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INNOVATIVE WORKING BODIES OF OPENERS FOR SEEDING GRAIN CROPS

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Abstract

The working bodies of the openers are presented, which help to avoid the rolling of seeds along the length of the bottom of the furrow, as well as the displacement of seeds along the depth of their placement. Studies show that the depth of seed placement does not always coincide with the depth of the openers. This is explained by the fact that loose soil mass enters the internal space of the openers and is located on some inclined surface. To ensure an even predetermined placement depth, the seeds must be directed to the front of the openers where the scree does not fall and where the bottom of the furrow is horizontal. To do this, in the lower part of the openers set a plate inclined forward, hitting which, the seeds are discarded to the toe of the coulter. However, the seeds, having hit the inclined plate, randomly fall onto the prematurely sprinkled bottom of the furrow, and the uniform distribution of seeds along the row length and the depth of their placement is violated.

Key words*: grain seeder opener, crops, working bodies, grain speed quencher.*

INTRODUCTION

Currently, the functioning of agricultural production questions that reveal the problems of sowing grain crops are especially relevant. At the same time, the development of technological and technical systems for the cultivation of grain crops that most fully meet the agrotechnical requirements is a priority.

One of the prime areas for the development of agriculture in Russia is the improvement of the working bodies of agricultural machinery in order to increase the efficiency of the technological operations they perform (Larushin et al., 2018).

One of the most important operations in the cultivation of crops is sowing. The yield of the cultivated crop, the biological productivity of sowing, and the saving of seed material depend on the quality of sowing.

MATERIALS AND METHODS

In the review and comparative analysis of existing seeders and grain seeder openers, theoretical methods based on the principles of classical mechanics, mathematical analysis, modeling were used. The results of experimental studies of these seeders and grain seeder openers during laboratory and laboratory field studies were obtained using the theory of multivariate experiment, mathematical statistics and current Interstate Standard (IS). Processing of experimental data from research on innovative grain seeder openers bodies were performed using the application programs "Statistica 6.0", "MathCAD", 3D modeling programs etc.

RESULTS AND DISCUSSIONS

The invention relates to agricultural machinery, in particular to close-up working bodies of grain seeder openers.

The grain seeder opener (USSR Author's Certificate No. 1273006 A1) contains a casing, two discs mounted at an angle to each other and secured to the casing with a hinge and secured with a cord-shaped knife, with the aim of improving the quality of seed placement and reliability of work on soils of any kind humidity, the disks are located between the cheeks of the snake-shaped knife, the latter being equipped with a furrow-forming tool with a keel-shaped mouth mounted under the disks and attached to its cheeks.

The disadvantages of this grain seeder opener include the use of a skid-shaped knife of a furrow former installed in front of the discs, which increases the resistance of this grain seeder opener when it moves in the soil. Also, the used runner does not exclude the sticking of soil to it and soil unloading in front of the opener, which leads to disruption of the opener working process and to a

change in the seed placement depth and uniform distribution along the furrow length and seeding depth. In addition, the seeds are fed into the furrow behind a skid-shaped knife, where the soil crumbles into the furrow, and the sowing uniformity along the furrow depth and length would also be violated. All this leads to a decrease in crop yields.

Another grain seeder opener (RF Patent No. 2435356 C1) comprises a housing, a leash for attaching to the frame, two flat pointed discs, a seed guide, a scraper, two ball bearings, the opener having a figured plate made of highly wear-resistant steel, which is rigidly fixed with an adapter to the opener body and the adapter, made of spring steel, in the upper part has longitudinal holes for fixing bolts that allow to adjust the height of the adapter and curly plate, changing the density of the soil mass around the seeds, located at the bottom of the furrow.

The disadvantages of that kind of the grain seeder opener include soil sticking to a curly plate, which results in poor compaction of the bottom of the furrow and shifting of seeds along the furrow, which disturbs the uniform distribution of seeds along the depth and length of the furrow. In addition, in the opener, the seed guide is made of an open type, which leads to the ingress of seeds not to the bottom of the furrow, but to its walls, thereby violating the uniform distribution of seeds along the depth and length of the furrow. All these shortcomings lead to a decrease in crop yields.

