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# Analysis of the Trajectories of Seeds Falling on an Inclined Guide in the Etching Machine

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**ABSTRACT**: The article presents a design scheme and the principle of operation of an effective design of etched cotton seeds. An analytical method for determining the trajectory of cotton seeds in the fall zone to the inclined guide of the treatment plant is presented. The obtained expressions for definition coordinate trajectory pubescent seeds in potrebitelei machine defines the trajectory of the seed at different values of frequency brasenia toothed drum and the angle of ejection of the seed from sublow drum. The regularities of changing the trajectory of cotton seeds in the zone between the toothed drum and the inclined guide from changes in the rotation frequency of the toothed drum and the angle of seed ejection in the initial zone are constructed. It was found that increasing the coordinate of the seed trajectory along the x-axis leads to an increase in the values of moving the seed along the tray, which is undesirable. Increasing the coordinate on the vertical axis of the seed movement can lead to a significant accumulation of seeds in the zone of entry to the dosage system. The most acceptable is the angular speed of the gear drum (6,0÷6,35) $s^{-1}$, which ensures a more uniform distribution of the seed on the inclined tray of the installation. It is established that the angle of seed ejection in the initial zone leads to an increase in the horizontal component of the initial seed velocity vector. It is recommended that $\alpha=20^0\div30^0$.

**KEY WORDS**: protectant, pubescent seeds, trajectory, coordinate, rotation speed, toothed drum, comb, inclined guide, ejection angle, productivity.

## I.INTRODUCTION

Preparation of seed is mainly made after their etching suspension in special machines. Known seed treater comprising a hopper for seeds communicating with him receiving chamber in which, by means is provided with a counterweight and lever axis is two-piece bucket, and on the drive shaft of a pump mounted yoke, and the lever axis established by the bracket for engagement with the yoke drive shaft of the pump [1]. Disadvantage this treater is the fact that a change in productivity of feed of seeds is impossible to ensure the flow of slurry corresponding to the volume flow of seeds and to provide adjustment of suspension feeding. In addition, the probability of not getting the necessary dose of suspension on the seeds poured out of the bucket increases, which causes their free passage without treatment with pesticides. This reduces the quality of seed treatment.

The etcher is intended for processing only bulk materials. In another well-known seed protectant, containing a seed feeder with a hopper, a seed line, a container for pesticides with a pipeline, and a nozzle (Yubus (Spain) of the D-2-VH brand) [2].

The disadvantage of this etcher is the manual adjustment of the suspension feed. The manual adjustment mode reduces the accuracy of the seed feed to match the slurry flow rate and the performance of the seed feeder. Also, the nozzle installed above the tray does not ensure uniform application of the suspension to the seeds rolling along the tray. With high productivity of the seed feeder, the layer of rolling seeds increases.

## II. MATERIALS AND METHODS

To increase the quality of the process of etching pubescent cotton seeds with a suspension at high productivity, a new [3] effective design was developed (Fig.1).

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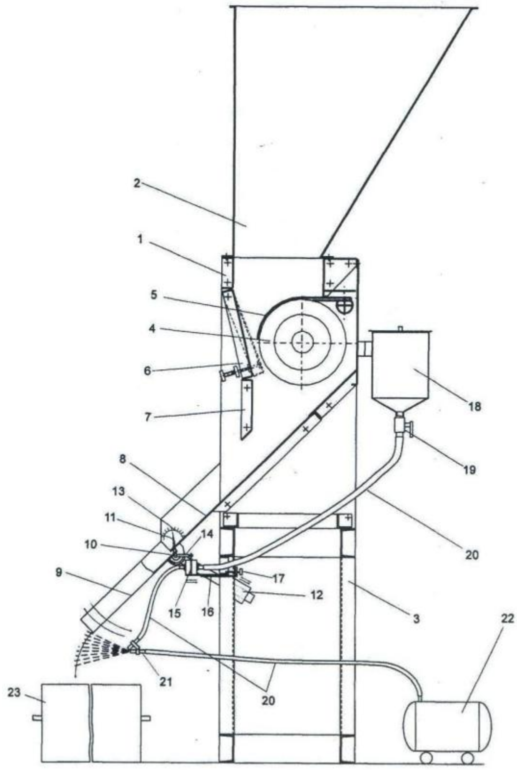


**Fig.1. Seed protectant**

The device contains a feeder 1, including a hopper 2, a frame 3, a feeding drum 4, grate combs 5, a flap 6, a partition 7, and a seed line 8. It is adapted to the oscillating tray 9 with a shaft 10, consisting of an index arrow 11 and a counterweight with a regulating load 12, a scale 13 attached to the sidewall of the rolling tray, a lever 14, a crane 15 with a slide, a bracket 16 of the screw mechanism 17, a container 18 for suspension with a crane 19, hoses 20, a nozzle 21, a compressor 22 and a box 23.

