

EFFECT OF THE INSTALLATION HEIGHT OF THE SCRAPER BODY (ANGLE SCRAPER) ON THE CENTER OF ROTATION ON THE PERFORMANCE OF THE DISC PLOW

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Annotation. The article presents the results of field experimental studies carried out to investigate the influence of the installation height of the scraper (angle scraper) body relative to the center of rotation on the performance indicators of a disk plow. The installation height was varied from 0 to 15 cm at 5 cm intervals. The experiments aimed to determine the effect of the structural and technological parameters of the angle scraper on the operational efficiency of the disk plow. During the tests, the degree of soil pulverization, the completeness and depth of crop residue incorporation, the height of surface irregularities after plowing, and the specific draft resistance of the plow were analyzed. The obtained results provide an assessment of how the installation height of the angle scraper affects soil tillage quality and the overall energy efficiency of the plow's operation.

Key words: disc plow, scraper (angle scraper), disc body, degree of soil crumbling, working surface, height of installation relative to the center of rotation of the body, number of soil fractions, plant residues, depth and completeness of incorporation, unevenness of the plowed surface, depth of cultivation, specific traction resistance, speed of movement.

Introduction. At the global level, extensive scientific research is being conducted to develop resource-saving technologies for preparing agricultural lands intended for crop cultivation, as well as to establish new scientific and technical foundations for the machinery that implements these technologies.

In this direction, priority is given to improving soil tillage machines equipped with disk bodies fitted with special scrapers (angle scrapers), whose working elements perform both translational and rotational motion. In particular, ensuring resource efficiency during the interaction between working elements and soil is of significant importance. Therefore, the development of disk plow designs with working bodies in the form of spherical disks equipped with scrapers (angle scrapers), as well as increasing their operational efficiency, is considered one of the urgent scientific and technical tasks. In the Republic, it is planned that in 2025 more than 1,007.3 thousand hectares will be sown with winter cereal crops, of which 311.5 thousand hectares will be open fields and 695.8 thousand hectares will be inter-row areas of cotton fields sown with winter cereals [1]. In agricultural production, comprehensive measures are being implemented to reduce labor and energy consumption, ensure resource efficiency, cultivate crops based on advanced technologies, and develop high-performance agricultural machinery. In particular, special attention is being paid to the development of technical means that ensure high-quality execution of technological processes with reduced energy consumption during plowing operations. Taking this into account, the use of a disk plow for soil inversion on stubble fields after wheat harvesting is considered appropriate.

Materials and Methods. Experimental studies on the development of a disk plow equipped with a scraper (angle scraper) were carried out using experimental field devices, as well as methods of mathematical planning of experiments and tensometry.

The agrotechnical and energy performance indicators of the disk plow equipped with a scraper (angle scraper) are determined in accordance with UzDSt 3412:2019 “Testing of agricultural machinery. Soil tillage machines and implements. Test program and methods” and UzDSt 3193:2017 “Testing of agricultural machinery. Method for energy evaluation of machines” [2,3]. The following performance criteria are evaluated:

- height of surface irregularities formed after plowing;
- soil crumbling quality;
- tillage depth and its uniformity;
- draft resistance of the plow.

Field experiments were conducted by researchers of Tashkent State Technical University named after Islam Karimov. During the experiments, a prototype of the disk plow equipped with scrapers (angle scraper) was developed.

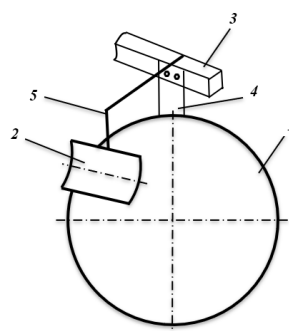
The main function of the developed scraper (angle scraper) is to additionally crush the soil slice cut by the disk body and ensure its complete inversion, thereby contributing to the full and deep burial of plant residues and weeds. The working process of the disk plow equipped with a scraper (angle scraper) proceeds as follows: during operation, the disk body performs both translational and rotational motion, cutting a soil slice with a groove-shaped cross-section, lifting it along the working surface of the disk, and partially crumbling it into smaller aggregates.

During the experiments, the installation height of the scraper (angle scraper) relative to the rotation center of the disk body was varied from 0 to 15 cm with an interval of 5 cm. The tillage depth was set at 25 cm, and the aggregate travel speed was set at 6 and 9 km/h.

The results obtained from experiments aimed at studying the effect of changes in the installation height of the scraper (angle scraper) relative to the rotation center of the disk body on agrotechnical and energy performance indicators are presented in detail in Table 1.

In the experimental studies, the influence of the installation angle of the scraper (angle scraper) relative to the horizontal, the aggregate travel speed, the completeness of burial of plant residues, the burial depth of plant residues, the height of surface irregularities after plowing, and the specific draft resistance of the plow were investigated. The experiments were conducted on irrigated fields of the research station after wheat harvesting. Table 1 below presents the characteristics of the field soil prior to the experiments, including soil moisture, hardness, and the amount and height of stubble residues.

