Justification of the Parameters of the Ripper and the Coulter of the Seeder, Sowing Seeds of Repeated Crops on Untreated Soil

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Abstract. One of the leading places in the world is occupied by the development and application of technologies and technical means of sowing seeds on untreated soil. The great importance is the creation and production of machines and devices that allow planting seeds of agricultural crops on untreated soil with high quality and yield in one pass. In the world, targeted research is being carried out to develop scientific and technical foundations for improving energy- and resource-saving technologies for sowing seeds of repeated crops in crop-free and winter fields, create new models of machines and installations for their implementation, as well as improve the quality of work and reduce energy and material consumption. In particular, in this direction, the development of a constructive scheme of a seeder capable of sowing seeds of repeated crops in fields freed from early crops and winter grains, and the justification of the technological process of work. One of the most pressing issues is the conduct of scientific research based on parameters that ensure the resource efficiency of the interaction of its working bodies with the soil.

Keywords: two-disc seeder, direct seeding, repeated crops, seeder, no-till, ripper, coulter, parameters, moisture conservation

1 Introduction

In order to reduce the labor intensity and energy intensity of agricultural production in the republic, large-scale measures are being implemented to save resources, grow crops based on advanced technologies for the development and efficient use of high-performance agricultural machinery, in particular. The article presents the results of theoretical studies based on the parameters of a double-flat disc seeder, which performs direct sowing of repeated crops without tillage in wheat-free fields in the soil and climatic conditions of Uzbekistan. Based on agrotechnical requirements and calculations, the diameter of the zigzag disk ripper, the angle of sharpening of the blade of the zigzag disk, the radius of curvature and the central angle of the blade and the angle of attack of the ripper, as well as the depth of sealing, the width of the gap and the clamping force of the coulter are determined. It is shown that the rational parameters of the working organs ensure a

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decrease in traction resistance, moisture retention and an increase in field germination of seeds. 1.87 billion hectares are sown annually all over the world, the creation and manufacture of machines and devices that allow planting seeds of crops on untreated soil with high quality and yield in one pass is of great importance. Certain results have been achieved in this direction in foreign countries, including the USA, the Russian Federation, Brazil, France, Germany, England, Italy, Romania, Turkey, China, and India.
Reducing the labor intensity and energy intensity of agricultural production in the republic, large-scale measures are being implemented to save resources, grow crops based on advanced technologies for the development and efficient use of high-performance agricultural machinery, in particular, special attention is paid to the development of technical means to ensure reliable and high-quality implementation of established technological processes with lower energy consumption when sowing seeds of repeated crops on vacant from the harvest and winter fields.

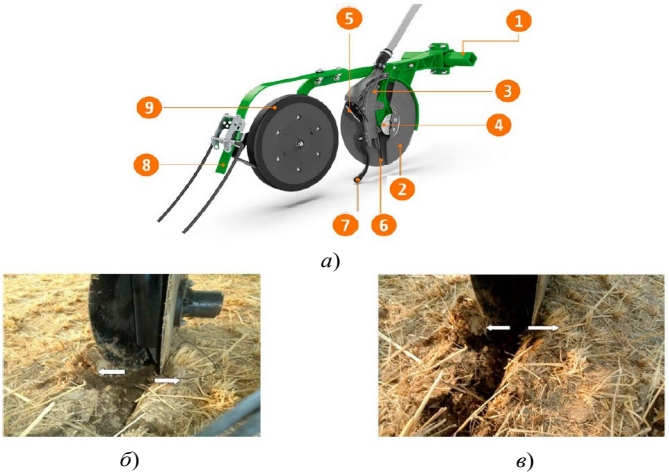
2 Materials and methods

Research on the creation of technologies used in sowing seeds of repeated crops in the world, and the technical means that implement them, and improve existing ones were carried out by different countries. In the research conducted by M. Aduov, S. Nukusheva, T. Tulegenov, K. Volodya, K. Uteulov, B. Karvat and M. Bembenek[1-5], a seed drill was developed based on No-till technology for the soils of Northern Kazakhstan (Fig. 1.), and its tests were carried out. In this regard, scientific research aimed at improving the mechanical properties of aluminum alloys is carried out by the world's leading research institutes [6-9]. One of the methods for improving the properties of aluminum alloys is the introduction of micro alloying elements into their composition [10-13]. In this research work, germanium oxide and silicon elements were introduced into aluminum alloys, aluminum-copper and aluminum-magnesium alloys as modifiers, and their effect on tensile strength was studied. Testing materials for tensile strength of alloys is a scientific experiment. The purpose of this is to determine the strength of materials under the influence of external forces. Tensile strength is one of the main characteristics of alloy deformation [14-22].

