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Abstract. The article describes the device and the technological process of operation of a potato planter equipped with a disk planter designed for use in low-contour areas. The results of experimental studies to determine the quality indicators of its work in the field are also presented. The authors propose a potato planter which is simple in design and compact, less metal-intensive, easy to manufacture, has the ability to use it both in small-circuit and relatively large areas, which ensures resource saving and efficiency in the technological process of planting potatoes.

1. Introduction

Potato is considered one of the main agricultural crops that are in great demand all over the world. In our country, this culture is given special attention. It is used as a food, technical and fodder crop. Potato tubers contain about 25 % dry matter, including 12-22 % starch, 1.4-3 % protein, and other substances. They include various vitamins like C, B, PP and carotenoids.

Potatoes serve as raw materials for the starch and dextrin industry, and are used in the production of glucose, alcohol, etc.

Alcohol obtained from potatoes is widely used in the pharmaceutical, perfumery and alcoholic beverage industries, starch confectionery, textile and sausage production.

Potatoes are also widely used as feed. One kilogram of potatoes contains 0.2-0.3 feed units. Animals are fed with tubers, tops, as well as pulp, bard - products after industrial processing of potatoes [1, 2, 3].

If in our country in 2021 3.3 million tons of potatoes were produced, then in 2022, by increasing the sown area by another 243,000 hectares, it is planned to produce 4.1 million tons of potatoes. Of the planned volumes of potatoes, 2.6 million tons are planned to be grown in farms, and 1.5 million tons of potatoes in household plots. [4]. About 90 % of the potatoes produced are grown on low-contour land plots of less than 2 hectares. [5].

Potato production in small contour plots has a low level of mechanization of potato cultivation, labor costs are high [6].

In the general complex of work on the mechanization of potato cultivation, the mechanization of planting works occupies a special place. From the mechanization of planting depends on the quality of all operations, up to harvesting potatoes. Namely, row-spacing tillage operations, mechanical weed control operations, soil loosening operations, watering, etc. Therefore, the creation of a compact potato

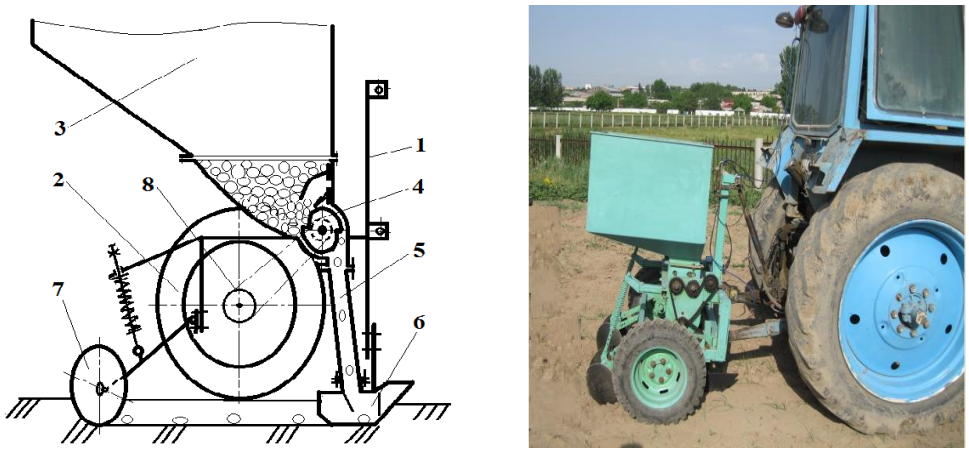
planter, easy to use in small contour areas that meet the agrotechnical requirements for planting potatoes, is one of the important tasks.

2. Materials and methods

At present, a potato planter equipped with a disk planter of a new design, which is aggregated with tractors of the 0.6-0.9 kN class, has been created at the Department of Agricultural Machinery and Technologies of the TIIAME, National Research University [7, 8].

The proposed potato planter consists of a frame 1 with support wheels 2, a hopper 3 installed on it, a disk planter 4, a tuber 5, a coulter 6, disk closing devices 7 hinged and equipped with springs, and drive devices for transmitting movement to the planter (figure 1). The cellular disc of the planting device is driven by the support-drive wheels of the machine.

The planting machine of the potato planter (figure 2) is installed in the lower part of the hopper, which consists of a 2-mesh disc installed inside the casing, a finger grid 8 and a reflector 9. Several (1-4 pieces) cells 3 are made on the cylindrical part of the disc. the cell walls are blocked by the flat sidewalls of the disk.



a) b)

Figure 1. Potato planter equipped with a disc planter: a-diagram of the machine; b - general view of the machine. 1- frame; 2 - support wheel; 3 - bunker; 4 – disk planting device; 5 - tubers; 6 - coulter; 7 - closing device; 8 - chain drive.

