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

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According to the developed technique, the laboratory and field research tests were carried out for the experimental installation of the stubble grain seed drill with working organs for separate application of seeds and fertilizers [1, 2]. The test conditions were determined in accordance with SST 20915 [3]. The evaluation of agrotechnical indicators was carried out in accordance with SST 31345 [4].

During the tests, the investigated parameters were the working velocities of the experimental setup \( V = 8; 10 \) and \( 12 \) km / h, setting depth of coulters \( h = 5; 7; 10 \) cm. The row spacing is 22.8 cm. The repetition of the experiment is four-fold. Determination of the experimental traction resistance of a set of prototypes of the working bodies of the seeder was carried out in accordance with the requirements of SST R 52777 [5] simultaneously with the evaluation of agrotechnical indicators.

To record and process the experimental data, a measurement information system was used with the IS 264 with the module MS-5 of the KubNIITiM [6].

Processing of primary materials of experimental studies was carried out using appropriate software tools in the MathCad, MSEexcel and descriptive mathematical statistics. The results of the data are presented in the table.

To determine the traction resistance of the seed drill theoretically, the previously obtained formulas were used:

- With series claw coulters [7]:

\[
R = G \cdot f + \frac{3}{b \cdot q \cdot d^2} \cdot \frac{D^4}{b \cdot q \cdot d^2} + h \cdot b \cdot n \cdot \left( K_m + K_p + K_k \right),
\]

- with coulter for separate seeds and fertilizer introduction [8]:

\[
R = G \cdot f + \frac{3}{b \cdot q \cdot d^2} \cdot \frac{D^4}{b \cdot q \cdot d^2} + n \cdot \left[ h \cdot b \cdot \left( K_m + K_p + K_k \right) + 2h_1 \cdot b_1 \cdot \left( K_{1m} + K_{1p} + K_{1k} \right) \right],
\]

Where \( h_1 \) - Depth of the horizontal jaw, m;
\( b_1 \) - The width of the horizontal jaw, m;

The results of theoretical calculations \( (R_t) \) and experimental studies \( (R_1^t \) and \( R_2^t \)) are given in the table (field background - stubble). The tiller aggregate tractor Belarus 952 + SZTSS-2.0 seeder with serial claw coulters \( (R_1^t) \) and with coulters for separate seed and fertilizer application \( (R_2^t) \).

| Table: The results of the theoretical calculations \( (R_t) \) and experimental studies \( (R_1^t \) and \( R_2^t) |  
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Experiment No | date | Description | soil depth cm | Average soil moisture, % | Average hardness of soil, kg/cm² | Theoretical traction resistance \( R_t \), kN | Actual velocity \( \text{km/h} \) | Average traction of central shovel \( (R_1^t) \), kN | Average traction for separate application of seeds and fertilizers \( (R_2^t) \), kN | Av. Fuel consumption \( \text{g/h} \) | Theoretical traction resistance \( R_2^t \), kN |
| 1 | 28.09.2016 | Tractor Belarus 952 + C3C 2,1 with central shovel ploughshare and coulter for separate application of seeds and fertilizers | 4 | 5.6 | 138 | 6 | 5.57 | 7.264 | 7.41 | 19.09 | 7 |
| | | | | | | 8 | 7.9 | 8.561 | 8.90 | 23.443 | 7.56 |
| | | | | | | 10 | 9.51 | 9.33 | 9.80 | 17.258 | 8.35 |
| | | | | | | 12 | 11.6 | 11.49 | 12.18 | 18.951 | 10.52 |
| 2 | 28.09.2016 | | 7 | 37 | 267 | 6 | 5.74 | 7.602 | 7.83 | 20.196 | 7.10 |
| | | | | | | 8 | 7.74 | 8.05 | 9.07 | 23.104 | 8.49 |
| | | | | | | 10 | 9.84 | 8.492 | 11.29 | 17.723 | 10.25 |
| | | | | | | 12 | 10.91 | 11.78 | 12.49 | 19.156 | 12.00 |
| 3 | 28.09.2016 | | 10 | 49.4 | 348 | 6 | 5.81 | 8.294 | 8.54 | 21.965 | 8.2 |
| | | | | | | 8 | 7.78 | 8.894 | 10.00 | 23.365 | 8.9 |
| | | | | | | 10 | 9.6 | 9.187 | 10.80 | 19.67 | 10.3 |
| | | | | | | 12 | 11.6 | 12.06 | 12.90 | 21.065 | 12.30 |

A comparative analysis of the results obtained is presented in Figures 1-3. Thus, analysis of figure 1 shows that with a depth of tillage \( a = 4 \) cm and a change in the working speed of the unit from 5.57 km / h to 11.6 m / s, the theoretical traction resistance of the seeder \( (R_t) \) increases from 7.0 kN to 10, 52kN. In this case, the value of the working speed of the unit \( V \) is increased by...
more than 2 times, and the $R_t$ value is increased by 50%. The results of processing the experimental points show that they are approximated by a second-order polynomial dependence ($R_1^E$ and $R_2^E$) with $R^2 = 0.99$ reliability. When the working speed of the unit varies within the specified limits, the value of the experimental traction resistance of the seeder with the serial claw coulters ($R_1^E$) increases from 7.26 kN to 11.49 kN, which is about 60%. Similar data for a seeder with coulters for separate application of seeds and fertilizers, the value of $R_2^E$ increases from 7.41 kN to 12.18 kN, which is more than 64%. In general, the percentage of growth in the values of $R_1^E$ and $R_2^E$ is the same, and the difference between them is about 4%. We note that with the increasing of the working speed of the aggregate, the difference between theoretical $R_t$ and experimental ($R_1^E$ and $R_2^E$) traction resistances increases. Similar results were obtained for soil depth $a = 7$ cm and $a = 10$ cm.