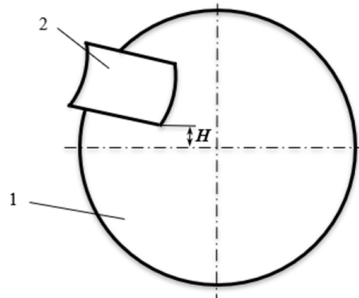
The structural scheme of the disk plow equipped with a scraper (angle scraper) mounted on the disk body is presented (Figure 1). It consists of a disk body (1) and a scraper (angle scraper) (2) installed in front of it. These components are separately attached to the plow frame (3) by means of supports (4 and 5).



1 – disk body, 2 – scraper (angle scraper), 3 – frame, 4 – support of the disk body, 5 – support of the scraper (angle scraper)

Figure 1. Structural scheme of the disk body equipped with a scraper (angle scraper)

Below, the parameter of the disk body scraper investigated during field experimental studies is presented (Figure 2).



1 – disk body, 2 – scraper (angle scraper).

Figure 2. Investigated parameter of the scraper (angle scraper)

Results and Discussion. During the experimental studies, the device was aggregated with a New Holland TD5.110 tractor.

In these experiments, the installation height of the scraper (angle scraper) relative to the rotation center of the disk body was varied from 0 to 15 cm with an interval of 5 cm. Other parameters were kept constant, namely: the radius of curvature of the scraper working surface was 30 cm, the installation angle relative to the horizontal was 20°, the length of the working surface was 35 cm, the tillage depth was 25 cm, and the aggregate travel speed was set at 6 and 9 km/h.

The analysis of the results obtained from experiments aimed at studying the effect of changes in the installation height of the scraper (angle scraper) relative to the rotation center of the disk body on agrotechnical and energy performance indicators (presented in Table 3.4) shows that increasing the installation height from 0 to 15 cm improves soil crumbling quality. Specifically, the proportion of fine soil fractions increases, while the amount of large clods decreases. This can be explained by the fact that, as the installation height increases within this range, the degree of fragmentation of soil slices also increases, thereby reducing the likelihood of large clod formation. However, when the installation height exceeds 15 cm, the amount of fractions larger than 50 mm slightly increases, since the soil does not fully reach the working surface of the scraper.

As the installation height of the scraper (angle scraper) relative to the rotation center increases from 0 to 15 cm, the inversion of soil slices improves, which leads to better burial completeness and depth of plant residues, as well as a reduction in surface irregularities after plowing. When the installation height exceeds 15 cm, these indicators deteriorate. This is due to the fact that at greater heights, the soil slices do not fully interact with the scraper working surface, resulting in incomplete inversion.

Table 1

Effect of the Installation Height of the Scraper (Angle scraper) Relative to the Rotation Center of the Disk Body on the Performance Indicators of the Disk Plow

Installation height of the scraper	Soil fraction distribution, %	Burial of plant residues	Surface roughness height after	Specific draft resistance

(angle scraper) relative to the rotation center of the disk body, cm	Fraction size, mm			Burial complete ness, %	Burial depth, cm	plowing, cm	of the plow, kN/m
	>100	100-50	<50				
$V = 6 \text{ km/h}$							
0	6,3	5,9	87,8	86,9	8,5	6,4	8,35
5	3,7	5,4	90,9	91,4	11,2	5,2	6,57
10	3,1	4,1	92,8	94,5	12,3	4,6	5,72
15	2,9	4,9	92,2	93,5	11,9	4,7	5,45
$V = 9 \text{ km/h}$							
0	4,9	5,5	89,6	89,5	9,8	5,5	9,55
5	2,3	4,8	92,9	93,5	12,4	4,5	7,45
10	2	3,6	94,4	96,1	13,1	3,7	6,95
15	1,7	4,5	93,8	95,5	12,8	3,9	6,48

It was also observed that with an increase in the installation height of the scraper (angle scraper), the specific draft resistance of the plow decreases significantly. This is explained by the reduced interaction between the scraper and the soil as the installation height increases.

An increase in speed from 6 km/h to 9 km/h shows similar trends: when the installation height varies from 0 to 15 cm, soil crumbling quality improves, soil inversion enhances, the completeness and depth of plant residue burial increase, and surface irregularities decrease. However, when the height exceeds 15 cm, the proportion of fine fractions (less than 50 mm), as well as the completeness and depth of burial of plant residues, decrease, while surface irregularities slightly increase.

At both speeds (6 and 9 km/h), an increase in the installation height of the scraper relative to the rotation center of the disk body results in a noticeable decrease in the specific draft resistance of the plow.

In summary, based on the conducted research, it was determined that the optimal installation height of the scraper (angle scraper) relative to the rotation center of the disk body is within the range of 10–15 cm, at which the performance indicators of the disk plow are the most effective.

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