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Article

Two Parameters of The Sewer Base

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Abstract: Considering that the designs of existing seed machine coulters are not suitable for sowing wheat seeds in between the cotton rows, a new streamlined coulter design has been proposed. The article presents the results of studies to substantiate the parameters of the coulter while it's working in between the cotton rows, taking into account its interaction with the soil. Dependencies are obtained to determine the entry angle of the coulter's knife into the soil, the curvature radius of the knife's front, the sharpening angle of the knife's front, and the resistance force of the coulter's knife.

Keywords: between the cotton rows , wheat sown , seeder , " streamlined form " coulter, manyrow sowing, edge of coulter, radius of curvature, angle of bevel

Introduction

There are planters with different constructions that plant the seeds of various plants [1], [2]. They are mainly intended for planting seeds in open areas.

In order to select seeders for planting between cotton rows, seeders for sowing vegetables and pulse crops were also analyzed [3], [4], [5], [6], [7]. As a result, it was concluded that the design and overall dimensions of the planters intended for open fields are not adapted to their use between cotton rows.

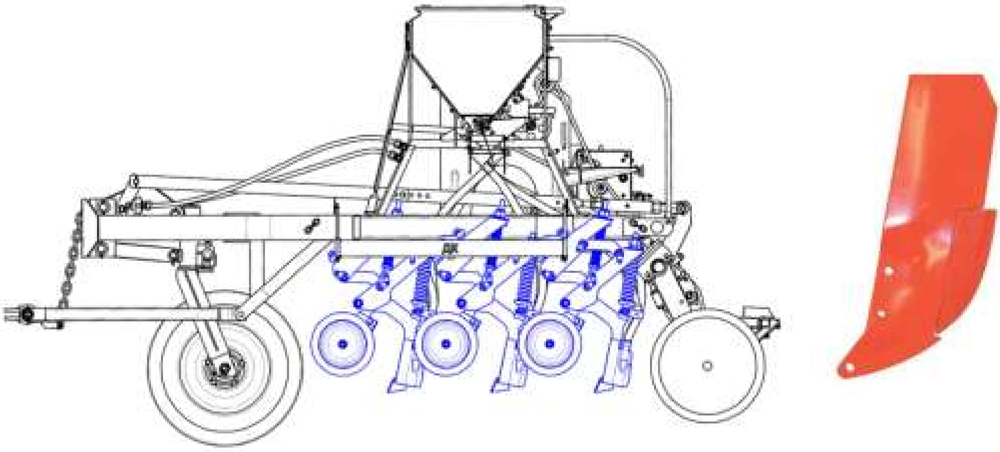
Along with the above, planters intended for use in cotton rows were also studied [8], [8], [9]. Although the design of these planters is adapted to work between rows, they have some shortcomings in performing the tasks assigned to the planters. Taking into account the above data, the design of a planter was selected that would sow grain seeds in multiple rows between cotton rows at the required level and qualitatively perform the task assigned to them, Figure 1. This planter was called a “rooted” planter because of its high rooting ability.

This type of cultivator differs from others in that the sharpening angle of the coulter's blade is the same as the sharpening angle of the blade, so the blade is understood together with the blade, and since the width of the blade base is the same as the width of the coulter, it pushes the soil (including weed residues) to both sides, clearing the way for the coulter.

Materials and Methods

Purpose of work. Basing the optimal values of the parameters and gauge dimensions of the selected "anchor" shaped planter in order for the planters to fully fulfill the tasks set before them, to increase the quality of planting and to reduce the drag resistance of the planter.

Solution: To justify the optimal parameters of the planters, their relationship with the soil is taken into account, taking into account the physical and mechanical properties of the soil, namely, its density, resistance to volumetric compaction, resistance to crushing of the soil surface under pressure, and angles of frictional resistance.



A) Б)

Figure 1. The structure of the "anchor" shaped planter

The parameters of the "anchor" type seeder are: the angle of immersion of the seeder blade into the soil - α , the radius of curvature of the seeder blade -R, the angle of sharpening of the coulter - $2\beta^1$, the constructive angle of sharpening of the seeder - 2β, the drag resistance of the seeder. Seeders with correctly selected parameters perform the tasks assigned to them qualitatively. This also leads to an increase in productivity [10].

Results and Discussion

Determining the angle of penetration of the "Ankirli" type seeder into the soil and its radius of curvature . The blade of this seeder differs from the blade of other seeders. In this case, the width of the blade base is equal to the width of the seeder.

During movement, weeds, first of all, meet the coulter blade at a height h above the sowing depth, that is, at the soil surface. In the "ankirli" type coulter, since the width of the base of the sharpening angle of the blade is equal to the width of the coulter base, it not only cuts the weed residues, but also pushes them to both sides, opening the way for the coulter to move. If it does not have time to cut, the coulter pushes them down and passes over them. In other coulters, plant residues are only cut with the blade or pushed down, but not pushed to both sides.