One more grain seeder opener (RF Patent No. 2427124 C1) contains a furrow-forming disk mounted on a frame with a leash, on which there is a push rod with a spring, a seed guide located behind the furrow-forming disk, a shut-off valve, a coulter-stopper depth limiter coulter, characterized in that the furrow-forming disk on the periphery has a wedge-shaped shape, the wedge of the disk being rounded, the seed guide in the lower front part is equipped with a two-sided scraper made integrally with the seed guide, a shut-off valve is installed angles on the shafts inside the guide seeds and has a center of gravity offset relative to this shafts, earthing devices stroke limiter depth, the grain seeder opener is mounted on the guide frame for seeds. One of the drawbacks of this grain seeder opener is the installation of the seed guide behind the furrow-forming disk above the soil level, which leads to the shedding of the soil into the furrow before the seeds reach its bottom. Therefore, the seeds are laid in violation of the uniform distribution of them along the depth and length of the furrow. In addition, the presence of a shut-off valve in the seed guide complicates the design and leads to its enveloping with plant residues and clogging of the seed guide, interfering with the normal operation of the grain seeder opener. Because the opener-limiter of the depth of the opener stroke is made of a passive type, it unloads the soil during operation, which negatively affects the uniform distribution of seeds along the depth and length of the furrow. The installation of a disk scraper in the soil leads to its clogging with plant residues and soil, while the furrow-forming disk is slipping, or it stops completely and the coulter will heap the soil.

There the grain seeder opener of RF Patent No. 2427124 C1 should also be mentioned. It comprises a housing and two discs mounted at an angle of 18 ° to each other, while to increase the efficiency of seed distribution over the feeding area, a plate is installed between the discs to form a horizontal profile of the seed bed and a seed diffuser her.

The disadvantages of that grain seeder opener include the manufacture of a seed diffuser in the form of a plate, which, when the grain seeder opener is used, leads to seeds getting on the grain seeder opener discs and engaging them in rotation with the disc, while the uniformity of the supply and distribution of seeds in the furrow along the depth and length of the furrow is violated. In addition, the manufacture of the profiler also in the form of a plate leads to the falling of the furrow formed by it before the seeds get into it from the seed diffuser, which leads to a violation of the uniformity of the depth of seed placement and the uniform distribution along the length of the furrow.

It is necessary to pay attention to the opener and device for planting seeds (Certificate for utility model of the Russian Federation No. 37904 U1) and disk grain seeder opener (RF Patent No. 2237396 C2), including two discs, seed guide and device for planting seeds.

The disadvantages of highly mentioned grain seeder opener include the production of the seed guide tube vertical or curved and open type, and also due to the lack of a device for preliminary compaction of the walls and the bottom of the furrow, when sowing, the walls of the furrow are shed before the seeds get into it and the bottom of the furrow is not horizontal, and the seeds bounce off the bottom of the furrow and the

seeds are laid on an unconsolidated bed, which leads to a violation of the uniform distribution of seeds in depth and further worsens the germination of seedlings.

A grain seeder opener battery is known (RF Patent No. 2125359 C1), including a shaft, spherical disks and racks installed between them with the fertilizer and the seed guide, moreover, paired bows are fixed on each rack, the lower edges of which are placed at the level of the lower edge of the spherical disks, while the working surfaces narralniks (for drawing a furrow in the soil) are made in the form of convex parts of truncated spherical segments facing towards each other, and between them in front of the direction of placement of the pipelines.

The disadvantages include the fact that the opener battery, as well as the openers, are rigidly attached to the seeder frame on one shaft, without taking advantage of the opener suspension, which negatively affects the uniformity of the sowing depth. Also, spherical discs form pile ridges and an uneven bottom of the furrow, violating the uniformity of sowing of seeds and fertilizers in depth. Paired arrays on not sufficiently leveled soil form grooves of different depths, which is unacceptable by agrotechnical requirements when sowing.

The opener (USSR Author's Certificate No. 1688796 A1) comprises a casing, two discs mounted at an angle to each other on the casing, a seed guide and a cultivator in the form of a dihedral wedge located in front of the discs at an acute angle to the horizontal plane, while increase the uniformity of seed placement in depth, the cultivator is equipped with a stabilizer made in the form of wings fixed in its lower part. Moreover, the wings of the stabilizer are directed upward at an acute angle to the horizontal.

The opener's disadvantages include the manufacture of a seed guide in the form of a plate and a cultivator in the form of an open type chute, which leads to seeds getting onto the opener discs and engaging them in rotation together with the discs, while the uniformity of seed supply and distribution in the furrow along the depth and length is violated furrows. Also, the manufacture of a cultivator in the form of an open gutter leads to the rolling of seeds along the bottom of the furrow and falling asleep of the furrow formed by it until the seeds get from the cultivator, which leads to a violation of the uniformity of the depth of seed placement and the uniform distribution along the length of the furrow. In addition, the installation of a cultivator with a stabilizer in the front of the opener does not allow to obtain an even furrow bottom, since the stabilizer made with wings creates vibrations of the coulter in the longitudinal-vertical plane, which will affect the depth of seed and fertilizer placement and their uniform distribution along the furrow length. Also, the installation of a cultivator with a stabilizer in the front of the coulter cannot be carried out for design reasons, since in this part of the opener discs there is no necessary gap between the coulter discs for installing a cultivator with a stabilizer between them. With an increase in the size of the gap between the opener discs of more than 1 mm, the discs become clogged with soil in the front part of the opener while they are working, and the openers deepen and the seeds are distributed in violation of the set depth. Also, the design of a cultivator with a stabilizer will lead to a violation of the stability of the opener in the soil in a longitudinally vertical plane, which would not allow the formation of the necessary furrow for laying out the seeds, while the formed furrow has loose sides and a bottom of the furrow, which eliminates the attraction of moisture to the seeds. All this leads to lower crop yields and higher production costs.