Figure 1. A seed drill based on No-till technology, developed for the soils of Northern Kazakhstan. 1-frame, 2-seed hopper, 3-application device (fertilizers), 4-sowing section, 5-sowing machine, 6-drive wheel (movement wheel)

According to the results of the tests, the following was noted: the germination rate of Burabai wheat seeds sown with the developed seeder turned out to be 3.56% higher than that of the seeds in the control area. The improved germination of wheat seeds is due to the higher quality of the seed portion of the developed seeder compared to the seed portion of the prototype seeder. When using this seed drill for sowing wheat, the uniformity of the seed depth increased by 4.95% compared to the standard. The yield increased by 5,361 kg/ha compared to the control plot. Traction resistance was 12.3% lower than that of existing analogues.

A study of the parameters of two-disc seeders for No-till technology conducted by Bogdan Rosu, Gheorghe Voicu, Gabriel-Alexandru Constantin, Paula Tudor and Elena-Madalina Stefan, as well as an analysis of their working condition (Fig. 2).



а)

б) *в*)

Figure 2. Two-disc seeder (a) and the working processes of the seeders (b, c).
To increase the accuracy of sowing, especially in untreated conditions, it is necessary to choose the right angles of the discs of the double-disc seeders and the speed of the unit. 1-Frame; 2-Two-disc seed drill; 3, 6-Seed guide lines; 4-Bearing; 5-Seed cleaner; 7-Seed regulator (ensures alignment of sown seeds in one line); 8-Rack; 9-Soil compactor.

Faz Ahmad, Ding Weiming, Ding Qishuo, Mubshar Hussain and Khawar Jabran investigated the parameters of double-disc seeders for sowing, as well as the processes of their interaction with soil and plant residues.
Their studies showed that with a disk diameter of 330, 450 and 600 mm, the traction resistance was 648.9, 737.2 and 784.6 N, respectively. In addition, the average efficiency of cutting straw with double discs with a diameter of 330, 450 and 600 mm was 39.36%, 78.47% and 65.46%, respectively. A 450 mm diameter disc showed a higher efficiency of cutting straw compared to a 600 mm diameter disc. The 450 mm diameter disc also provided the highest straw cutting efficiency (88.6%) at a working depth of 90 mm. This indicates the optimal performance of the 450 mm diameter disc compared to other discs.
In the Republic, A.Y.Tolibayev and B.V. Abdulaev worked in this direction. Scientific research work was carried out on the development of a combined unit designed for minimal tillage after harvesting wheat and sowing seeds of repeated crops, as well as on the justification of its parameters, performed by A.Y. Tolibaev.
Figure 3 shows a combined unit developed by A.Y. Tolibaev, which provides minimal tillage after harvesting wheat and sowing seeds of repeated crops. According to the results of his experimental studies, it was found that for minimal surface treatment of the ridge, it is necessary to use working bodies consisting of three flat discs, one pointed foot, a leveler and a rotary ripper.

Figure 3. Drawing. A combined unit for minimal tillage in wheat-free fields and for sowing seeds of repeated crops.

In addition, the conditions for separating and removing seeds from the total mass were determined, depending on the size and weight of the seeds, the angles of friction and the natural angle of inclination of the seeds, the surface of the seeds in the receiving chamber, the rotation speed and radius of the seed disk, the area of the suction opening and vacuum in the vacuum chamber.

B.V. Abdullaev conducted research on the development of a seeder for repeated crops and the justification of its parameters.

Figure 3 shows a seeder for repeated crops, designed by B.V. Abdullaev. Based on the results of his research, the following conclusions were drawn:

To prevent clogging of the working organs with plant residues during sowing and fertilization for repeated crops, it is advisable to install a straw-grinding roller on each row.

To prevent clogging with plant residues and soil sticking when creating furrows for seeds and fertilizers in one pass, it is advisable to use seeders with two-disc coulters of various diameters.

