THE RESULTS OF THE LABORATORY AND FIELD TESTS OF SEEDERS WITH COMBINED PLOUGHSHARES

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We have developed direct seeding seeders based on the AGTS-2,0 stubble drill with the following coulter combinations [1, 2]:
- Disc and chisel openers installed in at least two rows, in one of the rows there are chisels, and in the other - disk, which provide high throughput and low traction resistance when working on stubble untreated backgrounds;
- Disc and cultivator claws with seed spreaders for sowing with a wide belt (band-sowing seed), providing high throughput, low traction resistance and increasing yield.

If the theoretical traction resistance of the seed drill with serial claw coulters was determined by the following formula [3],

\[ R = G \cdot f + \sqrt{\frac{1}{b \cdot q \cdot d^2} + h \cdot b \cdot m \cdot n \left(K_m + K_p + K_k\right)} \]  \( \text{(1)} \)

Then traction resistance of seeders with different combinations of working organs was found in the following dependencies:
- For working bodies: Central shovel \( \rightarrow \) Double-disc \( \rightarrow \) Central shovel:

\[ R = G \cdot f + \sqrt{\frac{1}{b \cdot q \cdot d^2} + h \cdot b \cdot m \cdot n \left(K_m + K_p + K_k\right)} + n \cdot h \cdot b \left(K_m + K_p + K_k\right) \]  \( \text{(2)} \)

- For working bodies: Chisel \( \rightarrow \) Double-disc coulter \( \rightarrow \) Chisel:

\[ R = G \cdot f + \sqrt{\frac{1}{b \cdot q \cdot d^2} + h \cdot b \cdot m \cdot n \left(K_m + K_p + K_k\right)} + n \cdot h \cdot b \left(K_m + K_p + K_k\right) \]  \( \text{(3)} \)

where \( m \) - is the number of central shovels or chisel openers;
\( n \) - is the number of disc coulters.

The technique of carrying out laboratory and field tests is developed to determine the dependencies of the agrotechnical and energy parameters of the experimental setup of a seeder with combined coulters on its technological parameters.

The evaluation of agrotechnical indicators was carried out in accordance with SST 31345 [4, 5]. Determination of the traction resistance of experimental seeders with disc, claw and chisel coulters was carried out in accordance with the requirements of SST R 52777 [6] simultaneously with the evaluation of agrotechnical indicators. The evaluation of agrotechnical indicators was carried out in accordance with GOST 31345 [4, 5]. The figure shows the theoretical \( (R_t) \) and experimental \( (R_e) \) dependences of the traction resistance of the seed drill with various working elements.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure.png}
\caption{Theoretical \( (R_t) \) and experimental \( (R_e) \) dependences of the traction resistance of the seed drill with various working organs on the working speed of the aggregate \( V \), with the depth of tillage \( a = 7 \text{cm} \) (1 - seeder with openers: chisel-disk-chisel, 2-seeder with openers: claw-disk-claw, 3-seeder with serial claw coulters).}
\end{figure}
The theoretical (RT) and experimental (RE) dependences shown in the figure show that the lowest value of the traction resistance of the seed drill from the working speed of the aggregate V at different depths of tillage (a) is observed for seedlings with coulters according to the scheme chisel → disk → chisel. Moreover, the discrepancy between the RT and RE dependences is insignificant. At the same time, as the working speed of the aggregate increases, V the theoretical (RT) and experimental (RE) dependences for a seeder with serial claw coulters increase intensively, on average by a factor of 1.5. This tendency is strengthened with a further increase in the depth of processing.

In the analysis of agrotechnological indicators, it was established that the highest field seed germination was found on the site sowed with an experimental plant with chisel and disc coulters 94.3%, then on the site sown with an experimental setup with claw and disc coulters 93.7%, and at the control site field germination was 91.4%. This is explained by the superiority in the uniformity of the seeding depth of the experimental coulters in comparison with the standard claw coulters.

The analysis shows that the seeding depth with the chisel and disc openers exceeds the serial seeding by 5.1% (respectively 12.5% and 17.6%), by the uniformity of the depth of seeding of the experimental setup, and the experimental plant of the seeder with claw and disc coulters exceeds the production seeder by 2.4% (15.2% and 17.6% accordingly).

Experimental settings of seeders with combined coulters are superior to the series seeder in terms of the number of seeds embedded in the layer of the average actual depth and two adjacent layers. Thus, this parameter is equal to 92% in the experimental setup of the seeder with chisel and disc openers, the experimental setup of the seeder with the claw and disc openers exceeds the production seeder by 2.4% (15.2% and 17.6% accordingly).

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Harvesting in the experimental plots showed that the highest yield is 21.22 centners / ha in the plot planted with the experimental plant of the seeder with the claw and disk working bodies, then on the site seeded with the experimental plant of the seeder with the chisel and disk working organs is 20.35 centners / ha.

Conclusions:
- Theoretical and experimental dependences of the traction resistance of the experimental setup of a seeder with combined coulters on the depth of seeding and working speed were obtained;
- The smallest value of the traction resistance of the seed drill from the working speed of the aggregate at different depths of tillage is observed for the seeder with coulters according to the scheme chisel → disk → chisel. Moreover, the discrepancy between the RT and RE dependences is insignificant. However, with an increase in the working speed of the aggregate, the theoretical (RT) and experimental (RE) dependences for a seeder with series claw coulters increase intensively, on average by a factor of 1.5. This tendency intensifies with further increase in the depth of processing and further research is needed to clarify the main regimes and parameters of the seeding machine.
- To evaluate the effectiveness of using a seeder with different openers, further research is needed;
- It is necessary to justify a seeding unit made up of seeders with combined coulters for tractors of various traction classes.
- High agrotechnological indices with an experimental setup with chisel and disc openers, and then with claw and disk coulters.

REFERENCES
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