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Experimental research of parameters of work of top-gathering machine for continuous cut of tops of vegetable

Bulgakov V.[1], Ignatiev Ye.[2]

[1]National university of bioresources and wildlife mana-gement of Ukraine, Heroiv Oborony Str., 15, Kyiv, 03041, Ukraine, [2]Tavria state agrotechnological university, B. Khmelnytskyi Ave., 18, Melitopol, Zaporizhzhia oblast, 72312, Ukraine; e-mail: [1]vbulgakov@meta.ua, [2]yevhen.ihnatiev@tsatu.edu.ua

The purpose. Experimental determination of rational parameters of cutting tops of vegetable by the developed unit for maintenance of necessary quality of cleaning tops of vegetable. **Methods.** Rational machine-using in plant growing, experimental researches and field tests of agricultural machines, estimation of parameters of quality of work. **Results.** Field experimental researches were carried out of frontally hung on wheel tilling tractor of new top-gathering machine intended for continuous non-sensing cut of green mass of tops of vegetable of sugar beet. Thus, new laboratory-field apparatus was developed which consisted from frontally hung top-gathering machine of rotor type with horizontal axis of rotation, cross-section screw for gathering the cut off tops of vegetable, loading mechanism in the form of paddle blower, and loading branch pipe. On the prepared plot of crops of sugar beet they cut off mass of tops of vegetable at various parameters of technological process of cleaning which then estimated by amount of tops of vegetable which remained on heads of root crops and in row width of crops (non-cut off rests of tops of vegetable). **Conclusions.** Under the developed program and technique they carried out statistical processing of results of experimental researches by means of personal computer. It allowed to receive graphic dependences of the specified rests of tops of vegetable on heads of root crops that helped to determine parameters of work of new top-gathering machine for continuous cut of tops of vegetable of sugar beet. The established dependences enabled to choose rational constructive and technological parameters of harvesting tops of vegetable of frontally hung top-gathering machine.

Key words: *tops of vegetable, harvesting, continuous cut, experimental researches.*

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Formulation of the problem. Highly productive and qualitative harvesting of sugar beet tops remains a rather complicated and topical task of the beet-breeding industry. Recently, the most widespread in the world is a multi-stage method of harvesting a tops, based on which at the beginning a continuous main cut of the entire mass of the tops (on the width of the pickup of the pickup machine), its harvestion and transportation to the moving vehicle, and then using individual copying of each Root root head in a row, provided with cleansing or trimming (or simultaneously: both cleansing and pre-cutting by various working organs) of root crops from the remnants of the glyca. Since these operations are carried out consistently for sugar beet root crops in the soil (ie, at the root) and the harvesting of the hook is preceded by the operation of digging the beet root crops from the ground, hoeing machines, as independent agricultural machines, or harvesting modules, as constituents of beet harvesters, are necessarily located in the frontal position relative to the power tool (to the tractor - in the case of hook-picking machines or to the front of the frame self-propelled beet-harvesters However, the experiments carried out by us have established that in the process of work, a hinged machine carries a frontal hitch on a tractor, the movement in the space, which is determined by the relief of the surface of the field, the progressive speed of the tractor, the placement of the copying wheels, the suspension system of the car, etc., which significantly affects on the quality of this technological process. The use of pneumatic wheels as duplicators - causes fluctuations in the cutting machine in the vertical plane, which will most likely affect the quality of the process - the cutting of the joint of the heads of the root crops throughout the width of the capture, the most complete collection and transportation without loss. The practical solution to this problem determines the relevance of this work.

Analysis of recent publications. In spite of the wide spread of front-mounted hook-in modules of Western-made beet-harvesting machines, as well as some of the designs of domestic frontal-hoisting hoeing machines, this almost did not cause analytical and experimental studies of their oscillatory motion. However,

in part, the problem of studying the influence of structural parameters on the motion of rows of sugar beet root crops and on the roughness of the soil surface was attempted by other scientists [1-5].

Purpose. Experimental determination of rational cut-off characteristics of the tops by the designed aggregate to provide the required quality of the tops harvesting.

Methods. In the course of the research, the methods of machine use in crop production, methods of experimental research and field tests of agricultural machines, as well as methods for evaluating the quality indices of their work are used..

Results. Experimental studies were conducted in the field conditions of the Fastovsky district of the Kyiv region. The object of experimental research was the working process of cutting the hitch developed by the unit. The conditions for conducting studies that were identified according to known methods [6-9] are given in the table 1.

