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EXPERIMENTAL RESULTS ON THE INFLUENCE OF THE INSTALLATION ANGLES OF THE SUPPORT DISC MOUNTED ON A DISC PLOW RELATIVE TO THE VERTICAL ON THE PLOW'S PERFORMANCE INDICATORS

PhD.docent **Ishmuradov Shukhrat Ulugberdievich**
Researcher **Khudoyberdiev Muhammad Solih Avlokul ugli**
PhD, senior lecturer **Abdumajidov Rustamjon Bakhtiyor ugli**
Tashkent state technical university
rustamjonabdumajidov007@gmail.com

Abstract. This article presents the experimental results on the influence of the installation angles of the support disc relative to the vertical on the performance indicators of a plow. It was determined that when the installation angle of the support disc relative to the vertical is 0°, the supporting surface is insufficient. As a result, during inversion plowing, the actual working width of the plow exceeds the design working width by 5.1 cm and 8.2 cm, respectively. At this angle, the plow operates with lateral deviation. When the installation angle of the support disc relative to the vertical is in the range of 10° to 20°, the plow operates without lateral deviation, and therefore its actual working width does not significantly exceed the design working width. However, when the installation angle increases from 20° to 30°, the support disc does not sufficiently rest on the bottom of the furrow, which leads to an increase in the plow's working width.

Keywords. Support disc device, installation angle of the support disc relative to the vertical, actual working width of the plow, design working width of the plow, root mean square deviation of the plow working width, surface roughness height of the furrow, specific draft resistance of the plow, operating speeds.

Introduction: In recent years, due to the widespread implementation of energy- and resource-saving technologies and machinery in agriculture, the use of disc plows—whose working bodies are spherical discs—for primary tillage (plowing) has become increasingly important. This is because, compared to moldboard plows, they exhibit lower draft resistance, higher productivity, and can operate without clogging from plant residues and weeds [1].

Problem statement. During the experiments, the following parameters were adopted: support disc diameter – 450 mm; load applied to the support disc – 700 kN; installation angle of the support disc relative to the vertical – 20°; drawbar length – 70 cm; tillage depth – 30 cm; and the operating speeds of the arperate were set at 6 and 9 km/h.

The results obtained from experiments studying the effect of changes in the installation angle of the support disc relative to the vertical on the agrotechnical and energy performance indicators of the disc plow are presented in Table 1 and Figures 1–4. The analysis shows that when the installation angle is 0°, the support disc does not adequately rest on the furrow bottom. Due to the insufficient supporting surface, the actual working width of the plow increases compared to its design working width during inversion plowing.

In other words, the variation range is significantly large. This is because the insufficient contact of the support disc with the furrow bottom substantially affects the width of the soil clods being processed. When the installation angle of the support disc relative to the vertical is between 10° and 20°, the plow operates without lateral deviation, and therefore its actual working width is nearly equal

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to the design working width.

The analysis also indicates that when the installation angle is 0°, due to the insufficient supporting surface, the actual working width of the plow exceeds the design working width by 5.1 cm and 8.2 cm during inversion plowing. This confirms that the plow operates with lateral deviation under these conditions. In contrast, within the 10°–20° range, the plow operates stably without lateral deviation, and the increase in actual working width is negligible.

Table 1

Effect of the Installation Angles of the Support Disc Relative to the Vertical on the Plow Performance Indicators

Installation Angle of the Support Disc Relative to the Vertical, deg	Plow Working Width, cm	Root Mean Square Deviation of the Plow Working Width, cm	Height of Surface Irregularities of the Furrow, cm	Specific Draft Resistance of the Plow, kN/m
V=6 km/h				
0	95,1	6,7	8,4	8,14
10	92,4	3,7	5,5	7,35
20	92,3	3,4	4,7	7,27
30	97,2	6,2	7,3	8,35
V=9 km/h				
0	98,2	7,7	7,3	9,22
10	96,3	4,6	4,3	8,29
20	94,1	4,4	4,4	7,38
30	97,4	7,2	6,9	9,12

