УДК 631.3327/8:811.111
DOI 10.26897/0021-342X-2018-1-139-146

QUALITY AND OPERATIONAL INDICATORS OF A POTATO PLANTING MACHINE FOR GERMINATED POTATOES

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An experimental model of a potato planting machine for germinated potatoes has been developed for mountain farming. The design of a planting unit, which is a sound-valve type, is expected to improve the quality of planting. The potato planting machine has been tested in four experimental fields both in plain and mountain conditions. The main quality and operational indicators of the model have been determined. The obtained parameters of the quality indicators completely meet modern agro-technical requirements for planting germinated potatoes. The machine performance is thus comparable with that of the existing machines of the considered type.

Key words: *potato farming, mechanization, potato planting machine, germinated potatoes, mountain farming.*

Introduction

A large part of potato production areas in Bulgaria are located in mountainous areas. Most of them are irregularly shaped, undersized and with slopes of up to 15°. Access to them is difficult because of poor roads [1]. Due to the changing nature of the climate in these areas, the agro-technical period in the implementation of the individual technological processes is shortened. Specific conditions make it difficult to mechanize main potato production operations [4, 5, 6], so most operations are done manually or using draft animal power. An example of this is one of the most labor-intensive operations, potato planting, which in most cases is done by grooving and subsequent manual planting of the potatoes. In order to overcome the shortened agro-technical period during planting, it is appropriate to plant germinated potatoes.

In this way, germination and development of potato plants occur in more favorable climatic conditions: a large stock of soil moisture and a suitable temperature. Improving productivity and facilitating the work of potato producers can be achieved by using potato planting and potting machines that meet the specific requirements for potato production under the above-mentioned conditions [7, 9]. In connection with the aforementioned problems, N. Pushkarov ISSAPP in Sofia has developed an experimental model of a Potato planting machine for germinated and non-germinated potatoes for operation in mountainous conditions and inclined terrains [3].

The aim of the study is to determine the quality and performance indicators of a potato planting machine for operation in mountainous conditions and inclined terrains.

Object and methodology of investigation

The subject of the investigation is a potato planting machine for germinated potatoes. Fig. 1 shows the structure of the potato planting machine.

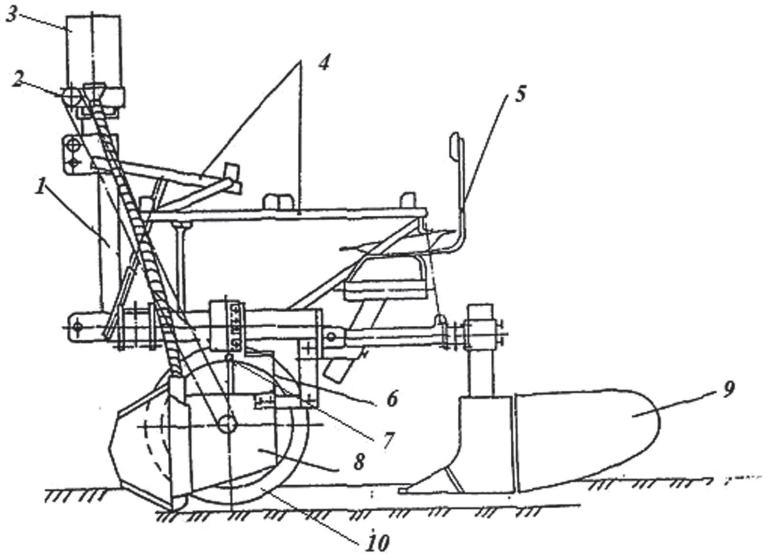

Fig. 1. A potato planting machine for germinated and non-germinated potatoes: 1 – frame; 2 – driven wheel of the fertilizer; 3 – fertilizer disk-dosing device; 4 – potato-planting platforms; 5 – planter's seat; 6 – planting device; 7 – driving mechanism; 8 – seed coulter; 9 –harrow; 10 – support drive wheel

