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JUSTIFICATION OF THE MUTUAL ARRANGEMENT OF THE WORKING BODIES OF THE MACHINE FOR PREPARING THE SOIL FOR SOWING MELONS AND GOURDS UNDER THE TUNNEL FILM

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Annotation

In the world, much attention is paid to the development and use of machines that perform all the technological processes of soil cultivation and preparing it for sowing crops in one pass across the field. The aim of the study is to justify the design scheme and the relative position of the working bodies of the machine for preparing the soil for sowing melons under the tunnel-type film.

Keywords: machine, soil, melons, technology, deep-ripper, film, tunnel.

Introduction

Timely high-quality soil preparation for the cultivation of agricultural crops is an urgent task in agriculture. The existing technologies of soil preparation for sowing are carried out by single-operation machines in several passes, which leads to excessive soil compaction, a decrease in labor productivity, an increase in labor and funds consumption, a delay in soil preparation, intensive soil drying, which entails a decrease in crop yields [1- 13].

Literature Review

The problems of processing and preparing soils for sowing agricultural crops are considered in many scientific works [1-3]. Research on improving soil preparation technologies for sowing melons, creating machines for melon growing, substantiating the structures and parameters of their working bodies were carried out by F. Mamatov, B. Mirzaev [1-8, 10-12], D. Chuyanov [7], and others ... F. Mamatov, B. Mirzaev [1-8] substantiated and developed working bodies for the main tillage for sowing melons and other crops. D. Chuyanov's research is devoted to the preparation of the soil for sowing melons in autumn [7]. All these studies are aimed at improving technologies and technical means of processing for preparing the soil for sowing melons in open ground. These technical means cannot be used to prepare the soil for sowing melons under a tunnel-type film.

The aim of the study is to substantiate the mutual arrangement of the working bodies of the combined machine for preparing the soil for sowing melons and gourds under the film.

Materials and methods

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

Research results. The combined machine (Fig. 1), which implements the proposed technology, consists of a frame 1, a duckfoot share 4, paired left and right deep loosening machines 5 and 6, a furrow cutter 7 and rotary working bodies 9. The machine, based on the technology of sowing melons and gourds under a closed tunnel film must process and prepare a strip with a width of 1.4 m in one pass. During the operation of the machine, the duckfoot share 4 superficially processes a strip equal to the width of the furrow cutter 7, loosens the soil and cuts off the roots of weeds. First, the chisel of the subsoiler 6 enters the soil and loosens it. In this case, the cracks formed spread to the soil surface at an angle □ = 40-45º. And then the subsequent subsoiler 5 acts on the soil in a similar way. The result is the best possible soil crumbling in the sowing area. Then the furrow cutter 7 cuts the furrows in the middle of the sowing zone. The process of soil preparation for sowing under a closed tunnel-type film ends with the processing of a strip for sowing melons and gourds, with rotary working bodies 9.

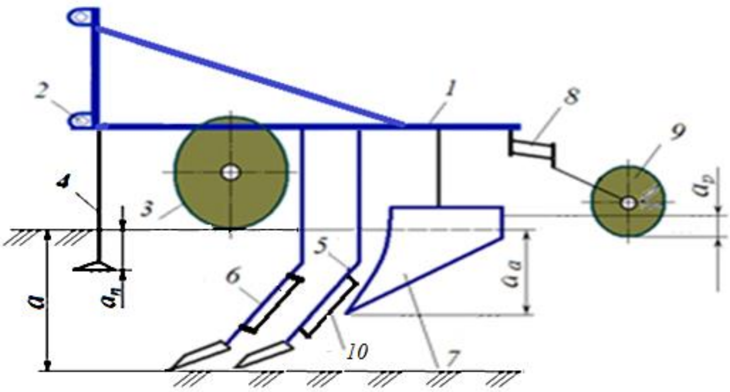
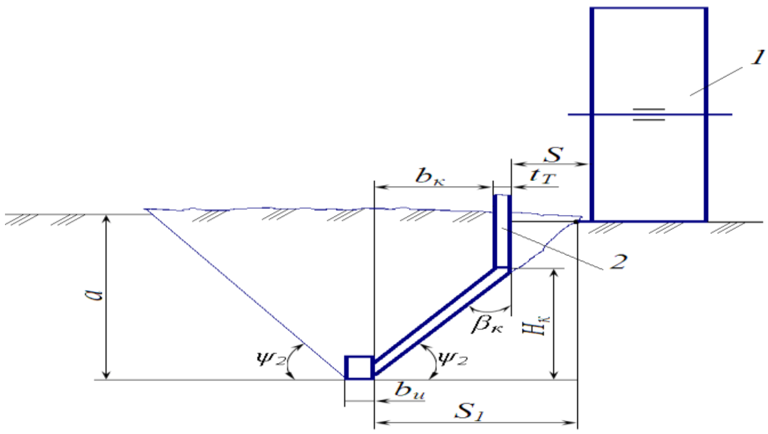


