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# Research Results on Determining Rational Parameters of a Mechanical Seeding Machine

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**Annotation.** The article provides data on the volume of onion cultivation in the world, as well as an analysis of agrotechnical requirements and onion planting technologies. At the same time, the influence of mechanical seeders on the sowing process is described, the results of theoretical and experimental studies of a honeycomb-mechanical seeder for sowing onion seeds in rows are given, and conclusions are given.

**Keywords.** *Vegetables, onions, seeds, sowing, mechanical, variation, ratio, base wheel, cell disc, rotating roller, chain drive, speed, agronomic requirements.*

## Introduction

Currently, the leading position in the agricultural sector is the production of resource-saving technologies and means of technique used in the cultivation of vegetable products, including onions. "Considering that 92.1 million tons of onions are grown worldwide and the volume of onion cultivation is growing by 2-3% annually" [1], one of the important tasks in the cultivation of onion seeds is the development of high-quality and resource-saving technical means and devices. In this regard, one of the vital tasks of science is to provide seed use to meet established norms in sowing onion seeds and to develop devices with high accuracy of planting seeds one by one in the growth of quality onions.

According to the agro-technical requirements, it is recommended that the longitudinal distance between onion seeds sown is 8-10 cm, the number of seeds sown in one hole is up to 3, the unevenness of seed distribution should not exceed 10%. It is stated that the error of the measuring interval should not exceed ± 0.5 cm [2]. The longitudinal distance between the seeds sown in a row, average square deviation, coefficient of variation, and number of seeds in the hole should not exceed or decrease the values specified in the initially developed requirements.

Fulfillment of the above agrotechnical requirements is a process that depends on the number of revolutions of the rotating roller, which rotates the cell disk and excess seeds by mechanical planter machine with a cell disc, which sows onion seeds one by one in rows. In this regard, the theoretical and experimental study of the planting apparatus requires the justification of operating modes.

## Methods

The movement to the working parts of mechanical planters is usually transmitted through the base wheels. The movement of both the cell disk and the rotating roller of the recommended planter is transmitted from the base wheel by means of a chain drive. The kinematic scheme of the transmission mechanism of this sowing machine is shown in Fig. 1.

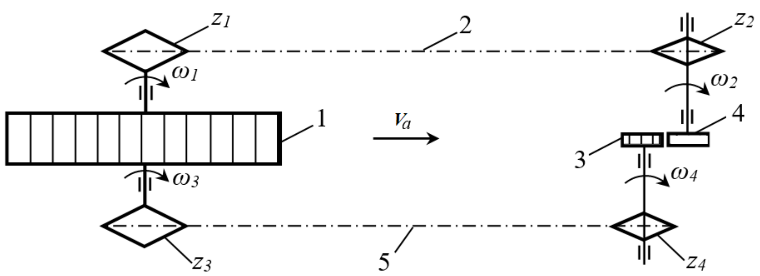


**Figure 1. Kinematic scheme of the transmission mechanism of the planter**

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According to the kinematic scheme shown in Figure 1, the leading joint is the base wheel 1. The movement to the cell disc 3 and the rotating roller 4 is passed from the base wheel 1 through the chain drive 2 and 5, respectively. Here, the cell disc 3 and the rotating roller 4 perform a rotational motion in the same direction.

In the process of planting the seeds, the planter moves at any $V_a$ speed. As a result of this $V_a$ speed, the base wheel performs a rotational motion. The angular velocity of the base wheel is expressed as follows:

$$\varpi_1 = \frac{V_a}{R_г}, \qquad (1)$$

Note that $V_a$ stands for the speed of movement of the planter or the linear velocity of the base wheel, m/s; $R_г$ stands for the radius of the base wheel, m.

We express the number of revolutions of the base wheel as in the following:

$$n_1 = \frac{30\varpi_1}{\pi}. \qquad (2)$$

Taking into account the execution of the technological process, we express the number of revolutions of the cell disk as:

$$n_u = \frac{60V_a}{lZ}, \qquad (3)$$

here $l$ - the distance between the seeds in a row, m; and $z$ - the number of holes on the cell disk.

If we consider the expression (1), then the number of revolutions of the cell disk can be expressed as follows:

$$n_u = \frac{60V_a p}{lD\pi} \text{ or } n_u = \frac{n_{mг}}{u} \qquad (4)$$

$u$ stands for the number of transmissions of the chain transference.

We determine the number of revolutions of the return roller by the following condition, based on the technological process

$$n_p \geq n_u. \qquad (5)$$

The reason for the inclusion of this condition is that the return roller must have time to keep the seeds that are outside the disc compartment and they must not get stuck in the groove.

