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THEORY AND EXPERIMENTAL RESULTS OF SURVEYS TO DETERMINE THE DIAMETER OF TEETH PLANK

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Abstract: The article presents the results of an experimental study of the effect of the diameter of the gear-bar roller on the performance of a machine that tracks the newly cultivated lands. It was determined that the diameter of the gear-bar roller should be in the range of 36-40 cm to ensure the required level of performance.

Keywords. Roller, plank, soil, rack, experiment, criteria, width,

soil density, depth, resistivity, humidity, unit, energy consumption.

Introduction. Vegetables and potatoes, which are grown as a supplementary crop on winter wheat and vacant fields in our nation, are directly planted on new, i.e. plowed soil before planting. In this situation, the plowed areas are readied one by one for sowing, and then sowing methods are implemented.

Many gaps are known to exist on newly plowed soils, which prevent quality planting, irrigation, and inter-row cultivation, as well as having a negative impact on plant development. It should also be highlighted that the plowed surface must meet the standards for the background of sowing on the quality of soil compaction and the level of leveling and compaction for quality sowing and harvesting of seeds. Based on the foregoing, compaction of the entire driving layer, as well as leveling and crushing of the surface, should be included in the preparation of new arable lands for planting.

Based on these studies, the Research Institute of Agricultural Mechanization built and tested an experimental prototype of a machine for sequential tillage of arable land.

The machine was designed into plywood-like working surface discs, levelers, and rollers based on specifications, literature, and examination of technological processes of various working bodies. The piston disks grind and crush the overturned plows during machine operation, and the leveler plows the plow surface.

After that, the soil is exposed to the roller, which compacts the plowed surface to the required level and forms a fine layer of soil in it [2].

This paper presents the results of theoretical and experimental studies on the effect of the developed machine roller diameter on its performance.

We define this parameter by the following expression derived from the condition of passing through the blocks encountered in the path of the roller [4]

$$D \geq \frac{d_k\left[1+\cos\left(\varphi_1+\varphi_2\right)\right]+2h_0}{1-\cos\left(\varphi_1+\varphi_2\right)} \qquad (1)$$

or

$$R \geq \frac{d_k\left[1+\cos\left(\varphi_1+\varphi_2\right)\right]+h_0}{1-\cos\left(\varphi_1+\varphi_2\right)}, \qquad (1, a)$$

here D – is diameter of the roller, m ;

$= r_k$, d_k – correspondingly the lumps encountered in the path of the roller radius and diameter, m;

φ_1, φ_2 – angles of external (i.e., metal) and internal (i.e., ground) friction of blocks, degrees.

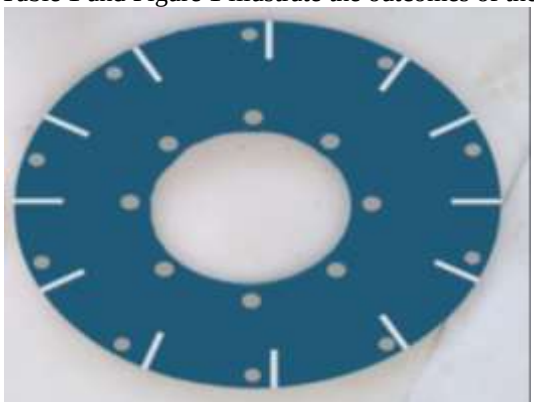
If the conditions *(1)* and (*1, a*) are met, the lumps on the path of the roller will be crushed, otherwise the lumps will be piled up in front of the roller and as a result the specified technological process will not be performed [4].

In order to verify the results of theoretical research and to substantiate the optimal parameters of the machine gear rack for continuous tillage on plowed lands, the effect of the diameter of the gear rail roller on the performance indicators was studied in experimental studies.

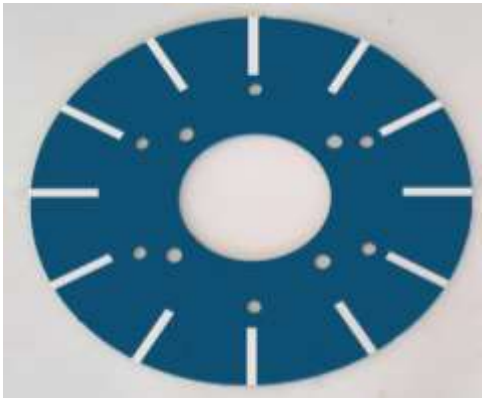
In order to test the theoretically based parameters of the roller selected for experimental research in the field, the roller bases of different diameters with a coverage width of 1.5 m *(Figure 1)* were developed and prepared [5].

