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Effect of Combined Machine Softward Parameters on its Performance

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ABSTRACT. The article describes the development of a combined machine consisting of softeners and bulldozers, leveling-compactor and plank rollers for pre-planting tillage, and the width of the softener 6.3-6 to ensure high-quality tillage with low energy consumption, according to experimental studies. , In the range of 6 cm, the angle of entry into the soil should be 29-30° and the radius of curvature should be in the range of 253-276 mm.

KEYWORDS: combined machine, softener claw, its width, angle of entry into the soil, radius of curvature, speed of movement, depth of tillage, quality of soil compaction, traction resistance

I.INTRODUCTION

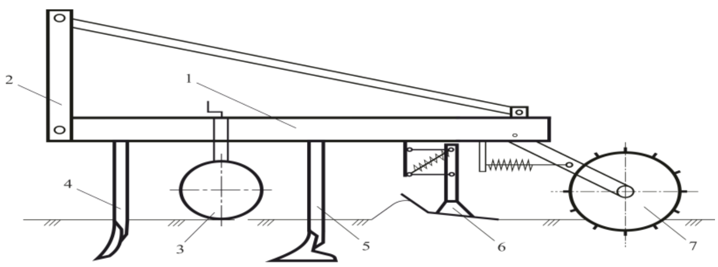
Machinery and equipment used in pre-sowing tillage in our country do not meet modern requirements, such as minimal and economical tillage, and their use leads to deterioration of physical and mechanical properties of soil, loss of moisture in many soils and increased fuel consumption and other costs.

II. SIGNIFICANCE OF THE SYSTEM

The article describes the development of a combined machine consisting of softeners and bulldozers. 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.

III. METHODOLOGY

Based on these considerations, a combined machine was developed to be used for pre-planting tillage. It has a frame (Fig. 1), a series of softeners and axial claws placed on it, a leveling- compactor and lattice roller. In the process of work, softeners and ridges loosen the soil to a depth of 14-18 cm, leveling-compactor and plank roller flattens, compacts the surface of the layer treated by them and forms a soft soil layer on the field surface, ie sowing seeds or other crops in the field prepares for. This leads to a reduction in labor, energy and fuel consumption, as well as the fact that the soil is not over-compacted and moisture is retained in it.



1-frame; 2 hanging device; 3 base wheels; 4 and 5 softener and axle claws; 6 leveler-compactor; 7-plank roller coaster.

Figure 1. Schematic of a combined machine

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IV. EXPERIMENTAL RESULTS

This paper presents the results of experimental studies on the width b of the combined machine softener claw, the angle of entry into the soil α and the radius of curvature R (Fig. 2) to study its impact on gravity, working depth and soil compaction quality. Experimental research was carried out on the plowed and irrigated area, which was then irrigated. DST 3412: 2019 "Testing of agricultural machinery. Machines and weapons for tillage. Test programs and methods "and Oz DST 3193: 2017" Testing of agricultural machinery. Method of energy evaluation of machines "[1, 2]. A special laboratory-field device was developed for the experiments, and softening claws with widths of 40, 50, 60 and 70 mm, penetration angles of 20, 25, 30, 35 and 40° and a radius of curvature of the working surface of 200, 250, 300 and 350 mm. prepared (Fig. 2).

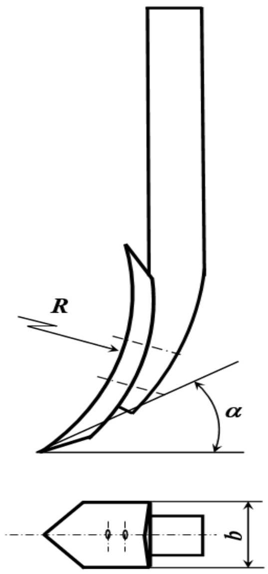

Figure 2. Parameters of the softening claw

During the experiments, the processing depth was set at 20 cm, and the speed was set at 6 and 8 km / h. An analysis of the data presented in Table 1 shows that a change in the width of the softener claw from 40 mm to 70 mm led to an increase in machining depth. This can be explained by the fact that as the width of the softening claw increases, the height and width of the irregularities formed at the bottom of the treated layer decrease. In addition, as the width of the softening claw increases, the depth of critical softening of the soil increases, and the volume of soil that remains loosened between the working bodies decreases. With increasing width of the softening pad, the amount of soil fractions larger than 100 mm and in the range of 100-50 mm increased in the treated layer, while the amount of fractions smaller than 50 mm decreased, ie the quality of soil compaction deteriorated. This can be explained by the fact that as the width of the softening claw increases, the deformation zone of the soil increases and the probability of moving large lumps increases. An improvement in soil compaction quality was observed as the speed increased from 6 km/h to 8 km/h.

