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Study of the influence of roller disk thickness on the performance indicators of the device

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Abstract: The article describes the results of experiments based on the thickness of the discs of a combined disc roller machine, which are used in preparing new plowed land for planting. In it, when the thickness of the drum discs increased from 17.5 mm to 25.0 mm at a machine speed of 6.7 km/h, the size was greater than 100 mm, and fractions in the range of 100-50 mm decreased by 4.8 and 4.3 percent, respectively, while fractions less than 50 mm increased by 9.1 percent at a speed of 8.3 km/hThey were 4.1%, 5.5% and 9.6%, respectively.

Keywords: disk rollers, diameter, thickness and angle of grinding of disks, vertical load on each disk, speed of movement, multi-factor experiment

1. Introduction

In our country, crops such as wheat, which is sown in the open field, and vegetables and potatoes, which are sown as repeated crops in areas free from wheat, are sown in new, i.e. directly before sowing, plowed land. In this, plowed lands are prepared for row planting and then planting activities are carried out.

At present, the preparation of newly plowed land for planting is carried out several times separately by means of toothed and disk harrows and various levelers. But this leads to the deterioration of physical and mechanical properties of the soil, a lot of moisture loss from the soil, and an increase in fuel consumption and other costs [1].

The analysis of the scientific and technical achievements achieved at the world level and the research carried out in our Republic [2,3,4] shows that the shortcomings in the preparation of newly plowed land for planting are all technological processes for preparing the soil for planting in one pass through the field (complete compaction of the plowed field, leveling of the surface of the field and crushing) can be eliminated by developing a machine that ensures complete processing in one pass before planting. The use of such a machine in the pre-planting treatment of newly plowed land increases productivity, improves the quality of tillage, prevents moisture loss, and reduces the number of trips of aggregates through the field. It allows to plant and harvest the seeds [5].

In the conditions of our republic, when fields empty of wheat or repeated crops are plowed, the upper layer of the soil containing plant residues and weeds is overturned and thrown to the lower layer, as a result of which many gaps and unevenness are formed in the plowed layer. If these are not eliminated or their extent is not minimized, the quality of planting, irrigation and inter-row cultivation activities will deteriorate. In addition, for high-quality planting of crops, the state of the top layer of the soil - its density and flatness - should correspond to the agrotechnical requirements of the planting background. Therefore, when newly plowed land is prepared for planting, the soil clods overturned by the plow bodies should be compacted, crushed and leveled. Based on these points, the author developed a combined machine used in the cultivation of newly plowed land.

2. Materials and methods

Experimental studies to determine the agrotechnical and energy performance indicators of the disc rollers of the combined machine were conducted in the experimental farm of the Research Institute of Agricultural Mechanization on fields irrigated after winter wheat and plowed to a depth of 30-32 cm for growing repeated crops. The soils of the experimental fields are gray soils of medium-heavy loamy mechanical composition, previously irrigated, with groundwater at a depth of 10-12 m. Before conducting experiments, GOST 20915-11 "Testing of Agricultural Machinery. Methods for Determining Test Conditions"[6]. The moisture content, hardness, and density of the soil in the 0-10, 10-20, and 20-30 cm layers were determined.

3. Results and discussion

It is known that in newly plowed fields, large-sized lumps are present in the soil. The planting process cannot be carried out without crushing and compacting them. Disc or gear harrows are usually used for this. The use of disc harrows (harrows) in preparing newly plowed land for planting gives the desired effect. When using these disc rollers, the diameter, thickness and sharpening angle of the discs should be considered in order to achieve the desired effect. For this purpose, experiments were conducted on the basis of the thickness of the discs of the combined machine disc roller [7,8,9,10,11].

In the experiments, the thickness of the roller discs was changed from 17.5 mm to 25.0 mm with an interval of 2.5 mm. In this case, the diameter of the disks, the angle of sharpening, the depth of immersion in the soil, the width between their traces, the vertical load applied to each disk and the longitudinal distance between the rollers are unchanged and was accepted as equal to 450 mm, 60^0, 5-6 cm, 10 cm, 600 N and 60 cm, respectively.

Here, too, experiments were conducted at speeds of 6.7 and 8.3 km/h.

The results obtained in the experiments are presented in Table 1 and Figures 1-4. Their analysis shows that with an increase in the thickness of the discs of the rollers, the quality

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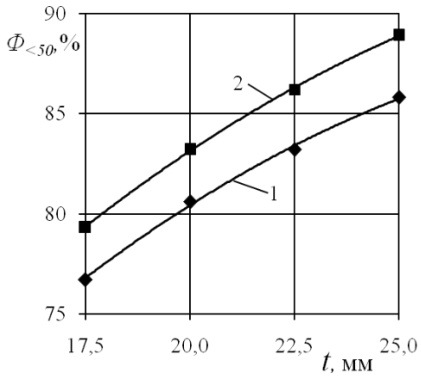
of soil compaction improved, that is, in the 0-10 cm layer, the amount of fractions larger than 100 mm and in the range of 100-50 mm decreased, and the amount of fractions smaller than 50 mm increased. For example, at a driving speed of 6.7 km/h, when the thickness of the roller discs increased from 17.5 mm to 25.0 mm, the fractions larger than 100 mm and 100-50 mm decreased by 4.8 and 4.3 percent, respectively, compared to 50 mm and fractions smaller than increased by 9.1 percent, at a speed of 8.3 km/h, these indicators are 4.1, respectively; It was 5.5 and 9.6 percent. Here, it should be noted that with the increase in the thickness of the discs, the fractions larger than 100 mm and in the range of 100-50 mm decreased, and the fractions smaller than 50 mm increased intensities. For example, when the thickness of discs increased from 17.5 mm to 20.0 mm, the amount of fractions larger than 100 mm and between 100-50 mm decreased by 1.5-1.8 and 2.1-2.4 percent, respectively, and the size of 50 The amount of fractions smaller than mm increased by 3.9 percent, and when increasing from 22.5 mm to 25.0 mm, these indicators were 0.3-0.9, 2.4-2.7, and 2.5-2.6, respectively. percent.