The diameter of the gear-bar roller was altered at intervals of 5 cm in the range of 30-45 cm, and its performance was investigated, based on the results of theoretical study completed during the trials. Other characteristics remained unchanged, such as the number of gears on the roller being ten, their height being five centimeters, the angle of their installation relative to the roller's axis of rotation being set at 15 degrees, and the specific vertical load on the roller being 700 N / metib.

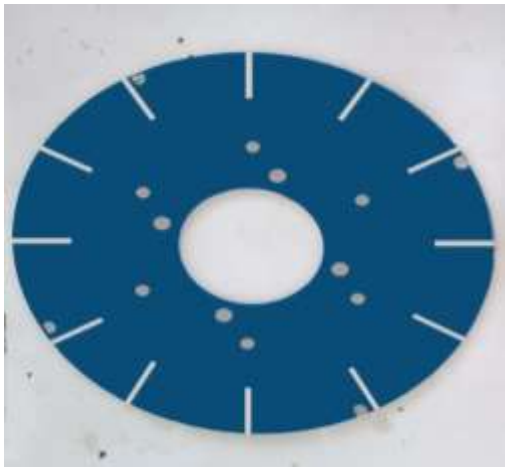
Table 1 and Figure 1 illustrate the outcomes of the experiment.



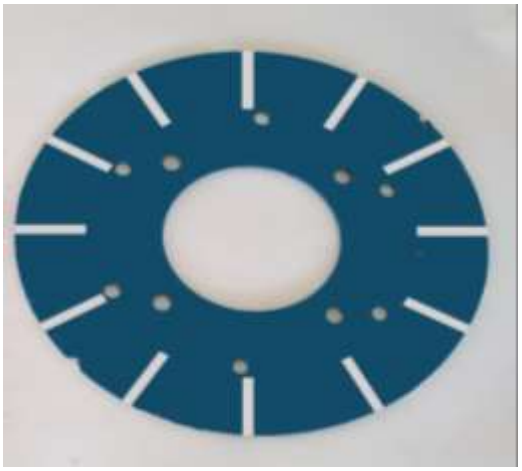
D=45



D=40



D=35



D=30

Figure 1. The bases of the roller with different diameters

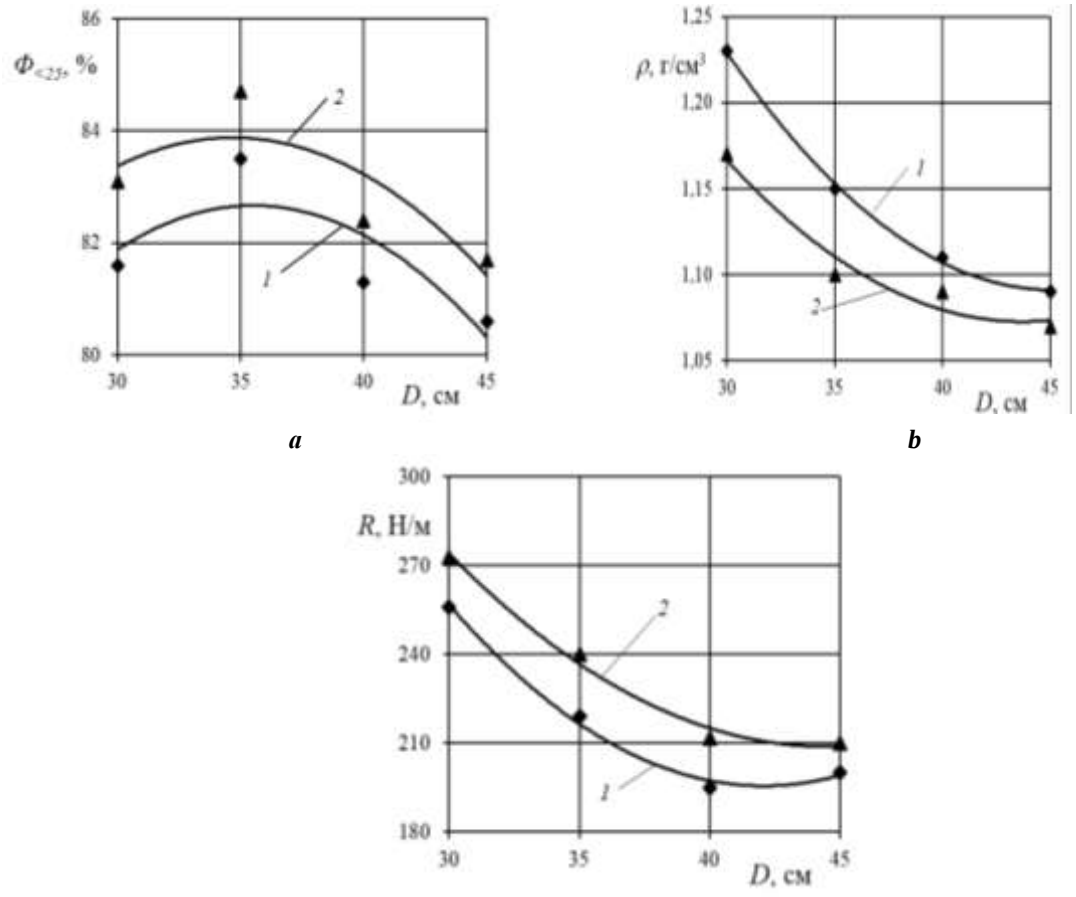
The number of soil fractions less than 25 mm increased at both speeds when the diameter of the roller was increased from 30 cm to 35 cm, but the amount of fractions smaller than 25-50 mm and greater than 50 mm reduced, indicating that the interaction of planks with soil process was activated. The quality of tillage of the roller dropped as the diameter grew from 35 cm to 45 cm, i.e. the quantity of fractions lower than 25 mm reduced and the amount of fractions between 25-50 mm and larger than 50 mm increased.

