Вісник Тернопільського національного технічного університету
Scientific Journal of the Ternopil National Technical University
2018, № 2 (90)
ISSN 2522-4433. Web: ***visnyk.tntu.edu.ua***

MANUFACTURING ENGINEERING AND AUTOMATED PROCESSES

МАШИНОБУДУВАННЯ, АВТОМАТИЗАЦІЯ ВИРОБНИЦТВА ТА ПРОЦЕСИ МЕХАНІЧНОЇ ОБРОБКИ

UDC 631.31

ANALYTICAL AND APPLIED MODEL OF THE PROCESS OF THE CUT VEGETABLE COMPONENTS FEEDING TO THE SCREW CONVEYOR OF THE TOP GATHERING MODULE

Tymofiy Rybak; Anna Tson; Mykola Stashkiv; Oleg Tson

Ternopil Ivan Puluj National Technical University, Ternopil, Ukraine

Summary. *The article deals with the analytical and applied model of feeding of cut vegetable components from root crops to the screw conveyor, the analysis of the theoretical level and possible limits of the change of technological feed of the cutter knives built in the screw conveyor. The advantage of the offered mathematical model in comparison with the traditional one is to take into account such factors as the influence of the hips yield in the row, the specific mass of weeds in the row, the density of the root crops planting, the rate of movement of the root crop harvesting machine.*

Key words: *tops, roots, cutting, screw conveyor, technological process, knife.*

Received 22.05.2018

Statement of the problem. The difficult and changing conditions of technological operation of the top gathering machines and the lack of adaptation of existing structures of cutting tools to these changes do not allow to obtain constant agrotechnical indices, especially at high yields, uneven arrangement of root crops in the row, unsatisfactory state of tops, fould fields, therefore, the development of the new and improved existing designs of the top gathering machines is needed [1].

Analysis of the available researches and publications. Analysis of recent research and publications. The advantage of the offered mathematical model in comparison with the traditional one is to take into account such factors as the influence of the yield of the hips in a row, the specific mass of weeds in the row, the density of the root crops planting, the rate of movement of the root crop harvesting machine. The experimental and theoretical investigations requiring more detailed description and improvement by means of mathematical modeling are presented in papers [2, 3, 4].

The objective of the paper is to develop the analytical and applied model of feeding of the cut plant components from root crop heads by the top remover module to the screw conveyor, to analyze and determine at the theoretical level the possible limits of the change in technological feed of the plant components cut by rotary top cutter knives the to the screw conveyor aimed to obtain the analytical functional regularities of the change in technological top feed from the root crop plantating parameters and module operation technological parameters.

Statement of the task. To calculate and substantiate the main structural and kinematic parameters and operating modes of the screw conveyor of the top gathering module, to determine analytically the limits of the change of the second feed of the plant components to the conveyor.

The results of the investigations. The technological process of the module operation for harvesting the tops of root crops is primarily regulated and depends to a large extent on the technological feed of the plant components cut by rotary top gatherer knives to the screw conveyor.

In this case, the technological feed of the cut plant components to the screw conveyor also depends on the total yield of the root crops tops and the weed mass amount, their agrobiological characteristics and properties, the movement speed of the top gathering module, its cutting width, or the root crops row number number being simultaneously cut, quality indicators of cutting and gathering the tops cut by the operating parts and the number of other objective and subjective reasons.

It is known that in general aspect, the theoretical feed of the plant components cut by the rotary top cutter knives from a single row of root crops over durin the period of time t, denoted as $\Pi_k(t)$, consists of the total feed of the cut tops $\Pi_г(t)$ and the weed feed $\Pi_б(t)$ located in the row or in one neighbouring row spacing.

$$\Pi_k(t)=\Pi_г(t)+\Pi_б(t). \tag{1}$$

If the top gathering is from N root crops rows 1 (Fig. 1), then the total theoretical feed of the plant components $\sum_{i=1}^{N}\Pi_{ki}(t)$ cut by the rotary cutter 2 knives 3 to the screw conveyor during the period of time t is determined by the formula

$$\sum_{i=1}^{N}\Pi_{ki}(t)=\sum_{i=1}^{N}\Pi_{гi}(t)+\sum_{i=1}^{N}\Pi_{бi}(t),\ i=1,2,\ldots,N, \tag{2}$$

where $\sum_{i=1}^{N}\Pi_{гi}(t)$ – is the total feed of the cut tops from N root crops rows, kg.