We implement numerical solutions of the above expressions. According to the agro-technical requirements developed by the Scientific Research Institute of Agricultural Mechanization, the scheme of sowing onion seeds is given:

$$\frac{(40+10+10+10)\,8\,см}{4}, \frac{(40+15+15)\,8\,см}{3}, \frac{(50+10+10)\,8\,см}{3} \text{ or } \frac{(50+20)\,8\,см}{2}$$ [3].

$$l_{mг} = 2\pi R_г. \qquad (6)$$

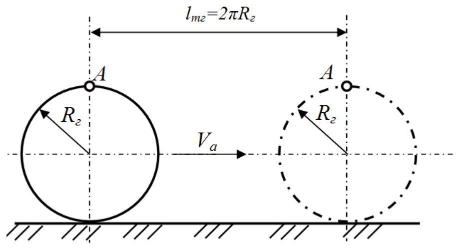


**Figure 2. Schema determining the distance traveled by the base wheel of a planter once it is fully rotated**

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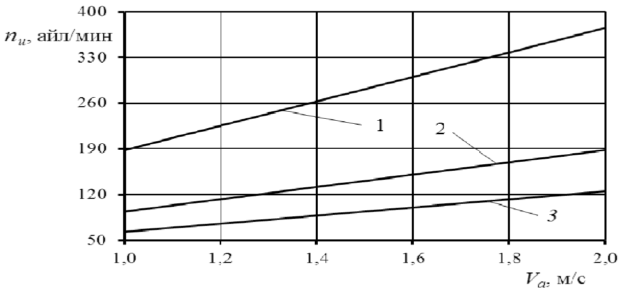
It can be seen from the figure that the distance between the seeds in the row is l = 8 cm, the speed of movement of the planter is between of Va = (1-2) m / s, the radius of the base wheel is $R_c$ = 0.2 m and the number of cells in the cell disk is z = (4-12)

Since the cell disc and the return roller receive motion from the base wheel of the planter via chain transmission, we determine how long the base wheel will travel once it is fully rotated (Fig. 2) [4].

Based on the numerical solution of expression (6), we determine that the base wheel travels a distance of 1.25 m when it is fully rotated once. Based on the accepted values of the parameters, performing numerical solutions of expressions (1) and (2), we determine that the number of revolutions of the base wheel is in the range of $n_1$ = (47.8-95.5) rpm, depending on the speed of movement of the planter. The graph of the dependence of the number of cell disk rotations on the speed of movement of the planter and the number of cells is given in Figure 3.

The analysis of the graphs in Figure 3 shows that as the speed of movement of the sowing machine increases, the number of revolutions of the cell disk at any value of the number of cells must increase with a straight-line regularity. That is, when the speed of the planter is 1 m / s, if the number of cells is 4, the number of revolutions of the cell disk must be 187.5 rpm, if the number of cells is 8, 93.75 rpm, and if the number of cells is 12, 62.5 rpm. If the speed of the planter is increased by 1.5 m / s, then when the number of cells is 4, the number of revolutions of the cell disk should be 281.25 rpm, when the number of cells is 8, 140,625 rpm and when the number of cells is 12, 93.75 rpm. If the speed of the sowing machine is chosen to be 2 m / s, then when the number of cells is 4, the number of revolutions of the cell disk should be 375 rpm, when the number of cells is 8, it must be 187.5 rpm, and when the number of cells is 12, 125 rpm.




1-*z*=4; 2-*z*=8; 3-*z*=12

**Figure 3. Graph of the dependence of the number of revolutions of the cell disk on the speed of movement of the planter and the number of cells**

So, according to the agro-technical requirements of the planter, the number of cells for planting onion seeds in rows at intervals of 8 cm is 4, and the ratio of chain drive is 0.25 when the speed of the sowing machine is 1.5 m / s, and when the number of cells is 12, the transmission ratio of the chain drive is 1.02.

In the study of technological processes and technical means, theoretical study is not enough. Numerous and repeated experimental studies are required to determine the exact or optimal values of the results obtained. The results obtained in theoretical research are mainly based on experimental research, or the results that cannot be determined in theoretical research are determined in experimental one.

**Results.**

Based on the above, experimental studies of the planter in the laboratory condition were carried out on the basis of the results obtained in theoretical research.

The graphs from the experimental studies are shown in Figures 4 and 5. The graph shown in Figure 4 shows that when the number of revolutions of the cell disk increased from 80 rpm to 140 rpm, the falling distance of the onion seed decreased from 12.7 cm to 6.5 cm, and its standard deviation increased from 0.57 cm up to 2.49. This can be explained by the fact that as the number of revolutions of the cell disc increases, the cells toss seeds faster into the seed transfer hole.

