

RESULTS OF EXPERIMENTAL RESEARCH OF THE WORKING SECTION OF THE DIRECT SOWING (NO-TILL) DEVICE

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Abstract. The operating principle of the device for direct sowing (No-till) of repeated crops on fields freed from grain and the results of experimental investigations of a double-disc no-tillage opener are presented in this article.

1. Introduction

Uzbekistan, like the rest of the world, is currently facing the effects of global climate change. Recent water shortages, the worsening of irrigated land reclamation, and the fall in crop yields are all evident examples of this.

Mini-till, Strip-till, No-till, and other technologies that save water in agriculture and allow efficient use of soil, based on the experience of industrialized countries, should be implemented as a solution to the difficulties.

The term resource-saving and soil conservation agriculture has gained popularity in recent years in our country as well as in Central Asian countries [1], with more than 150 million hectares under cultivation utilizing these technologies [2].

Soil conservation and resource-saving agriculture are based on three interrelated principles:

- minimal mechanical tillage or no tillage at all (no plowing);
- saving excess water consumption at the expense of plant residues in the soil, reducing soil erosion, and protecting the soil with the help of legumes, which can be used as fertilizers, protecting soil microorganisms;
- doubling crop yields and crop diversification by growing crops from different families as repeated (secondary) crops; (FAO, 2008).

The importance of Strip-Till and No-Till technology in Uzbekistan is seen above. In light of this, it is critical for agricultural production to define the specifications and dimensions of the working bodies of the proposed device for directly sowing of intermediate and repeated (secondary) crops (No-till) and to refine its design.

A number of scientific studies in this area have been carried out around the world, as well as in Uzbekistan.

For strip-till technology, P.A. Smirnov and others studied rotational working bodies [3], while Ergashev I. and other scientists studied the device of crushing plant residues for this technology [4]. Mamatov F, Ravshanov K studied the physico-mechanical and technological properties of eroded soils. [5,6]. R. Yusupov proposed an hoe-type no-tillage opener. To prevent plant residues from becoming lodged in the hoe-type no-tillage opener, a disc blade is installed in front of the opener [7]. S.J.Baker and others examined forms of slot shape that seeding openers form at No-Till technology [8]. The design of disc, hoe-type and other types openers for direct seeders was researched by Calixto Vento and others [9]. The technological procedures of double disc openers were researched by I.Marozov and V. Marozov [10]. I.Karasev proposed a disc design for sowing small-seeded plants [11]. V.R.Petrovets and others proposed a construction scheme of a combined double disc openers, which simultaneously sows the seeds of cereals with mineral fertilizers [12].

The experiments described above were done mostly in soil climatic circumstances when soil moisture was adequate or excessive. Sowing of repeated crops takes place in late June and early July in Uzbekistan. The daily air temperature is over 40°C during this time, and the moisture content of the soil released from the fall grain is less than 10% in a layer of 0...10 cm. As a result, it is critical to design a structure that is appropriate for the conditions in Uzbekistan and to define its parameters.

The aim of the study was to determine the effect of the parameters of the double disc no-tillage openers on the size of the shaped slots formed for sowing and the effect of resistance on traction was determined.

2. Methods and materials

Based on the above research, the Patent of the Republic of Uzbekistan was obtained for the direct sowing device of the seeds of repeated crops by No-Till technology in the areas free from grain (Figure 1). The direct sowing device consists of several working sections, each section consists of a frame 1, a hanging device 2, a spring 3, a press wheel 4, a seed signing 5, large and small diameter double disc openers 6 and 7, and a straw grinder 8.