Therefore, considering whether the part of the coulter blade that touches the soil surface acts on weeds or soil particles with a normal force N, we divide it into two components, namely the force T and the force P acting along the blade, Figure 2.

In that case $$T = \frac{N}{\sin\alpha}; \quad P = Ntg\left(\alpha - \frac{\pi}{2}\right) \quad (1)$$

Here α - the angle of immersion of the plow blade into the soil, grad.

During movement, P>F must be present to ensure that the plant debris slides along the blade. In this case,

$$P = Ntg\left(\alpha - \frac{\pi}{2}\right) > F = Ntg\varphi \quad (2)$$

Here, φ is the angle of friction of the seed material with plant residues, grad. Then from inequality (2) we have the following

$$\alpha > \frac{\pi}{2} + \varphi (3)$$

If we take into account that in practice φ-30 [0] ...35 [0] , we get that α>120 [0] is greater than. The force T acting in the direction of the axis can subsequently be included in the resistance forces.

The radius of curvature of the blade . This radius is equal to [11] according to the form in Figure 2

$$R > \frac{N}{1 - \sin\alpha} \quad (4)$$

According to agrotechnical requirements, it is recommended to sow grain seeds to a depth of 3...8 cm [12]. Assuming this value as h $_0$ =4 cm, and taking into account that the angle of immersion of the seeder into the soil is α=120 ^{0} , we determine the value of R using the above expression as R=28.5 cm.

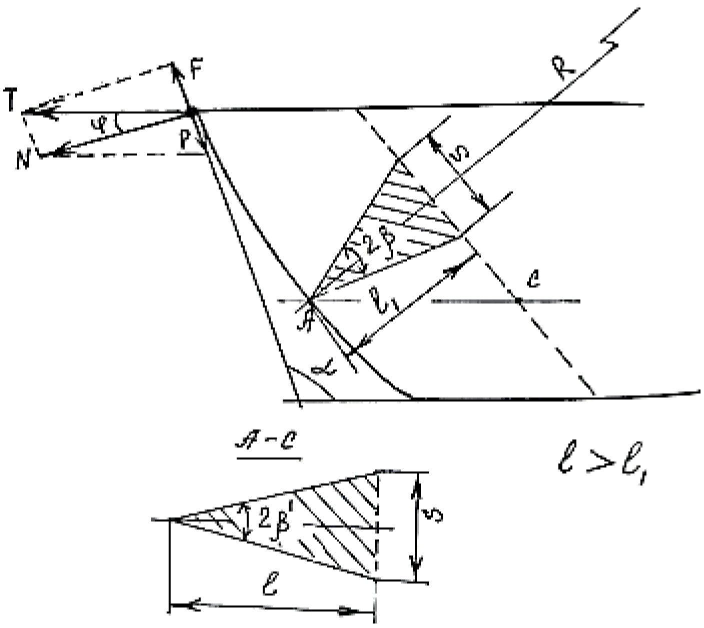


Figure 2. Schemes for determining the constructional and sharpening angles of the chest blade .

Angle of sharpening of the chest blade 2β [1] . This angle is usually determined based on the condition that there is no soil mound in front of the coulter and that the soil is scattered to a certain extent in both directions [13], [14]. In this case, we call the determined angle of sharpening the standard (optimal) angle and denote it by 2β ^{1} $_{opt}$.

But the "anchored" shape is defined by the condition that the angle of sharpening the blade of the coulter gently slides along the sides of the coulter without splashing the soil in both directions. In this case, the soil is only deformed on both sides of the tiller. In this condition, the sharpening angle 2b ^{1} is smaller than the optimal angle 2b ^{1} $_{opt}$, i.e.

$$2\beta^1 < 2\beta^1_{onm}$$

Therefore, to determine 2β $2\beta^1_{onm}$ ^{1} , it is necessary to determine the amount of . To do this, the soil particles acting on the side of the acute angle move at a speed V $_a$ along the direction of the equal action of the friction force and the normal forces [15]. The constituent of this speed V $_k$ determines that the soil does not accumulate and stick to the sides of the acute angle, and it also splashes in both directions. Its expression is determined as follows.

$$V_k = V\frac{\sin\beta^1{}_{onm}}{\cos\varphi}\cos\left(\beta^1{}_{onm}+\varphi\right) \quad (5)$$

Here, φ is the friction angle, degrees.

