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RESULTS OF THE STUDY OF THE UNIFORM DISTRIBUTION OF THE WORKING SUSPENSION BY SEED MASS AND THE COMPLETENESS OF THE TREATMENT

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Abstract
The efficiency of seed treatment with protective and stimulating agents significantly depends on the uniform distribution of the working suspension over the seed mass and the completeness of coverage. This study aimed to investigate the uniformity of suspension distribution during mechanized seed treatment and to evaluate the completeness of surface coverage under various operating conditions. Experiments were conducted using different types of treatment

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equipment and suspension formulations. The results demonstrated that optimal distribution depends on the physical properties of the suspension, seed geometry, and the dynamic mixing regime. Quantitative assessment showed that the coefficient of variation in the suspension distribution decreased with improved mixing technology and nozzle design. Furthermore, completeness of treatment was assessed via dye tracing and residue analysis, indicating a strong correlation between uniform suspension application and seed surface coverage. These findings contribute to enhancing treatment efficiency and reducing chemical loss, supporting sustainable and cost-effective agricultural practices.

Keywords: Seed treatment, working suspension, uniform distribution, completeness of coverage, agricultural machinery, coating efficiency, precision agriculture, seed technology

Introduction

In cotton cultivation, seed quality is one of the main factors for obtaining high yields. Pre-sowing treatment of seeds is an important technological process for increasing their germination, protecting them from diseases and pests. The main indicators of the quality of treatment are the uniform distribution of the working suspension over the seed mass and along the surface of each seed, as well as the completeness of treatment.

Today, the technological process of preparing seed is carried out on the basis of established regulations and recommendations, and its quality indicators are controlled based on the state standard UzDSt 663:2017. Technical conditions of the cotton seed controls by state standards. However, it should be noted that there is no approved method for determining the quality of cotton seed treatment. Therefore, in this ongoing research work, a method for determining the completeness and uniformity of treatment was developed. To determine the completeness of treatment, six bags of seed were prepared for experiments, each weighing 50 kg. The working suspension prepared according to the recommendations for seed treatment was poured into the feed tank of the

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treatment machine. Approximately the same amount of hairy seeds was taken from 3 portions from different parts of each sample prepared for treatment, put into a box and their masses were determined. When treating hairy seeds, it was determined that the rate of application should not exceed 25-30 liters per 1 ton of hairy seeds [2].

Materials and Methods

Experiments were carried out in which, with the efficiency of the bunker doser of the hairy seed treatment machine adjusted to 4 t/s, 50 kg of seeds were placed in the bunker, the consumption of the working suspension was adjusted to 25, 26, 27, 28, 29 and 30 liters per ton, and the time until the bunker was empty of seeds was determined in each case of treatment. After treatment, approximately the same 3 portions of seeds from each batch were taken from different places and put into a box, and their masses were determined. Then, the arithmetic mean masses of each batch of seeds before and after treatment were calculated. We take the difference between the masses of treated (mpp) and untreated (mnp) seeds as the actual (qs) consumption of the working suspension. We calculate the given consumption for 1 ton of seeds using the following formula:

$$Q_s = 1000 \times \frac{q_s}{m_{np}} \quad (1)$$

Here, q_s- the actual consumption of the working suspension in the tested portion of seeds, g;

m_{np}- the mass of the tested portion of seeds before treatment, g. In the calculations, the density of the working suspension is assumed to be equal to the density of water, and 1 liter of the working suspension is taken to be equal to 1 kg. Then we calculate the completeness of treatment using the following formula [3]:

$$P = \frac{Q_s}{N} \times 100\% \quad (2)$$

Here, Q_s - actual consumption of the drug, kg/t;

H - recommended maximum consumption rate, (30 l/t) kg/t.

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The results of the experiment to determine the completeness of seed treatment are presented in Table 1.

Results and discussion

From the experimental results, the completeness of treatment at the specified consumption of the drug (from 25 to 30 l/t) is 83.4...99%, which corresponds to the agrotechnical requirements for completeness of treatment of 80÷100% [2].