Device and technology process

The planter consists of the following groups of operational and auxiliary technological units: The frame (1) is designed for fixing all the operational and auxiliary parts of the machine. It is equipped with a universal 3-point suspension device compatible with tractors belonging to pulling classes 9 and 14 *kN* [2, 8]. The seed coulters (8) are passive; the nose of the seed coulter is flat with a sharpened lower edge, which forms a 30° angle with the soil surface. The aim is to stop plant waste from clogging it and to reduce drag. The design of the coulter allows for terrain copying and emergency obstacle overtaking, such as stones, etc. The operation depth of the seed coulters is steplessly adjusted by the support wheels. A pipe for feeding the mineral fertilizer at the beginning of the furrow is mounted on the seed coulter.

The planting device (6) differs in its structure and performance from the semi-automatic planters used so far. It is a valve with a two-component signaling effect for planters, thus avoiding various rotational and relative shifts of the device at work, which leads to the rapid fatigue of the planters. Due to the device, a separation of the signal effect is achieved, as part of the planting operation is performed with the participation of the visual perception, while the rest is performed with the sound perception, thus reducing the planters' burden and fatigue. The sound of the valve must be sufficiently clear and not irritate or make weary the planters [10].

Driving mechanism of the planting device (7). It has the following basic functioning: there are a number of radially drilled holes in the drive wheel disc (10), where a number of drive plates are mounted depending on the required step. When drive wheels rotate, the plates trigger a lever mechanism that periodically opens the valve of the planting device. The wheel flange does not allow the planter to go down the slope. The ridge forming tools (harrows) (9) are passive cultivator points. It makes possible the following adjustments

ensuring ridges of various shapes and parameters: displacement of the pole of the harrow in a vertical direction up to 30 cm steplessly; rotation of the ridge-forming boards around vertical axes.

Planters' seats (5). These can be adjusted vertically and across of the machine. Potato planting platforms (4). Four platforms are mounted on the machine providing up to 200 *kg* of planting material per charge. Disk-dosing device for mineral fertilization (3). ATD-2 disk fertilizers are mounted on the planter. They spread up to 1000 *kg* of granulated mineral fertilizers per hectare.

In order to determine the main quality and operational characteristics of the potato planting machine, an experimental study of the machine in real field conditions was carried out by potato growers growing potatoes for consumption and seed.

The separate experimental fields are provisionally marked as follows:

experimental field I – the village of Pasarel;

experimental field II – the village of Bogdanitsa;

experimental field III – the town of Kostinbrod;

experimental field IV – the town of Troyan.

Due to climatic conditions, the main crops produced in these areas are late potatoes for seed and consumption. The study is conducted on different soil types, taking into account the results of other similar studies. A number of factors and indicators related to the assessment of the entire production process are taken into account during the study. For the experiments, the potato planting machine is equipped with 14 *kN* tractors for fields I, II (Figure 2) and III and with 9 *kN* tractors for field IV.

Fig. 2. A potato planting machine-tractor unit during operation

Determining and taking into account production conditions

For the particular production field, the following indicators are taken into account:

location and altitude;

- type of soil;
- transverse and longitudinal slope;
- foregoing crop;
- soil moisture;
- soil hardness;
- area size.

The different monitored indicators are determined by means of standard methods and instruments.

Determination of the main quality and operational parameters of the potato planting machine.

The investigation of the potato planting machine is carried out in field conditions, the major manageable factors being:

Va – the forward velocity of the unit;

S – planting step;

H – planting depth.

The following quality and operational indicators are taken into account when the machine is working:

Quality indicators:

h – planting depth, mm;

oz – planting step deviation,%;

or – row axis deviation,%;

sk – quantity of broken sprouts,%;

sx – instability in the course of the unit, $cm.m^{-1}$.

Operational indicators:

T – coefficient of working periods during a shift;

Tto – technological service time;

Wh – performance per hour;

Workers needed – for the potato-planting unit, number.

Results and discussions

Table 1 shows the results of the investigation of the potato planting machine for germinated potatoes.