Table 2

Characteristics of the Field Where the Experiments Were Conducted

№	Name of the Indicators	Values of the Indicators
1.	Soil Moisture by Layers (cm), %:	

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	0-10 10-20 20-30	12,2 15,3 17,4
2.	Soil Hardness by Layers (cm), MPa: 0-10 10-20 20-30	 0,64 1,83 2,89
3.	Depth of Irrigation Furrows, cm: Mo' $\pm\sigma$	 14,8 2,4
4	Plant Residues per 1 m², kg:	0,492
5.	Stubble Height, cm: $M_{o'}$ $\pm\sigma$	 24,4 4,3

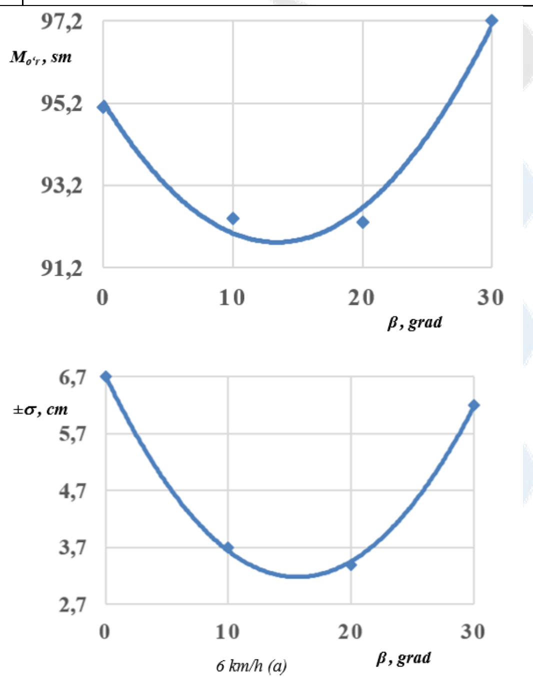


Figure 1. Graphs of the variation of the disc plow working width (M_{or}) and the root mean square deviation of the plow working width (±σ) as functions of the installation angle of the support disc relative to the vertical (β).

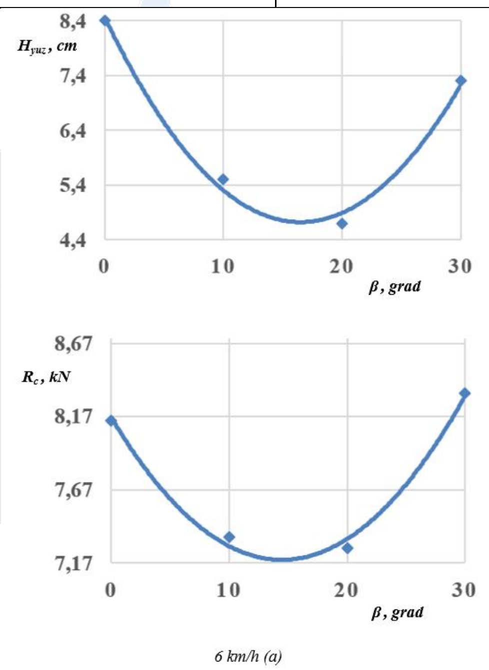


Figure 2. Graphs showing the variation of the height of surface irregularities of the furrow (H_{yuz}) and the specific draft resistance (R_c) as functions of the installation angle of the support disc relative to the vertical (β).