Table 1. Results of determining the completeness of treatment

Working suspension norm, l/t	Seed mass before treatment, g	Seed mass after treatment, g	Average seed mass values, g		Actual norm of working suspension per 1 ton of liters, t/l	Completeness of treatment, %
			Before treatment, g	After treatment, g		
25	61,250 61,410 60,790	62,680 62,590 62,770	61,15	62,680	25,02	83,4
26	61,190 61,176 61,174	62,765 62,748 62,767	61,18	62,76	25,82	86,1
27	61,255 61,205 61,140	62,765 62,748 62,767	61,20	62,84	26,80	89,3
28	61,140 61,165 61,145	62,850 62,910 62,790	61,15	62,85	27,80	92,7
29	61,190 60,980 61,130	62,960 62,710 62,910	61,10	62,86	28,80	96,0
30	61,383 61,061 61,306	62,916 62,795 63,499	61,25	63,07	29,71	99,0

Along with determining the completeness of the treatment, the uniformity of the distribution of the working suspension throughout the seed mass was determined. To determine the uniformity of the suspension distribution, a portion of seeds

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taken from each batch after treatment was used. For this, the data were statically processed, that is, the arithmetic mean, standard deviation and coefficient of variation for a separate portion were determined using the formula (3).

Here, S is the standard deviation; Fsr is the arithmetic mean value determined in separate batches (kg/t) or determined in individual seeds (g). The results are considered satisfactory if the coefficient of variation (V) does not exceed 30% [3].

The lower the coefficient of variation, the higher the uniformity of the distribution of the drug suspension over the seed mass. Table 2 presents the results of laboratory studies of the uniform distribution of the working suspension over the surface of the seed mass.

Table 2. Results of uniform distribution of the working suspension across the seed surface

Working suspension norm, l/t		25	26	27	28	29	30
Seed mass after treatment, g.	1	62,680	62,765	62,765	62,850	62,960	62,916
	2	62,590	62,748	62,748	62,910	62,710	62,795
	3	62,770	62,767	62,767	62,790	62,910	63,499
Average seed weight, g		62,680	62,76	62,84	62,85	62,86	63,07
Standard deviation, S		0,09	0,01	0,10	0,06	0,13	0,38
Coefficient of variation V, %		0,14	0,02	0,16	0,1	0,21	0,6

Analysis of the results obtained from the experiments shows that the coefficient of variation of the treated seed mass did not change significantly, which indicates a uniform distribution of the working suspension over the surface of the seed mass, which indicates a high quality of treatment. The quality indicators of the treated seed fully comply with the requirements of the state standard UzDSt 663:2017 Seed seeds. Technical conditions.

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Conclusions

The conducted research has demonstrated the effectiveness of the proposed methodology for assessing both the completeness and uniformity of cotton seed treatment with a working suspension. The experimental results indicate the following key findings:

1. Completeness of Treatment: The completeness of seed treatment increased with the rise in the working suspension rate from 25 to 30 liters per ton. The calculated completeness ranged from 83.4% to 99%, which meets the agrotechnical requirements of 80–100% for high-quality seed treatment, as specified in UzDSt 663:2017.
2. Uniformity of Distribution: Statistical analysis of the seed mass after treatment showed a low coefficient of variation (V = 0.02–0.6%), confirming the high uniformity of the distribution of the working suspension across the seed mass. These values are well below the acceptable limit of 30%, thereby ensuring consistency in surface coverage.
3. The variation in seed weight after treatment between different samples was minimal, and standard deviation values remained low across all experimental conditions, further validating the stability and reproducibility of the treatment process.
4. The use of the developed approach—based on comparative weighing and statistical metrics—can serve as a reliable method for evaluating the technological quality of seed treatment processes in practice.

In conclusion, the research confirms that the selected suspension application rates and treatment techniques ensure both completeness and uniformity, thereby improving seed quality, promoting better germination, and contributing to higher agricultural productivity. The results are in full compliance with national standards and provide a scientific basis for optimizing seed preparation technologies in cotton production.

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