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Study of Forces Affecting Sowing Of Bean Seeds

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Abstract:

This article develops the change in the trajectory of the seed flow when sowing legume seeds, the location of the seed on the drum, the forces acting on the seed, the pressure force acting on the falling seed, based on the layout of the seed relative to the side walls of the coil, the friction force of the seed on the surface with the wall of the coil, expressions are given to determine the force that forms the force and the angle of inclination when the seed falls.

Keywords: cell, seeds in the hopper, location of the seed in the reel, side walls of the reel, driving force, angle of deviation of the seed, movement of the seed, size of the seed, pressure force acting on the seed, normal force, effort force.

As you know, the sowing device is recommended for planting granular seeds. Continuous supply materials often fail to meet agricultural requirements due to the instability of overall planting and uneven planting performance between individual devices.

Movement of seeds along the seed canal Vasilenko P.M, Shevchenko I.A, Gevko B.M, Kirova A.A, Manchev A.V, Radugina N.P, Sysolina P.V etc, the methods of calculating the value of the movement speed of seeds in the straight and curved parts of the seed channels and exiting the seed channels are fully described in their scientific works.

In order to evenly distribute the seeds in the planter, the seed entering the spreader must, firstly, have the same path of the seed, and secondly, it must freely reach the top of the hopper. These two conditions are necessary because the non-fulfillment of these conditions (even if it is insignificant) leads to a significant uneven distribution of seeds along the width of the seedling [1]. One of the reasons for the change in the trajectory of the seed flow movement within the seed fall paths is the change in the position of the seed on the reel as the seed deviates by a certain degree from the vertical position during the forward movement of the reel rotation. In this process, the seeds are unevenly distributed across the width of the seed canals during the time of descent. In order to eliminate this shortcoming, it is necessary to make the seed channel equal to $70^{0}$and larger, eliminating all kinds of twists that prevent the movement of seeds in the seed channels. As a result, the quality indicators of the planting system are significantly improved.

A legume seed drill has a reel mounted on the top of the planter, and these reels have slots. During the rotation of the reel, one by one, the seeds in the hopper are placed in the cells. Since the roller moves from the hopper at an angle of α, as it moves away from the bottom of the hopper, the seeds gradually fall out of the slot due to their own weight.

When determining the location of the seed on the reel, the gravity of the seed as shown in the diagram

It is determined by the expression $G = mg$.

Here: m -seed weight, kg;

g -speed of free fall, $\frac{m}{c^2}$

The distance between the seeds in the paddy field is given in question 1.

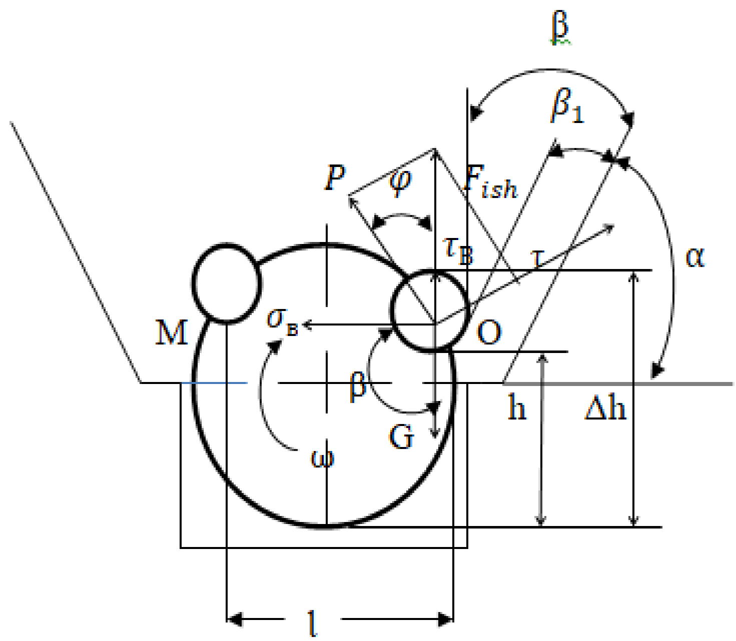

Figure 1. Scheme of arrangement relative to the side walls of the coil.

