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STUDY OF THE WORKING BODIES OF THE MACHINE THAT PREPARES THE SOIL FOR PLANTING POTATOES

Kodirov Uchkun Ilkhomovich, Doctor of Philosophy (PhD) Technical sciences,
Karshi Institute of Irrigation and Agrotechnologies of National Research University "TIIAME"

Abstract. The purpose of the study is to substantiate the parameters of the guide knife and the loosening pointed leg of the machine. The basic principles and methods of classical mechanics, mathematical analysis and statistics were used in this study. Theoretical studies were carried out to determine the parameters of the guide knife and the loosening pointed leg of the machine. It is established that to ensure the required value of the crest height with minimal energy consumption, the height and length of the guide knife should be 8 and 15 cm, respectively, the angle of the knife blade to the horizon - 30º, the longitudinal distance from the toe of the ploughshare body of the knife toe – 13 cm. To ensure the required crumbling of the soil, the width of the pointed loosening paw should be 15 cm.

1 Introduction

In the world, the leading place is occupied by the development and application of energy-saving and high-performance machines for tillage and preparing it for sowing. At the same time, much attention is paid to the development of machines that perform all the technological processes of tillage and preparing it for sowing potatoes on ridges in one pass through the field.

F.M.Mamatov [1-2], V.I.Kurdyumov [3], B.C.Lakhmakov [4] and others were engaged in research on the creation and use of combined machines for processing and preparing soil for sowing agricultural crops, substantiating the parameters of working bodies, as well as studying their processes of interaction of working bodies with the soil.

However, these studies do not sufficiently study the issues of tillage for sowing potatoes with the simultaneous formation of ridges that ensure high quality work with minimal energy costs.

The purpose of the study is to substantiate the parameters of the guide knife and the loosening pointed leg of the machine.

2 Methods and results

The basic principles and methods of classical mechanics, mathematical analysis and statistics were used in this study.

In order to substantiate the constructive scheme of the machine implementing the proposed technology and the types of working bodies, the constructions of the machines preparing the fields for planting were created in detail by the researchers. As a result, a constructive scheme of the machine was developed, which implements the technology of preparing the soil for planting potatoes for planting (Fig. 1).

It includes frame 1, tractor mounting bracket 2, base wheels 3, frame-mounted recesses 4, axle softener claws 5, right and left swivel housings 6 and 7, guide blades 8 and The profile consists of 9 reels.

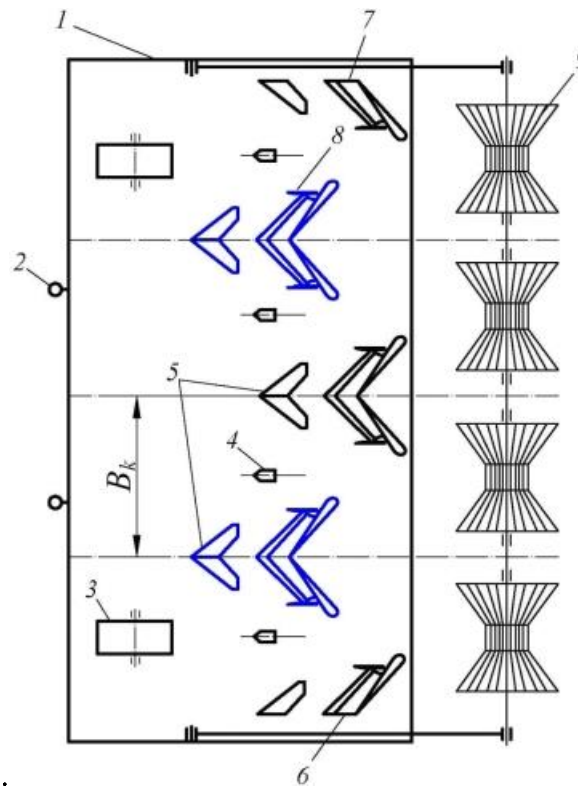

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Fig. 1. *Layout of work tools on the frame: 1 – frame; 2 – wing share; 3 – base wheel; 4 – deep softener; 5 – axial softening claw; 6 and 7 – right and left turning bodies; 8 – guide knife; 9 – profile roller*

The main working bodies of the machine are the body with a guide plate and a pointed flat-cutting paw. Depending on the nature of the machine, we can determine the parameters of the blade and the axle.