Table 1

Characteristics of the experimental fields

№	Indicators	Measure-ment unit	Value			
			Field I	Field II	Field III	Field IV
1	Type of soil	-	Sandy, rocky soil	Sandy-clayey soil	Leached black soil	Alluvial sandy-clayey soil
2	Inclined surface. Longitudinal Adverse	*grad.*	7 11	3 6	0 1	1 2
3	Foregoing Crop	-	Potatoes	Wheat	Potatoes	-
4 4	Pre-sowing soil preparation: depth surface	*M*	Cultivation 0,15 Flat	Cultivation 0,16 rough	Disking 0,15 rough	Cultivation 0,18 Flat
5	Absolute soil moisture: layer 0-15 *cm.*	*%*	11,5	18,23	16,3	14,9
6	Soil hardness: layer 0-15 *cm.*	$N.cm^{-2}$	40,6	67,2	70,05	54,7
7	Area size	*ha*	1,8	2	1	0,6

The results concerning the planting depth (Fig. 3) show that, for a given depth, the deviations vary from 0,5 to 1*cm*. The values of the standard root mean square deviation s and of the coefficient of variation V show that, under severe conditions characterized by a variable macrorelief and stony soils, the planting depth forming process is stable and the deviations are insignificant.

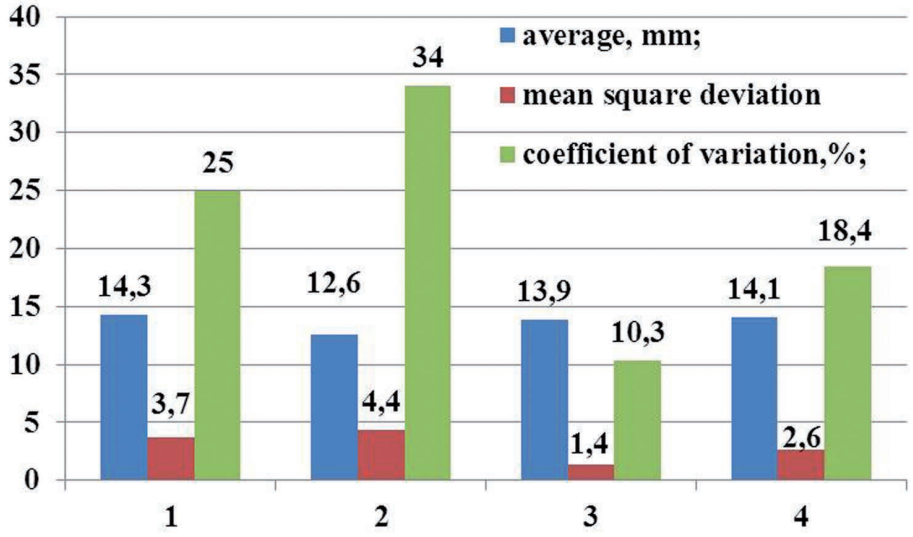

Fig. 3. Planting depth

The values of the quality indicators, Planting step deviation, Row axis deviation, Quantity of broken sprouts, (Fig. 4) comply with the agro-technical requirements and would not affect negatively the development of the plants.

