ISSN NO: 2770-0003
Date of Publication : 05-12-2021

Machine For Preparing the Soil for Sowing Melons Under the Film

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Abstract. The aim of the study is to develop a machine for preparing the soil for sowing melons under a tunnel film. The authors have developed a machine for preparing the soil for sowing melons under a tunnel film, which is equipped with deep-diggers with an inclined stand of the "paraglaw" type, a furrow maker and rotary working bodies. A design diagram and a fragment of the machine operation are given. The basic principles and methods of classical mechanics, mathematical analysis and statistics were used in this study. Tests have established that the developed machine reliably performs the specified technological process and its performance indicators fully meet the requirements. When using the developed machine for preparing the soil for sowing melons under the film, the direct cost of processing one hectare of area is reduced by 33.4%.

Introduction

Currently, the preparation of fields for sowing melons, consisting of plowing, harrowing and cutting of irrigation furrows, is carried out by separate units, which in turn leads to the loss of soil moisture, delaying the sowing period and increasing operating costs [1-4].

Research on the creation of machines for preparing the soil for sowing melons, justification and improvement of technological processes of their working bodies and parameters were carried out by F. M. Mamatov [1-6], N. V. Aldoshin [3, 10, 11], I. Ismoilov [3] B. S. Mirzaev [4-12], D. Sh. Chuyanov [5], V. G. Abezin [13], A.D. Em [14], V. N. Zhukov [28], H. Fayzullaev [2, 24-26] and others. However, in these studies, the issues of substantiating the parameters of the working bodies of a combined machine for sowing melons under a closed tunnel film, which ensure high quality of work with minimal energy consumption, are not sufficiently studied.

The analysis of the studies showed that the reduction of fuel consumption and other costs, as well as the harmful effects on the soil of agricultural implements, can be achieved by using combined machines that perform all technological processes (loosening the soil to a given depth, leveling its surface part, compacting and cutting furrows) of preparing the soil for sowing melons under a closed tunnel type film in one pass of the unit through the field.

The aim of the study is to develop a machine for preparing the soil for sowing melons under a tunnel film.

Methods and results

The authors have developed a combined machine based on deep-drilling working bodies of the "paraglau" type, designed to prepare the soil for sowing melons under the film of a closed tunnel type. Combined machine (Fig. 1) frame 1 and mounted suspension 2, support wheels 3, axle claw 4, right and left pair of pits 5 and 6, bearing 7, parallelogram mechanism 8, rotary worker The organ consists of 9. The combined machine is aggregated with Class 2 tractors.

The frame is fixed to the frame by means of an axial claw, recesses and a clamp (fixed), the rotating working body is hinged (movable) by means of parallelogram mechanisms. During the work, the claw softens the middle part of the cultivated strip to a depth of 8-10 cm and a width of 25 cm, the dredgers soften the planting zones, the ditch forms an irrigation ditch, and the rotary dredgers create a seed or seedling line. It softens the top of the ridges and forms a soft layer on it.

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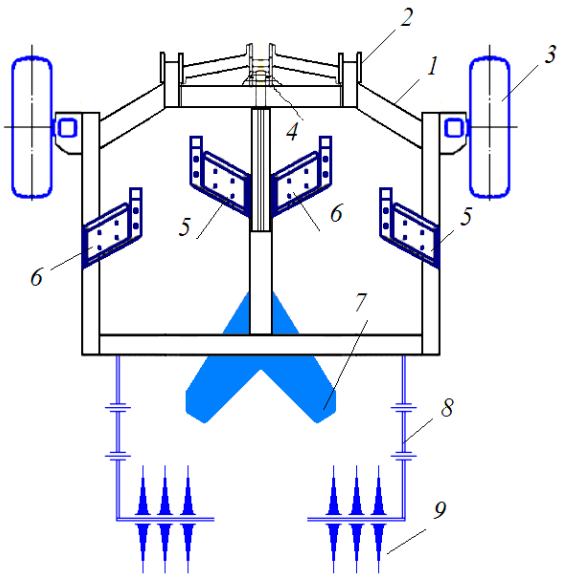

Fig. 1. *Constructive scheme of the combined machine (view from above): 1 – frame; 2 – hanging device; 3 – base wheels; 4 – story claw; 5 and 6 – left and right pits; 7 – drain; 8 – parallel mechanism; 9 – rotary working body.*

The machine prepares the entire tunnel for planting with a closed tunnel in one pass through the field.

To study the transverse and longitudinal distance between the deep dredgers, as well as the working speed on their traction resistance and the degree of soil crumbling, multivariate experiments were conducted using mathematical planning of experiments.

