Comparative evaluation conducted on the selection of the type of roller shredder for the cultivation of plowed land

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Abstract. The results of experimental investigations into the features of the roller shredder that breaks down plowed land one by one are presented in this article. This allowed for the determination of the optimum roller parameter values and the examination of the shredder type selection. According to experimental research, selecting the right type of roller is primarily responsible for guaranteeing that the field surface is completely treated. Typically, these rollers are working parts with slats, gear-slats, or rods for installation on a reel that provide moisture feeding at the level necessary for germination in compliance with agrotechnical requirements. Slatted, toothed-slatted, and rod roller shredders with comparable diameters were designed and used in experimental investigations to confirm the results that we had acquired. In experimental studies, after using different constant diameter roller shredder, the influence of soil on the degree of abrasion, its density and drag resistance was studied. To reduce the influence of various variable factors on the results obtained, the experiments were carried out on a specially prepared agricultural background, which was first plowed and then leveled. In order to test the theoretically based parameters of the roller shredder selected for experimental research in the field, a fixed-diameter roller shredder base with a coverage width of 1.5 m and strips with gear strips and rod strips that can be installed on them were developed and prepared. Based on the results of experimental studies, the following can be noted: in order for the quality and density of soil abrasion to meet agrotechnical requirements, and the tensile resistance of the coil to be minimal, the roller shredder must be with a slatt.

1. Introduction

Along with other countries, the Republic of Uzbekistan has currently implemented a number of measures aimed at reducing labor and energy costs associated with grain preparation and resowing, conserving resources through the application of cutting-edge technologies, and developing combined machinery that is highly efficient for processing agricultural crops. The majority of farmers are getting closer to working in the fields as the weather steadily gets better. Fieldwork has already begun for some. But there's still time to complete tillage tool preparation for spring fieldwork. It is recommended that farmers examine and analyze the layout of the soil-engaging parts of their tillage tools, determine the likelihood of soil erosion, and consider the likelihood of an abundant crop. Whether the purpose of spring tillage is to prepare the seed bed, apply herbicides, spread residue uniformly, or get ready for the next crop in rotation, a well-adjusted and well-used tillage tool will minimize field trips, improve crop quality and performance management, and, ideally, reduce potential erosion.

The action plan for the Republic of Uzbekistan's future growth over the next ten years listed the tasks of modernizing agriculture, gradually raising agricultural production, enhancing a nation's food security, and utilizing highly productive agricultural machinery [1]. Developing a single machine to perform all technological tasks associated with preparing the soil for planting in a single field transition—compaction of the sealing layer, leveling, and crushing of the field surface—that is, comprehensive processing in a single pass—is one of the main challenges in carrying out these tasks [2, 3, 4].

When choosing and parameters of the working bodies of soil-cultivating machines, as well as when assessing their performance, the condition and topography of the cultivated areas, the type and physical and mechanical properties of the soil on them are the main factors.

Deep rippers have been the subject of extensive investigation and discussion recently. Using a ripper in dry soil conditions is advised if deep ripping is utilized to alleviate actual soil compaction. However, this operation would be

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better suited as an autumn activity rather than a spring tillage expenditure because the optimum effects happen in dry soils. Deep rippers break the compacted soil layer, loosen the material in shattered planes running diagonally from the tool tip to the soil surface, and promote the growth of dense root systems. They accomplish this by having extremely thin blades or shanks that pierce the earth between 12 and 14 inches. Plants with deep roots have easier access to nutrients and moisture in the subsurface throughout the entire soil profile.

2. Research Methods

Based on a review of the literature, comparative tests were performed on roller shredders with a slat, a toothed slat, and rods to determine the best type of reel. To conduct comparison testing, roller reels with slat, toothed slat, and rods of the same diameter (40 cm) and covering width of 1.5 m were constructed, as well as a customized frame (laboratory-field device) on which they are mounted. Their experimental samples have been prepared (Figures 1–3). Figure 4 depicts the functioning sections of the designed roller shredders [5; 6; 7].

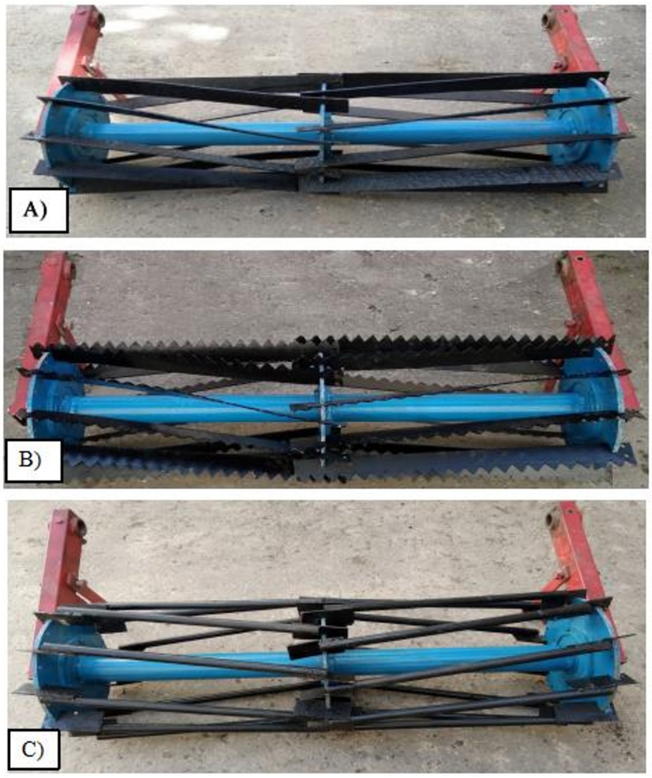

Fig. 1. Slats (A), gear-slats (B) and rods (C) roller shredders

Fig. 2. Side (right one) and rear (left one) views of the laboratory-field device, (1) frame suspension device; (2)-roller

