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Studying the Movement of Soil Plates Outside the Working Body of a Machine Disk with Full Opening of Pomegranate Balls

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ABSTRACT: The article notes that machines have been developed to partially and fully open buried pomegranate bushes, and based on the research, analytical connections have been obtained and analyzed to determine the distance and speed of movement of soil pomegranate bushes across the working surface of a machine disc working body.

KEYWORDS: Embedded pomegranate bushes, semi-opening machine, full opening machine, disc working body, soil pieces, moving distance and speed.

I. INTRODUCTION

In order to prevent frostbite in the conditions of the republic, pomegranate bushes are buried in late autumn and open in spring. However, due to the lack of special equipment, the burial and opening of pomegranate bushes is not mechanized and is still carried out by hand. This, in turn, leads to an increase in labor costs and other costs, and hinders the growth of pomegranate cultivation, the establishment of pomegranate plantations on large areas. Based on this, the Research Institute of Agricultural Mechanization conducted research on the development of machines for opening pomegranate bushes and determining the rational values of their parameters [1-4]. Our research has shown that it is advisable to open buried pomegranate bushes in two stages. In the first stage, the pomegranate tubes are half-opened by machines equipped with working bodies in the form of a plug body, in the second stage, they are fully opened by machines equipped with disc working bodies and fans. This article presents the results of research on the movement of soil particles on the working surface of a machine disc working body that fully opens pomegranate bushes. Fully open pomegranate tubes machine frame 1, hanging device 2, disc working body 3, leveler 4, ski (slider) 5, hydraulic cylinder 6, parallelogram mechanism 7, reducer 8, extension 9, cardan extension 10, fan 11 and nozzle 12 (Fig. 1), the working process of which is as follows: the disc working body 3 carries the rest of the soil pile on the pomegranate bushes from the semi-opening machine to the working surface and to the edge formed by its semi-opening machine body, ski 5 using the built-in leveler 4, the irregularities between the rows of pomegranate are smoothed, the soil left over from the disc working body 3 and stuck to the pomegranate bushes is pushed between the rows by the air flow coming out of the nozzle 12 of the fan 11 and the pomegranate bushes are fully opened. This ensures that the hydraulic cylinder 6, the parallelogram mechanism 7 and the ski 5 fan nozzle 12 are held at the required height and the soil compaction is fully sprayed.

II. SIGNIFICANCE OF THE SYSTEM

The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

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III. METHODOLOGY

Theoretical research was carried out using the basic laws and rules of higher mathematics and theoretical mechanics to study the motion of the working surface of the machine disk body, which fully opens the pomegranate bushes of soil fragments.

IV. EXPERIMENTAL RESULTS

The following forces act on a piece of soil moving on the working surface of a disk working body (Fig. 2):

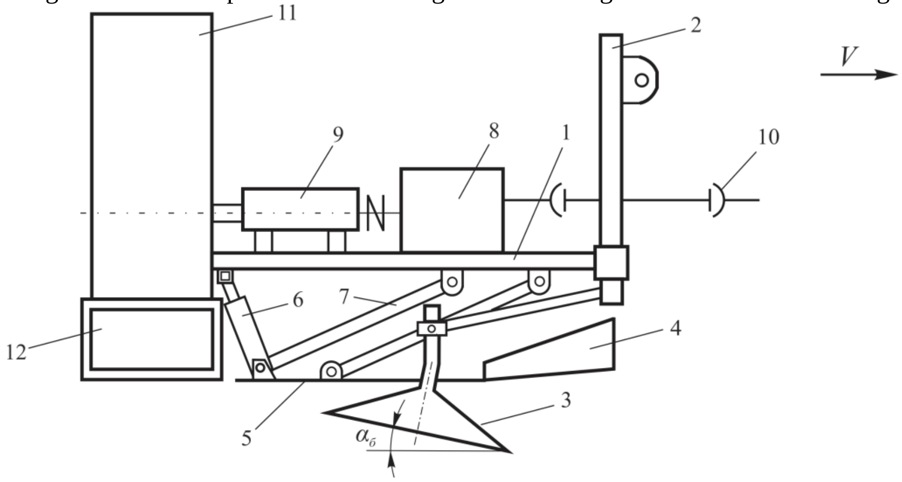

Figure 1. A schematic diagram of a machine that fully opens pomegranate bushes

$G=mg$(where m - mass of the soil fraction, kg; g- acceleration of free fall, m/s^2) - gravitational force, H;