The data in Table 2 show that the increase in the angle of penetration of the softening claw to the soil from 20 ° to 30-35 ° at both speeds of movement of the unit is the quality of soil compaction.

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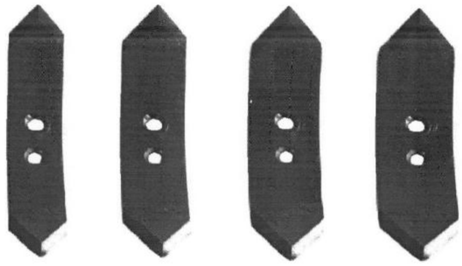
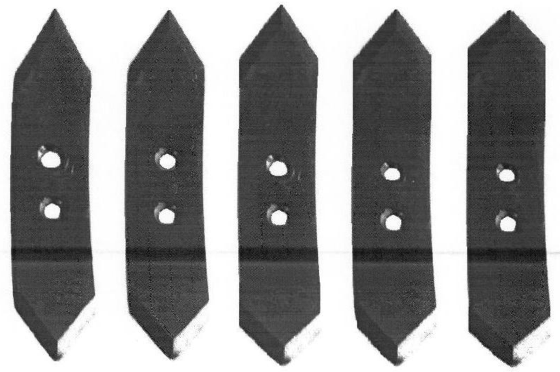
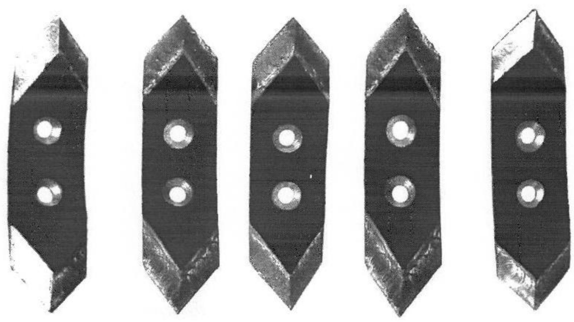


1, 2, 3, 4 - softener claws with widths of 40, 50, 60 and 70 mm, respectively
a) 1, 2, 3, 4, 5 - softening claws with an angle of entry into the soil of 20, 25, 30, 35 and 40°, respectively



b) 1, 2, 3, 4, 5 - softener claws with a radius of curvature of 200, 250, 300, 350 and 400 mm, respectively



v) Figure 3.3. Softening claws with different width (a), angle of entry to the ground (b) and radius of curvature (c)

Table 1
The effect of the width of the softening claw on the performance of the combined machine

Indicators name	The width of the softening claw, mm			
	40	50	60	70
Processing depth, cm: M middle $\pm\sigma$	16,2/16,3 1,9/2,2	17,9/18,0 1,8/1,7	19,1/19,7 1,7/1,8	20,7/20,8 2,0/1,9
The following dimensions (mm) fractions amount, %: > 100 100-50 <50	2,1/1,5 15,6/14,1 82,3/84,4	2,9/2,5 16,8/15,3 80,3/82,2	3,7/3,2 18,5/17,1 77,8/79,7	4,5/3,8 20,4/19,3 75,1/76,9
Gravity resistance of the softening claw, kN: M middle $\pm\sigma$	2,35/2,73 0,21/0,22	2,58/2,88 0,18/0,27	2,75/3,15 0,23/0,19	2,97/3,41 0,30/0,25

Note: The operating speed was 6 km/h; at the exit - 8 km/h.

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Improved, and an increase from 30–35 ° to 40 ° led to a deterioration in this index. This can be attributed in large part to the fact that the size of the lumps separating from the soil under the influence of the softening claw changes in many respects depending on its angle of entry into the soil [3]. The dimensions of the soil fractions had a minimum value when the softening claw penetration angle to the soil was 30–35 °. The increase in speed from 6 km / h to 8 km / h has led to an improvement in the quality of soil compaction here as well.

