged seeds, mineral and organic impurities, as well as empty seeds, significantly reduces the germination potential of the seed material. Therefore, the sorting and cleaning stages of seed cotton are considered among the most critical technological processes and play a key role in ensuring high productivity and yield [5, 6].

In the technological sequence of seed preparation, the initially fuzzy (linted) seed cotton is subjected to sorting and cleaning using a pneumatic-mechanical method based on the Cotton seed sorting unit combined with a mechanical seed cleaning system. During this stage, the seed fraction is first separated by an air flow, after which the selected fuzzy seed cotton is further cleaned from impurities using a mechanical seed cleaning device of the Mechanical seed (cotton seed) cleaning type (Fig. 1).

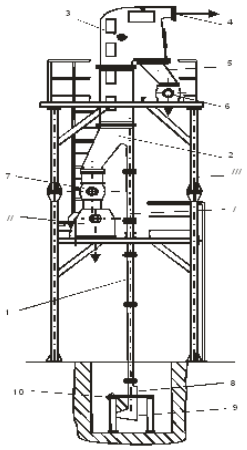

Figure 1. Cotton seed sorting unit-type fuzzy seed cotton sorting and cleaning system.

Figure 2. Methodology for optimizing the 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 seeds supplied to the seed preparation workshop ranges from 8.5 to 10.0%. Due to this level of lint, the separation of organic and inorganic impurities contained in the seed mass represents a complex technological 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 occurs as the seeds pass over the mesh surface under the mechanical action of the slatted drum, which results in the removal of impurities.

Long-term observations and analyses have shown that, due to certain design limitations of the currently used mechanical seed cleaner, the cleaning efficiency of the equipment remains relatively low. It is well established that the dimensions

of the mesh surface and the arrangement pattern of its openings significantly influence the efficiency of the cleaning process. Therefore, the effect 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 the most 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 result, an improved mesh surface design for the mechanical seed cleaner was developed, and its influence on the seed cleaning process was further investigated (Fig. 2).

The experiments were conducted on the Cotton seed sorting unit using both the standard Mechanical seed (cotton seed) cleaning device and the improved version of the Mechanical seed (cotton seed) cleaning unit. Seed cotton of the Namangan-77 selection variety (R-3 generation) was used, with three replications. Laboratory analyses were carried out in the seed preparation workshop laboratory. 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. Comparison of Conventional and Improved Cotton Seed Cleaning Performance

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 demonstrated that the Cotton seed sorting unit equipped with the improved Mechanical seed (cotton seed) cleaning system exhibits higher efficiency compared to the existing unit, with its productivity increasing to 2500–3000 kg/h. At the same time, the quality indicators of seed cotton were significantly improved: the mass of 1000 seeds increased to 1.3–1.4 g, the impurity content decreased to 0.22–0.31%, and mechanical damage was reduced to 0.2%. These positive outcomes were achieved through the selection of the optimal configuration of mesh surface

openings in the Mechanical seed (cotton seed) cleaning-type seed cleaning device.

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

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