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IMPACT OF SAW SPACING ON LINT REMOVAL EFFICIENCY AND QUALITY IN THE LINTING PROCESS

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Abstract: This article presents the results of experimental studies conducted in laboratory conditions to investigate the impact of the saw spacing in linting equipment, enhanced with a working gin chamber, on the performance of lint removal and the quality of the obtained lint and lintered seeds. The experiments focus on how different saw intervals affect the productivity and the quality of both the lint and the lintered seeds.

Keywords: improved, linter, saw, spacing, lint removal, productivity, trash impurities.

Introduction. In the linting process, the spacing between the saws is a critical factor that directly influences the performance of the linter, the lint yield, the type and quality of the lint, as well as the proportion of whole seeds and trash impurities. Furthermore, it has a direct correlation with the seed roll density in the chamber and the mechanical damage to the seeds.

Methodology & empirical analysis. For the improved linter, the UMPD working chamber of the gin and the 4DP-130 model gin grates were selected. In the process of separating lint from the seed, the traditional method using a saw cylinder and slotted grate was applied. The experimental linter was developed based on the working chamber of the gin, with a length of 485 mm. On the laboratory stand, the saw spacing in the 5LP linter was maintained at 8.75 mm, with 50 saws installed. When the saw spacing was adjusted to 8.75 mm and 9.75 mm, the number of saws in the working chamber naturally decreased. During the experiments, to ensure that the saw cylinder operates under almost constant voltage and to create uniform conditions for comparing the parameters of the experimental linter, the amount of seed fed into the working chamber is regulated using an ammeter connected to the seed mixer's electric motor circuit. The productivity of the linter is determined by the mass of the seed processed during the test. Subsequently, the density of the seed roll is calculated as the ratio of its mass to the volume of the working chamber.

Results. In the improved linter device, experiments were conducted by maintaining the speed of the seed agitator at 500 rpm and the saw cylinder at 730 rpm. The distance between the seed agitator and the saw cylinder was set at 20 mm, and the distance between the seed comb and the saw cylinder was maintained at 25 mm. To study the impact of saw spacing on lint removal from ginned seeds and the productivity of the linter, tests were carried out by reducing the number of saws on the saw cylinder and

adjusting the saw spacing to 8.75 mm, 9.75 mm, and 10.75 mm. Average samples of lint and seeds were collected, and the following quality indicators were determined in the laboratory:

- the amount of defects and trash impurities in the lint;
- the staple mass length of the lint;
- the degree of mechanical damage to the seeds;
- the complete fuzziness of the seeds.

The introduction of seeds into the linter's working chamber was regulated by the linter's feeder. For each experiment repetition, 50 kg of uniformly fuzzy seeds were used. Each experimental variation was repeated three times. Before starting the experiments on the linter, the necessary adjustments planned for each experimental variant were made. The results of the experimental trials are presented in Table 1.

As seen from the indicators in Table 1, the spacing between the saws in the linter has a direct impact on the linter's productivity, the lint yield, its staple mass length, the amount of trash impurities, the proportion of whole seeds, the density of the seed roll in the working chamber, and the mechanical damage to the seeds.

For instance, when the saw spacing was set to 10.75 mm, the density of the seed roll in the chamber was relatively low, measuring 294 kg/m^3. The residual fuzz on the lintered seeds was 8.2%, which exceeded the standard requirements. Due to the higher residual fuzz on the lintered seeds, the productivity of the linter in terms of lint removal was relatively low, at 4.1%. However, the staple length of the obtained lint was 7/8 mm, which classified it as type "A."

The results of studying the impact of saw spacing on the productivity of the improved linter in terms of lint and seed processing, as well as the quality of the lint and seeds, are as follows:

- Saw Spacing and Productivity: As the saw spacing increased, the productivity of the linter in removing lint from the seeds generally decreased. Larger spacing resulted in lower seed roll density in the chamber and, consequently, less efficient lint removal.

- Lint Quality: The staple length of the lint tended to increase with larger saw spacing, resulting in better quality lint, particularly in terms of staple mass length. However, at wider saw spacing, the presence of residual fuzz on the seeds increased, leading to a higher percentage of uncleaned seeds.

