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Studies of the Working Body for Inter-Shutter Tillage in Vineyard Rows

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Abstract: It was discovered in the article that the value of the necessary speed of paw rotation increases with a reduction in the size of its blade **L,** as well as the necessities for the speed of the paw's retraction, provided that the necessities for the speed of the paw's retraction and insertion are met simultaneously, depending on the precise size of the paw **L, a** particular combination of translational and angular speed, and the paw's dimensions, the actuating spring is chosen with a specified rigidity ratio.

Keywords: Vineyard, inter-bush tillage, self-deflecting rotary share, hydraulic drive, and others

Introduction

Vineyard inter-bush tillage should be done by specialized working bodies that can enter and exit the row in the spaces between plants as the unit moves forward.

The inter-bush tillage device that has been suggested enables you to alter the width of processing based on the thickness of the tree trunk, improving inter-bush tillage accuracy, dependability, and productivity.

For inter-bush processing, flat-cutting swivel paws come in a wide range of useful configurations. The number and size of cutting blades, the ratio of their lengths and locations, the angles of soil crumbling and cutting in the design, various kinds of additional loosening elements, etc., are all ways that they differ from one another.

The practice of using rotary paws with a hydraulic servo drive in two-section devices of vineyard and orchard machinery, however, revealed relatively challenging operating conditions for these devices. The primary drawbacks include the significant effort needed to turn the paw when avoiding bushes, the effect of vineyards' weediness on the speed of the hydraulic drive system, and the physical and mechanical nature of the soil [1].

The idea of creating a more sophisticated self-deflecting swivel paw design was sparked by the possibility of totally giving up the usage of a very complicated hydraulic drive system in agricultural equipment.

Methodology. The goal of tillage in vineyards is to improve the environment for plant growth and fruiting. Through tillage, they are able to increase aeration, destroy weeds and pests, fertilize, and protect the vineyard from winter frosts. They also accumulate and preserve moisture.

Research results The intricate hydraulic servo drive mechanism was replaced by a spring that was made to resist dirt when it came to the share's rotation during bush bypassing in order to fix the flaws in the construction of the current rotary shares.

The choice of a method for avoiding the bush during cultivation in rows by making direct contact of the working body with the root stem was influenced by the fact that vineyard formation is mostly conventional, long-sleeve fan. [2].

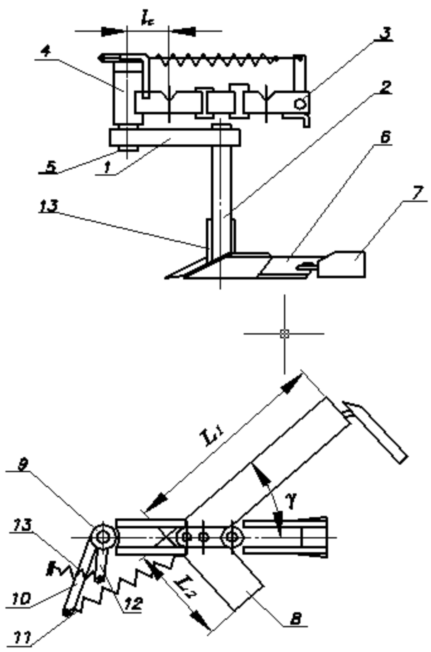

Figure 1 Scheme of a rotary self-aligning paw

1- leash, 2- rack, 3- beam, 4,9- sleeve, 5- shaft, 6- long paw, 7- farmer, 8- short paw, 10, 12- lever arm, 11- spring, 13- balancing spring

The rotary paw (Fig. 1) is made up of a leash 1, a rotating rack 2, and a beam 3 whose front sleeve 4 houses the bearings that allow the shaft 5 of the leash of the rotary paw 6 to rotate. Due to the differing lengths of the paw's blades and the presence of a tiller on the long paw 7, which also ploughs the soil, a specific device is used to balance off the burden on the short paw 8. The mechanism is made up of a shaft 5, a sleeve 4 with a lever 10 of the tension spring 11, a lever 12 freely mounted on the shaft 5, a compensating spring 13, and the tension spring 11.

The working body number six, which touches the grapes' roots, avoids disturbing the soil along the biting strips while working body number eight, whose blade working bodies deeper, cuts weeds and loosens soil as the unit advances along the aisle of the vineyard.

Think about a one-sided paw's work, where the cutting line runs across the center of its spin. This indicates that a double-sided rotary share is a combined tool, and its operation may be described using the traits of a one-sided share.

The process of bypassing the trunk with a rotary paw includes the three most characteristic states:

1. holding paw in full insertion position ($\varphi_л=\varphi_{л0}$, $\dot{\varphi}_л = 0$);
2. paw withdrawal ($\varphi_л \leq \varphi_{л0}$; $\varphi_л^{om} < 0$);
3. paw movement to enter ($\varphi_л \leq \varphi_{л0}$; $\varphi_л^{в} > 0$).

The paw engages in a complex movement when it bypasses the plant, including portable (translational) movement at a constant speed of *V* and relative (rotational) movement. In addition, the second component must change in line with the input signal in both signs and a broad range of absolute values.