The multivariate experiments were conducted according to the Hartley-4 plan. At the same time, the main factors were selected as the longitudinal (X_1), and transverse (X_2) distance between the deep reclaimers, the depth of processing (X_3) of the deep reclaimers, as well as the speed of the unit (X_4).

The degree of soil crumbling (Y_1), i.e. the amount of fraction less than 50 mm in size and the traction resistance (Y_2) of deep-diggers were used as evaluation criteria.

The data of the obtained multivariate experiments were processed according to the PLANEX program. At the same time, the Cohren criterion was used to estimate the variance of adequacy, the Student criterion was used to estimate the values of the coefficients, and the Fisher criterion was used to evaluate the adequacy of regression models.

The experimental results were processed according to the specified procedure and the following regression equations were obtained that adequately describe the evaluation criteria: by the degree of soil crumbling (%):

$$Y_1 = 82{,}501+5{,}507\,X_1- 2{,}960\,X_2 -0{,}917\,X_3+5{,}100\,X_4-2{,}718\,X_1^2+ +1{,}562X_1X_2 +1{,}121X_1X_4+1{,}715\,X_2^2-0{,}471\,X_2X_3--2{,}813\,X_2X_4-2{,}518\,X_3^2+0{,}965\,X_4^2; \quad (1)$$

- according to the specific traction resistance of the deep loader (кN) :

$$Y_2 = 6{,}467-1{,}122\,X_1-0{,}853X_2+1{,}480\,X_3+0{,}515\,X_4+0{,}681X_1^2- - 0{,}124X_1X_2+0{,}198\,X_1X_3-0{,}049X_1X_4+1{,}173\,X_2^2-0{,}577X_2X_3- -0{,}449\,X_2X_4-0{,}341X_3^2+0{,}103X_3X_4+0{,}324\,X_4^2. \quad (2)$$

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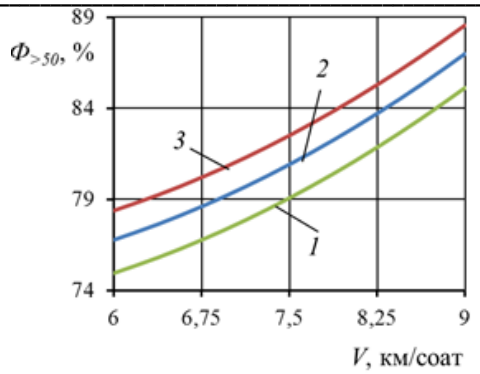

Fig. 2. *Graphs of the dependence of the degree of crumbling of the soil on the speed: 1, 2 and 3, respectively, at a depth of 25, 29 and 33 cm*

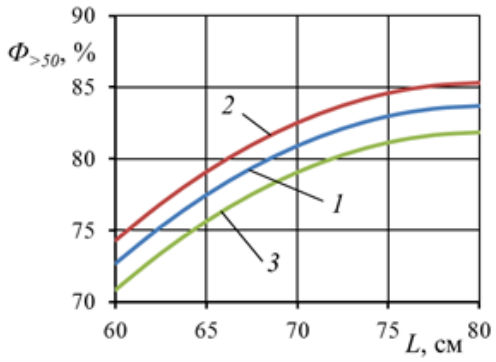

Fig. 3. *Graphs of the dependence of the degree of crumbling of the soil on the longitudinal distance between the deep dredgers: 1, 2 and 3, respectively, at a depth of 25, 29 and 33 cm*

The analysis of the obtained regression equations showed that all factors had a significant impact on the evaluation criteria.

When determining the values of the parameters that provide the required quality of work with minimal energy consumption, the regression equations (1) and (2) were solved together using MS Excel and Planex programs. When solving the regression equation together, the following conditions were accepted: criterion Y1, i.e. the amount of fraction less than 50 mm in size must be at least 80%, and criterion Y2, i.e. the traction resistance of the deep loader must have a minimum value.

According to the results obtained, at speeds of 6-9 km / h, to ensure the required quality of work with minimal energy consumption at a processing depth of 25-33 cm, the longitudinal distance between the paired deep reclaimers should be within 75-78 cm, and the transverse distance should be within 55-61 cm. These results correspond to the results of theoretical studies.

Based on the results of theoretical and experimental studies, an experimental sample of the combined machine was made (Fig. 4 and 5).