To determine the optimal value of the angle of refraction, we take the derivative of the expression with respect to $\beta^1{}_{opt}$, set the result to zero, and determine the optimal value of $\beta^1{}_{opt}$ *for the practical values of the friction coefficients* ($\varphi=25^0$ and $\varphi=35^0$), i.e. . Thus, the angle of refraction β $2\beta^1_{onm}=54^0...66^0$ 1 of the "anchored" type of coupling can be taken in the range $\beta^1=17^0...25^0$ ($2\beta^1=34^0...50^0$), taking into account that the optimal value of this angle is less than $\beta^1{}_{opt}$.

The constructive sharpening angle 2b of the Ekkich knife is determined by the following expression [16], [17].

$$tg\beta = tg\beta^1\cdot\sin\alpha \quad (6)$$

If we solve this expression with respect to b, we get the following, i.e

$$2\beta = arctg\frac{tg\left(\frac{\pi}{2}-\varphi\right)}{\sin\alpha}. \quad (7)$$

$\alpha=120^0$ and $\varphi=35^0$ into the obtained expression, we find that the constructive sharpening angle of the blade is equal to $2b=54^0$.

Determining the possibility of the seeder sinking to the planting depth under its own weight . It is desirable that the seeder sinks to the planting depth under its own weight. If this does not happen, an external force must act on it. This leads to some complexity of the design. In previous studies, the vertical pressure force P_s required to sink the seeder to the planting depth was determined, i.e. its value is $P_s = 25$ *N.*

If it is possible to lower the seeder to the planting depth by its own weight, then the following condition must be met:

$$Q_e \geq P_c \quad (8)$$

Here Q_e is the gravitational force of the couple, N;

Based on this condition, the amount of Q_e is also determined by the condition that the slider is stuck on the moving surface along the surface S_c. In this case, Q_e is determined by the following expression.

$$Q_э = g\cdot\rho_м\cdot S_c\cdot\delta \quad (9)$$

Here p_m is the density of "anchored" shaped planting material, kg/m^3;

g – acceleration of free fall, m/s^2;

δ - thickness of planting material, m.

the constructive and physical quantities, namely δ=0.03 m, *g* =9.8 m/s^2 and ϱ_m =7850 kg/m^3 into the expression , we obtain an expression relating Q_e to S_c.

$$Q_э = 230{,}8\cdot S_c \quad (10)$$

expression (10) for the assumed h_o=0.04 m is presented in Figure 3a.

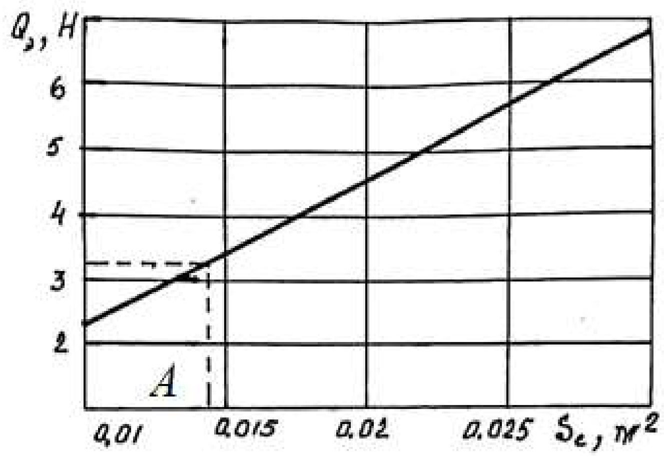


Figure 3. The change in the depth of planting the ekkich in relation to the surface of the slide.

It is clear that as the surface of the slipper increases, the weight of the seeder increases. If we take into account that the surface of the selected "anchor"-shaped slipper in contact with the soil surface is S_c=0.2·0.07=0.014 m^2, Q_e=3.2 N (point A). When comparing this with the vertical pressure force Ps determined above and required, it is found that Ps is less than the value when the sowing depth is h_o =0.04 m, i.e. condition (8) is not met. Because when S_c=0.014 m^2, the vertical pressure force required to immerse the seeder to h_o=0.04 m is Ps =25 N.

Therefore, in order to lower the seeder to the planting depth, it is necessary to use, in addition to its own weight, the weight of the section working between the rows where they are fastened, or the spring force of the parallelogram mechanism.

Determining the drag resistance of Ekkich . Eckich's resistance to drag consists of the sum of several resistances, Fig. 4. We determine them based on the following studies, i.e

$$R_э = T + 2P_1 + 2F_1 \quad (11)$$

Here, T is the force that resists the blade sinking into the soil during the movement of the plow, N;

This force was determined by the following expression

$$T = 2q_м \, \delta \cdot h_o \left(ctg\beta^1 \cdot tg\varphi_T + 1 \right) \quad (12)$$

Here q_m is the resistance of the soil to volumetric compression, N/m^3;

d – blade thickness, m;

h_o – planting depth, m;

φ_T – friction angle, degree;

b^1 – blade sharpening angle, grad.