3 Results

However, these studies have not sufficiently studied the development of a seed drill that sow's seeds of repeated crops on untreated soil, and the justification of the parameters of the working bodies.

The aim of the study is to improve the quality and yield of re-sowing seeds by substantiating the type and parameters of a seeder that sows re-sowing seeds in areas free of winter crops on untreated soil, as well as ensuring energy efficiency. As a result of the

analysis of the research work carried out and a large number of studies, a design scheme for a seeder sowing seeds of repeated crops on untreated soil was developed (Fig. 4). A seeder sowing seeds of repeated crops on untreated soil (hereinafter referred to as the seeder) is equipped with a frame 1, a support wheel 2, a zigzag disk ripper 3, a double flat-disc coulter 4, a pneumatic seeding machine 5, a sealer 6, a compactor, a compacting soil layer over the sown seeds 7, an extractor 8, a hose 9 and a seed hopper 10.

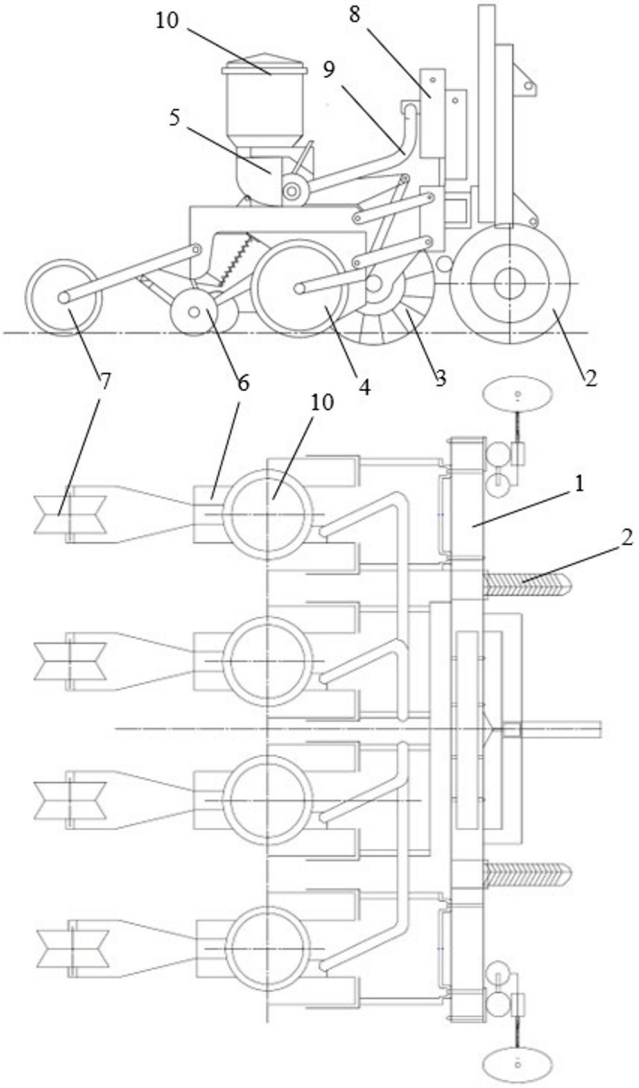
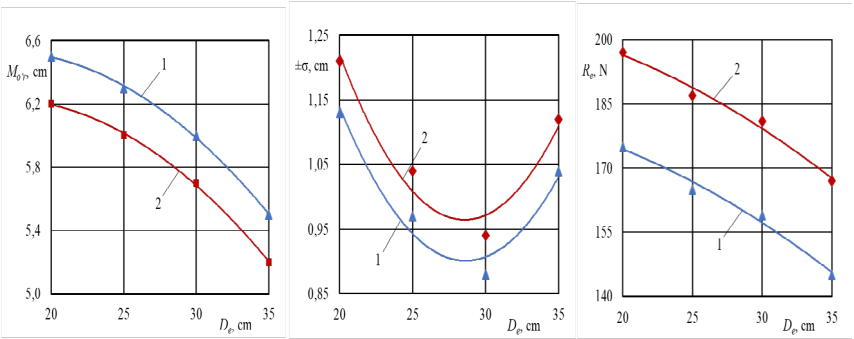


Figure. 4. Design diagram of the seeder. 1-frame; 2-support wheel; 3-zigzag ripper; 4-double flat-disc coulter; 5-pneumatic seeding machine; 6-sealer; 7-sealer; 8-extractor; 9-hose; 10-grain hopper

