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JUSTIFICATION OF FLAT TILLAGE HOE PARAMETERS

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This paper presents replacement of loosening and breaking up the soil by a cultivator chisel with universal center hoes in the process of loosening in the minimum tillage. The equations have been obtained for calculating the parameters characterizing geometric shape of flat-cut universal hoes and defined their optimal parameters. To solve the problem, the working surface of the center hoe is represented in the form of a three-sided wedge. In case of parameters obtained theoretically the resistance to cutting of a weedy earth mass by a cultivator equipped with a center hoe decreases sharply.

Key words*: cultivator, cultivator center hoe, trihedral wedge, soil mass.*

Introduction

A large number of fundamental research and experimental works are available in literature on selection of machinery and systems used for cultivation of cereal crop. The attention of world scientists on land cultivation is explained not only by the necessity to create favorable conditions for intensive growth and development of the grains, but also the importance of rational solution of the problems related to land-processing technology and energy saving systems of technical means.

The statement of the problem It is well known that 30-40% of total energy used in agriculture is spent on land cultivation. crop production share of energy used for land cultivation amounts to 70 percent of the consumed total energy [1].

Since the beginning of the early 70s of the last century prices for fuel and agricultural machinery on the international market have seen continuous drastic rise issuing a serious challenge to scientists, researchers, experimenters, engineers and designers to develop land cultivation energy saving technology and create new generation of energy efficient agricultural machinery. As a result of carried out fundamental investigation and drastically taken measures gradually was developed and introduced a land minimum cultivation technology composed of cultivation, cultivation by such tools as discs and chisels components.

The selection of the above mentioned technologies designed for surface tillage depends on the soil physical-technological properties and structural behavior.

In case of irrigated agriculture, maximum grain yield is provided by up to 18 cm cultivation depth, therefore, it is reasonable to evaluate technological parameters of the cultivation hoes presently in use and to reveal apparent defects.

It is well-known that the minimum loosening process of the soil is performed by chisel crushers, of which technological process can be replaced by cultivator’s loosening hoes. Consequently, our research is aimed at technological and energy analysis of the parameters describing the geometrical shape of flat-cut cultivation hoes.

Complicated technological process of weedy soil mass loosening by flat-cut centre-toes and simultaneous cutting of weeds using a milling cutter was developed by A.P.Tarverdyan [2,3].

According to analysis of results obtained by theoretical and experimental research it was confirmed that weedy soil mass cutting by a flat-cut knife edge consuming minimum energy can be achieved by oblique sliding motion providing $\alpha_{ւap} = 20 \div 22^{o}$ transformed position angle. At the same time, it is necessary to ensure coincidence of the cross-section plane of the stress-strain state and the trajectories of the main platforms.

Under these conditions, the material cutting process is transformed into a forced development of the crack, without the use of additional effort, thereby contributing to a drastic reduction in material resistance to cutting.

Results of the research

To solve the problem under discussion the half of the working surface of the center toe is represented by a triangle ABC three-edged wedge and is characterized by loosening α_1 angle, turn over β_1 angle, and side pushing γ_1 angle (Figure 1).