$\sum_{i=1}^{N}\Pi_{бi}(t)$ – is the total feed of the cut weeds from N root crops row spacing, kg.

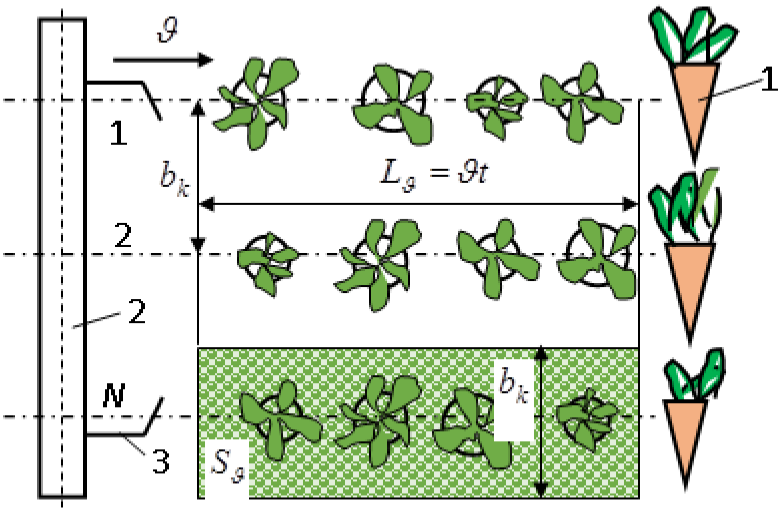

Figure 1. Scheme for calculating the feed of the cut plant components to the screw conveyor: 1 – root crop; 2 – rotor top cutter; 3 – knife

The theoretical feed of the cut top $\Pi_г(t)$ by the knives of the rotary top cutter from each of i-th rows of root crops durin the period of time t depends mainly on the number of root crops K_z from which the top is cut by the knives of the rotary top cutter and the yield of the i-th row of the root crops $U_г$, or $П_г(t) = U_г K_z(t)$.

The number of root crops K_z (pieces) on one i-th row from which the top is cut depends on the speed of the module ϑ, or the path $L_\vartheta = \vartheta t$ covered by the module for the time t and the number of root crops located on 1 linear meter of the row (1 lin.m) of root crops, which in its turn depends on the density of crop planting per 1 m^2 which we denote as $Г_k$ or the average distance between the root crops in the row denoted through c_k.

Then the number of root crops K_z (pcs.) on the i-th row where the top is cut by the knife of the rotary cutter during the time t of the module movement can be determined by the formula:

$$K_z = L_\vartheta k_z = \vartheta t k_z;\; K_z = \frac{L_\vartheta}{c_k} = \frac{\vartheta t}{c_k};\; K_z = Г_k S_\vartheta = Г_k \vartheta t b_k, \tag{3}$$

where L_ϑ – is the path or the number of linear meters covered by the module while it is moving during the time t, m;

k_z – is the average number of root crops on 1 lin.m, pcs.;

c_k – is the average distance between the root crops in one row, m;

ϑ – is the speed of module movement, m/sec.;

$Г_k$ – is the available dencity of the root crops planting in one row during the harvesting time, pcs./m^2;

S_ϑ – is the area of root crops planting from which the top is cut on one row, m^2;

b_k – is the width of the root crops row spacing, m.

The theoretical feed of weeds $П_б(t)$ cut by the knives of the rotary top cutter from each i-th root crops row spacing diring the period of time t depends mainly on the path $L_\vartheta = \vartheta t$ covered by the module during the time t and width of the row spacing b_k of the root crops planting, or the area S_ϑ from which the weeds are cut, the specific weeds mass $M_б$ on the i–th root crops row spacing, or $П_б(t) = S_\vartheta(t) M_б$.

At the first stage of the analysis of the technological feed of the cut plant components to the screw conveyor we consider the solution of the simplified problem, specifying the following assumptions and simplifications:

- the yield of the top of each individual K_z-th root crop is the same, that is equal to the average value $U_{г.с}$;

- the number of weeds on the area S_ϑ from which the weeds are cut, or the corresponding specific mass of weeds on the area S_ϑ of each i-th row spacing is the same, that is equal to the average value $M_{б.с}$;

- the density of root crops planting of of each i-th row during the harvesting time is the same, that is equal to the average value $Г_{k.c}$ i.e. the same to number of root crops k_z, located on 1 lin.m of row, or the number of root crops K_z, located along the length path $L_\vartheta = \vartheta t$ of each i-th row, or equal to the average value $K_{z.c}$.