**Figure 1** - Theoretical ($R_t$) and experimental dependencies of the traction resistance of the seed drill AGSSS 2.0 with serial central shovel coulters ($R_1^E$) and coulters for separate application of seeds and fertilizers ($R_2^E$) from the working speed of the aggregate $V$ at the depth of tillage $a = 4$ cm.

**Figure 2** - Experimental ($R_2^E$) dependence of traction resistance of the seeder with openers for separate application of seeds and fertilizers from the working speed of the aggregate $V$ at various depths of tillage: 1- $a = 10$ cm; 2- $a = 7$ cm; 3- $a = 4$ cm;
Analysis of the results of the experimental dependences of the traction resistance of the seed drill on the working speed of the aggregate $V$ at various depths of tillage $a$ (Fig. 2) shows that when $V$ is changed from a mean of 5.81 km/h to 11.6 km/h, i.e. increases 2 times. At the same time, the value of the $R^2_E$ curve for curve 1 is increased from 8.54 kN to 12.9 kN, i.e. on the average 50%. From the analysis of figure 2 (curves 2 and 3) it follows that the same pattern is observed when analyzing the experimental data for the seeder coulters for separate application of seeds and fertilizers ($R^2_k$).

It is shown more clearly in Figure 3 the effect of depth of tillage on the traction resistance of the seed drill with coulters for separate application of seeds and fertilizers ($R^2_k$). So, with a depth of tillage $a = 4$ cm, a change in the working speed of the aggregate $V$ from 5.81 km/h to 11.6 km/h leads to an increase in the traction resistances $R_t$ and $R^1_E$ by 0.25 kN on the average.

![Figure 3](image)

**Figure 3** - Theoretical ($R_t$) and experimental ($R^1_E$) dependences of traction resistance of the seed drill AGTS-2.0 with openers for separate application of seeds and fertilizers from the depth of tillage at various operating speeds of the aggregate $V$.

Similar results for the depth of tillage $a = 10$ cm show that with an increase in the working speed of the aggregate $V$, there is a stabilization of the technological process and a share of the increase in the traction resistances $R_t$ and $R^1$ decreases from 1.2 kN to 0.25 kN.

The results of the agrotechnical evaluation of the experimental set up of the stubble grain seeder with separate application of seeds and fertilizers are recorded in the observation log. Observations of the experimental sites showed that the field germination of seeds in the area sown by the experimental installation of a stubble grain fertilizer seeder with separate application of seeds and fertilizers exceeds the field germination of the control plot by only 1.1%.

An analysis of the agrotechnical evaluation of the experiments shows that, in terms of the quality of the work, the experimental installation of a stubble grain seed drill with separate application of seeds and fertilizers is slightly superior to the serial stubble grain seed drill: according to the uniformity of seeding 1%; on the distribution of plants in the area of food 1.2%.

The results of the agrotechnical evaluation of the experiments show that the number of productive stems in the experimental area exceeds the number of productive stems on the control plot (306.3 and 274.8), and the mass of grains in the spike on the experimental site is higher than the mass of grains in the spikelet (1.26g and 1.17g). Accordingly, the yield in the experimental plot is 26.61 kg/ha, and in the control plot 22.94 kg/ha, so the difference is 16%. The increase in yields is due to the fact that this year the month of June was droughty and the roots of plants in the control plot did not use fertilizers located in the same horizon and spread to the depth of the soil. And in the control plot, the experimental coulter laid fertilizers 2 cm deeper than the seeds and the plants effectively used the starting dose of fertilizers.

In the final, based on the above, we can draw the following conclusions:

- Theoretical and experimental dependences of the traction resistance of the experimental seeder plant with coulters for...
separate application of seeds and fertilizers from the depth of seeding and working speed were obtained;
- The results of the study show that the traction resistance of the seed drill AGTS-2.0 with openers for separate application of seeds and fertilizers exceeds the traction resistance of the seed drill AGTS-2.0 with serial central shovel claw openers \( (R^1_L) \) by 5-10%.
- It is required to clarify the main operating modes of the seeder;
- Further research is needed to justify the rational design parameters of the opener for separate application of seeds and fertilizers, taking into account the agro-technical performance indicators;
- To evaluate the effectiveness of using a seeder with coulters for separate application of seeds and fertilizers, comparative tests of various designs of working elements are necessary.

References