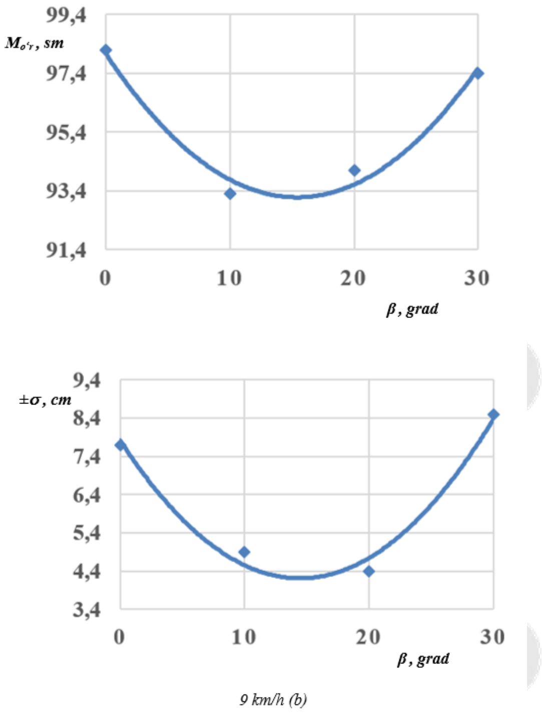
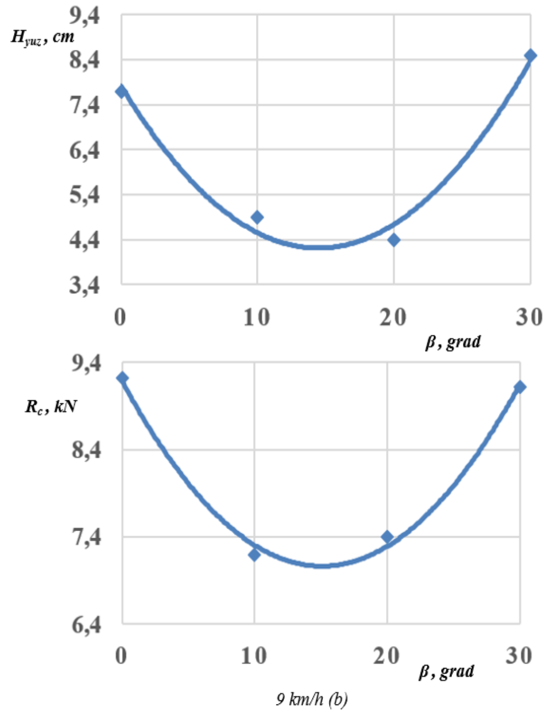


Figure 3. Graphs illustrating the variation of the disc plow working width (M_{or}) and the root mean square deviation of the plow working width (±σ) as functions of the installation angle of the support disc relative to the vertical (β).



4-rasm. Graphs showing the variation of the height of surface irregularities of the furrow (*H_{yuz}*) and the specific draft resistance (*R_c*) as functions of the installation angle of the support disc relative to the vertical (*β*).

When the installation angle of the support disc relative to the vertical increased from 10° to 20°, the uniformity of the plow working width improved.

Changes in the installation angle of the support disc relative to the vertical from 20° to 30° had a significant effect on the uniformity of the plow working width. Specifically, as the angle increased within this range, the support disc did not sufficiently rest on the bottom of the furrow, which led to an increase in the plow working width.

An increase in operating speed from 6 km/h to 9 km/h also resulted in an increase in the plow working width, a decrease in the height of surface irregularities formed on the furrow surface, and an increase in the specific draft resistance of the plow.

Research Methodology. The tests were conducted on a field of the institute's experimental plot that had been cleared after winter wheat harvesting.

The experiments were carried out on wheat-harvested and irrigated fields of the experimental station of QXMITI.

Table 2 above presents the characteristics of the field soil prior to the experiments, including soil moisture, hardness, as well as the quantity and height of stubble.

In conducting the experimental studies, a disc plow equipped with a support disc device was arperated with a New Holland TD5.110 tractor.

During the experiments, the specific draft resistance of the unit was determined using strain gauge sensors in accordance with O'zDSt 3193:2017 "Testing of agricultural machinery. Method for energy

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evaluation of machines," while the agrotechnical indicators were determined in accordance with O'zDSt 3412:2019 "Testing of agricultural machinery. Soil-working machines and implements. Test program and methods" [2–3].

Conclusion. Based on the results of the conducted research, it was established that to ensure uniform operation of the disc plow in terms of working width, the installation angle of the support disc relative to the vertical should be 20°.

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