The bottom of the cell starts from the cylindrical surface of the disk, bends into the inner side of the disk in the form of involute 5 and forms holes. The width, depth and thickness of which correspond to the size of the sown potato tubers.

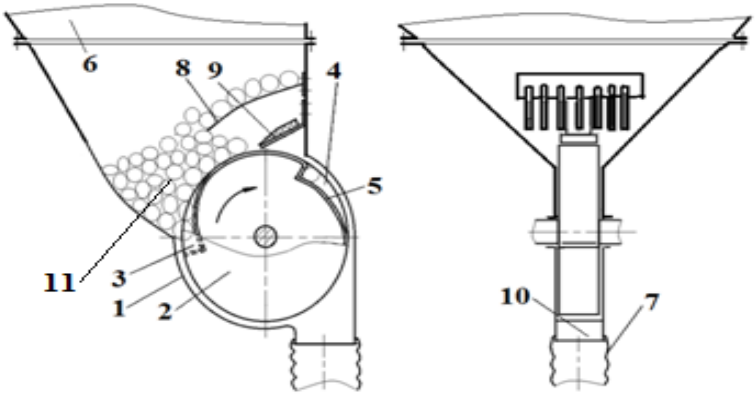


Figure 2. Scheme of the disk planter potato planter apparatus: 1-casing; 2 - cellular disk; 3 - cells; 4 - side wall disk; 5 - the bottom of the cell bent in the form of an evolvent; 6 - bunker; 7 - tubers; 8 - finger grate; 9 - reflector; 10 - casing window; 11 - feeding bucket.

The working process of the potato planter is as follows (figure 1, a). When the machine moves, the potato tubers from the hopper under the weight of the potato mass continuously move down and enter the feeding bucket 11 and fill it, close contact with the cellular disk 2 is ensured. potatoes, while the tubers remain almost motionless. As the disk rotates, its cylindrical part, and then the bottom of the cell, made in the form of an involute, slides under the potato tubers, while first the cylindrical part of the disk passes under the potato tubers, and then the bottom of the cell shaped like an involute and the tubers under their own weight and the weight of the tubers located above completely sunk and move up with the disk. When the cell reaches the upper position, the excess potato tuber is cleaned off by a reinforced reflector 9, the reflector directs them back to the feeding bucket. Next, the disk moves the potato tubers to the tuber unloading area. Here, the potato tubers, under the action of centrifugal force and under the action of their own weight, are dropped from the cell to the sowing window of the casing 10 of the apparatus. Next, the tubers enter the coulter through the tuber line 7 and are embedded at the bottom of the furrow with the help of closing devices. Then the cycle repeats. Finger grating 8 protects the upper part of the cellular disk from heavy loading, thereby ensuring its uniform loading, and also contributes to uniform filling of the feed bucket.

In order to obtain characteristics that determine its (potato planting machine) compliance with its purpose, identify shortcomings, as well as determine the quality indicators of the technological process, we have made an experimental model of the machine. A number of theoretical and experimental studies have been carried out to determine the main design and kinematic parameters of the machine using the methods of mathematical experiment planning, mathematical analysis and statistics, and others, as well as using the current regulatory documents (GOST 20915-11, O'zDSt 3211:2017, ISO 5691, Tst 63.03/2001RD Uz 63.03-98) [9, 10, 11, 12, 13, 14, 15, 16].

Experimental research methods were developed on the basis of O'zdst 3811-2017-testing a machine for planting potatoes [17]. To assess the quality indicators of the machine, a uniform distribution of tubers in a row was taken. The functional indicators of the potato planter were determined in the educational facilities of the Tashkent State Agrarian University. For this, an experimental sample of the machine was mounted on an MTZ-80 tractor (figure 1, b). The machine was tested at a unit speed of 1.3 m/s. At the same time, the machine was adjusted to the operating mode, when the distance between the nests of potato tubers was 25 cm, the planting depth was 10 cm. Figure 3 shows fragments of the site after planting and the process of measuring the distance between potato nests in a row and planting depth.

a) b)

Figure 3. Fragments of the field after planting potatoes (a) and the process of measuring (b) the distance between potato nests in a row and planting depth.

Before the experiment from the mass of seed material chose 100 pcs. Potato. Their particle size distribution was studied (using a vernier caliper, with an accuracy of ±0.1 mm) and weight (using electronic scales VLTK-500, ±1.0 g).