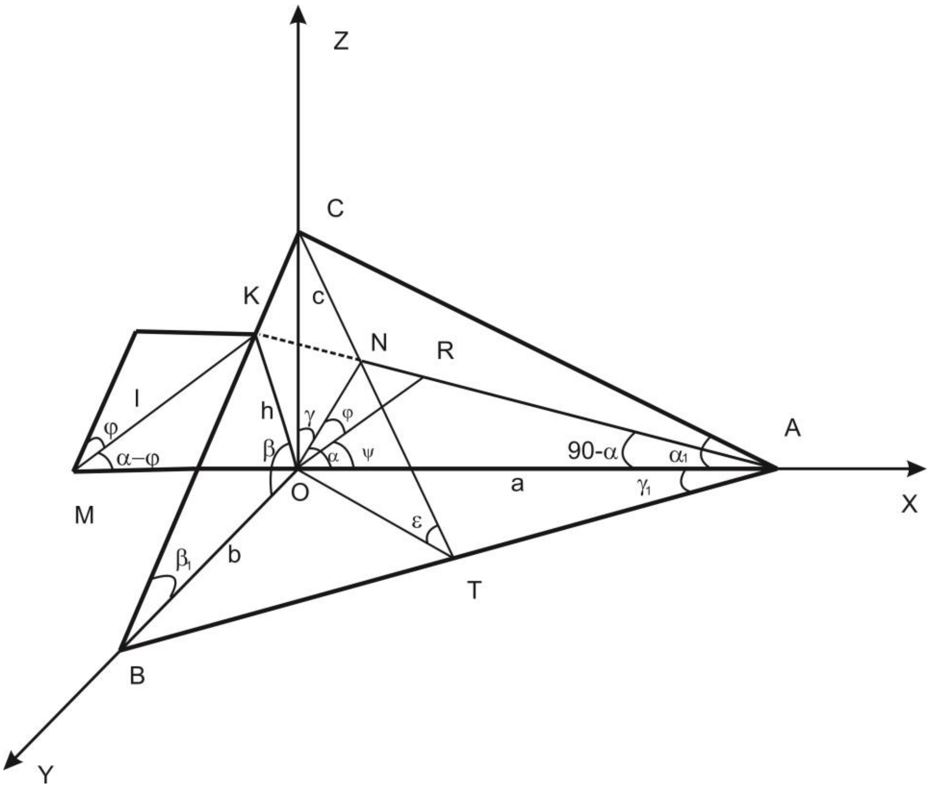

Figure 1. Principal scheme of a universal center hoe (three-edged wedge)

In Figure 1 A, B, C, the distance from the O reference point is equal to the line segments of a, b, c, respectively.

The angles between the normal (ON) to the working surface of the three-edged wedge of the flat-cut center hoes and coordinate axes are expressed with the following values:

$\angle$nox=α, $\angle$noy=β, $\angle$noz=β:

Net reaction force R is deviated from the normal by friction angle φ. According to triangles made by α_1, β_1, γ_1 angles of the three-edged wedge their trigonometric relations are expressed as follows

$$\left.\begin{aligned} tg\alpha_1 &= tg\beta_1 tg\gamma_1 \\ tg\beta_1 &= tg\varepsilon cos\gamma_1 \\ tg\alpha_1 &= tg\varepsilon cos\gamma_1 \end{aligned}\right\} \qquad (1)$$

The ABC equation $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$ of the wedge working surface is used to determine the values of direction cosines

$$cos\alpha = \frac{f_x^I}{\sqrt{f_x^{I2}+f_y^{I2}+f_z^{I2}}} = \frac{1}{\alpha\sqrt{\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{c^2}}}$$

Now let us denote $\frac{1}{\sqrt{\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{c^2}}} = \Delta$, therefore, $cos\beta = \frac{f_y^I}{\Delta}$, $cos\gamma = \frac{f_z^I}{\Delta}$ and

$$\left.\begin{aligned} cos\alpha &= \frac{1}{a\Delta} \\ cos\beta &= \frac{1}{b\Delta} \\ cos\gamma &= \frac{1}{c\Delta} \end{aligned}\right\} \quad (2)$$

The values of angles $\alpha, \beta, \gamma,$ formed by the normal of the wedge working surface are necessary for determining the direction of the crack occurred in the soil mass.

According to the magnitude of maximum shearing stresses directions of a crack in the soil propagate in H_1 and H_2 planes, by which the furrow slice can be decomposed as a result of cast, and is deviated from the direction of the surface reaction resultant at $\pm\frac{\theta}{2} = \frac{40\div50}{2}$. Therefore, on the basis of the results obtained by experimental studies can be accepted and accepted that the direction of the crack coincides with the direction of the reaction resultant acting on the surface of the wedge to the surface of the wedge and is deviated from the normal at the friction φ angle [4].

For the purpose of the solution of the problem under consideration the direction of that angle on the three-edged wedge will be $\psi = \alpha - \varphi$, but we have 90-$\alpha = 22^o$, $\alpha = 68^o$, thus $\psi = 68 - \varphi$ (3)

On the basis of the problem formulation let us take the external friction factor soil tg φ= 0.5$\div$ 0.7 for clay sand and loamy, then φ=$26^0 \div 35^0$. Let us now take the design friction angle $\varphi = 30^0$ or $\psi = 68 - 30 = 38^0$.

Thus, according to Figure 1 we will get the following necessary data for calculation of the three-edged wedge:

• The length of the furrow slice crack (MK) from the reference point at the depth (M) h
$l = hctg(\alpha - \varphi) = hctg\,\psi = 1.28$h

- The length of the x coordinate of the three-edged wedge is

$$a = htg\alpha = 2.475h$$

Let us take h = 10 cm, then we get a = 25 cm, 680.

Now we have to calculate b and c coordinates f the three-edged wedge. Since this procedure refers to the minimal cultivated technology of the soil, therefore, some technological parameters are selected according to the hoes run depth [4; 5]. In the case the depth of the h_{oe} run depth exceeds 20 cm, from the energy viewpoint, based on the results of the experimental studies, it is recommended to select the angle of development as $\gamma_1 = 35 - 40^0$.

