Justification scheme installation of a rotary working body for opening grape bushes

M Turakulov¹* and V Ermatov¹
¹Gulistan State University, Syrdarya, Uzbekistan

nashitom@mail.ru

Abstract. The article describes the nature of the movement of a non-driven rotary working body when working in row aisle: portable with speed $V_n$ and relative (rotational) around the axis of rotation with angular velocity $\omega$. The technological process of the operation of a non-driven rotary working body can be divided into three main interrelated points: the introduction of the dump into the soil, the descent of the soil from the surface of the dump, and the flight of soil particles discharged from the working body.

And also a diagram of the interaction of the blade of the working body with the soil. When a soil particle moves along the surface of the dump in the active working zone, where due to the soil cutter, the extreme point of the dump moves with acceleration, a force arises pushing the soil particles from the surface of the dump. Knowing the forces acting on the particle and the scheme of their action, it is possible to compose the differential equations of the soil on the surface of the dump. Formulas are given that determine the flight range of soil particles descending from the dump of a rotating working body. The length of the flight path of the soil particles after the descent of their working body is determined. The direction of soil displacement also depends on the inclination of the non-power rotary working body relative to the soil surface (horizon). When the rotational working body is tilted towards the row, the soil particles move to the middle of the aisle.

1. Introductions

The rotary working body makes a complex movement: portable with a speed $V_n$ and relative (rotational) around the axis of rotation with an angular speed of $\omega$ [1 – 15].

The technological process of the rotation of the working body can be divided into three main interrelated points: the introduction of the dump soil, the descent of the soil from the surface of the dump, and the flight of soil particles discharged by the working body.

2. Research Method

Figure 1a shows a diagram of the interaction of the blade of the working body with the soil. Here $CE$ is the blade of the working body: $OS = R$ is the distance from the axis of rotation to the outer edge of the blade; $\rho$ is the angle of entry of the dump into the soil. The symbol indicates the angle of rotation of the blade from the starting point E. Moreover, normal $N$ and force $F$ act on the soil particle. The first is decomposed into two components: $T$ and $S$, acting respectively in the direction of rotation speed and along the surface of the blade. Moreover, $T = N/cosp$ and $S = N/tg\rho$.

If the angle $\rho$ is positive, the force $S$ will be directed along the surface of the blade to the center of rotation (Fig. 1.a), and if $\rho$ is negative, it will be directed from the center of rotation (Fig. 1 b).

The friction force keeps a particle of soil from displacing along the surface of the blade. But under the condition $S > F$, the soil particles will mix along the surface of the blade at a positive angle $\rho$ to...
the center of rotation, and at negative ρ from the center of rotation. In the latter case, under the action of the force S, the soil is compacted in the working area of the dump, which is undesirable, since the volume of the movement of the soil between the rows is sharply reduced.

![Figure 1. Scheme of forces acting on soil particles at the time of the introduction of the dump into the soil: a) at an angle ρ > 0; b) at an angle ρ < 0](image)

To ensure effective displacement of the row-spacing soil volume, it is necessary that the force S be directed to the center of rotation of the working body and the condition $S > F$ or $N_{tg} > N_{tg} \varphi$ is provided where $\varphi$ is the angle of soil friction against the metal. This circumstance must be taken into account when designing a rotating working body, and the angle ρ should be taken greater than the angle $\varphi_n$. Under the action of the force $T$, the crushing of the soil occurs with periodic cleaving of the layer with a thickness equal to the depth of the blade in the soil.

Let us now consider the movement of soil particles on the surface of the dump in the active working zone, where due to soil, the end point of the dump moves with acceleration, and there is a force pushing out the soil particles with the following forces: weights – $mg$; centrifugal force – $m\omega^2X$; Coriolis force $2m\omega X_1$; soil friction force on the soil $F_{mg}$, where $f$ is the coefficient of soil friction on the soil; friction force of soil particles on the dump – $2f\omega X_1$; normal dump – $N$ reaction.

![Figure 2. Scheme of forces acting on soil particles upon descent from the soil surface](image)
3. Results and discussion

Knowing the forces acting on the particle and the scheme of their action, it is possible to compose differential equations of soil motion on the surface of the blade. After solving them and some transformations, we obtain a formula that determines the path, $X$ traveled by a soil particle along the dump of a rotating working body.

$$X = \frac{\omega^2 K_0 - f g}{\omega^2 (K_0 - K_2)} (K_1 e^{K_2 t} - K_2 e^{K_1 t}) + \frac{f g}{\omega^2}$$  \(1\)

Where: $K_0$ is the distance from the axis of rotation to the material point; $t$ is the time spent by the soil particle on the dump; $e$ is the base of the natural logarithm; $K_1$ and $K_2$ are the roots of the characteristic equation:

$$K_1 = \omega (\sqrt{1 + f^2} - f)$$

$$K_2 = \omega (\sqrt{1 - f^2} - f)$$

Using equation (1), we can find out how various factors affect the nature of soil movement along the dump of the working body.