-Seed Quality: Wider saw spacing also led to a greater amount of mechanically damaged seeds and a higher content of trash impurities. The residual fuzz percentage on the seeds rose as the saw spacing increased, which negatively affected the overall seed quality.

In conclusion, while wider saw spacing improved the staple length and quality of the lint, it reduced overall productivity and increased the percentage of residual fuzz on the seeds, indicating a trade-off between quality and efficiency.

Results of Saw Spacing on Linter Performance and Lint Quality:

Table 1.

Indicators	Saw Spacing (mm)		
	8,75	9,75	10,75
On ginned seed: - fuzz percentage	12,2	12,2	12,2
- mechanical damage percentage	2,4	2,4	2,4
After processing in improved linter:			
-trash and whole seed content in lint	6,7	6,9	8,2
Residual fuzz percentage on seed:			
-lint type	B	A	A
-staple mass length (mm)	6/7	7/8	7/8
Linter productivity:			
- seed processed (kg/h)	210	242	258
- lint produced (kg/h)	11,55	12,82	10,32
-lint yield (%)	5,5	5,3	4,0
-seed roll density in chamber (kg/m³)	316	312	294
-number of saws on saw cylinder	50	45	41

When analyzing the improved linter with different saw spacings, we observe the following:

1. Saw Spacing of 8.75 mm:

- Residual Lint Percentage: At this spacing, the residual lint percentage was 6.7%, which meets the standard requirements.

- Lint Quality: The obtained lint had a staple length of 6/7 mm, classified as type "B."

- Productivity: The linter achieved a processing rate of 210 kg/hour. This is 32 kg/hour lower compared to the 9.75 mm spacing variant.

- Impurities and Whole Seed Content. The impurity content and whole seed content in the lint were higher, at 5.7% and 4.93%, respectively. This indicates that the mechanical damage to the seeds was relatively high.

2. Comparison with 9.75 mm Saw Spacing:

- Residual Lint Percentage: The residual lint was slightly lower (by 0.2%) with 9.75 mm spacing.

- Productivity: The linter's productivity increased to 242 kg/hour with 9.75 mm spacing.

- Lint Quality:The lint produced had a better staple length of 7/8 mm, classified as type "A."

- Impurities and Whole Seed Content: With 9.75 mm spacing, impurities and whole seed content were lower compared to 8.75 mm spacing, making it a better option in terms of quality and productivity balance.

Conclusion:

- Optimal Saw Spacing: A saw spacing of 9.75 mm provides a good balance between productivity and lint quality. It offers higher productivity and better staple length of the lint compared to 8.75 mm spacing.

- Trade-offs: Although 8.75 mm spacing meets the standard requirements, it results in higher residual lint and increased mechanical damage. Conversely, 9.75 mm spacing minimizes impurities and improves overall lint quality while maintaining higher productivity.

Conclusions. In summary, for the improved linter, a saw spacing of 9.75 mm is recommended as it offers better performance in terms of both productivity and lint quality, while minimizing mechanical damage and impurity levels.

- while wider saw spacing improved the staple length and quality of the lint, it reduced overall productivity and increased the percentage of residual fuzz on the seeds, indicating a trade-off between quality and efficiency.

- while the 10.75 mm saw spacing yields the highest productivity and good quality of lint with low impurity and whole seed content, it also results in higher residual lint. This indicates that although the linter processes seeds effectively, the residual lint might exceed the acceptable limits set by standards.

Thus, while the 10.75 mm spacing is effective in terms of throughput and maintaining lint quality, it is crucial to balance this with the acceptable residual lint levels. This finding suggests that optimization of saw spacing might be needed to achieve a balance between productivity and meeting all quality standards.

These conclusions ensure that the linter achieves the best average performance indicators and complies with the relevant industry standards.

Based on the conducted experiments, it is appropriate to adopt the inter-tooth spacing of 9.75 mm for the improved linter equipment for future research. This spacing has the most favorable impact on the linter's operational efficiency and the quality of the lint. In subsequent experiments, it is necessary to maintain the inter-tooth spacing of 9.75 mm across all variants.

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CONTENTS