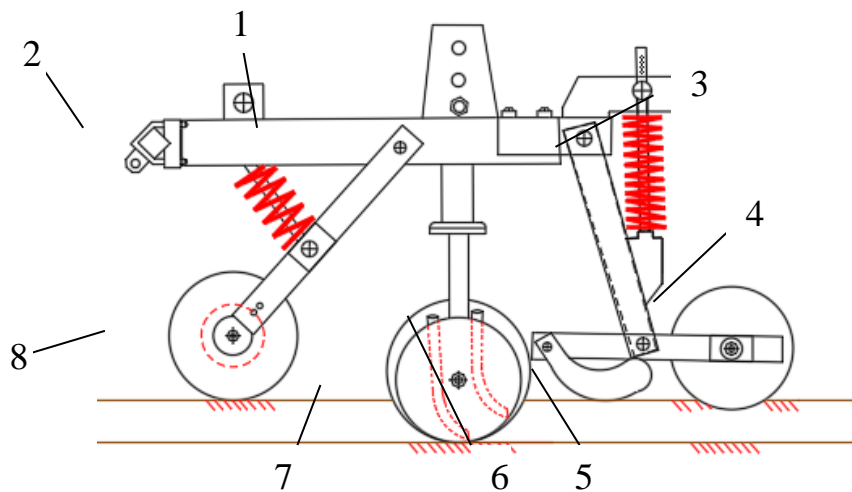


Fig 1. The structure of the working section of the direct sowing device

In order to verify the results of theoretical research and to determine the parameters that ensure the quality of work at the required level with low energy consumption in the sowing of repeated crops, a program of experimental research was developed:

- development and construction of laboratory-field equipment for experimental research;
- to study the diameters of the disks, the direction of movement and installation angles relative to the vertical, as well as the ratio of the diameters of the disks on the size of the shaped slots formed for sowing and the effect of resistance on traction.

Experimental studies were conducted in a field emptied from autumn grain. The average moisture content of the field soil in the 0-10 cm horizon was 12,1%, hardness was 1.80 MPa, the number of grain stalks was 105 grains per 1 pm, and the average height was 21,5 cm.

A laboratory-field device was developed for experimental research (Figure 2). The double-disc opener was mounted on a G-shaped strain gage.

A G-shaped strain gauge was weighed before and after the experiments. In this case, the strain gage was loaded with an interval of 0,4 kN in the range of 0-2 kN.

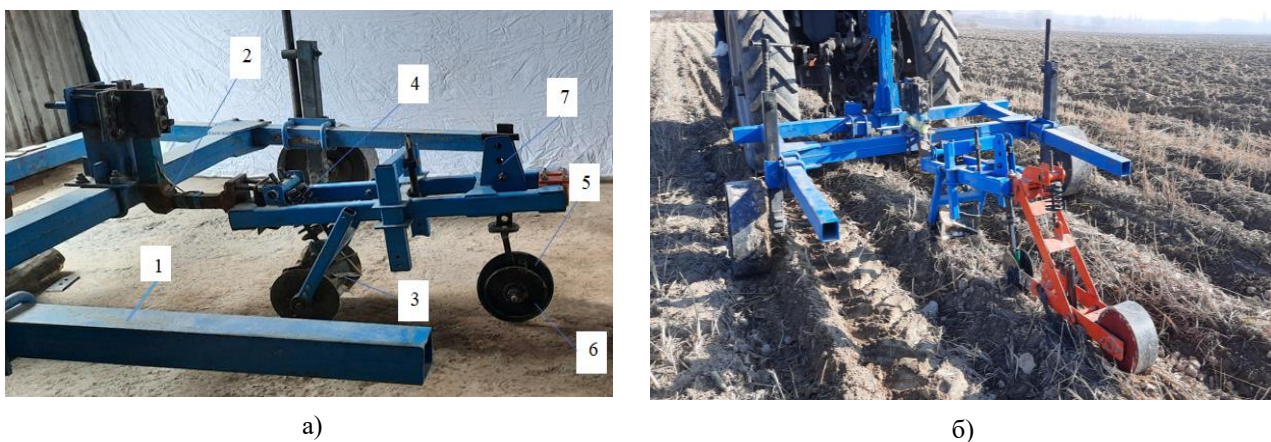


Fig 2. a) General view of the device mounted on a G-shaped strain gage.

b) Field operation of the device

1- frame, 2- G-shaped strain gage, 3- a straw grinder, 4 - pressure spring, 5-6 large and small diameter double disc opener.

