Justification of the Cross-Sectional Profile of the Grooves

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Abstract

The parameters of each level groove wall angle ɣ providing a first reflection of seed cotton from the wall and hititin the center of the groove that ultimately provides quality seed placement in the groove depth of seeding.

Keywords: opener groove slope, reflection, Kв-coefficient of restitution

An important link in the process of precision seed cotton see dislaying them in the grooves or covering soil. If the seed planter apparatus functions as uniform supply of seeds, the opener provides uniform stacking them in the groove[1].The higher Even supply of seed, the more important the second operation. Therefore, we propose the following hypothesis: to fulfill the requirements for agricultural seeding cotton possible by studies of the transverse profile grooves formed opener. [3] In the fall of cotton seed in a wedge-shaped groove of the probability of hitting exactly at its bottom is very small, because the seeds after ejecting the disc fly as group, with a width of about 4 cm So as seeds fall to the bottom of the groove and on its slopes, and hit the opener cheek . In each of these cases the seeds are reflected differently.

In this regard, it was assumed that for nests minimum length and width must be shaped cross-section grooves in which the seed is reflected from any point on its slope it, would fall right on her bottom. The experiments revealed that the seeds striking the bottom and sloping grooves recorded in the direction of motion of the drill, and with cheeks opener, on the contrary. [2]Assuming that the seeds fall on the slopes grooves at an angle to the horizon ɣ speed Vn, we assume that the directions of the velocity vector expressed angleβn. HereVn speed and angle of incidence βn different from the previous case. This is due to the fact that the seeds can fall at any point slope adjustment grooves. If the seeds fall to the bottom of the groove, the drop height is equal to H, and in the event of a fall on the slope, the drop height is equal to H1 = H-hi, hi-where the distance from the point of impact to the bottom of the groove (Fig. 1). Named values indexed :Vn 'and βn'. Their numerical values can be defined by the expressions (1) and (2) the corresponding values of H1.

$$\vartheta_n = \sqrt{\left(\frac{\vartheta_л}{\lambda}\right)} \cdot [(\lambda - cos\alpha) + sin\alpha] + 2gH \quad (1)$$

$$\beta_n = \text{arctg}\frac{\vartheta_{л}\left(\frac{1}{\lambda} - cos\alpha\right)}{\sqrt{2gH + \vartheta_л^2} sin^2\alpha} \quad (2)$$

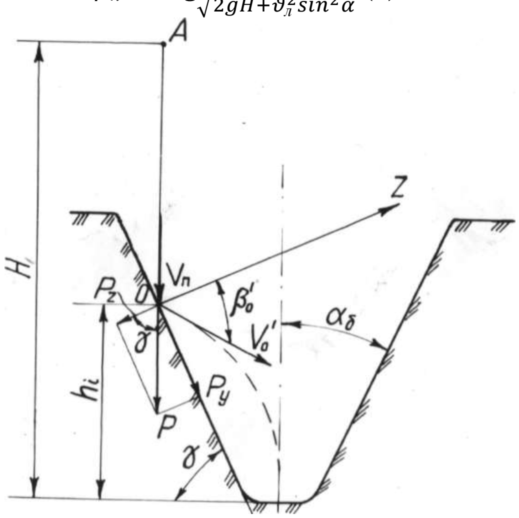

Figure 1.Scheme to substantiate cross-sectional profile grooves.

Consider the reflection of the seeds in detail (Fig. 2). Here, the rate of fall of seeds AC Vn, angle <CAB βn ', AB-vertical velocity component Vn', Sun-horizontal velocity component Vn ',< ABD=90-ɣ-angle between the vertical velocity component Vn 'and the plane of the slope furrows, AD-grooves perpendicular to the wall (slope).