Fig. 1. Structural diagram of a machine for preparing soil for sowing melons and gourds under a closed tunnel-type film: 1 - frame; 2 - hinged device; 3 - support wheel; 4 - lancet paw; 5, 6 - left and right subsoilers; 7 - furrow cutter; 8 - parallelogram mechanism; 9 - rotary ripper; 10 - ripping plate



1 - support wheel; 2 - subsoiler
Fig. 2. Scheme for determining the lateral distance between the support wheel and the subsoiler

The lateral distance between the support wheel and the subsoiler (Fig. 2) was determined from the condition that the soil deformed under the influence of the chisel did not reach the support wheel, i.e. the support wheel moved outside the deformed soil zone and the following expression was obtained

$$S \geq actg\psi_2 - b_к - t_T, \quad (1)$$

Where ψ_2 – soil cleavage angle in the transverse plane, degree; $b_к$ – width of the inclined part of the subsoiler, m; t_T – subsoiler stand thickness, m.

Taking $\psi_2 = 45^o$, $b_к = 0,22$ м,

t_T = 0,05 м and a = 35 см by expression (1) we get S ≥ 0,08 м.

The longitudinal distance l1 (Fig. 3) from the toe of the duckfoot to the toe of the subsoiler chisel is determined from the condition that the soil deformation zone processed by the subsoiler does not reach the structural elements of the duckfoot. At the same time, we take into account the destruction of the upper part of the formation raised under the action of the bit.

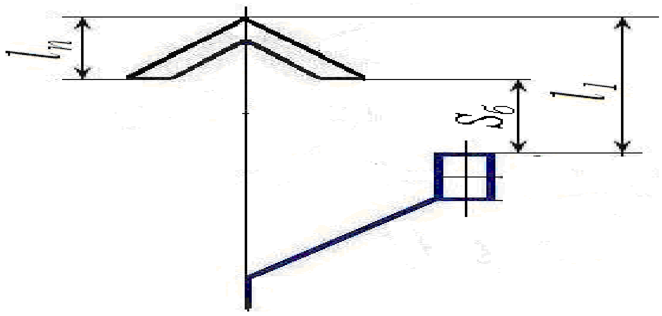


Рис. 3. Схема к определению продольного расстояния (l_1) между глубокорыхлителем и стрельчатой лапой

Based on experiments, the height of the destroyed part of the formation is determined by the expression h_c = (0,2-0,25) a.

From Fig. 4 we have

$$l_1 \geq l_n + S_б = l_n + (a - h_c) ctg\psi_1, \quad (2)$$

Where l_n – lancet paw length, m; $S_б$ – length of the deformed soil zone under the influence of the chisel, m; h_c – height of raising the soil layer along the working surface of the subsoiler bit, m; ψ_1 - the angle of soil chipping in the longitudinal-vertical plane, degree;

Calculations carried out according to expression (5) at a = 35 см, h_c = 8 см, ψ_1=45^0, h_u = 5,4 см, $l_п$ = 12,5 см, α_u = 20°, φ_1 = 30° and φ_2 = 40° showed that the longitudinal distance between the flat-cutting share and the subsoiler should be at least 39.5 cm.

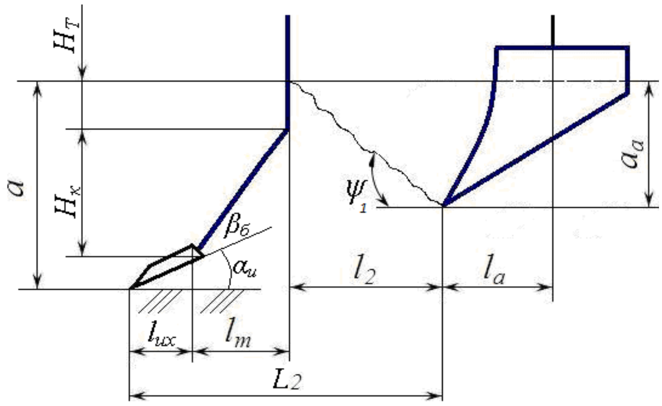


Fig. 4. Scheme for determining the longitudinal distance (l2) between the furrow cutter and the subsoiler

The longitudinal distance L2 (Fig. 4) from the toe of the deep-ripper bit to the toe of the furrow-cutter was determined from the condition that the soil deformation zone processed by the furrow-cutter did not reach the structural elements of the deep-ripper in front of it.