1-table

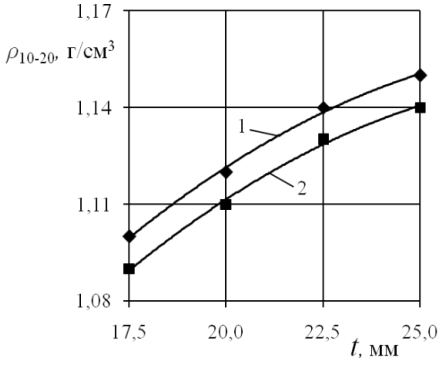
Change in the performance indicators of the laboratory-field installation depending on the thickness of the roller discs

N	Name of indicators	Disc thickness, mm							
		17,5		20,0		22,5		25,0	
		Values of indicators							
1.	Speed of movement, km/h	6,7	8,3	6,7	8,3	6,7	8,3	6,7	8,3
2.	Soil crumbling quality (amount of fractions of the following size), %								
	>100 mm	5,7	4,6	3,9	3,1	1,8	0,8	0,9	0,5
	100-50 mm	17,6	16,1	15,5	13,7	15,0	13,0	13,3	10,6
	<50 mm	76,7	79,3	80,6	83,2	83,2	86,2	85,8	88,9
3.	Soil density in the following layers, g/cm^3:								
	10-20 cm	1,10	1,09	1,12	1,11	1,14	1,13	1,15	1,14
	20-30 cm	1,12	1,10	1,14	1,13	1,17	1,15	1,18	1,16
4.	Specific drag resistance, kN/m	1,04	1,08	1,09	1,12	1,13	1,16	1,16	1,18



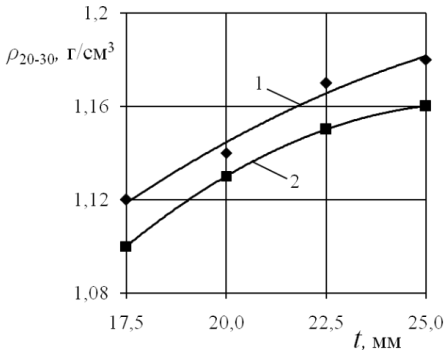
1, 2 - respectively at speeds of 6, 7 and 8.3 km/h;

Figure 1. Graphs of changes in the degree of soil crumbling depending on the thickness of the roller discs



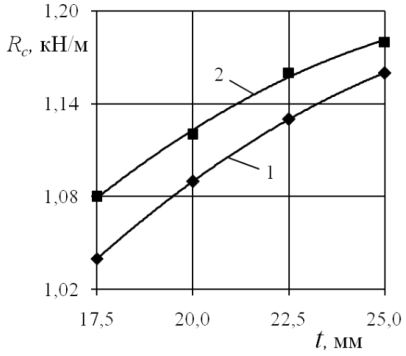
1, 2 - respectively at speeds of 6, 7 and 8.3 km/h

Figure 2. Graphs of changes in soil density in the 10-20 cm layer depending on the thickness of the roller discs



1, 2 - respectively at speeds of 6, 7 and 8.3 km/h

Figure 3. Graphs of changes in soil density in the 20-30 cm layer depending on the thickness of the roller discs



1, 2 - respectively at speeds of 6, 7 and 8.3 km/h

Figure 4. Graphs of changes in the specific tractive resistance of rollers depending on the thickness of their disks

With an increase in the thickness of the roller discs, the improvement in the quality of soil crumbling occurs mainly due to an increase in the zone of their impact on the soil, i.e., the volume of soil exposed to the discs increases.

With an increase in the thickness of the discs, the density of the soil in the 10-20 and 20-30 cm layers increased. For example, with an increase in the thickness of the discs from 17.5 mm to 25.0 mm, at a speed of 6.7 km/h, the soil density in the 10-20 cm and 20-30 cm layers increased by 0.05 and 0.07 g/cm3, respectively, and at a speed of 8.3 km/h - by 0.04 and 0.06 g/cm3. This also occurs mainly due to the increase in the zone of impact of the discs on the soil.

Due to the above reasons, an increase in the thickness of the roller discs from 17.5 mm to 25 mm led to an increase in their specific tractive resistance from 1.04 kN/m to 1.16 kN/m at a speed of 6.7 km/h, and from 1.08 kN/m to 1.18 kN/m at a speed of 8.3 km/h.

4. Conclusion

With an increase in the thickness of the roller discs, the improvement of the quality of soil compaction occurs mainly due to the increase of their impact zone on the soil, that is, the volume of the soil affected by the discs increases.

As the thickness of the discs increased, the density of the soil in the 10-20 and 20-30 cm layers increased. For example, when the thickness of the discs increases from 17.5 mm to 25.0 mm, at a speed of 6.7 km/h, the densities of the soil in the layers of 10-20 cm and 20-30 cm decrease by 0.05 and 0.07 g/cm3, respectively, 8 and at a speed of 3 km/h it increased by 0.04 and 0.06 g/cm3. This is mainly due to the increase in the impact zone of the discs on the ground.

The thickness of the discs should be in the range of 22-25 mm in order to ensure quality processing of the rollers at the speed of 6.0-8.0 km/h while spending less energy on the plow surface.

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