Results of studies of a potato digger with rod burning working bodies

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Abstract. The article presents the results of experimental studies of a potato digger with standard (control) and bar undermining working bodies (experience). A relationship has been established between the speed of the harvester and the loss (number of seedlings) of potato tubers for various harvesting options. The aggregate composition of the soil is justified when using the above potato digger. It was found that an increase in the speed of movement of the potato digger by 1 km/h leads to an increase in losses of potato tubers in the control variant by 2.7 pcs/m. In the experimental version, it leads to a decrease in losses of potato tubers by 2.0 pcs/m. Besides, in the control variant, an increase in the speed of movement from 1.8 to 3.4 km/h led to an increase in losses of potato tubers by an average of 4.7 pcs/m, when in the experimental variant the casualties were 4 pcs/m. However, with the pilot version, the speed increase was from 2.6 to 3.4 km/h, the losses decreased by an average of 1.0 pcs/m, with a parallel rise in potato digger productivity.

1. Introduction
Potato is a highly productive crop; the yield of some varieties reaches from 25 to 40 t/ha. Hence, one of the problems of agricultural producers is to remove the grown crop of this crop on time. In the production of potatoes, depending on the selected technology and physicomechanical properties of soils, about 40–60 % of the total costs and 35–70 % of energy and labor costs are harvested.

The problems of harvesting potatoes are the low level of mechanization of work, a large share of manual labor for the selection and sorting of tubers, the low productivity of harvesting units, as well as an increase in losses and injuries of potato tubers during mechanized harvesting. Therefore, the improvement of the technological process of harvesting potatoes contributing to the development of quality and reduction of injury to tubers is relevant.

2. Problem Statement
The issues of harvesting potatoes are the low level of mechanization of work, a large share of manual labor on the selection, sorting of tubers, as well as injury to tubers during their passage through the separating organs and low productivity of harvesting machines [6–10].

The goal that the producer faces is to improve the quality and reduce the cost of potatoes. For this, it is necessary to substantiate the technology of subsoil liquid organic fertilizer application, to develop a harvesting technology that reduces labor costs, direct production costs by increasing the productivity and quality of the potato harvester [1–3].
Besides, there are issues of improving the technological process of harvesting, reducing injury to potato tubers when harvesting by potato diggers, and improving the design of working bodies by almost no one has studied. These issues are not scientifically based on research results and production recommendations. Therefore, the presented study is relevant to agricultural theory and practice.

3. Research Questions
Experimental studies were carried out with standard and rod digging tools.

4. Purpose of the Study
The article is devoted to the study of the influence of the use of a bar undermining working body on the injury of potato shafts and the aggregate composition of the soil at different speeds in comparison with conventional undermining working bodies.

5. Research Methods
Field experiments were carried out to study the influence of the speed of the potato digger on the digging potatoes' quality of the varieties Volzhanin and Lorh. Operations depend on the potatoes harvesting technology and the aggregate composition of the soil, on the chernozems of the southern Republic of Ingushetia. The experiments were conducted in the period 2015–2017 in the conditions of peasant farming (peasant farm) "Khashagulgov AT" Republic of Ingushetia.

In the experiments, various technological schemes of harvesting potatoes with standard (control) and with a rod (experience) undermining working bodies were used.

The total area of 1 plot: 100 m x 1.4 m = 140 m², the length of the scheme according to the size of the field, and the width corresponded to the width of the potato planter KTN-2V. The systematic arrangement of options. The triple repetition of the experiment. Statistical processing of the research results was carried out according to B.A. Armor, who used computer programs Microsoft Excel and Statika.

6. Findings
An essential characteristic of diggers is to reduce the damage to tubers during harvesting. Harvesting methods used at farms have many disadvantages: significant losses of filled tubers after insufficient separation of the working bodies; low performance of harvesting and transport vehicles; selection workers – high labor costs; at high harvesting speeds, a sharp decrease in the quality of work of all working bodies (unloading plowshares, the inability of elevators to sift the soil) [8, 10].

In this regard, we laid down experiments. We conducted experimental studies of the influence of the speed of movement of a potato digger on the loss of potato tubers, i.e., the number of potato tubers covered with soil (Table 1) and the aggregate composition of the earth (Table 2).

Our correlation and regression analyses of experimental data made it possible to derive equations and theoretical regression lines, changes in the average number of seedlings of potatoes of the Volzhanin variety depending on the speed of movement of the potato digger (Figure 1). The following regression equations describe the indicated dependence of the change in the number of filled potato tubers of the Volzhanin variety depending on the speed of movement of the potato digger: for the control variant, \( Y = 2.7x + 19.5 \), and for the experimental modification, \( Y = 2x + 10.3 \).

Correlation and regression analyses showed that in the Volzhanin cultivar, in the control variant, the number of potato tubers covered with potato digger and the speed of the potato digger was close in the control variant and inverse ones in the experimental option. The obtained equations and regression lines show that an increase in the speed of movement of a potato digger by 1 km/h leads to an increase in losses of potato tubers in the control variant by 2.7 pcs/m², and in the experimental version, to a decrease in losses of potato tubers by 2.0 pcs/m².