The membership works as follows:

The prepared suspension is fed to the container 18, from where the suspension is fed by a uniform free pressure through the crane 19 to the valve 15. By adjusting the load of the counterweight 12, the oscillating tray with the lever 14, depending on the number of seeds being fed, is communicated with the gate valve 15, attached to the bracket 16 of the screw mechanism 17. The deviation of the arrow on the scale 11 indicates the angle of inclination of the oscillating tray 9, and simultaneously characterizes the rate of consumption of the suspension and the productivity of the seed feeder.

The capacity of the feeder is regulated by raising and lowering the grate combs 5 and adjusting the gap between the drum and the flap 6. Adjustment of the required amount of suspension feed is carried out by moving the valve 15 with the valve closer to the axis of the shaft 10 of the oscillating tray or further from the axis using the screw mechanism 17. The upper part of the valve valve with a hole is hooked on the finger of the lever 14.

The seeds fed from the oscillating tray 9, by their weight acting on the lever 14, open the valve of the crane 15 and provide a supply of suspension, which is sent to the nozzles 21 for spraying on the surface under air pressure supplied through the compressor 22. After passing the seeds, if the tray is empty, it is arbitrarily set to the initial position 0 ($36^0$), while the valve of the crane 15 closes the gap and stops the supply of the suspension. Then the process is repeated.

The use of the recommended device for the etcher increases the quality of seed etching, which in turn ensures high safety and germination of cotton seeds. The device is convenient for setting up by service personnel. The performance of the feeder and the corresponding slurry flow rate in the device can be determined by the index arrow 11 and the scale 13 showing the angles of inclination of the oscillating tray 9 and the corresponding performance of the seed feeder.

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## III. RESULTS AND DISCUSSION

In the recommended design, the seeds are fed to the inclined guide by a toothed cylinder. At the same time, taking into account the initial flight speed of the seeds, they fall on different parts of the guide. It is important to determine the trajectory of seed loss to the inclined plane of the guide from changes in the system parameters.
The calculation scheme for determining the movement of the seed is shown in Fig.2. In this case, the seed is mainly affected by the force of weight and the force of air resistance. To determine the greatest trajectory of the seed movement, we do not neglect the air resistance forces (due to their smallness).

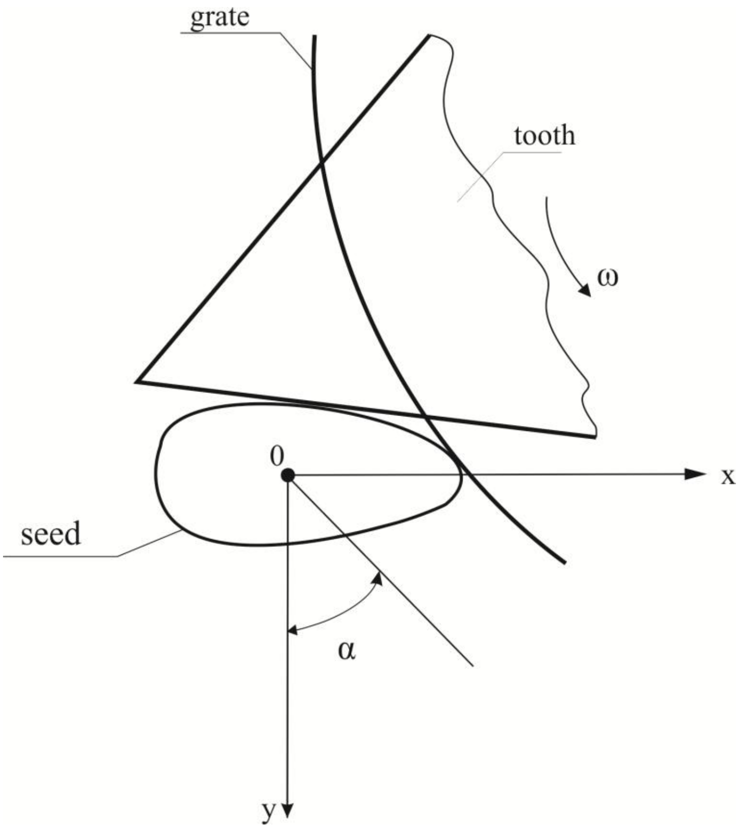


**Fig. 2 Calculation scheme**

Then the system of differential equations describing the movement of the seed has the form [4, 5]:

$$m\frac{d^2x}{dt^2} = 0; \quad m\frac{d^2y}{dt^2} = mg \qquad (1)$$

where, m is the mass of the seed, t is the time, x, y are the coordinates of the movement of the seed; g is the acceleration of free fall.
At the initial moment:

$$x_0 = 0; \frac{dx}{dt} = V_0 cos\alpha; \quad y_0 = 0; \frac{dy}{dt} = V_0 \qquad (2)$$