The graph shown in Figure 5 shows that as the number of rotations increases, the number of onion seed drops decreased first and then increased. For example, when the number of revolutions increased from 80 rpm to 120 rpm, the fall of onion seeds decreased from 1.45 to 1.22 rpm, and when the revolutions were raised from 120 rpm to 140 rpm, the fall grew by 1.36 rpm.

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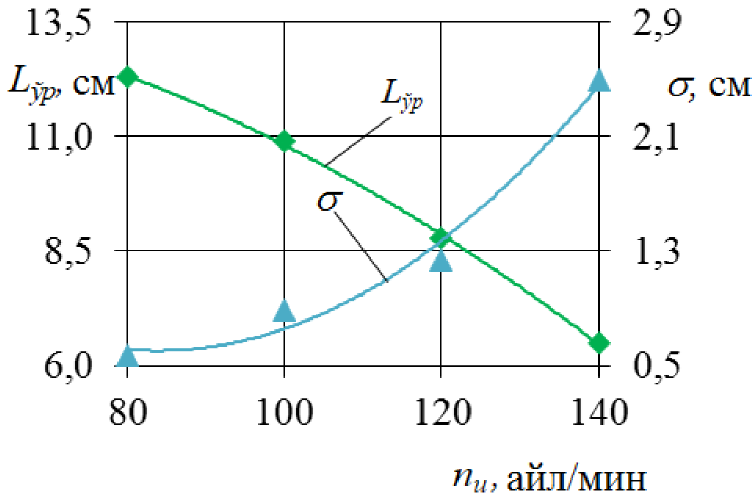


**Figure 4. Graph of change of longitudinal distance between seeds ($L_{ўр}$) and its standard deviation ($\sigma$) depending on the number of revolutions ($n_u$) of the cell disk**

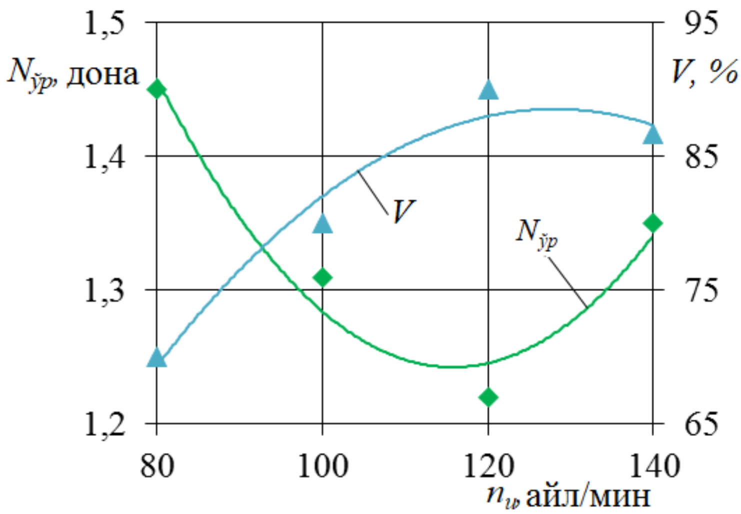


**Figure 5. Graph of the number of sown seeds ($N_{ўр}$) and their variation (±V) in relation to the number of revolutions ($n_u$) of the cell disk**

The above analysis shows that in order for a machine to sow onion seeds to meet the established agro technical requirements, the number of revolutions of its cell disk must be 140 rpm.

In theoretical studies, in order the planter to sow onion seeds at intervals of 8 cm in rows according to the established agro-technical requirements, the number of cells for planting should be 4 and when the speed of the sowing machine was 1.5 m / s, the ratio of chain drive must be 0.25, when the number of cells is 12, the transmission ratio was found to be 1.02

The regression equation obtained in the experimental studies and the graphical connections in Figure 6 show that the distances between sown seeds decreased with a straight-line regularity as the number of cells in the cell disk increased.

In this case, the number of cells in the cell disk is 8 and the distance between the seeds sown is 8.5 cm when the speed of the planter is $V_a$=1 m/s, 10.5 cm when the speed is $V_a$=1.4 m / s, and 15.5 cm when the speed of movement is $V_a$=1,8 m / s.