In this case for calculation of the wedge y = b coordinate we can write

$$b = \alpha \cdot tg\gamma_1 = htg\alpha tg\gamma_1 \quad (4)$$

Therefore, we get

$$b = 25 \cdot tg37 = 19\ uu:$$

For calculation of loosening angle β_1 of the wedge we make use of the KOB triangle

$$sin\beta_1 = \frac{h}{b} = \frac{h}{h \cdot tg\alpha tg\gamma_1}\ or\ n\beta_1 = ctg\alpha \cdot ctg\gamma_1 : \quad (5)$$

$$c = htg\alpha tg\gamma_1 tg[\arcsin(ctg\alpha ctg\gamma_1)]: \quad (6)$$

Now what remains from the wedge geometrical parameters to calculate is z = c coordinate and angle α_1, of which the following can be written $c = btg\beta_1$ or

$$c = htg\alpha tg\gamma_1 tg[\arcsin(ctg\alpha ctg\gamma_1)]; \quad (6)$$

Therefore, $c = 19tg32 = 12$ sm

$$tg\alpha_1 = tg\gamma_1 tg\,[\arcsin(ctg\alpha ctg\gamma_1)] \quad (7)$$

After the respective calculation, we have

$$\alpha_1 = 33^0$$

Thus, by the developed calculation theory geometrical shape and parameters of the working member of the cultivator meeting the requirements of the minimum soil tillage technology, relating it to the required shear stresses necessary to produce MK=l length of the crack.

Conclusion

The minimal loosening of the soil is performed by chisel crushers, of which technological process can be replaced by the universal hoes of the cultivator.

To justify the parameters of the center hoes of the cultivator their working surface is represented as a three-edged wedge.

By the developed theory, designed for grounding the geometrical shape and parameters of a cultivator working member satisfying land minimal preparation requirements, it is assumed as a basis that to make a crack in the soil of a certain length it is necessary to provide required stresses during operation of the cultivator.

For minimal energy consumption spent on the weedy soil mass cutting by a flat–cut knife edge it is necessary to implement cutting process by oblique slide of the knife, while simultaneously securing the transformed loosening angle at 20-22^0 degrees.

By theoretical studies the following optimal parameters of the loosening center hoe have been found – the loosening angle is 33^0, the furrow slice turn over angle is 32^0, and the cut mass side pushing angle is 35-40^0.

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ՏԵԽՆՈԼՈԳԻԱՊԵՍ ԲԱՐՁՐ ԵՎ ԷՆԵԳԱԽՆԱՅՈՂ ՀԱՐԹԱՀԱՏ ՀՈՂԱՄՇԱԿ ԹԱԹԻԿՆԵՐԻ ՊԱՐԱՄԵՏՐԵՐԻ ՀԻՄՆԱՎՈՐՈՒՄԸ

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Առաջարկվում է հողի նվազագույն մշակությամբ փխրեցման գործընթացում չիզելումը փոխարինել կուլտիվատորի ունիվերսալ սլաքաձև թաթիկներով: Տեսական հետազոտություններով ստացվել են կուլտիվատորային հարթահատ թաթիկների երկրաչափական ձևը բնութագրող պարամետրերի հաշվարկի հավասարումներ և որոշվել են դրանց օպտիմալ արժեքները:

Խնդրի լուծման նպատակով սլաքաձև թաթիկի բանվորական մակերևույթը ներկայացվել է եռեզր սեպի տեսքով:

Տեսականորեն ստացված պարամետրերի դեպքում կուլտիվատորի սլաքաձև թաթիկով հողամոլախոտային զանգվածի կտրման դիմադրությունը կտրուկ նվազում է:

Բանալի բառեր. կուլտիվատոր, սլաքաձև թաթիկ, եռեզր սեպ, հողամոլախոտային զանգված, կտրում

ОБОСНОВАНИЕ ПАРАМЕТРОВ ВЫСОКОТЕХНОЛОГИЧНЫХ И ЭНЕРГОСБЕРЕГАЮЩИХ ПЛОСКОРЕЗНЫХ ПОЧВООБРАБАТЫВАЮЩИХ ЛАП

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Предлагается в процессе рыхления минимальной обработки почвы чизелевание заменить универсалными стрельчатыми лапами.
Теоретическими асследованиями установлны уровнения расчета параметров, характеризующих геометрическую форму плоскорезных универсалььных лап и определены оптимальные их параметры.

С целью решения задачи рабочую поверхность стрельчатых лап представлена в виде трехгранного клина. Сопративление подрезания почвосорняковой массы резко снижается при работе стрельчатых лап культиваторов с теоретически обоснованными параметрами.

Ключевые слова: культиватор, стреловидная лапа, трехгранный клин, почва-сорняковая масса, резание