Results of the research of a combined aggregate straw grinder, which sows seeds of repeated crops

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Abstract. The article investigated the straw grinder of a combined aggregate, which sows seeds of repeated crops. The constructive parameters of the straw Grinder are studied, the effect of the layout scheme of blades mounted on the surface part of the grinder on the laying and grinding of the remains of straw.

1. Introduction

In the last years in the world, taking into account the biological characteristics of crops in the field of agriculture, as a result of the use of resource-saving technologies suitable for soil-climatic conditions, the properties of soils have been improved, and the consumption of side-lubricants and labor has been significantly reduced.

In addition to grain crops, leguminous grain crops play an important role in improving the supply of nutritious, high-quality food products that are required for the needs of the population in our country. Leguminous grain crops are grown as repeated crops mainly in the fields emptied from the autumn haul. Cereals with legumes only serve as a protein-rich feed for livestock, without becoming a food product. For this reason, repeated crops are being planted in the fields that are emptied from the existing autumn haul as the year goes on.

The agricultural preparation of soil for planting repeated sowing crops in the fields that are emptied from the wheat crops( fall grains), is especially done by traditional methods such as the process of tillage, harrowing, chiseling with chisel shanks and so on. A large amount of energy and fuel is spent on the processes carried out in such a sequence, which leads to a delay in the planting period from the particular time, as a result of which the maturation period of plants is also prolonged.

It is desirable to prepare the fields emptied from the grains for planting in the shortest possible time, as well as to use strip till technology in preparation of soil for planting qualitatively and to introduce such kind of devices which perform those functions.

In the world, great attention is paid to the creation of combined planting tools and research of resource-saving technologies [1-4].

In order to introduce such technologies, based on the results of the analysis and research, a combined device for road tillage and sowing the seeds of secondary crops was developed[5, 6]. This device is designed for sowing seeds of repeated crops directly into the fields emptied from the wheat
crops (fall grains) and is equipped with a straw grinder (katok) that crushes the wheat stalks on the top of the buds. The rational parameters of the straw grinder are important in ensuring the quality of work of the device.

2. Material and methods

For research, the straw grinder was prepared in the form of a submerged paraboloid surface in the reel and the blades to the surface were welded (1va 2-painting).

The main parameters of the grinder include large $D_m$ and small $d_m$ diameters, width $a_m$, curvature of the outer surface $R_m$, step $S_n$, between the Blades, the height of the Blades $h_n$, the angle of their installation relative to the axis $\gamma_n$.

The fact that the outer surface of the grinder drum is submerged ensures a smooth movement of the sector over the bush. When the grinder moves over the bush, the impeller and the blades (planks) on its surface are laid on the surface of the footstalk field. Under the influence of the blades, the stake is broken into several pieces. In this case, the soil base acts as a support surface for the division into pieces.

![Figure 1. Basic parameters of straw grinder reel](image)

The width of the grinder can be determined from the following expression $\theta_n$.

\[
\theta_n = a_n + 2\Delta_{\text{max}},
\]

(1)

here $\theta_n$ is the width of the treated part (corridor) of the chimney; $\Delta_{\text{max}}$ is the deviation from the direction of the aggregate motion, the coefficient taking into account the cross-oscillations of the sectional.

The outer diameter of the grinder drum is determined due to the conditions of its consistency. The wreck radius of the drum surface should ensure that the drum has a small diameter.

The blades on the surface of the drum are fixed with the condition that the step will break the stem 5...10 cm in length. The stem of this length is rotated along with the soil, without clogging the working organs.

The length of the blade is determined as follows:

\[
\ell_{\Pi} = \frac{\theta_n}{2} + \Delta_n,
\]

(2)

here, $\Delta_n$ - the fact that the Blades cover each other by the width of the coverage.
The height of the blade should be sufficient to ensure that the stem is not broken. The stem is pressed into the soil between the blade and the soil. In this case, the soil acts as a base surface. If the soil is soft, it is immersed in the soil, if the soil is hard enough, the stem breaks under the action of a knife and breaks into pieces. Excess energy is used to deform the soil if the blade height is too high.

