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Theoretical Substantiation of Parameters of the Cup - Shaped Coating Drums

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ABSTRACT: The article provides information on the principle diagram and principle of of the coating device`soperation of pubescent cotton seeds with a protective-nourishing shell consisting of a suspension of water and mineral fertilizers, as well as the results of theoretical studies to substantiate the parameters of a cup-shaped coating device.

KEY WORDS: pubescent cotton seeds, flowability, circumfiuence, coating, protective and nutritious sheii, devices, cup-shaped drum, suspension, water, mineral fertilizer.

I. INTRODUCTION

It is known that, due to residual fibrillation, pubescent cotton seeds adhere to each other. The latter does not allow them to be sown in an exact way or at a low norm. Therefore, when sowing, the consumption of pubescent cotton seeds is 2-3 times higher than the scientifically based norms of their sowing.

Given the above, scientists have proposed various ways to increase the flowability of pubescent cotton seeds by wrapping them with various protective and nutritional components [1, 2, 3, 4, 5]. However, due to the imperfection of the proposed methods and technicalmeans for their implementation, none of them has found wide application in technological lines for the preparation of sown seeds of agricultural crops.

II.THEORETICAL REASEARCH

Based on this, we, to increase the flowability of pubescent cotton seeds, developed a method and device based on enveloping their surface with a protective and nutritious shell consisting of a suspension of water and mineral fertilizer [6, 7].

Figure 1 shows a schematic diagram of a device for dragging pubescent cotton seeds with a protective-nourishing shell consisting of a suspension of water and mineral fertilizer. It consists of a vertical cylinder 1, conical diffusers 2, nozzles 3, truncated conical collector-collectors 4, a cup-shaped coating drum 5, a receiving hopper 6, an electric motor 7, and a vessel for suspension of water and mineral fertilizer 8.

A device for coating pubescent cotton seeds with a suspension of water and mineral fertilizers works as follows. Using a conveyor belt or auger, downy cotton seeds in a uniform layer, they are continuously fed through the entrance window into the vertical cylinder 1, rather. Seeds falling on the surface of the first conical diffuser 2 are scattered around its periphery and enter the spherical flow of the suspension formed by the nozzle 3. When the pubescent seeds meet with the flow from the suspension, A "fluidized bed of seeds" and the suspension sticks to their surface and with an increase in the mass of seeds they break through the flow of the suspension. The seeds coated with the suspension enter the surface of the truncated cone of the pelletizer-collector 4.When rolling on it, the suspension layer is smoothed out and the seeds are collected in a single stream. This flow of seeds enters the next conical diffuser 2 and the seeds roll

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down along its surface and their surface is smoothed out and dispersed again. The scattered seed stream enters the second spherical layer of the suspension and the process repeats.

He seeds rounded and smoothed with a protective-nutrient coating come out of the lower window of the vertical cylinder 1 and enter a rotating bowl-shaped coating drum 5. Under the action of rotational movement, the pubescent cotton seeds are enveloped with a protective-nutrient coating, consisting of a suspension of water and mineral fertilizer and a smooth layer forms on their surface.