$P_м = m\omega^2 X\cos\alpha_б$ (where ω- angular velocity of the disk workpiece, rad/s; X - coordinate axis along the working surface of the workpiece (cone maker), m;

$\alpha_б$ - installation of the disk workpiece in the longitudinal plane relative to the horizon angle, degree) - centrifugal force, H;

$F= f N = fm[g\cos(\alpha_u-\alpha_б) - \omega^2 X\sin\alpha_u]$(where $f = tg\varphi$ – coefficient of friction of the soil on the working surface of the disk working body; α_u-conical angle of the working surface of the disk working body, degrees) - friction force, H;

$F_к = 2m\omega\dot{X}$ (where $\dot{X}$ - the relative velocity of the piece of soil along the working surface of the disc working body, m/s) - Coriolis force, H.

Here, the Coriolis force $F_к$ - directed perpendicular to the plane of the circuit shown in Figure 2 and is therefore not visible in it.

By projecting the forces G, $P_м$, N, F and$F_к$ on the X axis, we obtain the differential equation of motion of a piece of soil along the maker of the working surface of a disk working body.

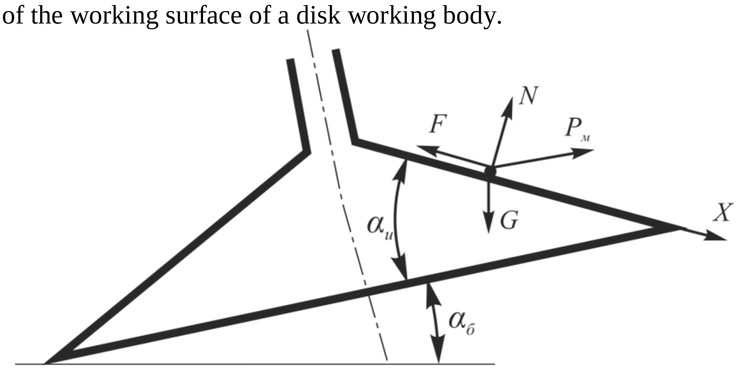

Figure 2.Scheme for studying the movement of a piece of soil along the working surface of a disk working body

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$$m\ddot{X} = mg\sin(\alpha_u - \alpha_\delta) + m\omega^2 X\cos\alpha_u -$$

$$- fm\left[g\cos(\alpha_u - \alpha_\delta) + \omega^2 X\sin\alpha_u\right] \quad (1)$$

or

$$\ddot{X} = g\sin(\alpha_u - \alpha_\delta) + \omega^2 X\left[\cos\alpha_u + f\sin\alpha_u\right] - fg\cos(\alpha_u - \alpha_\delta). \quad (2)$$

We present this equation as follows

$$\ddot{X} - \omega^2 X\left[\cos\alpha_u + f\sin\alpha_u\right] = g\left[\sin(\alpha_u - \alpha_\delta) - f\cos(\alpha_u - \alpha_\delta)\right]. \quad (3)$$

We enter the following definitions

$$\omega^2(\cos\alpha_u + f\sin\alpha_u) = C^2$$

and

$$g\left[\sin(\alpha_u - \alpha_\delta) - f\cos(\alpha_u - \alpha_\delta)\right] = E.$$

Given these definitions, Equation (3) has the following form

$$\ddot{X} - C^2 X = E. \quad (4)$$

The solution of this equation has the following form [5].

$$X = C_1 e^{Ct} + C_2 e^{Ct} - \frac{E}{C^2}, \quad (5)$$

where C_1 and C_2 are integration constants; t - time, s.

