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NEW WORKING BODIES OF SEEDERS FOR SOWING GRAIN CROPS USING ENVIRONMENTAL FRIENDLY TECHNOLOGIES

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Abstract

An analysis of the works devoted to the theory of the working process of sowing seeds of grain crops shows that the sowing machines are one of the most important working parts of the seeder, which, during their work, must ensure not only a continuous and uniform flow of seeds, but also the necessary stability of the established seeding rate, as well as the possibility of sowing seeds of various crops, the minimum injury of seed. The article is devoted to improving the quality indicators of sowing seeds with seeders for sowing grain crops using environmentally friendly technologies equipped with new coil-screw sowing machines with coils, the grooves of which are turned along a helix at an angle of 20 degrees, as well as a sowing machine with an increased volume of coil grooves, obtained correlations and graphic dependencies between the uneven distribution of seeds along the length of the row, on the forward speed of the sowing units equipped with seeders with the studied sowing machines.

Key words*: seeds, seeder, sowing machine, coil grooves, sowing technology, environmentally friendly.*

INTRODUCTION

For sowing seeds of grain crops using environmentally friendly technologies, the sowing unit remains one of the most important working parts of the seeder (Ovtov et al., 2020; Shumaev et al., 2021; Dorohov et al., 2019; Cheremisinov et al., 2016).

Currently commercially available seeders are equipped with sowing units with straight trough spools. Sowing machines equipped with such coils during operation do not always meet agrotechnical requirements, since they give a pulsating, not constant flow of sown seeds, which increases the uneven distribution of seeds along the length of the furrow (Shumaev et al., 2020; Aksenov et al., 2020; Hevko et al., 2016; Khudoberdiev et al., 2010; Yashin et al., 2021; Shevchenko et al., 2013).

The article describes an experimental coil-screw sowing machine with coils, the grooves of which are turned along a helix at an angle of 20 degrees, as well as a sowing machine with an increased volume of the coil grooves.

MATERIALS AND METHODS

Currently, grain crops are sown with grain seeders (SZ-3.6, SZT-3.6 and SZU-5.4-06, etc.), which do not fully ensure the necessary uniform distribution of seed along the length of the furrow. To solve this problem, Penza State Agrarian University designed, manufactured and tested the design of a coil-screw sowing machine with coils, the grooves of which are turned along a helix at an angle of 20 degrees, as well as a sowing machine with an increased volume of coil grooves.

The design of the coil-screw sowing machine with coils, the grooves of which are turned along a helix at an angle of 20 degrees (Patent for invention No. 2384040) contains a seed box 6 (Figure 1), a socket 2, a coupling 7, a valve 4, a seeding coil with grooves 1 The ribs of the grooved coil 1 are made along a helical line at an angle of 200 to the axial line of the coil. From below, the seed box 6 is closed by a spring-loaded valve 4. The rear end part of the valve 4 of the sowing unit is made of a rectangular shape. The cut line of the back of the valve is below the axis of the grooved spool 1 by 0.6R of the spool. The coil 1 is inserted into the socket 2. The slots of the sockets 2 are made in the form of the ribs of the grooved coil 1 and at an angle of 200 to the axial line of the grooved coil 1. A coupling 7 is put on the shaft of the sowing machine 3. A cylindrical shank 8 is inserted into the coupling 7.

The process of sowing grain crops from a coil-screw sowing machine with coils, the grooves of

which are turned along a helix, at an angle of 20 degrees, proceeds as follows. The seeds from the replaceable box flow by gravity into the seed box 6 of the sowing machine and fill the space around the grooved coil 1. Rotating, the grooved coil 1 moves the seeds sunk into the grooves, and part of the seeds of the active layer that do not fall into the grooves, but are located near its edges , into the lower part of the seed box 6 and dumps them at the end of the valve 4 into the funnel of the seed tube, and not in a pulsating batch, but smoothly and continuously due to the fact that the grooves of the grooves of the coil with grooves 1 are made along a helical line, and the rear end part of the valve 4 sowing machine is made of rectangular shape at work, as well as the longitudinal movement of the grooved coil 1 during adjustments, the grain does not spill out of the seed box, due to the socket 2, the slots of which are made in the shape of the ribs of the grooved coil 1. The gap between the valve 4 and the grooved coil 1 is set using the adjusting screw 5 in depending on the size of the seeds sown. When adjusting the seeding rate, the coil with grooves 1 is inserted into the seed box 6 by moving the coil 1 with the shaft 3 in the axial direction while scrolling the shaft 3 along the slope of the ribs.