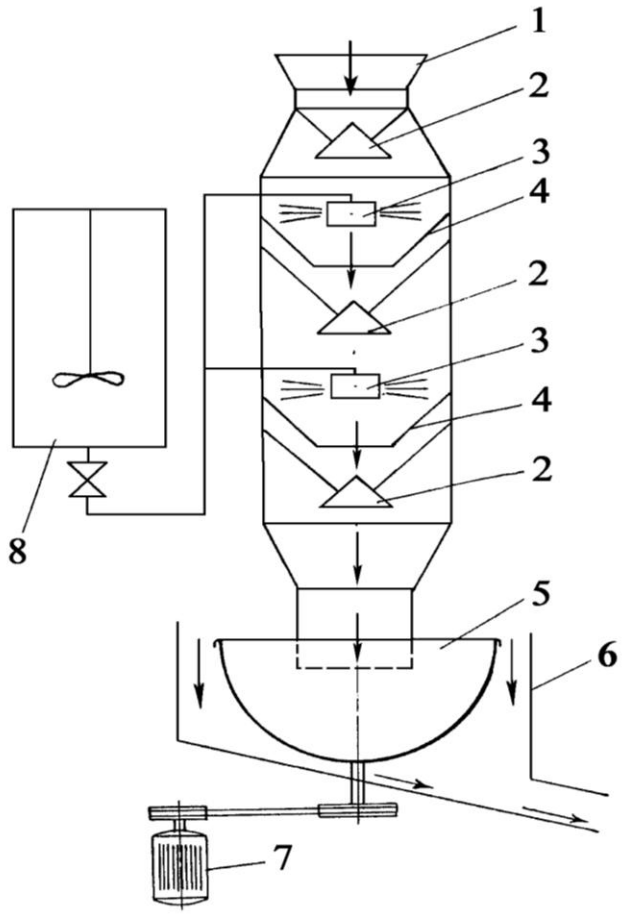

Figure 1. Schematic diagram of a device for coating pubescent cotton seeds with a suspension of water and mineral fertilizers: 1 – vertical cylinder; 2 – conical diffuser; 3 – nozzle; 4 – truncated conical pellet collector; 5 – bowl - shaped drum; 6 – receiving hopper; 7 – electric motor; 8 – vessel for suspension of water and mineral fertilizer

As the volume of the drum 5 is filled and under the action of centrifugal force, the coated seeds are thrown through the bent side into the receiving hopper 6, where they are fed with a conveyor belt for further drying or sowing. A suspension of water and mineral fertilizer is prepared in a special vessel 8 using a mixer with continuous stirring.

In order to qualitatively envelop and ensure a smooth layer on the surface of pubescent cotton seeds with a suspension of water and mineral fertilizers, it is necessary to justify the parameters of a bowl-shaped coating drum. To do this, consider the forces acting on the pubescent seeds located in it.

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III. EXPERIMENTAL RESULTS

Figure 2 shows a diagram of the forces acting on pubescent cotton seeds, enveloped by a suspension of water and mineral fertilizers located at a certain point in a bowl-shaped tantalizing drum.

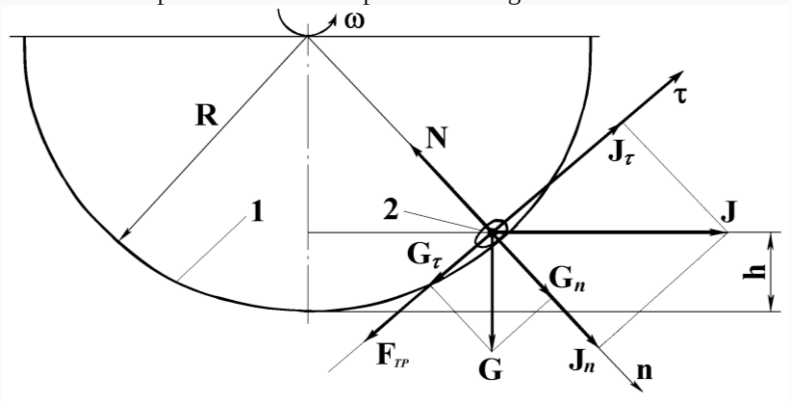

Figure 2. Scheme of forces acting on pubescent seedsof cotton in a bowl-shaped coating pan:

1– cup-shaped coating drum;
2– pubescent cotton seeds;

As follows from figure 2, the following forces act on the pubescent cotton seeds located in the bowl-shaped coating pan:

1. Gravity of seeds G

$$G = mg,$$

where m is the mass of seeds, kg;
g - acceleration of gravity m / s^2.

2. The inertia force J, that occurs when the drum rotates around a vertical axis

$$J = m\omega^2 R,$$

where ω- is the angular velocity of the drum, s^{-1};
R-is the radius of the drum, m

3. The normal reaction force of the drum N.

4. Friction force F_{tp}

$$F_{tp} = fN,$$

where f -is the coefficient of friction of pubescent cotton seeds on the surface drum.

Gravity forces G and inertia J, acting on pubescent cotton seeds are divided into normal and tangential components

$$G_n = G_{\cos\varepsilon} \text{ and } G_\tau = G_{\sin\varepsilon}, \quad (1)$$

as well as

$$J_n = m\omega^2 R\sin^2\varepsilon \text{ and } J\tau = m\omega^2 R\sin^2\varepsilon\cos\varepsilon, \quad (2)$$

where ε - is the central angle, degree.

