Results of acceptance tests of the disk plow for tillage in agriculture

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Abstract. Soil is the main natural resource for agriculture. All vital crops necessary for humanity and livestock are cultivated in it. As a result, a lot of research is being done on the creation of new technical tools and technologies for agriculture, including soil cultivation. The following years, disk plows, the working tools are in the shape of a spherical disk, have been widely used for plowing all over the world. Due to the fact that in addition to the forward movement of the working parts, the disc plows have less traction resistance than rotary plows and work without getting stuck in weeds and plant residues. In addition, disk plows are simpler in design than rotary plows, require less care and maintenance, as the cutting blades wear less and are constantly self-sharpening (due to rotation), and due to their length (compared to plow plows), disks work several times longer than plows with plowshares. The developed disc plow provides better soil compaction than a tipping plow, i.e. the number of fractions less than 50 mm in the area of its passage was 3.1-4.3 percent more, and the number of fractions more than 100 mm was 2.0-3 decreased by 6 percent.

1 Introduction

Soil is the main natural resource for agriculture. All vital crops necessary for humanity and livestock are cultivated in it [1-6]. Therefore, much research is being carried out on the creation of innovative agricultural technology and methods, including for soil cultivation [7-11].

Among them are installations for sowing legumes, which improve the condition of the soil. In addition, livestock excrement also serves to improve the soil. When manure is applied to the soil, soil fertility improves to a significant extent. And feeding animals with crushed roughage and concentrated feed improves the production of good manure for the soil [12-20].

An industrial copy of the disk plug was made based on the aforementioned studies [21, 22] carried out in our institute in collaboration with JSC "BMKB-Agromash," and acceptance testing was handled by the "Accredited Agrotechnical Testing Center."

The main frame 1 is equipped with a suspension device for disk plow (see Figure 1), support wheel 2 and its adjusting screw 3, additional frame 4, working bodies 5 in the form

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of a spherical disk with a diameter of 650 mm and radius. curvature 700 mm, L-shaped beam 6 and mounted on it support disk 7.

The support wheel is used to adjust the depth of penetration and ensure the specified depth of cultivation, and the support disk ensures straight plow movement in the horizontal plane, serving as a field board in this sense.

2 Materials and methods

The disk plow's technical specifications are displayed in Table 1, Figure 1 shows its general view, and Figures 2 and 3 in aggregate form on the tractor and in operation

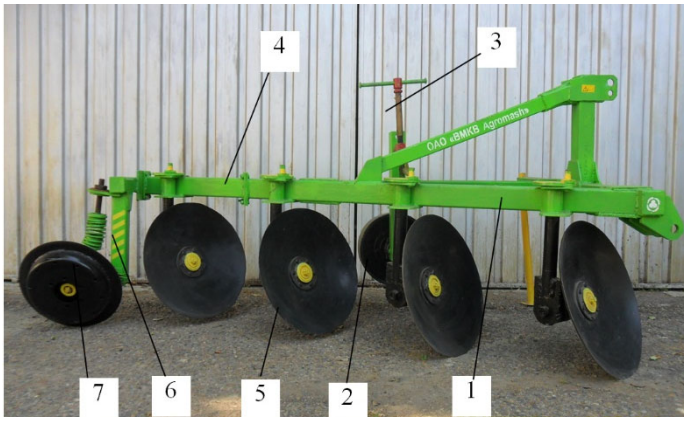

Fig. 1. General view of the disk plow.

Table 1. An explanation of the disk plow's technology.

The indicators' names	Number of indicators
1	2
1. Aggregate type	Hinged
2. Tractor traction class	1.4-2.0
3. Number of working elements (pcs)	4
4. Operating speed (km/h)	6-9
5. Working width (m): Working body plow	 0.3 1.2
6. Working depth (cm)	25-27
7. Aggregate weight (kg)	463
8. Angle of installation of working elements, degree: In the direction of travel Vertically	 Adjustable between 30-40° Adjustable between 15-20°
9. Overall dimensions, mm: Length height width	 2240 1210 1200
10. Capacity (ha/h)	0.72-1.08

Fig. 2. View of disc plow mounted on tractor.

Fig. 3. View of the disk plow in operation.

Tests of the disk plow were conducted in comparison with the existing plow PLN-3-35 In field 4, the Institute's experimental location, devoid of autumn wheat.

On tests both plows were aggregated with MTZ-82 tractor and transferred to VI and X gearboxes [23, 24].

The following plow indicators were determined:

- driving speed;
- working width and working depth;
- soil loosening quality;
- completeness and depth of burial of plant residues;
- height of irregularities formed on the surface and bottom of the dewlap;
- total and relative resistance to plow traction;
- work performance;
- fuel consumption.