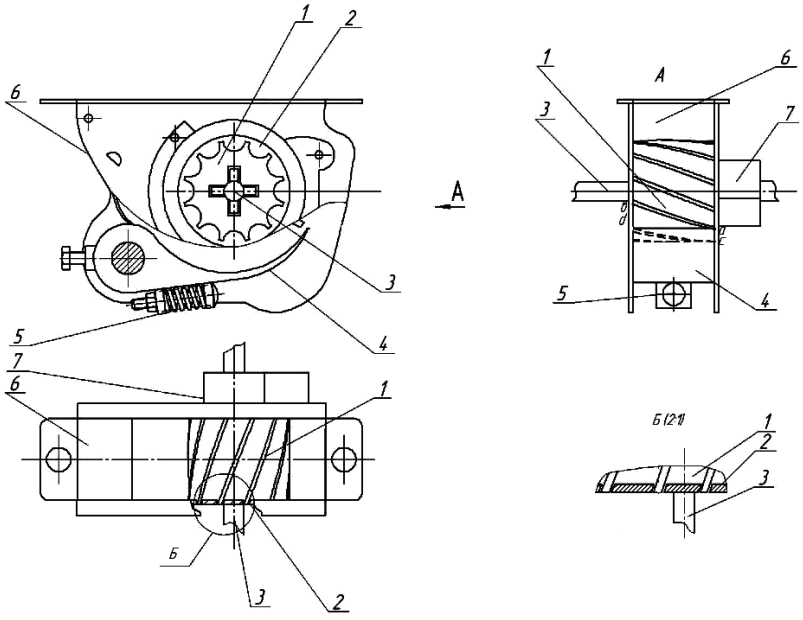

Figure 1 - Scheme of the sowing machine: 1 - coil with helical grooves; 2 - socket; 3 - shaft of the sowing machine; 4 - valve; 5 - adjusting bolt; 6 - seed box; 7 - clutch

The design of the sowing machine with an increased volume of the grooves of the coil (Patent for invention No. 2540547) contains a body 1 (Figure 2), a coil 2 in the form of a cylinder with grooves on its surface, made with an increased volume of the grooves. The coil 2 is made of wear-resistant plastic with anti-friction properties, the valve 3 is made without a seed discharge edge, the bottom 5 is rigidly installed on the valve 3 using supports 4, while the bottom 5 is made in the form of a part of the side surface of the cylinder, with the axis of symmetry coinciding with the axis of symmetry of the coil 2. The bottom 5 has a polished inner surface, front A and rear B edges, while the front edge A of the bottom is located in the third quadrant parallel to the axis of symmetry of the coil 2, the front edge A of the bottom is deflected in the course of rotation of the coil 2 at an angle α equal to 40 ... 45 degrees down from the horizontal plane of symmetry of the coil 2. surface of the bottom 5, more than the radius RK of the coil 2. The rear edge B of the bottom, made with a bevel 6 for dumping seeds, is deflected along the rotation of the coil 2 by an angle β equal to 54 ... 58 degrees to the right of the vertical plane of symmetry of the coil 2. To the front edge A of the bottom,

adjoins the shaper-guide 7 rigidly installed in the housing 1 of the sowing machine. The shaper-guide 7 is made in the form of a part of the side surface of the cylinder, with the axis of symmetry coinciding with the axis of symmetry of the coil 2, the shaper-guide 7 has a polished inner surface,

The free upper part of the shaper-guide 7 is deflected in the course of rotation of the coil 2 by an angle φ equal to 47...53 degrees to the left of the vertical plane of symmetry of the coil 2. The radius RF of the inner polished surface of the shaper-guide 7 is equal to the radius RD of the inner polished surface of the bottom.