Then, the average theoretical feed of cut tops $П_{г.с}(t)$ from each i-th root crops row and weeds $П_{б.с}(t)$ from each i-th rows spacing cut by the knives of the rotary cutter during the time interval $\boldsymbol{t}$ and the assumed assumptions is the same or equal to each other.

Consequently, taking into account the above mentioned records $П_г(t)=U_г K_z(t)$, $П_б(t)=S_\vartheta(t)M_б$ and the third dependence $K_z = Г_k \vartheta t b_k$ from (3), the average theoretical feed of the cut top $П_{г.с}(t)$ (kg) from each i-th row and the weeds $П_{б.с}(t)$ (kg) from each o i-th root crops row spacing cut by the knives of the rotary cutter to the screw conveyor during the period of time t is determined by the formula:

$$П_{г.с}(t)=\frac{dL_\vartheta}{dt}b_k t Г_{k.c}U_{г.с}\frac{dL\,\vartheta}{dt}b_k=\left(\frac{dL_\vartheta}{dt}\right)^2 b_k^2 t Г_{k.c}U_{г.с};\; П_{б.с}(t)=\frac{dL_\vartheta}{dt}b_k t M_{б.с}, \tag{4}$$

where $U_{г.с}=const$ – is the average top yield of each K_z-th root crop, kg/m^2; $M_{b.c}=const$ – is the average specific weeds mass of each i-th root crops row spacing, kg/m^2.

Then, in accordance with (2) and (4), the total theoretical feed $\sum_{i=1}^{N} П_{ki}(t)$ (kg) of the plant components cut by the knives 3 (Fig. 3.) of the rotary cutter 2 from N root crops rows to the to the screw conveyor during the period of time t is determined by the formula:

$$\sum_{i=1}^{N} П_{ki}(t)=\left(\frac{dL_\vartheta}{dt}\right)^2 b_k^2 t Г_{k.c}U_{г.с}N_i+\frac{dL_\vartheta}{dt}b_k t M_{б.с}N_i=\frac{dL_\vartheta}{dt}N_i t b_k\left(\frac{dL_\vartheta}{dt}b_k Г_{k.c}U_{г.с}+M_{б.с}\right). \tag{5}$$

However, during the top cutting from the heads of root crops 1 (Fig. 1) and from the surface of the field of weeds, their chopping on the basis of the rotation of the knives of the rotary top cutter and the movement of chopped tops and weeds along the trajectory of the directed movement to the groove of the screw conveyor, there are losses of the chopped tops and weeds. In order to take into account the losses of the tops and weeds, we introduce the correction factor of the tops losses denoting it by $\mu_г$ and the correction factor of weed losses denoting by $\mu_б$.

Taking into account the tops and weeds losses, the total theoretical feed $\sum_{i=1}^{N} П_{ki}(t)$ of the plant components to the screw conveyor of the module for tops gathering during the time interval t is determined by the formula

$$\sum_{i=1}^{N} П_{ki}(t)=\frac{dL_\vartheta}{dt}N_i t b_k\left(\frac{dL_\vartheta}{dt}b_k Г_{k.c}U_{г.с}\mu_г+M_{б.с}\mu_б\right). \tag{6}$$

In this case, the mass loss of the tops is the sum of the mass of tops remains on the root crops heads and the mass of the tops losses during its cutting and moving along the trajectory of the directed movement to the groove of the screw conveyor of the module for tops gathering.

These losses are taken into account by introducing the coefficient of loss of the tops remains on the root crops heads, which we denote by $\mu_{г.к}$ and the coefficient of loss of chopped tops movement, which we denote by $\mu_{г.т}$, i.e. $\mu_г=\mu_{г.к}+\mu_{г.т}$ [5].

To determine the correction factors for the tops losses $\mu_г$ and weeds losses $\mu_б$, we use the known regulations of the state standards [6, 7], which regulate the agronomic requirements for the technological process of tops gathering and operation of the root crops harvesting machines.

According to them, the length of the tops remains on the root crops heads after their cutting by the knives of the rotary tops cutter should not exceed 4 cm, or the specific mass of the tops remains on the area of 1 m^2 should not be greater than 8 % of the tops yield; the total specific mass of the tops and weeds losses on the area of 1 m^2 1 during their cutting by the knives of rotary cutters and screw conveyor movement should not be greater than 10 % of the tops yield and the specific mass of weeds [6, 7].