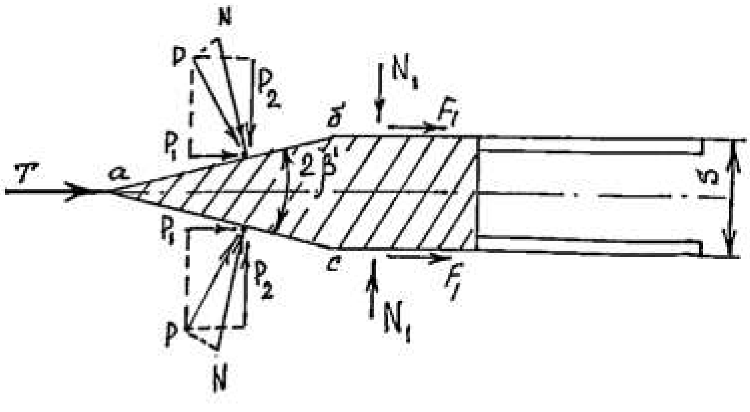


Figure 4. Forces resisting the movement of two.

During movement, the necks of the planter (*a-b* and *a-c*) are affected by the normal force N resulting from the compression of the soil. This results in a force P, which resists the movement of its horizontal component P_1. Its value is determined by the following expression.

$$P_1 = N\frac{\sin(\beta^1 + \varphi_T)}{\cos\varphi} \quad (13)$$

The normal force N acting on the neck of the blade should be determined taking into account the speed of the unit depending on the coefficient of resistance to volumetric compaction of the soil q_v [18]. However, since the anchoring of the seeder is high, its sides do not lead to the appearance of volumetric compaction of the soil. They only slightly compress the soil from the sides of the seeder necks to both sides, opening the way for the seeder to pass. Therefore, based on the condition that the force N due to the pressure of the soil on the seeder necks is the result of the resistance to compaction σ_c, we accept the following expression, namely

$$N = \sigma_c \cdot 0{,}5S\,L_{тиг} \quad (14)$$

Here S is the thickness of the screed, m;

L is the length of the seam at a distance of h_o from the edge , m.

σ_c - compression resistance of the soil affected by the height of the planter, N/m ^{2}.

Given the large radius of curvature of the curve, we conditionally accept it as a straight line. In this case,

$$L_{тиг} = \frac{h_o}{Sin\alpha} \quad (15)$$

Taking expression (15) and (14) into account, expression (13) can be written as follows

$$P_1 = \sigma_c 0{,}5 \cdot S \cdot \frac{h_o}{\sin\alpha} \cdot \frac{\sin\left(\beta^1 + \varphi_T\right)}{\cos\varphi} \quad (16)$$

Since the soil is compressed by the neck of the planter, this compression continues on its sides. As a result, pressure is created on the side of the planter, the normal acting factor N_1 is equal to:

$$N_1 = \sigma_c \cdot S_{ён} \quad \text{or } S_{side} = h_0 \cdot L,\ m^2 \quad (17)$$

Here: S is the area of the second side, m ^{2}.

L – length of the twin, m.

In that case

$$N_1 = \sigma_c \cdot h_o \cdot L \quad (18)$$

The frictional force producing this force on the side of the blade is:

$$F_1 = f_1 \cdot \sigma_c \cdot h_o \cdot L \quad (19)$$

When the received expressions (11), (17) and (20) are put into the expression (11), we get the expression of the drag resistance of the seed.

$$R_э = 2q_м\,\delta \cdot h_o\left(ctg\beta^1 \cdot tg\varphi_T + 1\right) + 2\sigma_c \cdot 0{,}5 \cdot S\frac{h_o}{\sin\alpha}\frac{\sin\left(\beta^1 + \varphi_T\right)}{\cos\varphi} + f \cdot \sigma_c \cdot h_o \cdot L \quad (20)$$

Substituting the following quantities into this expression: q_m = 45000 n/m ^{2}, δ=0.001 m, h_o=0.04, φ_t=30 ^{0}, β^1=20 ^{0}, σ_c=750 N/m ^{2}, S=0.11 m, α=30 ^{0}, φ=30 ^{0}, L=0.2 m, f=0.7, we find that the drag resistance of the seeder is 13.78 N.

Conclusion

1. It was determined that the parameters of the cultivator, i.e. the angle of immersion of the blade in the soil is greater than α>120 ^{0}, the radius of curvature is equal to R=28.5 cm, and the angle of sharpening of the chest seam is 2 It was assumed that b^1=34 ^{0}...50 ^{0}.

2. Considering that the self-weight force ($Q_e = 3.2$) N is less than the required force ($P_c = 25$ N) when lowering the seeder to the sowing depth, it was found that it is advisable to use the weight of the seeder section as an additional force.

3. The drag resistance of the Ekkich blade was found to be 13.78 N, and it is appropriate to compare this value with the results obtained based on experimental studies.

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