The device uses a G-shaped strain gauge to record the traction resistance of the double disc opener.

In experimental studies, the effect of the mounting angles of the disks to the direction of movement, mounting angles of the disks relative to the vertical and speed of movement of the device on their resistance to traction and the size of the forming seed slots was studied.

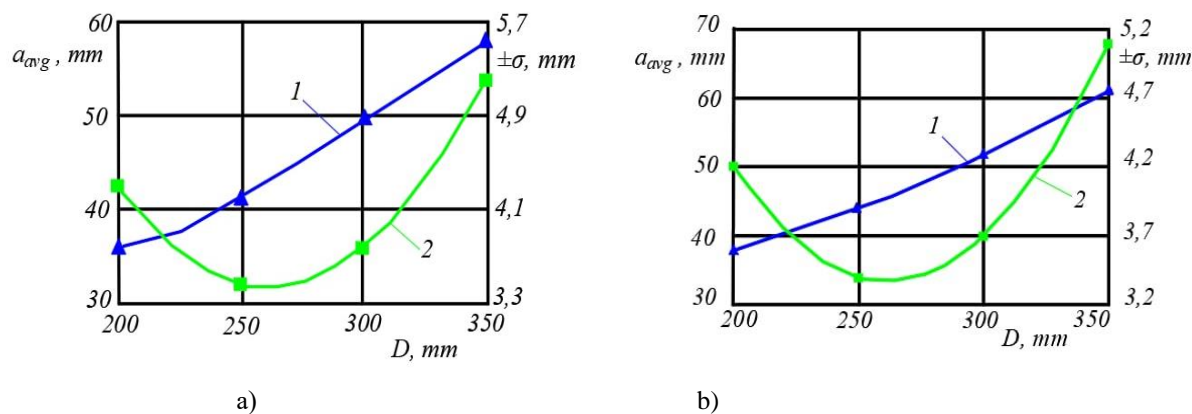
The diameter of the sowing disc was changed from 200 mm to 350 mm at 50 mm intervals. The ratio of the diameters of the discs was 0.8, the mounting angle was 12° to the direction of movement, and the mounting angle to the vertical was 15°.

The main parameters in the study of the diameter of the sowing disc were the depth and width of the formed seed slots, as well as the resistance to traction. The depth and width of the formed slots were determined at a total of 20 locations by opening the cross-

section of the double disc no-tillage openers that create vertical V-shaped slots after the device had passed.

3. Results and discussions

The change of the depth and width of seed slots formed in the soil under the influence of double discs opener depending on the diameter of the discs are shown in Figures 3 and 4.

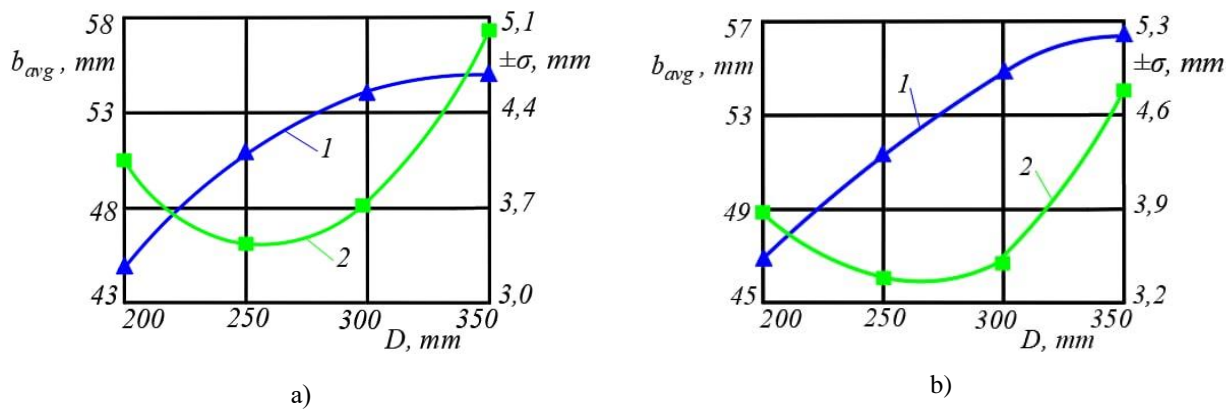


a, b – the speed of the device is 6 and 8 km/h, respectively

Fig 3. The change of the depth of the formed seed slots (1) and the square deviation (2) depending on the diameter of the discs