We define the integration constants C_1 and C_2 at t = 0 under the initial conditions $X = X_0$ and $\dot{X} = 0$.To do this, we obtain the following from equation (5)

where C_1 and C_2 are integration constants;

$$X(0) = C_1 + C_2 - \frac{E}{C^2} = X_0; \quad (6)$$

$$\dot{X} = -C_1 C e^{-Ct} + C_2 C e^{Ct}; \quad (7)$$

$$\dot{X}(0) = -C_1 C + C_2 C = 0. \quad (8)$$

Solving these together, we get the following results

$$C_1 = C_2 = \frac{X_0 C^2 + E}{2C^2}. \quad (9)$$

We set these values of C_1 and C_2 to (5)

$$X = \left(e^{-Ct} + e^{Ct}\right)\frac{X_0 C^2 + E}{2C^2}. \quad (10)$$

Given the above definitions for C_2 and E, Equation (10) has the following form

$$X = \left[e^{-\omega\sqrt{\cos\alpha_u + f\sin\alpha_u}\,t} + e^{\omega\sqrt{\cos\alpha_u + f\sin\alpha_u}\,t}\right]\times$$

$$\times\left\{\left\{X_0\omega^2(\cos\alpha_u + f\sin\alpha_u) + g\left[\sin(\alpha_u - \alpha_\delta) - f\cos(\alpha_u - \alpha_\delta)\right]\right\}:\right.$$

$$\left.:\left\{\omega^2\left[\cos\alpha_u + f\sin\alpha_u\right]\right\}\right\}. \quad (11)$$

We put the values of C_1 and C_2 on expression (9) in (7) and get the following result

$$\dot{X} = \left(e^{Ct} - e^{-Ct}\right)\frac{X_0 C^2 + E}{2C}. \quad (12)$$

Given the values of C and E in the above definitions, expression (12) takes the following form

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$$\dot{X} = \left[e^{\omega\sqrt{\cos\alpha_u + f\sin\alpha_u}t} - e^{-\omega\sqrt{\cos\alpha_u + f\sin\alpha_u}t} \right] \times$$

$$\times \left\{ \left\{ X_0\omega^2 (\cos\alpha_u + f\sin\alpha_u) + g[\sin(\alpha_u - \alpha_б) - f\cos(\alpha_u - \alpha_б)] \right\} : \right.$$

$$\left. : \left[2\omega\sqrt{\cos\alpha_u + f\sin\alpha_u} \right] \right\}. \quad (13)$$

$\omega = \dfrac{2V}{D}$ (where V - velocity of the aggregate) and we express the expressions (11) and (13) as follows

$$X = \left[e^{-\frac{2V}{D}\sqrt{\cos\alpha_u + f\sin\alpha_u}t} + e^{\frac{2V}{D}\sqrt{\cos\alpha_u + f\sin\alpha_u}t} \right] \times$$

$$\times \left\{ \left\{ X_0\left(\frac{2V}{D}\right)^2 [\cos\alpha_u + f\sin\alpha_u] + g[\sin(\alpha_u - \alpha_б) - f\cos(\alpha_u - \alpha_б)] \right\} : \right.$$

$$\left. : \left(\frac{2V}{D}\right)^2 [\cos\alpha_u + f\sin\alpha_u] \right\} \quad (14)$$

and

$$\dot{X} = \left[e^{\frac{2V}{D}\sqrt{\cos\alpha_u + f\sin\alpha_u}t} - e^{-\frac{2V}{D}\sqrt{\cos\alpha_u + f\sin\alpha_u}t} \right] \times$$

$$\times \left\{ X_0\left(\frac{2V}{D}\right)^2 [\cos\alpha_u + f\sin\alpha_u] + g[\sin(\alpha_u - \alpha_б) - f\cos(\alpha_u - \alpha_б)] \right\} :$$

$$\left[: 4\frac{V}{D}\sqrt{\cos\alpha_u + f\sin\alpha_u} \right] \Big\}. \quad (15)$$

VI. CONCLUSION AND FUTURE WORK

From expressions (14) and (15) it can be seen that the distance and velocity of the soil particles on the working surface of the disk working body depends on their initial distance (X0), the diameter of the disk (D), its longitudinal vertical plane (αb) and the workingDepending on the conical (αi) angles of the surface, the working speed of the unit (V) and the coefficient of friction of the soil (f), the increase in X0, V and αiAn increase in d and f leads to a decrease in them.

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