This is because their impact on the soil decreases due to the increase in the diameter of the roller and the increase in the distances between its planks [6].

Influence of roller diameter on its performance

The diameter of the roller, cm	Amount of soil fractions,%			Density of soil, g / cm^3	Comparative resistance of the roller to gravity, N / m
	Dimensions of fractions, mm				
	>50	50-25	25>		
V=6 km / h					

30	7,3	11,1	81,6	1,23	256
35	5,5	11,0	83,5	1,15	219
40	7,5	11,2	81,3	1,11	200
45	5,2	14,2	80,6	1,09	195
V=8 km / h					
30	5,1	11,8	83,1	1,17	273
35	4,1	11,2	84,7	1,10	240
40	5,2	12,4	82,4	1,09	212
45	4,4	13,9	81,7	1,07	210



a ***b*** ***c***

Figure 2. Variation of soil compaction rate (a), density (b) and rolling resistance (c) depending on its diameter.

The specific gravity of the roller increases from 256 N / m to 200 N / m at a speed of 6 km / h and from 273 N / m to 210 N / m at a speed of 8 km / h, respectively, while the soil density increases from 1.23 g / cm3 to 1.09 g / cm3 and from 1.17 g / cm3 to 1.07 g / cm3. The fundamental reason for this is that the space between the planks has increased, as has the roller's contact zone on the ground.

An increase in operating speed from 6 km / h to 8 km / h has led to an improvement in the quality of soil compaction and a decrease in density, as well as an increase in specific gravity. These occur due to the increase in the shock forces acting on the soil by the roller and the resistance forces acting on them by the roller, and the decrease in the time of the roller's contact with the ground.

The dependencies shown in Table and Figure 2 can be expressed by the following empirical formulas determined by the least

squares method:
a) by the degree of soil compaction (%):
When $V = 6$ km / h then $\Phi_{<25}$=-0,026 D^2+1,846D+49,9, (R^2=0,66) (1)
When V=8 km / h then $\Phi_{<25}$=-0,023 D^2+1,023D+56,225; (R^2 =0,6943) (2)
b) in terms of soil density *(g / cm3):*
When V=6 km / h then ρ =0,0006 D^2-0,0542D+2,315, (R^2=0,9983) (3)

When V=8 km / h then ρ =0,0005 D^2 -0,0437D+2,0275; (R^2=0,9568) (4)
c) by specific weight (N/m) of the rink:
When V=6 km / h then P =0,31 D^2-27,59 D +822,75, (r^2=0,9916) (5)
When V=8 km / h then P =0,42 D^2 -35,34 D +939; (r^2=0,9944) (6)

where $F_{<25}$ - the amount of fractions of soil size less than 25 mm,%;
ρ is the density of the soil, g / cm3;
P is the specific gravity of the roller, N / m.
Conclusion. The diameter of the gear rack of the machine for continuous tillage on arable land should be at least 36 cm, according to theoretical studies. The calculations obtained from the expressions show that the diameter of the roller of the machine for quality tillage at the required level with low energy consumption on arable land should be at least 36 cm.
The diameter of the discs should be 39.38-40.06 cm, according to experimental study, in order to achieve quality work at the required level with low energy consumption on the field surface at operating speeds of 6.0-8.0 km/h.
In conclusion, the quality of soil compaction should be between 35 cm and 40 cm in diameter to ensure that the specific gravity of the vatipliplanka roller meets the agro-technical requirements.

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