Fig. 4. General view of the combined machine in the unit with the tractor T 100 A (side view)

The main parameters of the working bodies of the combined machine are: the angle of entry of the bit of the deep dredger 200; the width of the bit is 5 cm, the maximum depth of processing of the deep-digger is 35 cm, the height of the deep-digger is 75 cm, the longitudinal and transverse distance between adjacent deep-diggers is 75 cm and 60 cm, respectively, the longitudinal distance between the deep-digger and the pointed foot is 40 cm, the transverse distance between the deep-digger and the support wheel is 10 cm, the longitudinal distance between the deep-digger and the furrow cutter is 50.6 cm, the longitudinal distance between the furrow cutter and the rotary working body is 123 cm. The working width of the developed machine is 1.4 m, the depth of tillage is 30-35 cm, the working speed is 6-9 km/h.

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In one pass, the following parameters of a combined machine that prepares the soil for planting melons under a closed tunnel film were determined: depth of cultivation; soil compaction quality; relief of the planting area; width and depth of irrigation ditches; work productivity; fuel consumption.

Fig. 5. *Fragment of the combined machine operation*

The study was conducted in 2018-2019 in the Kashkadarya region of Uzbekistan. Type soil dredger light serous. Tverness and moisture content of soils 0-10, 10-20, 20-30 cm were 1.87; 1.19; 1.92; 2.33 MPa and 17.9; 17.7; 17.5; 16.9%.

Specifications of the combined machine Tst 63.04:2001 "Testing of agricultural machinery. Machines and tools for surface tillage. Program and test methods", Tst 63.02:2001 "Testing of agricultural machinery. Machines and tools for deep tillage. Program and test methods" and Tst 63.03:2001 "Testing of agricultural machinery. Energy assessment methods" detected.

In the tests, the machine was aggregated with a TL 100A tractor (Fig.5). Table 1 shows the results of the combined machine tests. The trials were conducted in fields intended for planting melons in early spring (Fig. 5).

In the tests, the planting depth was set at 33 cm, but in practice the average value was 33.4 cm. Fractions smaller than 25 mm in size averaged 81.1%. The width of the upper part of the irrigation ditch was 50.8 cm and the depth of the irrigation ditch was 23.4 cm (Fig.5).

Table 1

Combined machine test results

№	Name of indicators	According to agrotechnical requirements	Based on the test results
1	Operating speed, km / h	6 - 9	7,3
2	Depth of planting area (pits), cm: $M_{ave.}$ $\pm\sigma$ *v;* %	30 см дан 35 см гача ±2 <10	33,4 1,6 6,2
3	The amount of the following size fractions in the soil of the area treated by the pits, % > 50 mm 50-25 mm < 25 mm	 < 10 - > 80	 9,1 9,8 81,1
4	Depth of irrigation ditch, cm	25 ± 3	24,9
5	The width of the upper part of the irrigation ditch, cm	50± 3	50,4
6	Fuel consumption, kg / ha	no information	10,5

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These data show that the performance of the combined machine meets the agro-technical requirements.

The combined machine developed in the tests performed the specified technological process completely and reliably, and the test results fully meet the requirements.

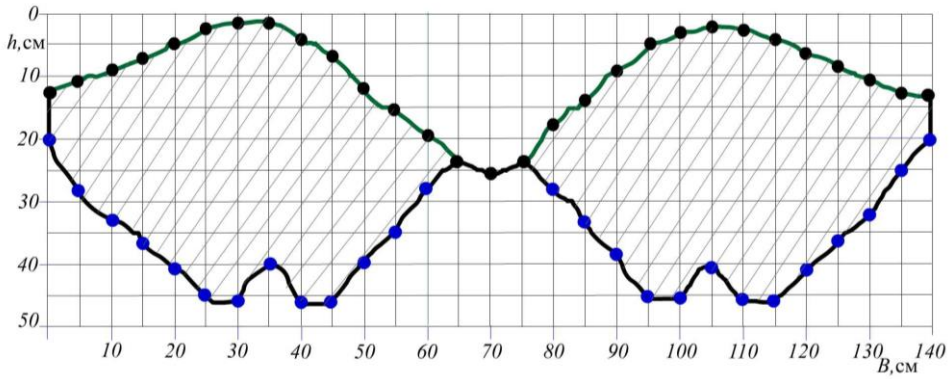

Fig. 6. *Cross-section profile of the field after processing by the machine*

Calculations show that the use of a combined soil preparation machine for planting melons under a closed tunnel film reduces the direct (operating) costs per 1 hectare by 33.4%.

Conclusions

1. The test results have established that the developed machine reliably performs the specified technological process and its performance indicators fully meet the requirements.

2. The use of a combined machine for preparing the soil for sowing melons under a film developed on the basis of research for tillage during preparation reduces the direct cost of processing 1 hectare of area in comparison with the technical means used by 33.4 %.

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