To solve the problem of improving the uniformity of seed distribution along the furrow length and the depth of their seeding, a coulter was developed and manufactured (RF Patent No. 2687368 C1) in Penza State Agrarian University (Vanin et al., 2017; Zubarev et al., 2019).

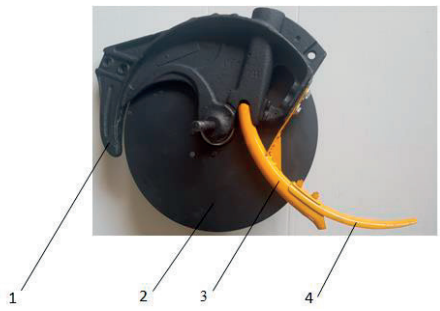

Figure 1. Grain seeder opener: 1 - housing; 2 - disk; 3 - seed guide; 4 - damper

The opener (Figure 1) contains a housing, two discs mounted at an angle to each other on the housing, a seed guide and a cultivator, characterized in that the seed guide and cultivator are made of an ellipsoidal tube as a whole, while the ellipsoid tube is bent to the side opposite to the motion of the opener, while the longitudinally vertical plane of symmetry of the ellipsoid pipe coincides with the longitudinally vertical plane of symmetry of the opener, while the shafts of symmetry of the pipe of the ellipsoid section is made with a radius R = 250-300 mm, at the same time, the ellipsoidal section pipe simultaneously serves as a seed guide and cultivator, while the upper part of the ellipsoidal section pipe is fixedly fixed with a funnel to the neck of the opener body, while inside the ellipsoidal section pipe, by gumming, a coating is applied, for example, from rubber, acting as a calming agent seed, while the coating inside the ellipsoidal tube has elastic-elastic and antifriction properties, while the ellipsoidal tube in the lower part has it has an ellipsoidal outlet that is identical to its contour, while the major axis of the outlet of the ellipsoidal tube is 30-35 mm, while the minor shafts of the outlet of the ellipsoidal tube is 15-17 mm, and all-metal is made below the outlet of the ellipsoidal tube a device made of a wear-resistant material in the form of a curved wedge, while the heel width of the curved wedge is e = 12-14 mm, while the curved wedge is attached to the ellipse-shaped pipe with the help of welding, while the middle part of the ellipsoid pipe is fixed to the coulter body using a bracket installed at the attachment point of the internal opener scrapers, and a seed speed damper is installed over the outlet of the ellipsoid pipe with a screw connection, while the seed speed damper has the mounting part, made in the form of a thickening at the place of its attachment to the ellipsoidal pipe and the working part, while the mounting part has a longitudinal groove intended for installation fixing screws in it, while the longitudinal axis of symmetry of the seed velocity damper coincides with the longitudinally vertical plane of symmetry of the ellipsoidal tube, while the seed velocity damper is directed backward relative to the outlet of the ellipsoid tube toward the bottom of the furrow, with a clearance *h* between the seed velocity damper and the furrow bottom, is equal to the smaller thickness of the seeds, while the contour of the working part of the seed velocity damper is made in the form the isosceles trapezoid with a slope of its lateral sides identical to the slope of the furrow walls, while the working part of the seed velocity damper is made concave relative to the longitudinal shafts of symmetry of the bottom of the furrow, while the profile of the concave working part of the seed velocity damper has the shape of a circular arc made with a radius r = 25-30 mm, while the longitudinal axis of symmetry of the working part of the seed speed quencher is made convex along a circular arc of radius r1 = 95-100 mm, relative to the shafts of symmetry of the bottom of the furrow, while the *a* width of the working part is grain speed quencher, in its front part, located at a height equal to the major shafts of the ellipse of the outlet of the ellipsoid tube, is 30-33 mm, while the width *b* of the rear working part of the seed velocity damper, located at the bottom of the furrow formed by the heel of the curved wedge, equal to 12-14 mm, while the thickness from the profile of the working part of the seed velocity damper is 2.5-3.0 mm, while the length l of the working part of the seed velocity damper is 120-150 mm, while the seed velocity damper is made of nylon.