Table 1. Conditions of conducting laboratory-field experimental researches of tops harvesting-machine

Indicator	Value
Type of soil	black earth is medium-humus, medium loamy
Hardness of soil in the zone of placement of root crops, MPa	0.94…2.30
Soil moisture in the root zone placement, %	18.0…21.6
Average yield of root crops, t ha^{-1}	46.4
Average tops yield, t ha^{-1}	44.8
Average planting density of plants sugar beets, thousand pcs ha^{-1}	112
Maximum deviation of the position of sugar beet root crops from the line line, mm	30…40
Position of heads of sugar beet root crops above ground level, mm	0…70
The shape of the sheaves on the heads of the root crops: – cones – half-open	(there is a significant number of dry and fallen stems of the hips) more than 90% 10%
The relief of the ground	regular
Maximum deviations of relief, deg	more than 2…4

To implement the program of experimental research of the technological process of removing the wick with the use of a wiping machine, a laboratory-field experimental setup (Fig. 1) was developed that is frontal hinged on an ore-propagating wheeled tractor of the traction class 3.0, and the shearing cutting apparatus is made in the form of a horizontal rotor 4]. The machine allows to realize a continuous, complete cutting of the main mass of the tops with its subsequent loading into the vehicle.

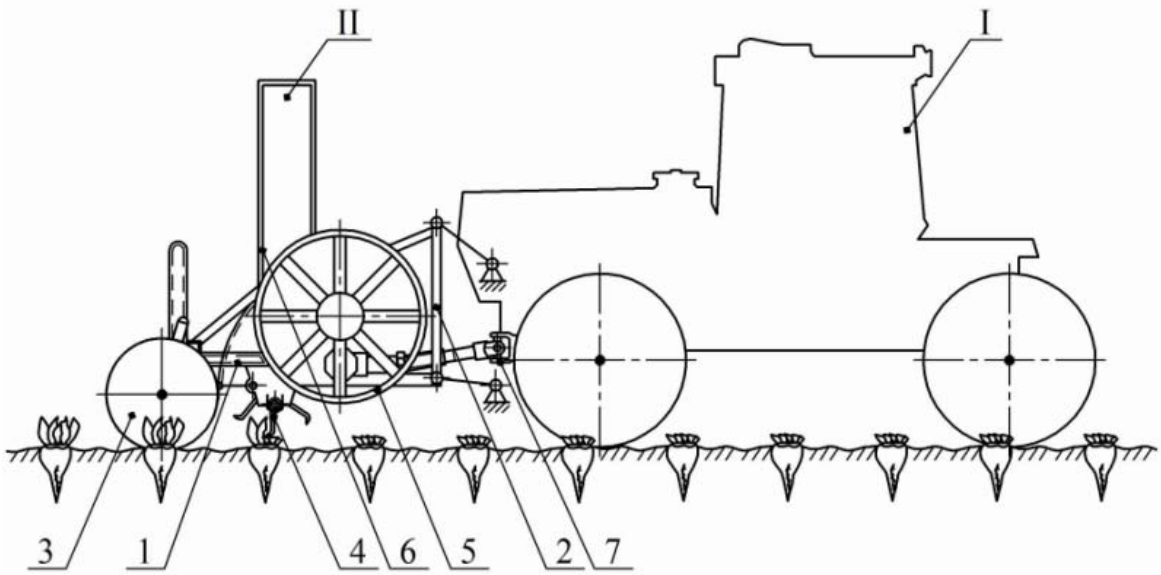

Fig. 1. Design scheme of laboratory and field experimental installation: I – wheeled arable and row-crop tractor; II – frontally mounted beet tops harvesting machine; 1 – frame; 2 – coupling device; 3 – support wheel; 4 – rotary cutting unit; 5 – transport device; 6 – loading device; 7 – drive

The laboratory field experimentation plant (Figure 1) consists of a wheel ornon-propagating tractor I and a frontally coupled hook-picking machine II, which contains a frame 1, a coupling device 2, a copper wheel 3, a rotary shearing cutter 4, a transport device 5, a loading device 6 , as well as drive 7.

The developed laboratory-field experimental setup [5] allows to fully carry out experimental researches of the experimental hoisting machine in accordance with the adopted program and methodology (Fig. 1), and consequently, with the possibility of changing the factors within the established limits: the rotor speed with the help of the drive mechanism and control tachometer; the speed of the hitch-picking machine by means of the tractor's gearbox and the control of its actual value by the track-measuring wheel; height of the rotor installation with a lever control mechanism with the ruler.