When determining the flight range of soil particles coming from the dump of a rotating working body, we will proceed from the position that gravity and air resistance force act on a soil particle. The latter is determined by the expression:

$$R = \gamma_B F_m V^2$$  \(2\)

where: $K$ is the coefficient of resistance; $\gamma_B$ is the air density; $F_m$ is the midsection of a particle.

Determining the length of the flight path of a soil particle after the descent of their working body can be done according to the formula [19].

$$X = \frac{\ln(K_n V_0/2h/g)}{K_n}$$  \(3\)

where: $V_0$ is the initial rate of descent of soil particles; $K_n$ is the coefficient of sailing; $H$ is the height of the location of the soil particles at the time of departure from the rotary working body.

4. Conclusion

From this dependence, it follows that the range of flight of soil particles depends on the initial speed, i.e. the speed with which a particle of soil leaves the rotary working body, from the height of the material point above the soil and the sailing coefficient. Moreover, the flight range increases with increasing $V_0$ and $h$ and decreases with increasing $K_n$. The direction of soil displacement also depends on the slope of the rotary working body relative to the soil surface (horizon).

When installing a rotary working body with an inclination towards the middle of the aisle, soil particles move towards the row of the covering vineyard. As a result, after the passage of the working body, the soil becomes denser in the zone of covering vines.
When the rotational working body is tilted towards the row, the soil particles move to the middle of the aisle. After the passage of the working body, the volume of soil under the sheathing vines significantly fits. As a result, a favorable condition is created for work for opening coverings of the active fan and vines of the vineyard [16 – 23].

References

[1] Khadanovich V 1989 Justification of the parameters of the non-driven rotary working body for inter-row tillage of cabbage p 17 Chelyabinsk
[2] Bok N B 1964 On the determination of the installation angle of the working body of tillage milling tractors and agricultural machines p 9
[3] Bok N B 1968 Technological calculation of tillage mills Agricultural mechanics T 10 Mechanical Engineering pp 16-23
[4] Bok N B 1965 On the kinematics of tillage cutters pp 44-46 Materials NTS VISKHOM
[5] Belyaev V I and Sulimin I P 1990 To the question of forces and moments acting on rotary mover – rippers Scientific works of the Voronezh Agricultural Institute 109 Voronezh
[6] Dohin B D 1964 The study and justification of the optimal parameters and the operation mode of row crop mills p 21 Chelyabinsk
[7] Grinchuk I M and Matyashin Y I 1969 On the issue of choosing the main structural parameters and operating modes of the soil mill Tractors and agricultural machinery # 1 pp 25-28
[8] Lukyanov A D 1970 Technological calculation of tillage cutters. // Tractors and agricultural machinery 8 pp 21-22
[9] Kanarev F M 1983 Rotary tillage machines and implements "Engineering" p 140 Moscow
[10] Vasilenko P M 1960 The theory of particle motion on rough surfaces of agricultural machinated p 283
[11] Vagin A G 1965 To the question of the interaction of the wedge with the soil Justification of the main parameters of aggregates for layer-by-layer fertilization in soil Questions of agricultural mechanics T XI pp 178-202 Minsk, Harvest
[12] Dolodze E I 1977 Rotary hoe for processing cultivated crops Mechanization and Electrification of Agriculture # 5 p 48-49
[13] Sineokov G N, Panov I M 1965 Theory and calculation of tillage machines Mechanical Engineering p 326
[14] Kanarev F M, Dontsov V B, Tkachenko A I 1969 The study of critical operating regimes of tillage mills Transactions of Kuban Agricultural Institute 29(57) pp 142-148 Krasnodar
[15] Goryachkin V P and Lucheniskogo N D 1968 Collected Works Ed. Vol 2 T 3 Moscow Kolos pp 294-300
[16] Reznik N E 1967 Some questions are the theory of blade cutting VISKHOM Proceedings 55 1967 pp151-168
[17] Reznik N E and Goryachkin V P 1968 Founder of the theory of cutting with a blade. "Mechanization and Electrification of Agriculture # 1 pp 3-22
[18] Sablikov M I 1963 On the critical value of the pinch angle Mechanization and Electrification of Agriculture 1963 # 2 p 44
[19] Nevezhenko E 1964 Mechanized shelter and opening of the vine Information leaflet pp 4-6
[20] Yankovsky Y S 1975 The working body for the disclosure of grape bushes № 472621. Discoveries, inventions, industrial designs, trademarks # 25

[21] Kuz V I and Shilkov V A 1973 A machine for opening vineyards *Horticulture, Viticulture and Winemaking of Moldova*

[22] Gaponov E P Zaitseva Y F 1969-1972 To find the working body and explore the technology of additional opening of the vines by air flow *Report*