Table 2.

Results of experiments to study the effect of the angle of penetration of the softening claw on the soil on the combined machine performance

Name of indicators	The angle of penetration of the softening claw into the soil, degrees				
	20	25	30	35	40
Processing depth, cm: M middle $\pm\sigma$	20,1/19,7 1,7/1,8	20,0/19,8 1,8/1,6	20,2/20,3 1,9/2,2	19,9/20,0 1,8/1,7	19,7/19,8 2,0/1,9
The following dimensions (mm) fractions amount, %: > 100 100-50 <50	5,1/4,3 20,0/19,9 74,9/75,8	3,7/3,2 18,5/17,1 77,8/79,7	2,1/1,5 15,6/14,1 82,3/84,4	2,9/2,5 16,8/15, 3 80,3/82,2	4,5/3,8 19,4/18,3 76,1/77,9
Gravity resistance of the softening claw, kN: M middle $\pm\sigma$	2,81/3,25 0,19/0,21	2,41/2,89 0,24/0,23	2,23/2,59 0,13/0,15	2,34/2,75 0,16/0,14	3,02/3,72 0,18/0,21

Note: working speed 6 km/h; denominator - 8 km/h.

The change in the angle of penetration of the softening pad into the soil in the range of 20–40 ° did not significantly affect the depth of tillage. The gravitational resistance of the softening claw changed in the form of a sunken parabola depending on its angle of entry into the ground, i.e. Decreased in the angle range of 20-30 °, increased in the angle range of 30-40 °. This can also be explained by the fact that a change in the angle of entry of the softening claw into the soil leads to a change in the size of the lumps separated from the soil. An increase in their size leads to an increase in energy consumption for soil decomposition, while a decrease leads to a decrease in energy consumption. The data in Table 3 show that an increase in the radius of curvature of the softening cage from 200 mm to 350 mm at both speeds of movement of the aggregate led to a slight decrease in the quality of soil compaction. However, this change did not significantly affect the processing depth. The increase in velocity led to an improvement in the quality of soil compaction. The increase in the radius of curvature of the softening jaw from 200 mm to 300 mm did not have a significant effect on the machining depth.

Table 3

The results of experiments to study the effect of the softening curve radius on the combined machine performance

Name of indicators	The radius of curvature of the softening claw, mm			
	200	250	300	350
Processing depth, cm: M middle $\pm\sigma$	18,9/19,1 1,6/1,4	19,3/19,2 1,3/1,5	19,7/19,4 1,5/1,7	19,9/19,6 1,5/1,3
The following dimensions (mm) amount of fractions, %: > 100 100-50 <50	1,6/1,2 15,3/13.4 83,1/85,4	1,9/1,4 15,6/14.3 82,5/84,3	2,2/1,8 15,8/14,7 82,0/83,5	2,7/2,3 16,0/15,4 81,3/82,3
Gravity resistance of the softening claw, kN: **M middle** $\pm\sigma$	1,71/2,13 0,14/0,12	1,75/2,17 0,17/0,14-	1,82/2,28 0,15/0,13	2,20/2,65 0,16/0,14

Note: working speed 6 km/h; denominator - 8 km/h.

The decrease in the quality of soil compaction with increasing radius of curvature can be explained by the decrease in the degree of compression in the horizontal direction by its softening claw. The change in the radius of curvature of the softening claw in the range of 200-250 mm did not significantly affect its resistance to gravity, in the range of 250-350 mm this figure increased rapidly. This can be explained by the fact that an increase in the radius of curvature of the softening cage leads to an increase in the volume of soil that rises and slides along its working surface. To determine the optimal values of the studied parameters of the softening jaw, multivariate experiments were carried out according to the Hartley-4 plan [4] and regression equations were obtained that adequately represent the performance of the combined machine. The obtained regression equations were solved together to ensure the required quality of work with low energy consumption, and the following optimal values of the width of the softening claw, the angle of penetration into the soil and the radius of curvature were determined: b = 6.3-6.6 cm, α = 29-30 ° and R = 253-276 mm.

VI. CONCLUSION AND FUTURE WORK

According to the results of the study, the width of the combined machine softener claw should be 6.3-6.6 cm, the angle of entry into the soil should be 29-30° and the radius of curvature should be in the range of 253-276 mm to ensure quality tillage at the required level with low energy consumption.

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