On the basis of performed calculations, previous studies and analysis of a priori information, levels of variation of factors are established:

- rotor speed of the machine: 500, 750, 1000 rpm;
- the speed of the tops harvesting machine: 0.5, 1.5, 2.5 m s^{-1};
- cut height of the tops: 0.02, 0.06, 0.10, 0.15 m.

The qualitative indicator of work, as indicated above, was taken by the remnants of the hook on the heads of root crops, in g m^{-2}, which were determined by harvesting all the residues (including not cut from the heads of the root crops of the part of the tops) from the area of 1 m2 after the passage of the experimental plant (Fig. 2) and weighing on electronic scales with an accuracy of 1.0 g.

Fig. 2. Determination of quality of tops removal by studied beet tops harvesting machine

The power tool (tractor), according to its technical characteristics, should provide the operation of the self-propelled machine at the required working speeds and adjust the running gear to the appropriate track width [11, 12].

The results of experimental studies were processed in accordance with the well-known method of statistical processing of experimental data [6, 8, 10] with subsequent representation in the form of functional and graphical dependencies, as well as with the application of applications for the PC.

As a result of conducted experimental research according to the accepted method, the following dependencies were obtained.

For a more complete description of the process of removing the tops by a rotary hitch, as a result of the processing of the results of the multifactorial experiment, we obtained a mathematical model in the form of the regression equation of the II degree:

- in natural form:

$$Q = -177.593 - 0.24224n + 530.8054V + 8680.805h + \\ + 0.000179nn - 109.767VV - 6795.18hh - \\ - 0.09602nV - 1159.51Vh - 4.22748nh + 2.158437nVh, \quad (1)$$

- in coded form:

$$Y = 587.2724 - 50.5026X1 + 168.38335327X2 + 327.8374X3 + \\ + 11.18333X1X1 - 28.783X3X3 + 21.86292X1X2 + 29.85444X2X3 - \\ - 16.0845X1X3 + 35.07582X1X2X3. \quad (2)$$

where V – translational speed of the tractor, m s^{-1}; n – frequency of rotation of the cutter rotor, min^{-1}; h – cut height of the tops, m.

The graphical interpretation of these regression equations (1) and (2) is presented in the form of response surfaces (Fig. 3, Fig. 4 and Figure 5).

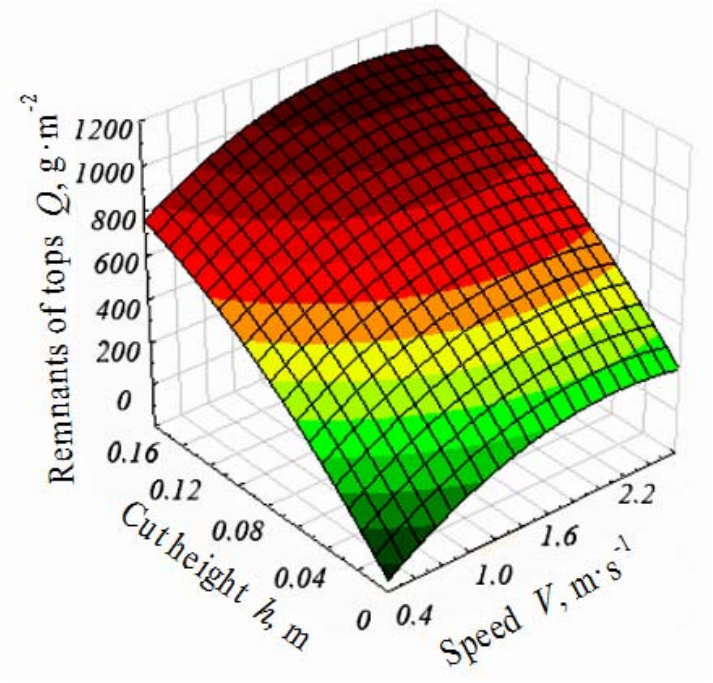

Fig. 3. The response surface of tops residues dependencies on root crops head surface on movement speed and cutting height at rotor speed 500 rpm