When the speed of the unit exceeds 6 km/h, that the depth of the double disc openers in the soil is shallower. The average depth of the double disc openers with a diameter of 350 mm is 4,7 mm at a speed of 8 km/h, while the average depth at 6 km/h is 5,7. The depth of the seed slots formed at both speeds was found to be almost directly proportional to the diameters of the discs, and the smooth motion of the discs was in the range of 250–300 mm. When the diameter of the discs is in the range of 200-250 mm, the working depth of the disks in the soil is in the range of 30 ... 40 mm, i.e. the average squared deviation is high because it is relatively low. The depth of the formed seed slots when the diameter exceeds 300 mm also exceeds 5.0 cm, but σ also increases significantly as a result of the increase of soil resistance.

The width of the seed slots formed by the double discs expanded as the diameter of the discs increased (Fig. 4).

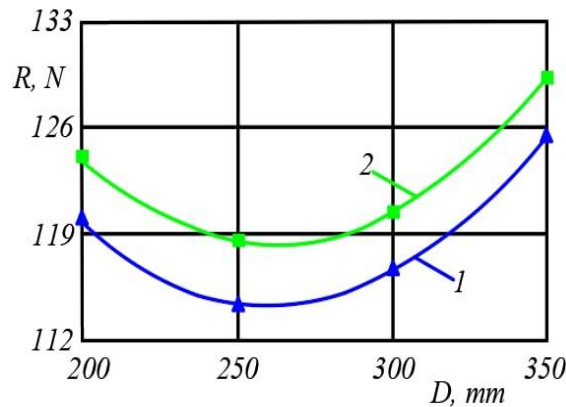


a, b – the speed of the device is 6 and 8 km/h, respectively

Fig 4. The change of the width of the seed slots (1) and its square deviation (2) depending on the diameter of the discs

This is explained by the fact that the discs penetration into the soil will be better. When the disc diameter exceeds 300 mm, this expansion is less than the expansion in the range of diameter of 200 ... 300 mm. This is because the incidence of the disc deviating from the specified depth increases. The minimum width deviation from the average value of the seed slots is in the range of 250-300 mm in diameter of the disc, i.e. the smooth operation of the double disc openers is ensured.

The results obtained by measuring the traction resistance of a double-disc opener are shown in Figure 5.



1, 2 – the speed of the device is 6 and 8 km/h, respectively

Fig 5. The traction resistance of a double-disc opener depends on its diameter

When the disc diameter increases from 200 to 250 mm, the traction resistance decreases. This is due to the fact that in small-diameter discs because the angle of coverage of soil lumps and plant residues is small, the disc pushes some of them to the front, forming a small soil pile in front of the disc. An increase in the coverage angle when the diameter is 250-300 mm improves the process of cutting plant residues and soil. As the diameter of the disc increases from 300 mm to 350 mm, the penetration of the disc into the soil increases, and the size of the seed slots also increases. As a result, the traction resistance of the disc also increases.

4. Conclusions

Double disc openers can be used at sowing seeds of repeated crops directly. In this case, when the diameter of the large disk is 250-300 mm, the diameter of the small disk is 0,8 of the large disk (200-240 mm), the discs are installed at an angle of 12° to the direction of movement and at an angle of 15 ° to the vertical, the depth of the formed seed slots is 4,1-5,0 cm and the width is 4,8-5,1 cm and the traction resistance of the double disc openers is in the range of 112-122 H. The fact that the small disk is at a ratio of 0,8 to the large disk, due to the difference in angular velocities, clears the large disk of plant residues from clogging and soil sticking.

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