The workflow of the developed seeder proceeds as follows: when the unit moves across the field, its zigzag disk ripper partially loosens the stubble of early crops and fields that have been freed from grain crops, and also pushes plant residues and weeds aside in front of the two-disc coulter. The two-disc coulter sows the seeds of repeated crops, supplied through a pneumatic seeding machine, to a predetermined depth. Then the seeds are sealed using a sealing device, and the soil layer above the seeds is compacted using a rolling mechanism. As a result, it is possible to sow seeds of repeated crops on untreated soil in a short time and ensure uniform germination. Methods and results of experimental studies" presents the results of single-and multifactorial experiments to study the effect of the diameter of a coulter disc with a double flat disc, the angle between its discs, vertical load on it, as well as the speed of the unit on the quality of work and energy performance.

A laboratory and field facility for conducting experimental studies has been developed. During the experiments, different types of soils were used, soil moisture and density varied, and various treatment modes were used. The data obtained made it possible to construct regression models describing the dependence of the furrow depth, grip width, specific traction resistance and energy intensity of the process on the factors studied. The analysis of the results showed that the diameter of the disc and the angle between them have the greatest impact on the quality of work, while the vertical load and the speed of movement of the unit determine the energy performance to a greater extent. Optimal ranges of values of the studied parameters have been identified to achieve maximum efficiency and minimize energy consumption during operation of the coulter. An analysis of the experimental results (Fig. 5) shows that with an increase in the diameter of the disc of a double-flat disc coulter, the depth of the opened seed furrow decreases, the average square deviation of the depth of the opened seed furrow changes according to the law of the concave parabola, first decreases and then increases, the traction resistance of the coulter increases. The above can be explained by the fact that with an increase in the diameter of the coulter disc with a double flat disc, its area of interaction with the soil increases.



1 and 2, respectively, at unit speeds of 6 and 8 km./h

Fig. 5. The effect of the diameter of the disc of the two-disc coulter of a seed drill for sowing seeds of repeated crops on untreated soil Ds on the depth of the sowing furrow opened by the coulter Mo'r (a) and its standard deviation ±σ (b), as well as on the traction resistance of the coulter Re (v).

4 Conclusion

Based on the research work carried out on the development of a seed drill for sowing seeds of repeated crops on untreated soil, which fully meets the agrotechnical requirements for sowing seeds of repeated crops on directly untreated lands, consumes little energy and resources, is structurally simple, with low metal consumption, insufficiently carried out. According to the results of comparative tests, a seed drill for sowing seeds of repeated crops on untreated soil must be equipped with a double-disc coulter in order to meet the requirements imposed on it.

The diameter of the zigzag disk ripper should be at least 36.5 cm from the condition of intersection of stems and roots of plant remains and weeds encountered during operation, the angle of sharpening of the blade of the zigzag disk should be 60 ° from the condition that the soil does not stick to it, and the radius of curvature of the blade of the zigzag disk should be 36.8 cm and the central angle 16°23' for a high-quality workflowdiameter of the zigzag disk ripper should be at least 36.5 cm from the condition of intersection of stems and roots of plant remains and weeds encountered during operation, the angle of sharpening of the blade of the zigzag disk should be 60 ° from the condition that the soil does not stick to it, and the radius of curvature of the blade of the zigzag disk should be 36.8 cm and the central angle 16°23' for a high-quality workflow. The vertical load on the zigzag disk ripper and t soil.

In order for the depth of the sowing furrow and its standard deviation, opened by the two-disc coulter of the seeder for sowing seeds of repeated crops on untreated soil, to meet existing agrotechnical requirements, the diameter of the two-disc disc of the seeder should be 30 cm, the angle between the discs 10 °, the vertical load on the coulter should be at least 250 N.

According to the results of the conducted multifactorial experiments, to ensure the required quality of work at speeds of 6.0-8.0 km /h with minimal energy consumption, the diameter of the disc of a coulter with two discs should be within 29.68-33.33 cm, the angle between its discs 6°36′-11°46′36′, and the vertical load on the coulter with two discs should be within the range of 202.10-251.15 N.

When using the developed seeder for sowing seeds of repeated crops, labor costs are reduced by 41.87% and operating costs by 71.73%.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

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