From the diagram shown in Fig. 4 it follows

$$L_2 \geq l_m + l_{ux} + l_2 = (a - H_T - h_u)tg\beta_б + l_u \cos\alpha_u + a_a ctg\psi_1, \qquad (3)$$

Where H_T – depth of immersion in the soil of the straight part of the stand of deep-burrowing machines, m; $h_и$ and $l_и$ – subsoiler bit height and length, m; $\beta_б$ – angle of installation of the rack of the subsoiler in the longitudinal plane, degree; a_a - furrow cutter processing depth, m

Calculations performed according to expression (3) at a = 35 см, H_T = 10 см, h_u = 5,4 см, l_u = 15 см, $\alpha_и$ = 20 градус, $\psi_1 = 30^o$ and $\beta_б = 45^o$ showed that the longitudinal distance between the subsoiler and the furrow cutter should be at least 50.6 cm.

The longitudinal distance L3 between the furrow cutter and the rotary working body (Fig. 5) is determined from the condition, excluding the ingress of soil particles coming from the wings of the furrow cutter to the teeth of the rotary working body, i.e.

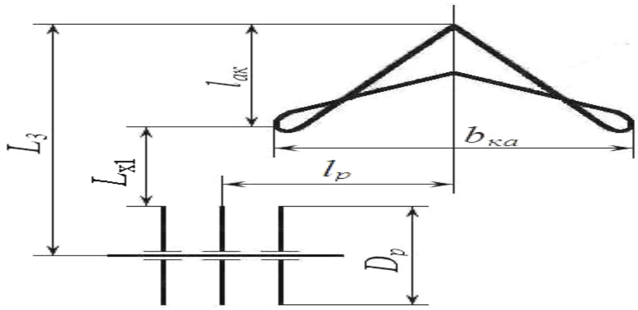


Fig. 5. Scheme for determining the longitudinal distance (L3) between the furrow cutter and the rotary working body

$$L_3 \geq l_{ак} + L_{x1} + \frac{D_p}{2}, (4)$$

Where $l_{ак}$ – distance from the toe of the bo-cutter to its wings, m; L_{x1} – distance of ejection of soil particles in the direction of movement of the machine, after being separated from the furrow cutter wing, m; D_p – diameter of the rotary working body, m. The minimum longitudinal distance between the subsoilers was determined from the condition that the ripper bits act on a soil particle coming off the subsoiler bits after they fall to the bottom of the furrow (Fig. 6).

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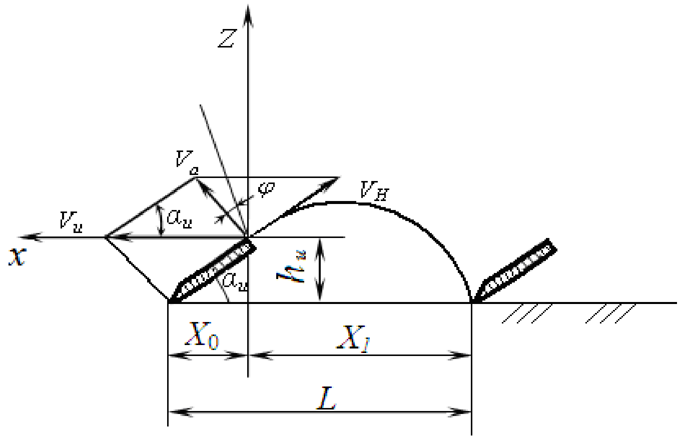

Fig. 6. Scheme for determining the minimum longitudinal distance between subsoilers

Based on fig. 6

$$L \geq \frac{V_u}{g\cos\varphi}\left[1 - \frac{\sin\alpha_u}{\cos\varphi}\sin(\alpha_u+\varphi)\right] \times \left\{V_u \sin\alpha_u \cos(\alpha_u+\varphi) + \right.$$
$$\left. + \sqrt{V_u^2 \sin^2\alpha_u \cos^2(\alpha_u+\varphi) + 2gh_u \cos^2\varphi}\right\} + l_u \cos\alpha_u, \qquad (5)$$

Where $V_и$ – translational speed of the unit, м/с; $h_с$ – the height of the soil layer rise along the working surface of the subsoiler bit, m.

The minimum longitudinal distance between subsoilers at $h_и = 0,054$ м, $\alpha_и = 20^o$, $\varphi = 30^o$, g = 9,81 м/с^2 and $l_и = 0,15$ м and V = 2,5 м/с by expression (5) is equal to

L ≥ 0,444 м**.** Accept 0.5 m.

CONCLUSIONS

According to the results of theoretical studies, it was found that high-quality field preparation for sowing melons and gourds under film with minimal energy consumption is provided with a longitudinal distance between the subsoiler and the duckfoot paw of 40 cm, the transverse distance between the subsoiler and the support wheel is 10 cm, the longitudinal distance between the subsoiler and the furrow cutter is 50 , 6 cm, longitudinal distance between furrow cutter and rotary working body 123 cm.

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