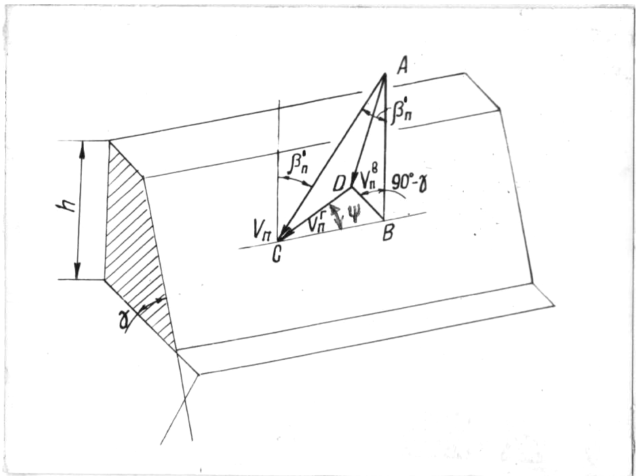

Figure 2. Scheme to determine the angle of incidence on the slope of seed furrow

It follows from the construction of the angle βn ''= <CAD is the angle of incidence on the slope seed furrow.
The angle βn ''of a right triangle ABC is lound:

$$AB=AC\ \cos\beta_n^1=\vartheta_n^1 cos\beta_n^1 \quad (3)$$

$$BC=AC\ \sin\beta_n^1 = \vartheta_n^1 \cdot sin\beta_n^1 \quad (4)$$

Of a right triangle have an AED:

$$АД=AB\sin(90\text{-}\gamma)=AB\cos\gamma = \vartheta_n^1 cos\beta_n^1 cos\gamma \quad (5)$$

$$ВД=AB\cos(90\text{-}\gamma)=AB\sin\gamma = \vartheta_n^1 cos\beta_n^1 sin\gamma \quad (6)$$

From the triangle ВСД have:

$$ДС=\sqrt{BC^2 + ВД^2} =\vartheta_n^1\sqrt{sin^2\beta_n^1} + cos^2\beta_n^1 \cdot sin^2\gamma \text{and} (7)$$

$$tg\beta_n^{11} =\frac{ДС}{АД}=\frac{\sqrt{sin^2\beta_n^1+cos^2\beta_n^1 \cdot sin^2\gamma}}{cos\beta_n^1 \cdot cos\gamma} (8)$$

Thus, the angle of reflection for this will be:

$$\beta_o^{11}= \text{arctg}\left[\frac{1-\mu}{K_в}\frac{\sqrt{sin^2\beta_n^1+cos^2\beta_n^1 \cdot \sin^2\gamma}}{cos\beta_n^1 \cdot cos\gamma}\right] (9)$$

From the triangle ACD follows also:

$$sin\beta_n^{11} = \frac{СД}{AC} = \sqrt{sin^2\beta_n^1 + cos^2\beta_n^1 sin^2\gamma} \quad (10)$$

$$cos\beta_n^{11} = \frac{АД}{AC} = \cos\beta_n^1 \cdot cos\gamma \text{and } (11)$$

$$\vartheta_n^{1в}=АД=\vartheta_n^1 cos\beta_n^1 \cdot cos\gamma (12)$$

And according to the equation (7)

$$\vartheta_n^{1г}=СД=\vartheta_n^1\sqrt{sin^2\ \beta_n^1 + cos^2\beta_п^1 \cdot sin^2\gamma} \quad (13)$$

Then, as in the previous one, the velocity components of the reflection will be:

$$\vartheta_o^{1в}=K_в \cdot \vartheta_n^1 \cdot cos\beta_n^1 \cdot cos\gamma \text{and} (14)$$

$$\vartheta_o^{1г}=(1\text{-}\mu) \cdot \vartheta_n^1 \cdot \sqrt{sin^2\beta_n^1 + cos^2\beta_n^1 sin^2\gamma} (15)$$

The latter with the line of the slope angle of the grooves is ψ, which, as follows from the triangle and the BCD according to (6) and (7), is:

$$< ВСД = \varphi = arctg\frac{ВД}{ВС} = arctg\frac{cos\beta_n^1 \cdot sin\gamma}{sin\beta_n^1} = arctg\left[\frac{sin\gamma}{tg\beta_n^1}\right]. \quad (16)$$