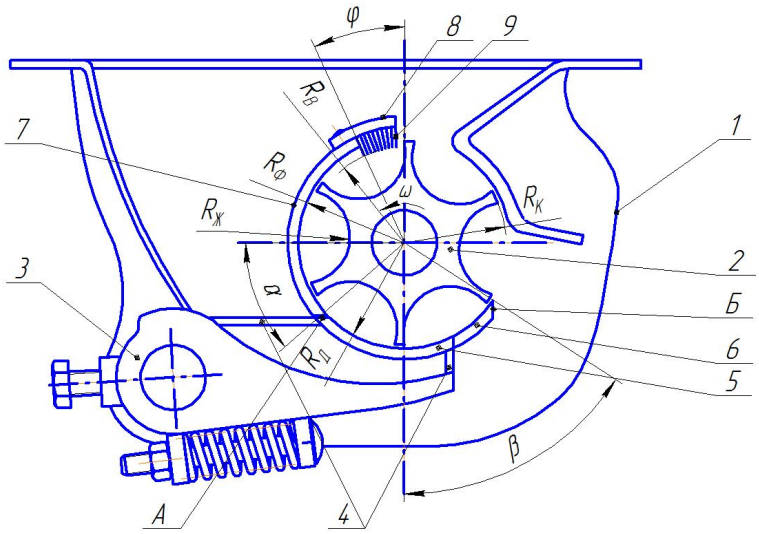

Figure 2 - Scheme of the coil apparatus: 1 - housing; 2 - coil; 3 - valve; 4 - support; 5 - bottom; 6 - bevel; 7 - shaper-director; 8 - brush; 9 - pile; A - the front edge of the bottom; B - rear edge of the bottom

Coil sowing machine works as follows.

During the operation of the sowing machine, the seeds fall into the grooves of the coil 2 in the form of a cylinder with grooves on its surface, made of wear-resistant plastic with antifriction properties, made with an increased volume of grooves in order to leave the process of sowing seeds of various crops without an active layer of seeds, with a smooth flow without pulsation and uniform over the sieving area, at minimum speed and maximum length of the coil 2. Seeds sunk into the grooves of the coil 2 are fed to the shaper-guide 7 rigidly installed in the housing 1. In order to avoid injury to the seeds at the entrance to the free upper part of the shaper-guide 7, the grooves with the seeds of the coil 2 meet with the brush 8 fixed to the free upper part of the shaper-guide 7.

Next, the seeds in the grooves of the coil 2 enter the zone of the shaper-guide 7. In the area of the shaper-guide 7, the formation of an active layer of seeds that is unstable in thickness and volume is excluded, since the seeds during the rotation of the coil 2 are only in the grooves of the coil 2 and are limited by the internal polished surface of the shaper - director 7. After the formation of the seed flow in the shaper-director 7, the seeds in the grooves of the coil 2 are sent to the zone of the bottom 5. At the end of the bottom 5, the seed flow formed in the grooves of the coil 2 of the sowing machine, with the specified parameters and in accordance with agrotechnical requirements, descends from the rear edge of the bottom 5.

RESULTS AND DISCUSSIONS

The studies were carried out using the SZ-5.4-06 seeder (Figure 3) with experimental coil sowing machines.

Figure 3 - General view of the seeder with experimental reel seeders

When determining the effect of the speed of the sowing unit on the uneven distribution of seeds along the length of the row, the speed of seeders with experimental coil-screw sowing machines with coils, the grooves of which are turned along a helix at an angle of 20 degrees, as well as sowing machines with an increased volume of coil grooves, changed within 1.47 ... 3.68 m/s, which meets the agrotechnical requirements.

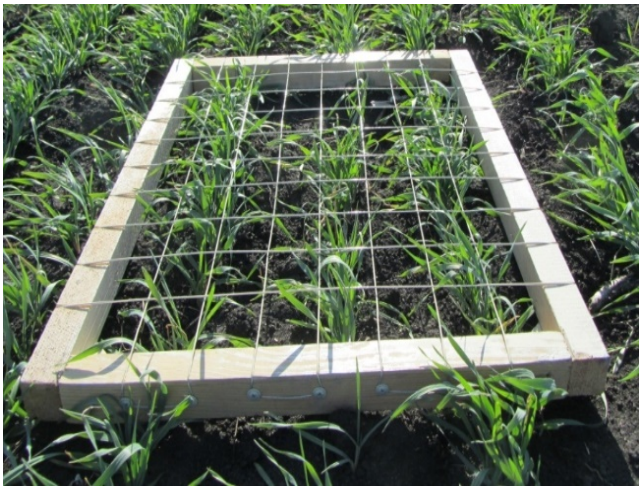

Figure 4 - General view of the frame for determining the uneven distribution of plants along the length of the row

Then they increased (by 25 ... 30%) according to STO AIST 5.6–2010. The operating speed of the unit was determined by the length of the accounting plot, taking into account the time of its passage.