From the diagram of forces presented in figure 2 follows

and

$$N = G_n + J_n = mg\cos\varepsilon + m\omega^2 R\sin^2\varepsilon \quad (3)$$

$$Ftp = fN = fm(g\cos\varepsilon + \omega^2 R\sin^2\varepsilon) \quad (4)$$

In order for the pubescent cotton seeds to rise upward on the working surface of the bowl-shaped pouch, the following conditions must be met

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$J_t > G_\tau + F_{tp}$. (5)

Substituting the value of the forces J_τ, G_τ, and F_{tp} into expression (5), we obtain the following inequality

$$\omega^2 R \sin^2 \varepsilon \cos \varepsilon > g \sin \varepsilon + f(g \cos \varepsilon + \omega^2 R \sin^2 \varepsilon). \quad (6)$$

Based on the force pattern, from Fig. 2, the values of sinε and cosε are expressed through the radius of the drum R and the seed height h relative to its bottom point, i.e.

$$\sin \varepsilon = \frac{\sqrt{R^2 - (R-h)^2}}{R} = \frac{\sqrt{2Rh - h^2}}{R} \text{ and } \cos \varepsilon = \frac{R-h}{R}. \quad (7)$$

Substituting these values of sinε and cosε into expression (6) we obtain the following expression

$$\omega^2 \sqrt{2Rh - h^2} \cdot (R-h) > g\sqrt{2Rh - h^2} + f\left[g(R-h) + \omega^2 (2Rh - h^2)\right] \quad (8)$$

Introducing the following notation

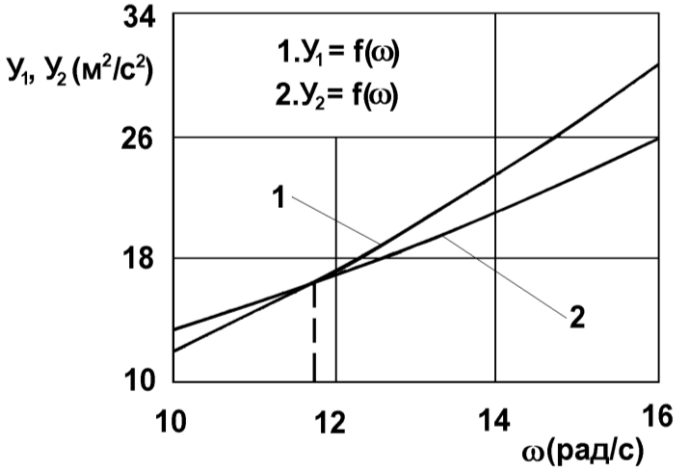
$$y_1 = \omega^2 \sqrt{2Rh - h^2}(R-h) \quad (9)$$

and

$$y_2 = g\sqrt{2Rh - h^2} + f\left[g(R-h) + \omega^2 (2Rh - h^2)\right], \quad (10)$$

and also taking the value f = 0,5 and R = 0,5, expression (8) is solved graphically.

The results are presented in the form of a graph in Figure 3.



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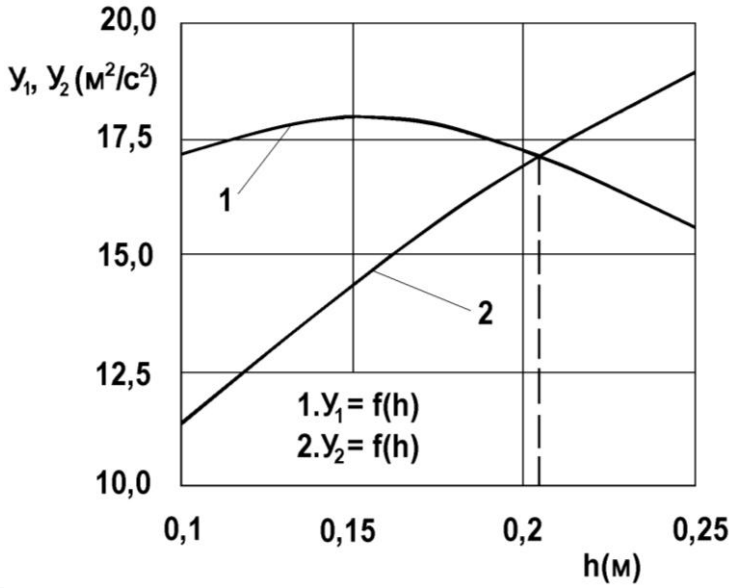

Figure 3. Variation of y1 and y2 depending on angular velocity drum ω (a) and seed height h (b)

IV. CONCLUSION

As follows from the dependency curves in Figure 3, for condition (8) to be satisfied, i.e. to advance pubescent cotton seeds along the working surface of the drum upward, at an angular velocity of 12 s^{-1}, the height of its edge to the bent part should be more than 0.2 m.

Experimental studies on dragging pubescent cotton seeds with a suspension consisting of water and mineral fertilizers have shown that, with justified parameters of the bowl-shaped tantrum drum, a uniform and high-quality protective and nourishing shell with a smooth surface is provided. The latter allows to increase the flowability and resistance of pubescent cotton seeds, to improve the growth and development of plants in the initial period of their vegetation, as well as to increase the productivity of sowing.

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