In addition, from the same triangle, based on the expressions (6) and (5), follows:

$$\sin\varphi = \frac{ВД}{ДС} = \frac{cos\beta_n^1 \cdot sin\gamma}{\sqrt{sin^2\beta_n^1 + cos^2\beta_n^1 \cdot sin^2\gamma}} \quad (17)$$

and on the basis of (2) and (5)

$$\cos\varphi = \frac{ВС}{ДС} = \frac{sin\beta_n^1}{\sqrt{sin^2\beta_n^1 + cos^2\beta_n^1 \cdot sin^2\gamma}} \quad (18)$$

Next, based on the expressions (14), (15) and (16) we make the appropriate structure and define the velocity vector Vo'naaxes will be expressed:

$$\vartheta_{oz}^1 = \vartheta_o^{1в} = K_в \cdot \vartheta_n^1 cos\beta_n^1 \cdot cos\gamma \quad (19)$$

$$\vartheta_{oy}^1 = \vartheta_o^{1г} \cdot sin\varphi = (1-\mu) \cdot \vartheta_n^1 \cdot cos\beta_n^1 \cdot sin\gamma \quad (20)$$

$$\vartheta_{ox}^1 = \vartheta_o^{1г} \cdot cos\varphi = (1-\mu) \cdot \vartheta_n^1 \cdot sin\beta_n^1 \quad (21)$$

The strength of the weight mg, naturally directed vertically downward, and its components are directed along the axes coordinates will be:

$$P_z = -mg \cdot cos\gamma \quad (22)$$

$$P_y = mgsin\gamma \quad (23)$$

$P_x = 0$ (24) Then the differential equations of motion have the form of a seed:

$$m\ddot{z} = -mg \cdot cos\gamma \quad (25)$$

$$m\ddot{y} = mgsin\gamma \quad (26)$$

$$m\ddot{x} = 0 \quad (27)$$

After integration of this system, we obtain

$$\dot{Z} = -gcos\gamma \cdot t + C_1, \; Z = -g\frac{t^2}{2}cos\gamma + C_3.t + C_2, \quad (28)$$

$$\dot{У} = -gsin\gamma \cdot t + C_3, \; У = -g\frac{t^2}{2}sin\gamma + C_3.t + C_4 \quad (29)$$

$$\dot{X} = C_5, \quad X = C_5 \cdot t + C_6 \quad (30)$$

At t = 0, Z = 0, Y = 0, X = 0

$$\dot{Z} = K_B\vartheta_n^1 \cdot cos\beta_n^1 \cdot cos\gamma \quad (31)$$

$$\dot{У} = (1-\mu)\vartheta_n^1 \cdot cos\vartheta_n^1 \cdot sin\gamma \quad (32)$$

$$\dot{X} = (1-\mu)\vartheta_n^1 \cdot sin\beta_n^1 \quad (33)$$

The constant coefficients will be:

$$C_1 = K_B \cdot \vartheta_n^1 \cdot cos\beta_n^1 \cdot cos\gamma, \quad C_2 = 0$$

$$C_3 = (1-\mu)\vartheta_n^1 \cdot cos\beta_n^1 \cdot sin\gamma, \quad C_4 = 0$$

$$C_5 = (1-\mu)\vartheta_n^1 \cdot sin\beta_n^1, \quad C_6 = 0 \quad (34)$$

The equations of motion take the form of seeds:

$$Z = -g\frac{t^2}{2} \cdot cos\gamma + K_B \cdot \vartheta_n^1 \cdot cos\beta_n^1 \cdot cos\gamma \cdot t \quad (35)$$

$$У = g\frac{t^2}{2} \cdot sin\gamma + (1-\mu)\vartheta_n^1 \cdot cos\beta_n^1 \cdot sin\gamma \cdot t \quad (36)$$

$$X = (1-\mu)\vartheta_n^1 \cdot sin\beta_n^1 \cdot t \quad (37)$$

Consider the motion of the seed furrow across the plane. For this equation (36) in the form:

$$\frac{2У}{gsin\gamma} = t^2 + (1-\mu)\vartheta_n^1\frac{2}{g}cos\beta_n^1 \cdot t$$