At the same time

$$V_0 = \omega(R - a) \qquad (3)$$

where, ω-is the angular velocity of the toothed drum; R is the outer radius of the toothed drum; a is the distance from the outer circumference of the drum to the center of mass of the seed.
Having integrated the first equation (1) twice, we get:

$$\frac{dx}{dt} = c_1; \; x = c_1 t + c_2 \qquad (4)$$

Given the initial conditions at t=0 determined by the constant of integration:

$$c_2 = V_0 cos\alpha;\; c_1 = 0$$

Then we get the following solution to the problem:

$$x = V_0 t cos\alpha;\; \dot{x} = \frac{dx}{dt} = V_0 cos\alpha \qquad (5)$$

By integrating the second equation (1) twice, we get:

$$V_y = \dot{y} = gt + c_1';$$

$$y = \frac{gt^2}{2} + c_1' t + c_2 \qquad (6)$$

Taking into account the initial conditions, we define constant integrations according to (2) :

$$t = 0;\; c_1' = 0;\; c_2' = V_0 sin\alpha \qquad (7)$$

Then the solution of the second equation (1) will be:

$$y = V_y = \frac{dy}{dt} = gt + V_0 sin\alpha;\;\; y = \frac{gt^2}{2} + V_0 t sin\alpha \qquad (8)$$

Given that the height of the fall of the seed from the toothed drum to the inclined guide is known (within certain limits), from the second equation (8), it is possible to determine the flight time of the seed:

$$t = \frac{V_0 sin\alpha \pm \sqrt{V_0^2 sin^2\alpha + 2gh}}{g} \qquad (9)$$

Substituting the obtained value of t into the solution (5) we have:

$$x = V_0 \left[\frac{V_0 sin\alpha \pm \sqrt{V_0^2 sin^2\alpha + 2gh}}{g}\right] cos\alpha \qquad (10)$$

The numerical solution of the problem for determining the trajectory of the seed into account the distance from the axis of the drum to the chute design 0,230 m, and in zone damper 0,264 m. Given that the frequency of rotation of a toothed drum, 60 r/m, take α in the range (π/6÷π/4).
The initial linear speed of the seed will be:

$$V_0 = \omega(R - a) = (0{,}734 \div 0{,}740)\, m/s$$

At the same time, R=0,125 m; $a=(5{,}0 \div 6{,}5)\times 10^{-3}$m.

The numerical solution of the problem is presented in the form of graphs, trajectories of the seed movement in the zone between the toothed drum and the inclined tray, which are shown in Fig.3. Analysis of the obtained seed movement trajectories shows that with an increase in the rotation frequency of the gear drum ( Fig.3 a) increases the horizontal component of the trajectory. So, in the first dependence, when the angular speed of the gear drum is 5,6 $s^{-1}$, the trajectory of the seed movement will be nonlinear and reaches the inclined tray at y=0,214 m and x=0,072 m, and at an angular speed of 7,0 $s^{-1}$, the coordinates of the seed on the surface of the inclined tray reach y=0,102 m and x=0,196 m. this means that with increasing the angular speed of the gear drum, the coordinate of the seed trajectory along the horizontal axis increases, and decreases along the vertical axis. It should be noted that increasing the coordinate of the seed trajectory along the X axis leads to an increase in the values of moving the seed along the tray, which is undesirable.