Studies to determine the uneven distribution of seeds along the length of the row were carried out using a frame with squares of 25 x 25 mm (Figure 4).

The frame was superimposed on the seedlings along the diagonal of the site, on three sites, each 30 m^2 in size (repeated three times).

In accordance with the presented method, the optimal parameters of the experimental coil-screw sowing machine with coils, the grooves of which are turned along a helix, at an angle of 20 degrees, were refined. After processing the experimental data, graphs were constructed and

correlations between the speed of the sowing unit and the uneven distribution of seeds along the length of the row were determined (Figures 5, 6).

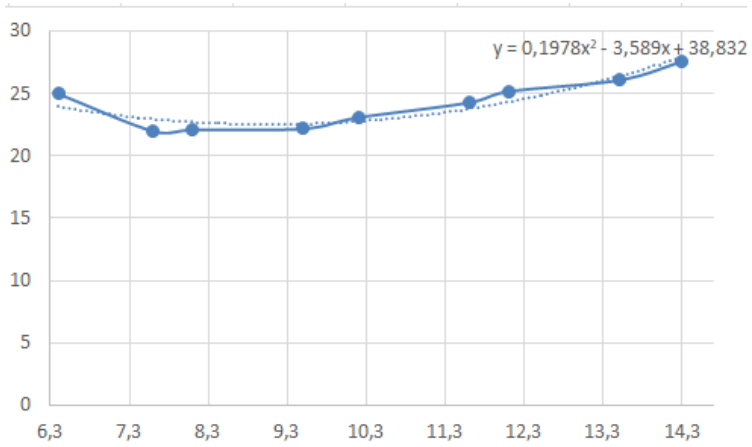

Figure 5 - Graphs of the dependence of the uneven distribution of seeds (ν) grain crops along the length of the row on the speed of the unit (u)

Correlation between the indicator of uneven distribution of seeds of grain crops along the length of the row (ν, %) and the speed of movement of the unit u (km/h) is expressed by the dependence:

$$\nu(u) = 38.832\text{-}3.589u + 0.1978u2 \quad (1)$$

In accordance with the presented method, the optimal parameters of an experimental coil-screw sowing machine with an increased volume of coil grooves were refined.

After processing the experimental data, graphs were constructed and correlations between the speed of the sowing unit and the uneven distribution of seeds along the length of the row were determined.

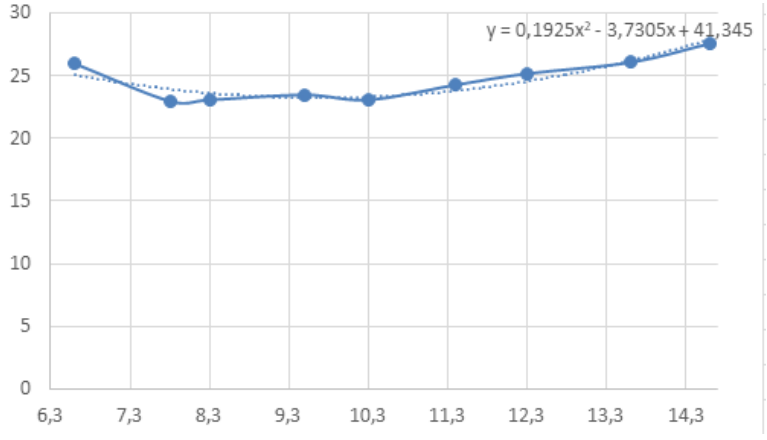

Figure 6 - Graphs of the dependence of the uneven distribution of seeds (ν) grain crops along the length of the row on the speed of the unit (u)

Correlation between the indicator of uneven distribution of seeds of grain crops along the length of the row (ν, %) and the speed of movement of the unit u (km/h) is expressed by the dependence:

$$\nu(u) = 41.345\text{-}3.7305u + 0.1925u2 \quad (2)$$

CONCLUSIONS

Laboratory and field studies of seeders equipped with experimental sowing machines with coils, the grooves of which are turned along a helix at an angle of 20 degrees, as well as sowing machines with an increased volume of coil grooves for sowing seeds of grain crops, confirmed the reliability of theoretical calculations and laboratory studies. The optimal value of the speed of the unit V can be considered the range of values from 7.8 to 9.7 km/h.

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