Hence

$$t = \sqrt{\frac{2У}{g \cdot sin\gamma} + \frac{(1-\mu)^2}{g^2} \cdot \vartheta_n^{12} \cdot cos^2\beta_n^1} - \frac{1-\mu}{g}\vartheta_n^1 \cdot cos\beta_n^1 \quad (38)$$

Next, substituting (38) into (35) we obtain the equation of motion in the form of seed:

$$Z=-\frac{g cos\gamma}{2}\left[\sqrt{\frac{2У}{g sin\gamma}+\frac{(1-\mu)^2}{g^2}\cdot\vartheta_n^{12}\cdot cos^2\beta_n^1}-\frac{1-\mu}{g}\vartheta_n^1\cdot cos\beta_n^1\right]^2+$$

$$+\left[\sqrt{\frac{2У}{g sin\gamma}+\frac{(1-\mu)^2}{g^2}\cdot\vartheta_n^{12}\cdot cos^2\beta_n^1}-\frac{1-\mu}{g}\vartheta_n^1\cdot cos\beta_n^1\right]\cdot K_B\vartheta_n^1\cdot cos\beta_n^1\cdot cos\gamma \quad (39)$$

For this equation, assume that Ƶ = 0. Then, after an appropriate transformation we obtain

$$У=\frac{2K_B}{g}[K_B+(1-\mu)]\cdot\vartheta_n^{12}\cdot cos^2\beta_n^1\cdot sin\gamma \quad (40)$$

This equation determines the range of seed after hitting a side wall, ie, the axis oy. An analysis of this equation, the range depends on the seed kV, μ, Vn, βn and ɣ, and Vn and βn by (1) and (2) depend on λ, α and H. Since λ and α discussed earlier, and HF and μ are constant, there is a particular interest of H and ɣ. (40) that for fixed ɣ, seed range is greater, the greater the H1. This is due to an increase in the rate of fall of semen, which leads to a corresponding increase intherate of its reflection. Obviously, the seeds will be set in concentration if they are independent of the levels of impact with the wall of the groove fall on her bottom from the first reflection, not a second of hitting the slopes. This requires that the flight path of the reflected seed pass through the bottom of the grooves. This can be achieved by changing the angle that ɣ tilt wall grooves. Further taking hi = 5 1cm intervals decided (39) and (40). Thus found for each level of the angle ɣ providing the above conditions, by constructing a trajectory seed. Profile constructed grooves shown in Fig. 3, which shows that each level (hi) corresponds to the angle ɣ. The average value of the latter is ɣ = 74^o. Naturally, the creation of a working body, capable of forming a groove, is a difficult task. Is due not only to the complexity of manufacturing, but also the fact that itscurved portion is more prone to sticking to the ground and now the trend of тhedesign aims to create a wedge-shaped groove forming openers.

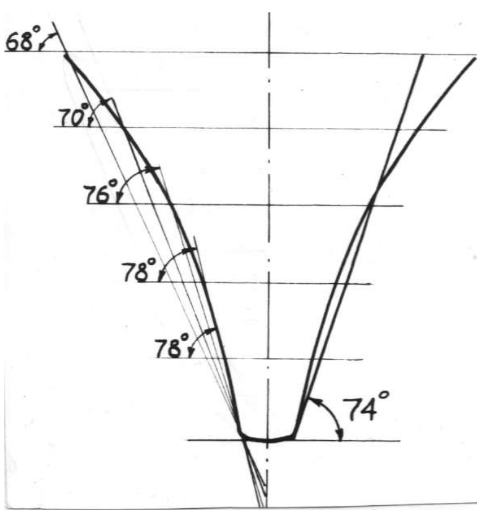

Figure. 3. Profile cross-section grooves

In this regard, it can be concluded that the preferred was flat (straight) wall. On that basis we made the average angle ɣ = 74^o. In this cross-sectional shape of the groove gets close to the wedge with the following parameters: the angle of repose ɣ = 74^o, the width of the grooves on the surface V = 4.0 cm, the width of the bottom of the I0 .... I2, depth h = 5 cm.

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