The normal force acts $P = f \cdot F_{ish}$

Here: f-seed is the coefficient of friction with the wall.

The coefficient of friction is determined when the force F_{max}that moves the material under study from its rest state reaches its maximum value.

As shown in figure 1, the movement of the seed tends to balance with the frictional force $G \cdot \cos\alpha$

Since the seed falls under the slope, the movement of the seeds does not start from the very edge of the reel, so the initial velocity V_0 of the seed can be considered equal to 0.

It can be seen from Figure 1 that the angle of deviation of the seed must be greater than or equal to the angles of friction on its upper and lower surfaces:

$\alpha \geq \varphi + \beta$

where: φ is the friction angle of the upper seed returner;

β is the friction angle formed due to the mutual contact of the upper and lower seeds.

When determining the movement of the seed, the following points can be taken into account:

1. When the seed is moving, the air resistance forces are not taken into account, because it is due to the friction force and the speed of the seed movement is relatively small during the movement along a rather inclined plane.
2. Since the seed dimensions are the difference between $a \succ b \succ s$, the friction force of the seed is not taken into account.
3. The mass of the seed is concentrated in its center of gravity [10.44-p]

$G_n = G\cos\varepsilon$ and $G_\tau = G\sin\varepsilon$ (5) [8. 247-p]

Thus, the quality of seeding during sowing is considered the main indicator of the seeding apparatus and affects the uniformity of seed placement in terms of seeding distance and depth. It should be noted that the speed of seed falling along the contact surface of the reel wall is constant.

If the angle of inclination b of the seeds located in the seed slots on the reel is variable, then the speed of the seed falling depends on its contact surface with the reel wall. Therefore, if $\beta = 0$, then the seed's falling speed is also equal to $V_{\text{yp}} = 0$ at this point of the coil.

If we analyze the above picture, the pressure force P acting on the falling seed during the movement of the seed is determined by the following equation:

$P = F_{ишк} cos\beta$ (6)

It can be seen from the expression that as the angle β increases, the speed of seeds falling also increases. If the angle β is constant, the pressure force will be constant regardless of the contact surface between the roller and seed surfaces.

It can be seen from the formula (1) that an increase in the angle b leads to an increase in the force P , and vice versa, if the angle decreases, the force decreases. It can be seen from figure 1 that the friction force is at the point M in the initial position of the seed, and it comes to the point O due to the rotation of the reel. The force of friction of the seed on the surface of the roller with the wall

is defined by expression.

$$F_{ишк} = mgtg\beta_1$$

Here: m - is the mass of the seed grain;

g - acceleration of free fall;

β_1 is the friction angle of the seed on the roller wall.

The direction of the frictional force generated during the movement of the seed on the surface of the reel is opposite to the direction of the speed of the reel. We divide the power F_{isq} into normal and effort forces directed through the point of contact with the working surface of the coil.

The normal force $F_{isq}\cos\alpha$ uses the reaction force P acting on the grain of the seed. Based on these considerations, the following expression can be written to determine the reaction force.

$P = F_{isq}\cos\beta$ (7)

The force that forms the attempt

$\tau = \tau_{в}\sin\beta$ (8) [11.61-p]

The driving force t causes the seed grain to slide along the surface of the reel. Therefore, in order for the seed to move when it is in contact with the surface of the reel, the following equation must be fulfilled.

$F_{ишк} = m \cdot g \cdot tg\beta_1$ (9)

From the above expression, it can be seen that $\alpha \succ \varphi$ is equal.