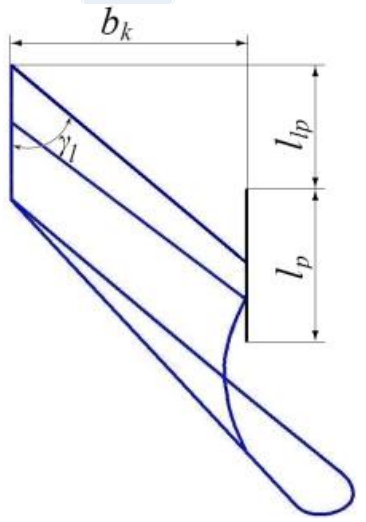

Fig. 2. Diagram for determining the parameters of the guide blade

The guide blade is attached to the edge of the 4 l ploughshare (Figure 2). Its main parameters are the distance from the beak to the blade l_{lp}; length and height of guide blade l_p and h_{ep}; the angle of inclination of the blade of the guide blade relative to the horizon α_p; i_n the sharpening angle of the blade is thread.

We determine the angle of inclination of the blade with respect to the horizon by the following expression from the condition of sliding the soil along it.

$$\alpha_p \le \frac{\pi}{4} - \frac{\varphi_1}{2}, \quad (1)$$

where φ_1 – is the angle of friction of the soil with the blade.

We put the known values of $\mathbf{j}_1$ (25-30°) in this expression and determine that the angle ap should be in the range 30-33° and assume a_p = 30 °.

We choose the height of the guide blade in order to minimize the interaction of the blade with the wall. Due to the fact that the housing works in a completely closed cutting position, the upper edge of the blade is crushed at the beginning of the rotation of the blade. The height of the blade, which guides the blade, can be determined by setting the rest of the blade from crushing and eliminating its interaction with the wall.

$$h_p \ge a - b_k tg\,\tau - \Delta_p, \quad (2)$$

We determine that the minimum height of the blade, which is directed to the expression (2) by b_k = 0.2 m, Δ_p = 0.05 m and t = 6 °, is not less than 79 mm. We assume h_p = 80 mm.

At the beginning of the rotation of the pelvis, the pelvis is in a state of tension due to the compression of its inner upper edges. In this case, it is difficult for the blade to penetrate the blade, which can lead to the accumulation of soil in front of the housing and disruption of the technological process at the beginning. Therefore, it is advisable to place the blade as close as possible to the line of the ploughshare beak in the direction of movement. In this case, the crushing of the slab with the wall is replaced by the crushing of the soil with a steel knife. Plus, you'll be getting rid of clutter you don't need. Due to the design difficulties associated with the installation of the blade, the blade nozzle can be installed at the following distances from the body ploughshares nozzle.

$$l_{lp} = (0{,}5 \div 0{,}6) b_k ctg\gamma_l. \quad (3)$$

Substituting b_k=0.2 m and γ_l=42º into expression (3), we determine that the longitudinal distance from the beak of the body ploughshares to the beak of the blade is l_{lp} = 0.22 m.

From Fig.2, we determine the length of the guide blade by the following formula

$$l_p = b_k ctg\gamma_l - l_{lp} + b_{le}\cos\varepsilon + \Delta l, \quad (4)$$

where b_{le} – is the width of the ploughshare heel; Δl – is the length of the blade, which allows the blade to touch the wall of the ridge after rising above the heel of the ploughshare.

Because the blade has a trapezoidal shape

$$\Delta l = h_p \cos\alpha_p. \quad (5)$$

Substituting the value of h_p for expression (5) into expression (2), we obtain

$$\Delta l = (a - b_k tg\tau - \Delta_p)\cos\alpha_p. \quad (6)$$

In that case

$$l_p = b_k ctg\gamma_l - l_{lp} + b_{le}\cos\varepsilon + (a - b_k tg\tau - \Delta_p)\cos\alpha_p. \quad (7)$$

Add the values b_k= 0.2 m, γ_p= 42º, a = 15 cm, l_{lp} = 0.22 m, Δ_p = 0.05 m, ε= 25º, τ = 6° and α_p= 30° to the expression (7). Calculated calculations showed that the length of the guide blade was 0.14 m.

The gravitational resistance of the guide blade is the resistance of its blade, bevel and sides (Fig.3).

$$R_{xp} = R_{xp}^{l} + R_{xp}^{f} + R_{xp}^{f}. \quad (8)$$

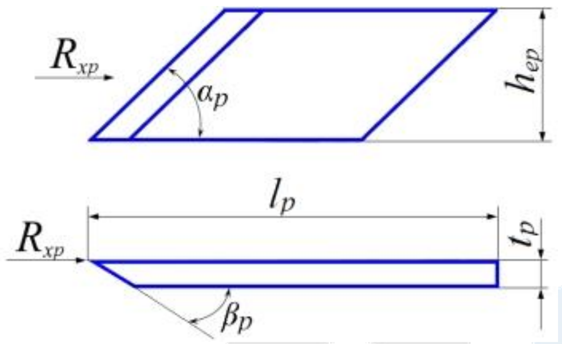

Fig. 3. Scheme for determining the forces acting on the blade

The resistance of the blade, chamfer and sides of the guide blade to the impact soil can be determined by the following formula:

$$R_{xp}^{l} = \sigma h_{pl} \delta (1 + f \cos\alpha_p), \quad (9)$$

$$R_{xp}^{f} = p \frac{t_p}{\sin\beta_n} h_p (1 + f \cos\alpha_p), \quad (10)$$

$$R_{x}^{fn} = 2 f \rho_1 (l_p - h_p ctg\alpha_p) h_p. \quad (11)$$

The resistance of the blade, chamfer and sides of the guide blade to the impact soil can be determined by the following formulas: where *s* – is the resistance of the soil to crushing in the horizontal direction; δ – is the thickness of the guide blade, m; *f* – is the coefficient of friction of the soil on the steel; β_{p} – is the sharpening angle of the guide blade; t_p – is the thickness of the blade; ρ_1` – is the specific pressure of the soil on the sides of the blade, Pa; *p* – is the specific pressure of the soil in the chamfer, Pa.

Then

$$R_{xp} = \sigma h_{pl} \delta (1 + f \cos\alpha_p) + p \frac{t_p}{\sin\beta_p} h_p (1 + f \cos\alpha_p) +$$
$$+ 2 f \rho_1 (l_p - h_p ctg\,\alpha_p) h_p, \quad (12)$$

h_p = 0,1 m; l_p = 0,032 m; σ = 2,10^6 Pa; *d* = 0,004 m; *f* = 0,95; *r* = 1,9210^4 Pa; r_1 = 1,64·10^3 Pa; b_l = 25º; Assuming b_p = 25º and t_p = 0,006 m, the calculations carried out by expression (12) show that the tensile resistance of the guide plate in the velocity range 1.5-2,0 m/s is 157,8 N showed.

The total resistance of the housing with the guide blade

$$R_k = (ab_k - \frac{1}{2} b_k^2 tg\,\delta)(K + \varepsilon_1 V^2) + \sigma h_{pl} \delta (1 + f \cos\alpha_p) +$$
$$p \frac{t_p}{\sin\beta_n} h_p (1 + f \cos\alpha_p) + + 2 f \rho_1 (l_p - h_p ctg\,\alpha_p) h_p. \quad (13)$$

Calculations from expression (13) showed that the total resistance of the guide blade housing in the velocity range of 1.5–2.0 m / s was 2065–2138 N.

We choose an oversized softening pad as a softener to be installed in front of the housings. It cuts weeds to a depth of 8-10 cm and grinds the soil well. We determine the part of the row spacing that the softener softens, that is, the width of its coverage, provided that the softener claws along the axis of symmetry of the formed groove. From Fig.4

$$b_p = (B_k - b_i) - 2(a_{cu} - a_p) ctg\,\psi_1. \quad (14)$$

where $B_к$ – is the transverse distance between the axial softening claws, m; a_p – is the working depth of the softening claw, m;

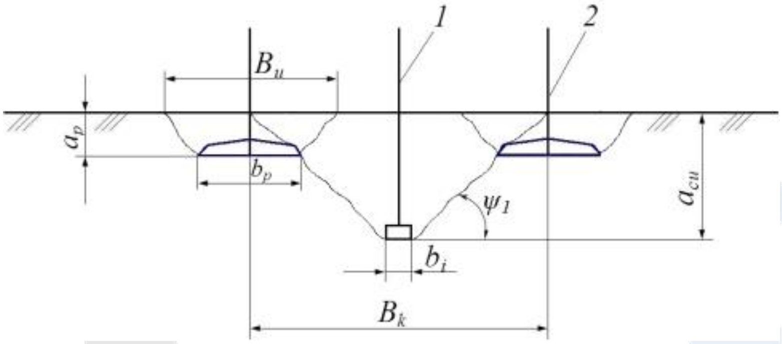

Fig. 4. Scheme for determining the coverage of the claw softening claw: 1 – deepening; 2 – shaped soft paw

Substituting the values B_k = 0,7 m, b_i = 0.08 m, a_p = 0.1 m, a_{cu} = 0.35 m and ψ_1= 48º into the expression (15), the minimum coverage width of the axial softening claw is 140 mm. We determine that should be, we accept b_p = 150 mm.

We use the following simplified formula to determine the drag resistance of an axial claw

$$R_p = k a_p b_p, \quad (15)$$

where k – is the specific resistance of the soil to the axial claw, Pa; a_p – working depth of the axial claw, m; b_p – is the width of the axial claw, m.

3 Conclusions

1. It is established that to ensure the required value of the height of the ridge with minimal energy consumption, the height and length of the guide knife should be 8 and 15 cm, respectively, the angle of the knife blade to the horizon – 30º, the longitudinal distance from the toe of the ploughshare body of the knife toe – 13 cm.

2. It is established that to ensure the required crumbling of the soil, the width of the pointed loosening foot should be 15 cm.

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