The opener (RF patent No. 2692622 C1) contains a casing (Figure 2), two discs mounted at an angle to each other on the casing, a seed guide and a cultivator, characterized in that the seed guide and a cultivator are made as a single

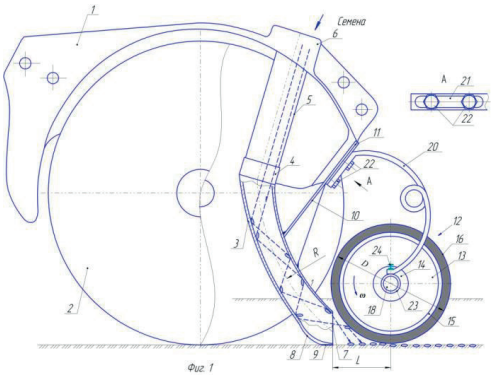

Figure 2. Opener: 1 - body, 2 - disk, 3 - guide, 4 - socket, 5 - gate, 6 - neck, 7 - hole, 8 - wedge, 9 - heel, 10 - bracket, 11 - scrapers, 12 - roller, 13 - disk, 14 - hub, 15 - rim, 16 - tire, 17 - bearing, 18 - axis, 19 - head, 20 - strut, 21 - groove, 22 - screws, 23 - sleeve, 24 - lock screw

unit of a rectangular pipe, while the pipe of rectangular cross section is bent to the side opposite to the movement of the opener, while the axis of symmetry of the pipe of rectangular section is made with a radius R = 150-160 mm, while the longitudinally-vertical plane of symmetry of the rectangular pipe coincides with the longitudinally vertical plane of symmetry of the opener, while the width of the pipe of rectangular section is 14 mm and the height is 25 mm, while the pipe of rectangular section simultaneously serves as a seed guide and cultivator, while the upper part pipes of rectangular cross section is fixedly fixed by a bell to the funnel of the neck of the opener body, while the pipe of rectangular cross section in the lower part has a rectangular outlet, the width of the outlet of the rectangular pipe is 11 mm and the height is 30 mm, while the gaps between the opener discs and the side surfaces of the rectangular pipe, measured near the cutting edges of the rear of the opener discs, are at least 12 mm on each side of the side surface of the pipe a rectangular section, while below the outlet of the pipe of rectangular section, a curved wedge is installed by welding, while the width of the heel of the curved wedge is equal to the width of the pipe of rectangular section 14 mm, while the middle part of a rectangular pipe is fixed to the opener body using a bracket installed at the attachment point of the internal opener disc scrapers, while a furrowed roller is installed behind the outlet of a rectangular pipe, and the longitudinally vertical plane of symmetry of the furrowed roller coincides with the longitudinally vertical the plane of symmetry of the pipe of rectangular cross section, while the furrowed packer roller consists of a disk with a hub and welded a rim on which is firmly attached, for example, with glue, to a tire made of rubber massif, while a furrowed packer roller is supported by a tire made of rubber massif to the bottom of the furrow formed by the opener discs, while the width of the tire made of rubber massif is equal to the width of the bottom furrows in = 12-14 mm, while the diameter of the furrow packer roller is D = 100-120 mm, while the distance between the transverse vertical plane of the outlet of the rectangular pipe and the transverse vertical plane of symmetry of a solid packer roller is L = 60-65 mm, while in the hub of the furrow packer roller a sliding bearing is installed, made in the form of a sleeve of antifriction material, while the hub of the furrow packer roller is supported through the bearings on the shafts, while the axis of the hub of the furrow packer roller has a head on one side, while the furrow packer roller has a spring strut, while the spring strut is made of alloy spring steel, while the upper part of the spring strut has a fastening part with a longitudinal groove for accommodating the screw connection necessary for fastening the spring strut to the opener body at the place of attachment of the internal opener disc scrapers, while the bush is fixedly attached to the bottom of the spring strut, while the bush is dressed on the shafts of the furrow-seaming hub roller and fixed motionlessly with a locking screw, while the shafts of the hub of the furrow packer roller from axial displacement relative to the hub of the furrow packer roller is held bare shafts and the end of the sleeve on the axle hub clad furrow packer roller, while on both ends of the hub, set of antifriction material washer.

CONCLUSIONS

Designed, innovative openers made, mounted on the seeder SZ-5.4 and tested in the field of the Penza region (Russia). The results of processing the experimental data showed an improvement in the uniformity of the distribution of seeds along the length of the row and the depth of their seeding, which led to an increase in the yield of grain crops by 12%.

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