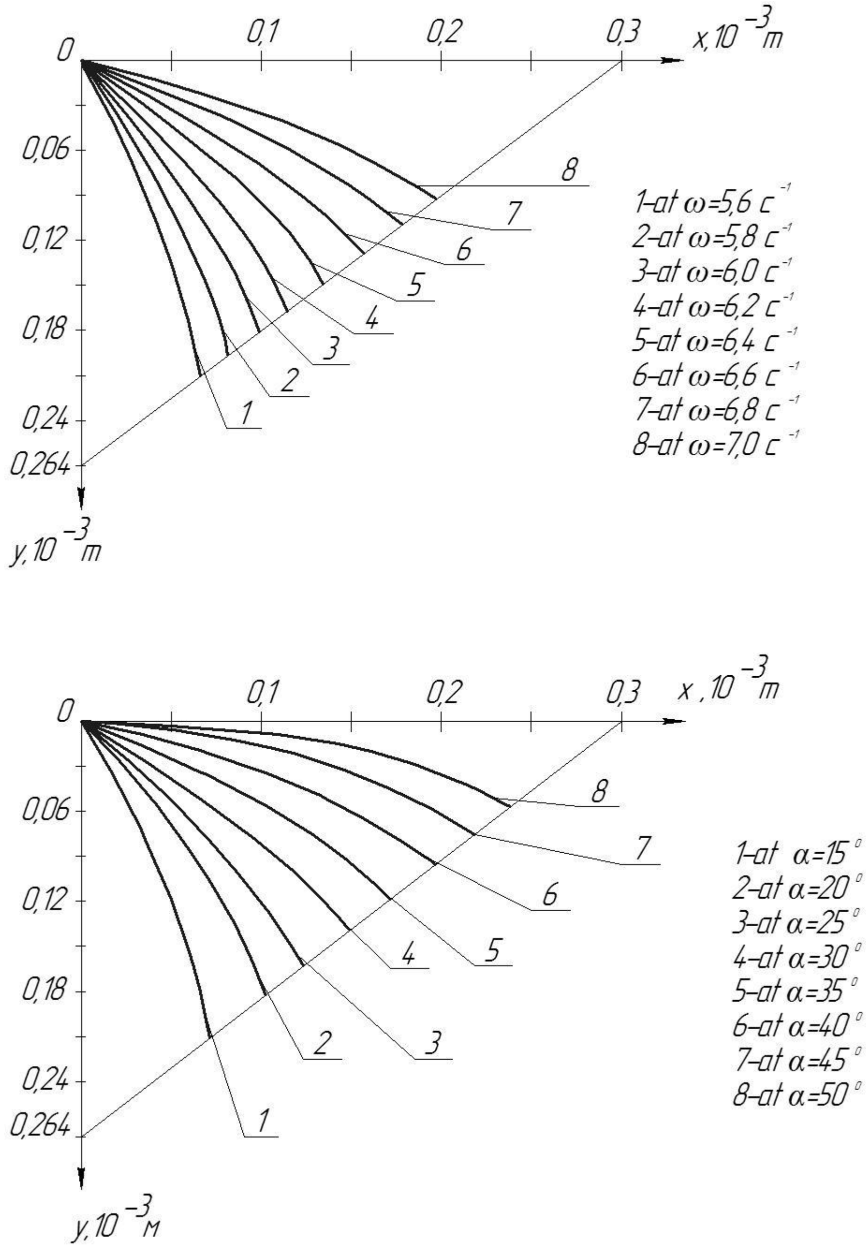


**Fig. 3. The trajectory of the cotton seed in the area between the toothed drum and the inclined tray.**
a - when changing the speed of the gear drum;
b - when changing the angle of ejection of seeds from the teeth of the drum.

Increasing the coordinate on the vertical axis of the seed movement can lead to a significant accumulation of seeds in the zone of entry to the dosage system, which is also not desirable. Therefore, the most acceptable is the angular velocity of the gear drum (6,0÷6,35) $s^{-1}$, which ensures a more uniform distribution of the seed along the inclined tray of the installation [6, 7, 8].

Analysis of graphs in Fig.3 b shows that the increase in the angle of fibrosa seed from the teeth of the drum, sabysachi from the phase location of the tooth leads to an increase in the coordinates of X. Thus, the greater the angle α of emission of semeny, the increased horizontal component of the vector of linear speed of semen at the initial time of emission. To ensure a uniform distribution of the seed on an inclined tray, $\alpha=20^0\div30^0$ is considered appropriate .

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## IV. CONCLUSION

The equations of motion of the seed when falling on an inclined guide are obtained. Formulas for determining the trajectory of seed movement were obtained using the analytical method. Formulas for determining the time of movement of seeds are obtained. The regularities of changing the trajectory of cotton seeds in the zone between the toothed drum and the inclined guide from changes in the rotation frequency of the toothed drum and the angle of seed ejection in the initial zone are constructed. It was found that increasing the coordinate of the seed trajectory along the x-axis leads to an increase in the values of moving the seed along the tray, which is undesirable. Increasing the coordinate on the vertical axis of the seed movement can lead to a significant accumulation of seeds in the zone of entry to the dosage system. The most acceptable is the angular speed of the gear drum (6,0÷6,35) $s^{-1}$, which provides a more uniform distribution of the seed on the inclined tray-installation. It is established that the angle of seed ejection in the initial zone leads to an increase in the horizontal component of the initial seed velocity vector. It is recommended that $\alpha=20^0\div30^0$.

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