The mounting angle \( \gamma \) of the blades relative to the drum axis should ensure that the drum rotates smoothly and that the plant debris slides along the blade surface, namely \( \gamma > \max(\varphi_m, \varphi_x) \), here \( \varphi_m, \varphi_x \) is the angle of friction of the soil and plant debris on the blade surface.

\[
\gamma = \frac{\pi}{2} - \frac{\varphi_m}{2} = \frac{90 - 30}{2} = 30^\circ.
\]

Based on the above, the following parameters of the grinder roller were determined: \( a_m = 250\,\text{mm} \); \( D_m = 200\,\text{mm} \); \( d_m = 100\,\text{mm} \); \( S_n = 62.8\ldots 125.6\,\text{mm} \); \( \ell_n = 150\,\text{mm} \); \( \Delta_n = 25\,\text{mm} \); \( \gamma_n = 30^\circ \).

Three grinding rollers were made according to the obtained parameters (Fig. 2). These grinders differ only in the layout scheme of the blades (Fig. 3).

**Figure 2.** Placement of cutting blades on the surface of the grinder:
Option 1. On the surface of the grinder, the cutting blades are placed parallel to the axis of the grinder; Option 2. The cutting blades are placed at an angle \( \gamma_n \) relative to the axis of the grinder; Option 3. The cutting blades are zigzagged at an angle to the axis of the grinder.

**Figure 3.** Scheme of installation of shredder blades: a-1 variant; b-2 variant; v-3variant

The shredders were compared to each other in terms of the degree of deposition and crushing of the straw stalks.

A frame was attached to the weighing device and three different versions of the grinder were mounted separately on the working section (Fig. 4).
Figure 4. Straw stalk pile (a) - with a row spacing of 60 cm formed in the soil channel; (b) - the process of impact of the crusher on the straw stalks on the pile.

In order to determine the performance of the crusher, conditions were created in the soil channel close to the field where the grain was harvested. In this case, a row with a row spacing of 60 sm was taken and vertical wheat stalks were piled on the ridge along the soil channel. 100 straw stalks were planted every 20x100 sm (1 p.m.) along the soil channel. Three plots of 20x100 cm were marked at the beginning, middle and end of the soil channel. The experiments were repeated 5 times.

After passing the crusher over the formed pile, the number of stalks laid and laid out from 100 laid straw stalks on pre-determined plots was determined as a percentage.

The degree of impact on the upright straw stalks along the pulp profile of the crusher was determined as follows

\[ \delta = \frac{n}{N} \cdot 100\% \]

where \( n \) is the number of stalks laid and cut; \( N \) - Number of vertical straw stalks in N-separated plots.

3. Experimental results and analysis

The table shows the laying and grinding of straw stalks perpendicular to the ridges under the action of the crusher.

| A plot separated Laying and grinding according to options | Rate, % from a soil channel |
|-----------------------------------------------------------|-----------------------------|
| Option 1        | Option 2        | Option 3        |
| outset          | 87.3            | 89.6            | 92.3          |
| midst           | 92.6            | 94.0            | 96.0          |
| end             | 84.3            | 91.3            | 91.6          |
| \( \bar{\delta}, \% \) | 88.1            | 91.6            | 93.3          |
| \( \sigma \)    | 4.20            | 2.21            | 2.36          |
| \( \lambda \)   | 4.77            | 2.40            | 2.57          |

The results of the experiment showed that the crushers of all variants lay and grind the straw stalks sufficiently > 85%. The layout scheme of the blades mounted on the crusher surface relative to the crusher axis was also found to have a significant effect on the stems. When the blades are placed parallel to the axis of the grinder (option 1), the degree of crushing of straw stalks is 84.3... 92.6%, when placed at an angle \( \gamma \) (option 2) 89.6... 94.0%, and when placed in a zig-zag pattern. (Option 3)
was 91.6…96.0%. In all variants, the coefficient of variation was less than 5%. The best performance was observed in the middle of the soil channel in all variants (92.6…96.0%). This is due to the fact that the crusher in the middle of the soil channel has a stable, sufficient speed of the working process.

4. Conclusion

The use of a knife roller to grind straw stalks in the intercropping machine with road tillage in the grain-free areas ensures the crushing and laying of up to 96% of the stalks. In this case, it is advisable to make the grinder to the dimensions specified above and place the zig-zag blades on the work surface.

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