The laboratory-field device was developed in such a way that it allows the installation of rollers of various possibilities, as well as the capacity to vary the force of direct pressure.
Comparative tests were carried out on a treated plot that was watered and plowed after wheat harvest, and the surface of this plot was treated with a machine with disc shredder and a straightener.
The tests were carried out in the third and fourth gears of the MTZ-80 tractor. The soil moisture and hardness in the 0-10 and 10-20 cm layers were determined by the presented methods before conducting comparative tests of the rollers. Their results are shown in Table 1.

Table 1. Soil moisture and hardness of the test site

Layer, cm	Soil moisture, %	Soil hardness, MPa
0 – 10	15,8	0,71
10 – 20	14,4	0,83
0 – 20	13,1	0,91

Fig. 3. Appearance of the laboratory-field device during operation

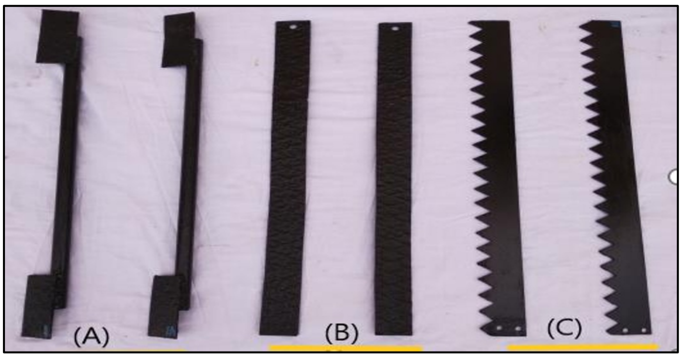

Fig. 4. Working parts of rollers A – rods; B – slats; C – toothed slats

The quality, density of soil loosening in a layer of 0-10 cm, as well as the tensile strength of the rollers were taken as evaluation criteria. Before and after the experiments, the roller spacers were calibrated. At the same time, they were given a load in the range of 1 kN with an interval of 0-5 kN (Fig. 5). The results obtained during the tests are presented in Table 2.

3. Results

Based on below findings them, the following can be noted:
– from the point of view of the quality of soil leveling, the plank toothed roller showed high performance compared to the plankola and prutok roller slides. Rilmol's rods and planks crushed the cuts somewhat poorly compared to hers.
As a result, when processing rolls of rods and planks, the size of the serrated rolls of planks was 25 mm smaller than the processed ones, while the fractions were smaller by 8.1-8.9 and 4.2-5.4 percent, respectively, and the fractions were larger than 50 mm were 6.2 -7.2 and 3.4-3.6 percent more;
– the soil density was almost the same in all three roller shredder ;

– according to the results of tensometry, the toothed-slats rollers had the greatest resistance to drawing, while the rod roller shredder had the least resistance. This can be explained by the difference in the depth of their immersion in the soil. The slat rollers with angled teeth is immersed deeper in the soil, while the rod roller is immersed shallowly [8; 9;10).

Fig. 5. Spacers (a, b – lower left and right; c – upper)

The increase in total travel speed from 6.2 km/h to 8.3 km/h was associated with improved soil leveling quality, reduced density and increased drag resistance of the coils. From observations it turned out that after the passage of planed and serrated planed turns, a thin layer was formed on the surface of the field, which ensured the preservation of moisture in the soil 3-4 cm thick; such a layer was not formed enough after the passage of the duct turns.

Table 2. Results of comparative tests of different roller shredders

Type of roller shredder	**The amount of fractions of the following size (mm), %**			**Soil density, g/cm^3**	**Pulling esistance N/m**
	>50	**50-25**	**<25**		
V=6,2 км/h					
Slats roller	6,8	9,2	84,0	1,24	202
gear-slats roller	3,4	7,2	89,4	1,22	228
Rods roller	9,6	9,1	81,3	1,25	193
V=8,3 км/h					
Slats roller	5,9	6,7	87,4	1,21	246
gear-slats roller	2,3	6,1	91,6	1,20	247
Rods roller	9,5	7,8	82,7	1,22	218

4. Conclusion

1) A plow equipped only with disc shredder and a straightener; when processed by a machine, the soil does not meet the requirements for the planting background in terms of quality, density and surface leveling.
2) According to the results of the comparative tests, the toothed shredder is recommended for installation on plowed land in the crawler tillage machine, and its parameters are studied in subsequent studies.

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