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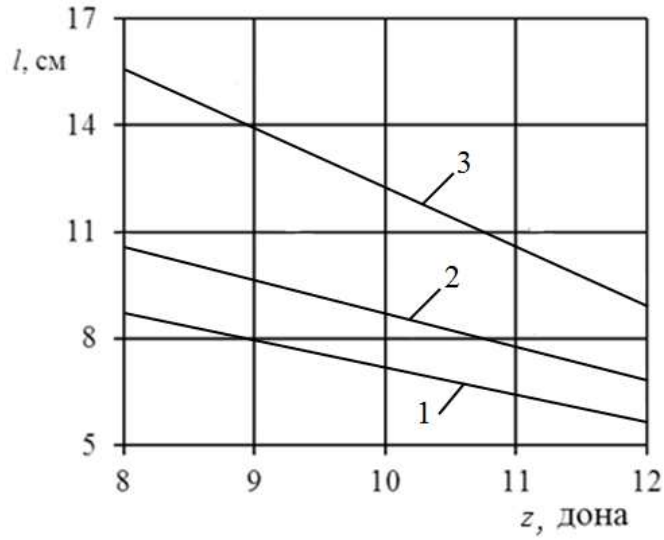
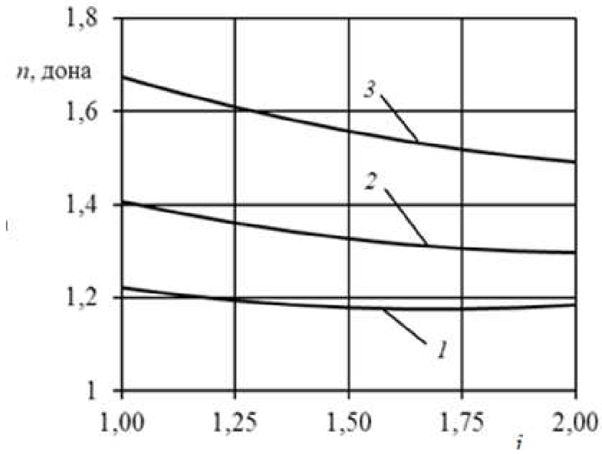



1 - when the speed of movement of the planter is $V_a$=1 m / s; 2 - when the speed of movement of the sowing machine is $V_a$=1.4 m / s; 3 - when the speed of movement is $V_a$= 1.8 m / s

**Figure 6. Graphs of change in the distance between seeds depending on the number of cells in the cell disk**

When the number of cells in the cell disk is 10 and the speed of the planter is $V_a$ = 1 m / s, the distance between the sown seeds will be 6.5 cm, when the speed of the planter is $V_a$ = 1.4 m / s, the distance will be 8.5 cm, when $V_a$ = 1.8 m / s, it is 12.5 cm, when the number of cells in the cell disk is 12 and the speed of the machine is $V_a$ = 1 m / s, the distance between the sown seeds is 5.5 cm, when the speed of the machine is $V_a$ = 1.4 m / s, it is 6.5 cm, and 8.6 cm when $V_a$ = 1.8 m / s.

Analysis of the graphical dependencies constructed by the regression equation shows that the seeds fell by 1-2 at all selected values of the number of revolutions of the cell disc. The graphical relationships in Figures 7 and 8 also show that in the ratio of the number of revolutions of the cell disk and the return rollers, as well as the number of cells in all accepted values in the cell disc, seeds fell by 1-2 seeds. However, it should be noted that with the increase in the values of all selected involving factors, the grain sowing accuracy increased with the curvilinear regularity.




1 - when the speed of movement of the planter is $V_a$ = 1 m / s; 2 - when the speed of the machine is $V_a$ = 1.4 m / s, 3 - when the speed $V_a$ = 1.8 m / s

**Figure 7. Graph of the accuracy of sowing the seeds in relation to the ratio of the number of revolutions of the cell disk and the return rollers**

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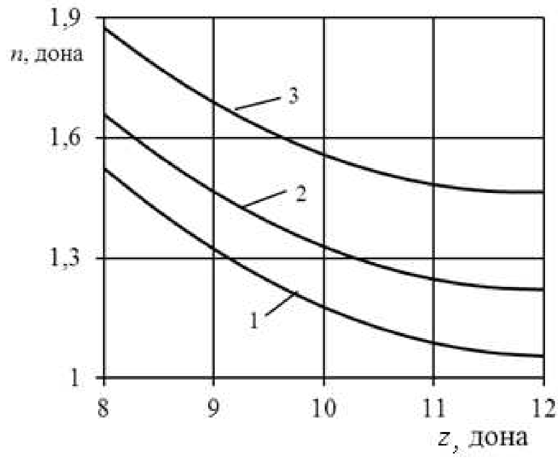


1 - when the speed of movement of the planter is $V_a$ = 1 m / s; 2 - when the speed of movement of the machine is $V_a$ = 1.4 m / s; 3 - when the speed of movement of the machine is $V_a$ = 1.8 m / s

**Figure 8. Graph of the dependence of the accuracy of sowing seeds on the number of cells in the cell disk**

**Conclusion**

In conclusion, we can say that the values obtained as a result of experimental research correspond to the values determined in theoretical research. For example, in theoretical studies, when the speed of the planter was in the range of 1-1.4 m / s, the number of revolutions of the cell disc was 140 rpm and the number of cells in the cell disc was 8, the distance between the sown seeds was calculated to be 7.5-10.5 cm and was observed to be in the range of 8.0–10.0 cm in experimental research.

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