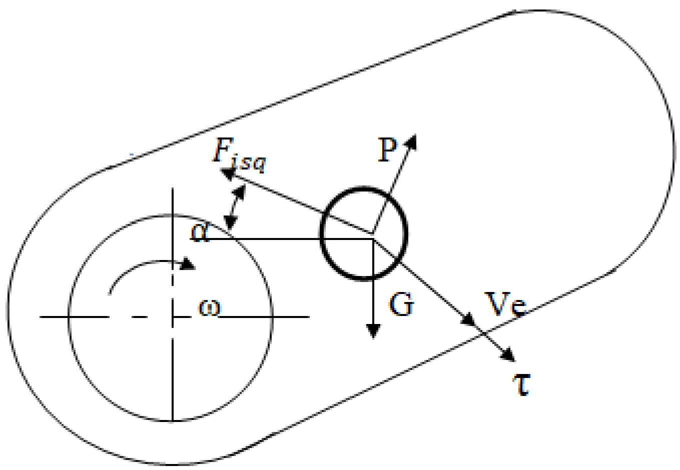

Figure 2. Seed movement detection scheme.

The following conditions should be taken into account when analyzing seed movement.

1. After the seed leaves the cell, due to its weight m, a force F_{isq} is generated, which is opposite to the movement of speed F_e.
2. A mg motion occurs as the seed falls off the spool.
3. The movement of the seed is determined by the following expression.

$ma = F$

Here: m -seed weight;

$a -$ seed movement rate.

It can be seen from figure 2 that the force F is equal to the sum of all acting forces and is opposite to the OX axis, which plays a key role in moving the seed from the seed slot on the reel. The force F affecting the movement of the seed is equal to the sum of the following forces.

$F = P + G + F_{isq}$ (10)

From expressions 8, 9 and 10, the speed of seed movement can be determined as follows.

$$ma = mg \cdot tg\beta_1 + mg + mg \cdot tg\beta_1 \quad (11)$$

11 expressions can be written as follows.

$$a = g(2tg\beta_1 + 1) \quad (12)$$

Taking into account that $a = \dfrac{dV}{dt}$ [10.54-p], we write the equation in the following differential:

$$\frac{dV}{dt} = g(2tg\beta_1 + 1) \quad (13)$$

Multiply both sides of the equation by dt. After integration, we get the following equation:

$$V = at$$

When the seed moves from point M to point O (fig. 1), its speed changes as follows.

$$V_e = at + V_m \quad (14)$$

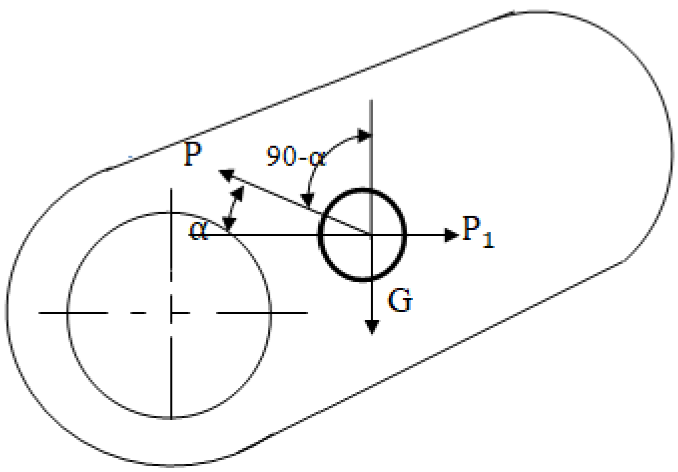

Figure 3. The scheme for determining the slope angle of the seed falling channel.

The balance equation of the forces of the projection of the movement of the seed on the coordinate axes is expressed by the following equation:

$$P \cdot \cos\alpha - P_1 = 0 \quad (15)$$

$$P_1 \cdot \cos\alpha - G = 0 \quad (16)$$

From this it becomes equal to $P = \dfrac{P_1}{\cos\alpha}$

From these expressions, the angle of settling of the seed in the seed slot on the slope of the OX axis and the reel rotation in the state caused by the non-stop movement of the seeds and their sliding along the lower part is made if the angle α is greater than the angle of friction of the seed (fig. 3).

$$tg\alpha \succ f$$

Here: f -coefficient of friction.

Since the coefficient of friction f is equal to 0.25...0.90 in seeds and plastic materials, the angle of inclination of the nest where the seed falls is $\alpha = 5 \ldots 10^0$.

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