Please take note of the characteristics of the creation of the processing border when bypassing the plant, which heavily depends on $\dot{\varphi}_л$.

Two scenarios are conceivable. In one of them, if the absolute velocity vector V_{abs} of the extreme kidney passes ahead of the paw blade, the tillage boundary is determined as the trajectory of the extreme point "rl" of the blade during rotation and portable translational motion of the paw. The observed pattern perfectly matches the holding and inserting of the paw as well as its retraction at relatively slow angular velocities (Fig. 2 a, b, v).

When the absolute angular velocity vector of the extreme point of the paw passes behind the blade line in the second scenario, the processing boundary is formed as an envelope of the set of positions of the working blade of the paw during its complex movement, which occurs at a relatively high angular velocity of retraction (Fig. 2g). Additionally, another characteristic of such a movement may be seen in this instance: the blade's periphery will no longer cut the SOIL, but rather crush it with its back side. This can have a substantial impact on the tap's energy usage.

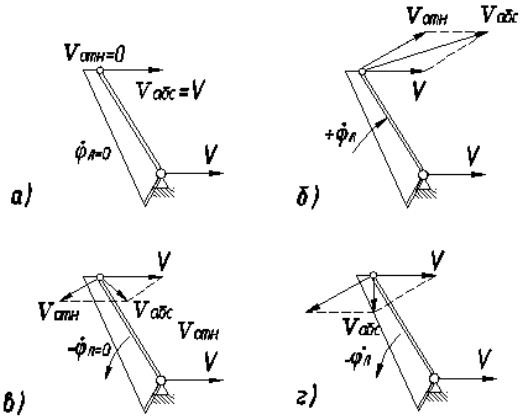

Figure 2. Typical cases of movement of the rotary paw.

On figure 3 shows the design scheme for the input of the paw. The end of the paw, being taken away *E* in the transverse direction by the protective dimension *B*, must not leave the tolerance zone facing the paw, and must pass at least at a distance A from the plant along the axis of the row.

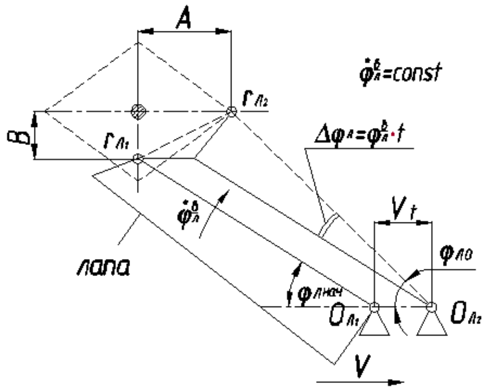

Figure 3. Estimated scheme of paw input.

In this case, the movement of the paw end corresponds to the system of equations:

$$\begin{cases} A = V \cdot t^2 + L\left[cos(\varphi_{л0} - \dot{\varphi}_л^в \cdot t^в) - cos\,\varphi_{л0}\right] \\ B = L \cdot \left[sin\,\varphi_{л0} - sin(\varphi_{л0} - \dot{\varphi}_л^в \cdot t^в)\right] \end{cases}, \qquad (1)$$

here $\dot{\varphi}_л^в \cdot t^в$ - paw rotation angle when moving its end from point r_{11} to point r_{12}. From the system of equations (1) we find the initial angle of the paw [3,4]:

$$\varphi_{лнач} = \varphi_{л0} - \varphi_л^в \cdot t^в = \arcsin\frac{L\sin\varphi_{л0} - B}{L}, \qquad (2)$$

and express the input process time

$$t^{в}=\frac{A-L[cos(\varphi_{л0}-\dot{\varphi}\cdot t)-cos\,\varphi_{л0}]}{V}. \quad (3)$$

Taking into account the last two expressions, we get:

$$\varphi_{л}^{в}=\frac{\varphi_{л0}-\arcsin\left(\sin\varphi_{л0}-\frac{B}{L}\right)}{A-L\left[\cos\arcsin\left(\sin\varphi_{л0}-\frac{B}{L}\right)-\cos\varphi_{л0}\right]}\cdot V. \quad (4)$$

In accordance with expression (4), the table presents the values of $\varphi_{л}^{в}(L)$ at: $\varphi_{л0}$ = 45° = 0,78 *rad/s*; *A* = 0,2 *m*; *B* = 0,1 *m*; *V* = 2,0 *m/s*.

Table Dependences of the length of the blade of the rotary paw on the angular displacement

L, m	0,525	0,625	0,725	0,825	0,925	1,0
$\dot{\varphi}_{л0}^{в}$, rad/s	3,5	3,25	3,0	2,75	2,5	2,25

Conclusion

An analysis of the movement of the kinematics revealed that the value of the required speed of paw rotation increases with a decrease in the size of its blade **L**, as well as the requirements for the speed of retraction of the paw, to be selected depending on the specific size of the paw **L, a certain** combination of translational and angular speed and paw size, i.e. ., at an angular velocity of 2.25 ... 3,5 rad/s, the length of the paw blade is chosen L = 0.525 ... 1.0 m, since at the retraction stage, the required paw entry speed decreases with increasing paw length.

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