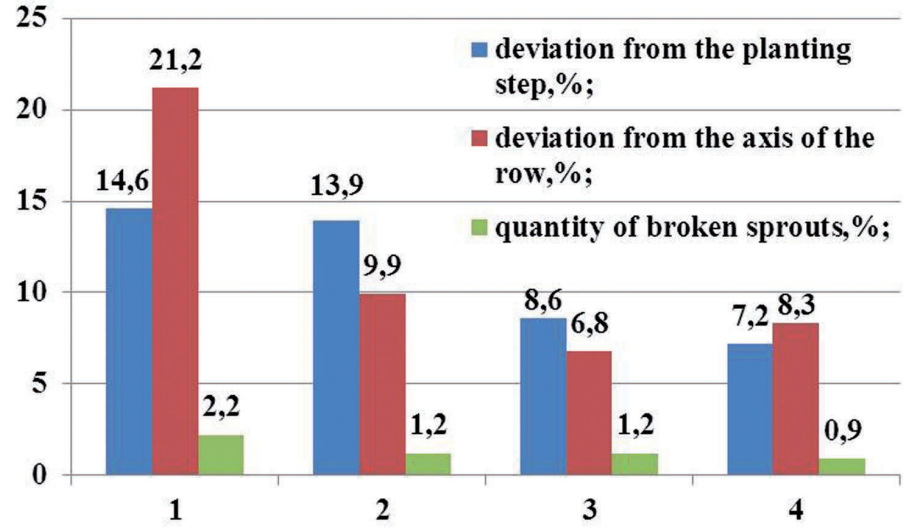

Fig. 4. Quality indicators of a potato planting machine for germinated potatoes

The operational indicators that have been investigated show that the time coefficient varies from 0.6 to 0.9, its lower values being taken in fields I and IV, which have a variable microrelief (Field I) and less space at the end of field for the unit to turn (field I, IV). The technological service time of the unit reaches 95 *min* and includes loading the machine with seed and fertilizer. The productivity of the machine is 0,8-1,0 *ha* per shift (Fig. 5).

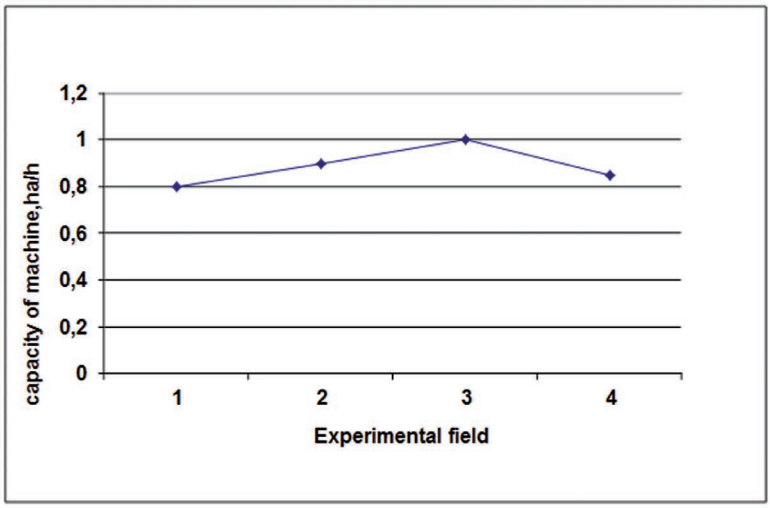

Fig. 5. Potato planting machine productivity

Conclusions

1. Considering the given plating depth, the deviations vary from 0.5 to 1*cm*, thus meeting the agro-technical requirements.

2. The values of the standard root mean square deviation s and of the coefficient of variation V show that, under severe conditions characterized by a variable macrorelief and stony soils, the planting depth forming process is stable and the deviations are insignificant.

3. The values of the quality indicators, Planting step deviation, Row axis deviation, Quantity of broken sprouts, comply with the agro-technical requirements and would not affect negatively the development of the plants.

4. The studied operational indicators show that the time coefficient varies from 0.6 to 0.9, its lower values being taken in fields which have a variable microrelief and less space at the end of field for the unit to turn.

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КАЧЕСТВЕННЫЕ И ЭКСПЛУАТАЦИОННЫЕ ПОКАЗАТЕЛИ КАРТОФЕЛЕСАЖАЛКИ ДЛЯ ПОСАДКИ ПРОРОЩЕННОГО КАРТОФЕЛЯ

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Разработан опытный образец картофелесажалки для посадки пророщенного картофеля в холмистой местности. В конструкции посадочного агрегата предусмотрены звуковые сигналы и клапан для улучшения работы оператора установки. Проведены полевые испытания картофелесажалки на четырех опытных участках на равнинных и холмистых полях. Установлены основные качественные и эксплуатационные показатели опытного образца. Полученные результаты качественных показателей полностью удовлетворяют агротехнические условия при посадки картофеля. Производительность данной картофелесажалки сопоставима с существующими агрегатами этого класса.

Ключевые слова: *картофелесажалка, посадка картофеля, пророщенный картофель, механизация, холмистая местность.*

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