Besides, in the control variant, an increase in the speed of movement from 1.8 to 3.4 km/h led to an increase in losses of potato tubers by an average of 4.7 pcs/m², when in the experimental variant the losses were 4 pcs/m².
Table 1. The number of potato tubers covered with various values of the speed of the potato digger movement, pcs/m

| Variety       | Bombarded tubers | Speed of movement, m/s | Control option | Experimental option |
|---------------|------------------|------------------------|----------------|---------------------|
| Volzhanin     | υ = 1.8 m/s      | 19 23 26               | 18 10 6       | 11.3                |
|               | υ = 2.6 m/s      | 24 26 23               | 44 11 4       | 16.3                |
|               | υ = 3.4 m/s      | 27 31 26               | 16 12 18      | 15.3                |
| Lorch         | υ = 1.8 m/s      | 18 20 24               | 16 9 8       | 11.0                |
|               | υ = 2.6 m/s      | 23 20 28               | 28 12 8       | 16.0                |
|               | υ = 3.4 m/s      | 28 16 32               | 19 24 7       | 16.6                |

1, 2, 3 – repetition of experience. The control option is MTZ-80 + KTN-2V with conventional plowshares; An experimental version is MTZ-80 + KTN-2V with bar plows + disk cultivator.

![Graph](image)

**Figure 1.** The average number of tubers of Volzhanin potatoes covered with soil at different values of the speed of movement of the potato digger, pcs/m

However, with the experimental version, the increase in speed was from 2.6 to 3.4 km/h, the losses decreased on average by 1.0 pcs/m², with a parallel increase in the productivity of the potato digger.

Correlation and regression analyses showed that there are close strong inverse relationships between the speed of movement and the number of seedlings of potatoes of the Lorch variety. The regression coefficients cr = 2.3 for the control and cr = 2.8 for the experimental versions show in which direction and by what value on average, the function (y) changes when the argument (x) changes. The obtained equations and regression lines show that an increase in the speed of movement of the potato digger by 1 km/h leads to an increase in the loss of tubers by 2.3 and 2.8 pcs/m², respectively, in the control and experimental versions (Figure 2).

However, with the experimental version, an increase in speed from 2.6 to 3.4 km/h led to an increase in losses by an average of only 0.6 pcs/m², with a significant rise in potato digger productivity.

Besides, one of the leading agrotechnological indicators for assessing the total soil composition is the degree of grinding, which is determined by the percentage of fractions of the following sizes: from 2.5 cm to 5.0 cm; from 5.0 cm to 10 cm and more than 10 cm.
Figure 2. The average number of tubers of the Lorch potato cultivated with soil at various values of the speed of movement of the potato digger, pcs/m²

Table 2. The aggregate soil composition, depending on the harvesting potatoes method, pcs/m²

| Soil particle sizes, cm | Potatoes harvesting technology | 1   | 2   | 3   | Average value | 1   | 2   | 3   | Average value |
|------------------------|-------------------------------|-----|-----|-----|---------------|-----|-----|-----|---------------|
| 10 cm and more          | Existing (control)            | 6   | 10  | 5   | 7             | 0   | 0   | 0   | 0             |
| from 5 to 10 cm         |                               | 15  | 15  | 25  | 11.6          | 2   | 0   | 3   | 1.6           |
| from 2.5 to 5 cm        |                               | 30  | 30  | 25  | 28.3          | 12  | 0   | 3   | 5             |

The use of a potato digger with bar digging working bodies contributed to the improvement of the aggregate composition of the soil. The development of the ground is explained by the fact that the process of cutting and feeding the formation by the digging working body is carried out without unloading by reducing the total amount of heaps and lumps fed to the separator. Also, soil improvement occurs due to sifting heaps through the gaps between the rods.

The results of the experiments and their analysis showed that the aggregate composition of the soil when harvesting potatoes in control and experimental versions have different values of the quantitative form of soil fractions (Table 2).

Using the recommended potato harvesting process, the average total content of the above fractions in the soil structure was 6.6 pcs/m², which is 40.0 pcs/m² less than the number of the same portions when using the existing potato harvesting process.

The data in Figure 3 indicate that the use of the recommended technological process of harvesting potatoes with bar undermining working bodies contributed to the improvement of the aggregate composition of the soil. So, the number of lumps from 2.5 to 5 cm in size decreased by 23.3 pcs/m², soil particles from 5 to 10 cm in size decreased by 10.0 pcs/m², and there were no fractions of 10 cm or more.

7. Conclusion
The study of the technological process of harvesting potatoes using rod undermining working bodies. It was established that this technology helped to reduce losses and injuries of tubers behind the harvester, to reduce the traction resistance of the unit and increase its productivity.
Figure 3. The aggregate composition of the soil depending on the method of harvesting potatoes, pcs/m² (1, 2, 3 – repetition of experience)

It was established that in the Volzhanin variety, in the control variant, there are close direct ones in the control variant and inverse dependencies in the control variant between the number of potato tubers sprinkled and the potato digger speed. Thus, an increase in the rate of movement of a potato digger by 1 km/h leads to an increase in losses of potato tubers in the control variant by 2.7 pcs/m². In the experimental version, a decrease in losses of potato tubers by 2.0 pcs/m². Also, in the control variant, an increase in the speed of movement from 1.8 to 3.4 km/h led to an increase in losses of potato tubers by an average of 4.7 pcs/m², when in the experimental variant the losses were 4 pcs/m².

For the Lorch variety, it was found that an increase in the speed of movement of the potato digger by 1 km/h leads to an increase in the loss of tubers from 2.3 to 2.8 pcs/m², respectively, in the control and experimental versions.

The use of the recommended technological process of harvesting potatoes with bar digging working bodies contributed to the improvement of the aggregate composition of the soil. Namely, the number of lumps from 2.5 to 5 cm in size decreased by 23.3 pcs/m², from 5 to 10 cm in size dropped by 10.0 pcs/m², and there were no fractions of 10 or more cm.

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