3 Results and discussion

Working width and depth of plows, quality of soil compaction, completeness and depth of weed incorporation, height of irregularities formed on the surface and bottom of the plow, traction force of the plow were determined according to normative documents. Special chronometric measurements were carried out to determine the productivity and fuel consumption of the plow, as well as plowed area and fuel, shift and working time utilization coefficients were determined within the unit of operational time [25-28].

The moisture and hardness of field soil, depth of irrigation beds, amount of crop residues and height of weeds were studied before the tests. Their results are summarized in Table 2.

Table 2. Description of the field of the test conducted.

Names of indicators	Number of indicators
1. Soil moisture by layer , %: 0-10 cm 10-20 cm 20-30 cm	 6.6 11.3 14.6
2. Soil hardness by layers, MPa : 0-10 cm 10-20 cm 20-30 cm	 1.99 2.83 3.15
3. Depth of watering beds, cm : M_{av} $\pm\sigma$	 16.4 2.2
4. Plant residues per 1 м^2, kg	0.880
5. Weed height, cm : M_{av} $\pm\sigma$	 26.8 3.6

The results of the tests performed are summarized in Table 3.

Table 3. Results of tests of the disk plow.

№	Names of indicators	Number of indicators				
		According to initial indications	plow PLN-3-35		Disc plow DP-4-30	
1.	Working speed, km/h	6-9	6.34	8.25	6.56	8.47
2.	Working width, cm: M_{av} $\pm\sigma$	 120 ± 5 -	 107.4 2.03	 106.8 1.96	 120.7 1.87	 121.3 1.93
3.	Depth of treatment,cm: M_{av} $\pm\sigma$	 25-27 -	 26.2 2.4	 25.7 2.3	 26.4 1.9	 25.3 2.2

4.	Quantity of the following fractions, %: >100 100-50 <50	- - >80	8.0 6.7 85.3	7.3 5.7 87.0	6.0 5.6 88.4	3.7 5.0 91.3
5.	Burying plant residues by: completeness, % depth, cm	 >90 >10	 95.1 12.2	 96.2 14.5	 91.7 11.7	 92.3 13.5
6.	Height of unevenness formed on the soil surface, cm	<5	4.6	4.2	4.3	3.5
7.	Height of unevenness formed inside the soil , cm	<5	-	-	4.5	3.6
8.	Plow resistance to traction: total, kN relative, MPa	 <1.4	 10.20 0.053	 11.29 0.060	 8.91 0.043	 9.34 0.047
9.	Main time productivity, ha/h	>0.50	0.48	0.61	0.63	0.80
10.	Fuel consumption, l/ha	-	16.61	17.09	13.29	13.48

Their analysis showed that agrotechnical indicators of the tested plows at both speeds of operation fully corresponded to the initial requirements. However, when using the disk plow, productivity was 1.3 times higher, and fuel was consumed by 3.32-3.61 kg less per hectare of plowed area. This is mainly due to the fact that the disk plow has a lower resistance to traction compared to the revolving plow and reliable operation without clogging with plant residues (the disk plow during the test period was not clogged with plant residues, while the revolving plow worked 2 -3 times per hectare of arable land). It should also be noted that the disk plow provided better soil compaction than the tipping plow, i.e. the number of fractions less than 50 mm on the area of its passage was 3.1-4.3 percent higher, and the number of fractions more than 100 mm was 2.0-3 decreased by 6 percent. In addition, when the speed was changed from 6 km/h to 9 km/h, the increase in traction resistance of the disk plow was less than half that of the tipping plow, that is, the tipping plow increased by 9.65 percent, while the disk plow increased by 4.60 percent. This is mainly due to the rotation of the working organ of the disk plug. Because in this case the magnitude of impact forces acting on the working body by the blade is reduced.

4 Conclusion

The research done revealed that the disk plow satisfies all requirements in terms of performance indicators and reliably executes the stated process.

Results of tests of the disk plow analysis showed that agrotechnical indicators of the tested plows at both speeds of operation fully corresponded to the initial requirements. However, when using the disk plow, productivity was 1.3 times higher, and fuel was consumed by 3.32-3.61 kg less per hectare of plowed area. This is mainly due to the fact that the disk plow has a lower resistance to traction compared to the revolving plow and reliable operation without clogging with plant residues (the disk plow during the test period was not clogged with plant residues, while the revolving plow worked 2 -3 times per hectare of arable land). When using

the disk plow, compared to the existing plow PLN-3-35, productivity increases by 1.3 times and consumes 3.32-3.61 kg less fuel per hectare.

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