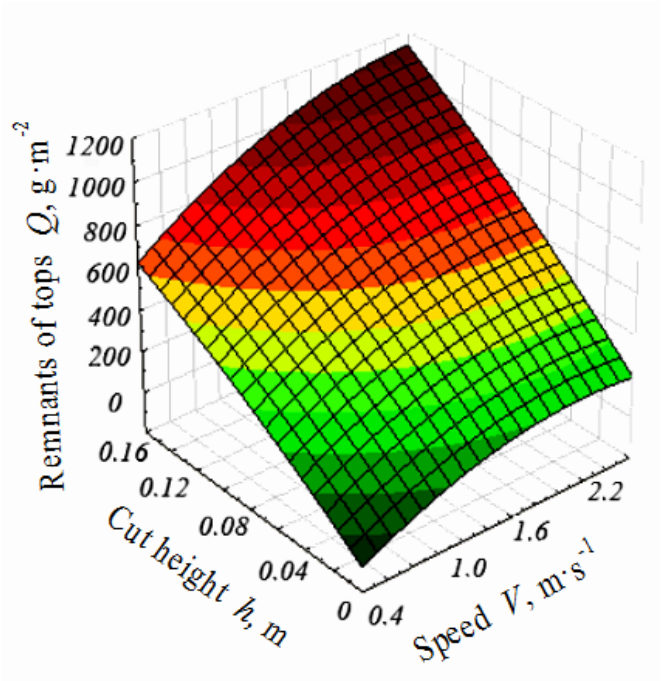

Fig. 4. The response surface of tops residues dependencies on root crops head surface on movement speed and cutting height at rotor speed 750 rpm

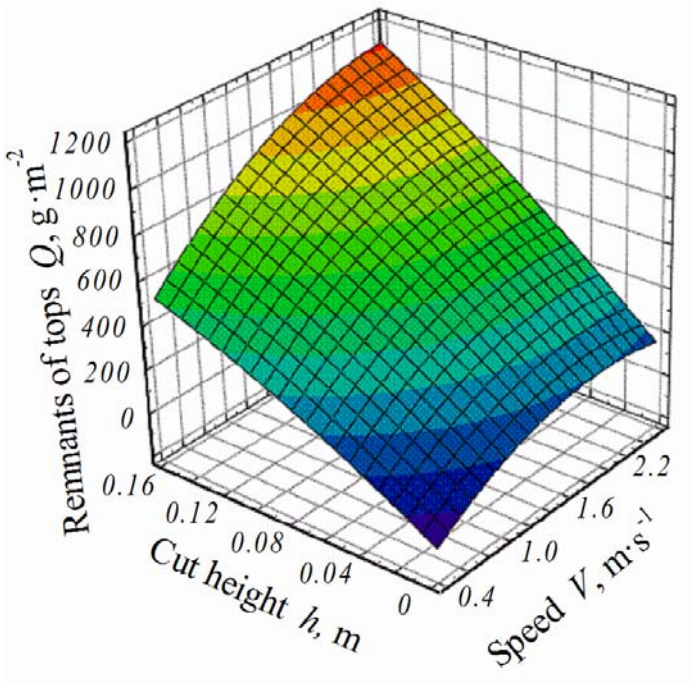

Fig. 5. The response surface of tops residues dependencies on root crops head surface on movement speed and cutting height at rotor speed 1000 rpm

On the basis of factor analysis of the obtained regression equation (2), rational parameters of the process are determined, during which a qualitative removal of the tops by a rotary beet tops cutting device will be achieved, namely: the height of the cut - 0.02 m, the speed of the machine – 1.5…2.0 m s^{-1}, rotor speed – 1000 rpm.

Conclusions

1. On the basis of the analysis of the empirical mathematical model in the form of the regression equation of the removal process of the coupling, it is established that the greatest influence on the mass of the rests of the tops on the surface of the heads of the root crops with the use of the rotary hinged machine has a cut height, and the least - the frequency of rotation of the cutting device. With an increase in the speed of the machine and the height of the cut will increase and the weight of the remnants of the tops on the root of the root, and the increase in the rotational speed of the rotor - on the contrary, to reduce the mass of remnants of the tops.

2. It has been established that the rational parameters of the process, at which the qualitative removal of the tops by the rotary hitch cutter apparatus is achieved, is the height of the cut – 0.02 m, the speed of the machine – 1.5 ... 2.0 m s^{-1}, rotor speed – 1000 rpm.

3. According to the results of field experiments on the work of a self-propelled cutting machine, which is frontally linked to an arable and row-crop tractor, when harvesting beet tops by continuous cutting, it can be concluded that the performance indicators of the machine correspond to the agrotechnical requirements, and therefore the feasibility of its application in the production conditions has been proved.

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