We also measured (with special electronic instruments) the moisture and hardness of the soil of the area where potatoes were planted from the daylight surface of the field at a depth of 0-5, 5-10 and 10-15 cm. All experiments were carried out with six repetitions and the data obtained were statistically processed.

3. Research results

Data on the conditions of the experiments: moisture, soil hardness, granulometric characteristics and soil weight of the experimental plot are shown in table 1.

Table 1. Characteristics of the test conditions.

No.	Name of indicator	Indicator value
1	Place of testing	experimental station of the Tashkent Institute of Irrigation and Agricultural Mechanization
2	Test time	04-12.07.2022 г.
3	Soil type	Serozem, medium loamy
4	Type of tillage prepared for sowing	Plowing, harrowing with thinning
5	Microrelief	Smooth
6	Potato variety	Zarafshan
7	Soil moisture, by layers (cm). % :	
	• 0-5	6.27
	• 5-10	10.5
	• 10-15	12.8
8	Soil hardness, by layers (cm), MPa:	
	• 0-5	0.3
	• 5-10	1.2
	• 10-15	1.8
9	Granulometric composition of the soil of the experimental plot prepared for planting, by fractions (mm), %:	
	• less than 1.0-10 mm;	74.2
	• 10-25 mm;	14.4
	• 25-50 mm;	8.5
	• more than 50 mm.	2.9

Table 1 shows that the moisture content of the soil in which potato tubers are planted is on average 10.5% in layers, and the hardness is 1.2 MPa. The degree of loosening of the soil of the experimental plot meets the agrotechnical requirements, since 88.6% of its composition contains soil particles with a size of 1-25 mm.

Granulometric characteristics and mass of potato tubers intended for planting (100 pieces) are presented in Table 2.

Table 2. Granulometric characteristics of potato tubers and their weight.

No.	Name of indicator	Indicator value
1	Potato variety	Zarafshan
2	Arithmetic mean sizes of potato tubers, mm:	
	• length	53.7
		46.1

	• width • thickness	39.6
3	Arithmetic mean mass of potato tubers, g	57.4
4	Potato tuber shape factor	219 (oval)

The data in table 2 show that the arithmetic mean dimensions: length, width and thickness and weight of potato tubers intended for planting, respectively, is 53.7; 46.1; 39.6 mm. and 57.4 g.

To assess the quality indicators of the technological process of the machine, the coefficient of preservation of the planting step, the uniformity of the distribution of tubers, the quantitative shares of skips and twins, damage to tubers and the depth of planting potato tubers were determined.

The measurement results are presented in Table 3.

Table 3. Quality indicators of the technological process of the potato planter.

No.	Name indicator	Indicator value According to the terms of reference	According to test data
1	Place of testing		Experimental station of the Tashkent Institute of Irrigation and Agricultural Mechanization
2	Test time		04.07.2020г.
3	Unit speed, m/	to 1.38	1.3
4	Average distance between potato tubers, see:		
	• to 10		2.3
	• 10 - 20		6.0
	• 20 - 30		70
	• 30 - 40		14.9
	• 40 - 50		6.8
	M (arithmetic mean)	25	26.4
	± σ		8.7
5	Uniform distribution of tubers in a row, %	60% not less	62.1
6	Quantitative share of twins, no more than, %	3	1.8
7	Quantitative share of omissions, %	3	2.8
8	Quantitative share of damaged tubers, no more than, %	5	3.8
9	Average planting depth of tubers, cm.	10	11.2

Checking and evaluating the quality indicators of the technological process of the proposed potato planter showed that such qualities of indicators as planting potato tubers with a given step (26.4 cm),

uniform distribution of them in a row (62.1%), quantitative shares of skips (2.8 %) and twins (1.8%), damage to tubers (3.8%) and planting depth of tubers fully comply with agrotechnical requirements.

4. Conclusions

The proposed potato planter is simple in design and compact, less metal-intensive, easy to manufacture, has the ability to use it both in small-circuit and relatively large areas, which ensures resource saving and efficiency in the technological process of planting potatoes.

Qualitative performance of the potato planter equipped with a disk planter, at a unit speed of 1.3 m/s, fully complies with the requirements of agricultural technology and ensures uniform distribution of tubers in a row by 62.1 %, and planting of tubers to a depth of 11.2 cm. At the same time, the quantitative proportion of twins is 1.8%, the quantitative proportion of skips is 2.8 %, and the quantitative proportion of damaged tubers is 3.8 %.

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