The maximum values of the above mentioned indicators we assume as the basis for calculations. Then the correction factor of tops and weeds losses $\mu_г$ equals $\mu_г = 1{,}0 - (0{,}08 + 0{,}1) = 0{,}82$ and the correction factor of weed losses is $\mu_б = 1{,}0 - 0{,}1 = 0{,}9$.

Then, taking into account the above described factors and equation (6), the second feed $П_k^*$ (kg/sec) of the plant components to the screw conveyor is determined by the expression

$$П_k^* = \vartheta N b_k \left(0{,}82 \cdot 10^{-3} \vartheta b_k Г_{k.c}^* U_{г.c}^* \mu_г + 0{,}9 M_{б.c}\right), \qquad (7)$$

where $Г_{k.c}^*$ – is the density of root crops planting thousand pcs./ha; $U_{г.c}^*$ – is the root crops tops yield, dt/ha.

Root crops harvesting machines sufficiently perform the operating process of root crops harvesting at operating speeds withing the range of 1,6…2,2 m/sec. According to agrotechnical requirements, the specific mass of weeds during the time of root crops harvesting should exceed 0,1 kg/m^2 [8].

Under the initial conditions $b_k = 0{,}45$ m, $N = 6$ pcs., $M_{b.c} = 0{,}1$ kg/m^2, $Г_{k.c} = 80...110$ thousand pcs./ha, $U_{г.c} = 50...100$ dt/ha [9] and according to formula (6) the dependencies of the change of the second feed $П_k$ of the plant components to the screw conveyor are constructed, and shown in Fig. 2.

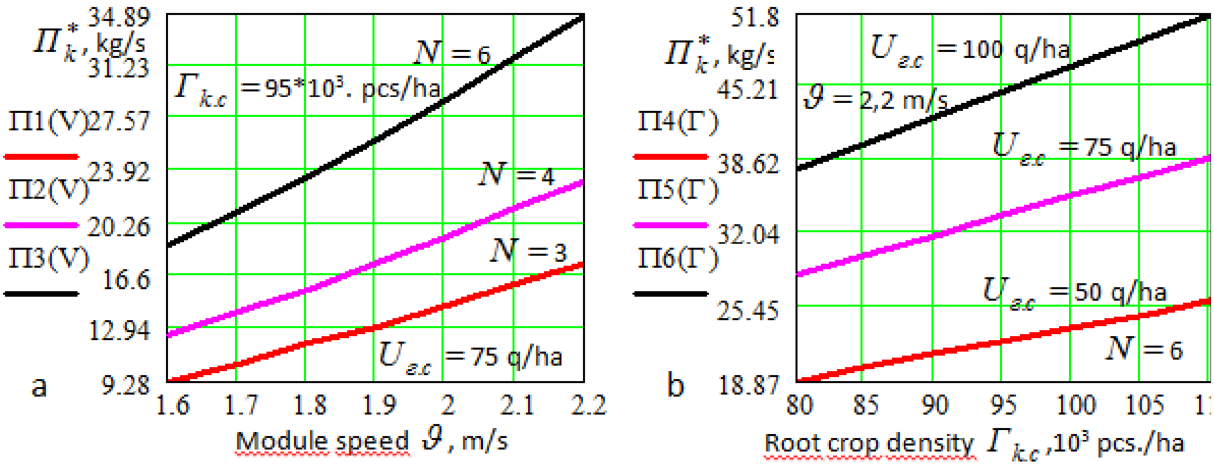

Figure 2. Dependence of the second feed $П_k$ of the plant components to the screw conveyor:

a – $П_k = f_П(\vartheta)$; b – $П_k = f_П(Г_{k.c})$

According to the graphic constructions (Fig. 2) we can state that the change of the second feed $П_k$ of the plant components to the screw conveyor has direct proportional character – with the increase of the speed ϑ of the module for the collection of tops, the number of root crops rows N (Fig. 2a), the density of planting $\Gamma_{k.c}$ and tops yield $U_{г.c}$ of the root crops (Fig. 2b) the second feed Π_k is also increased. Under the assumed initial conditions, depending on the change ϑ and $\Gamma_{k.c}$, the second feed Π_k of plant components to the screw conveyor of the module is within the limits from 9 to 35 kg/s (Fig. 2a) and from 19 to 52 kg/s (Fig. 2b).

At the same time, the significant influence on the change of the second feed Π_k of the plant components to the screw conveyor is the change in the tops yield $U_г$ and the density of root crops planting $\Gamma_{k.c}$ (Fig. 2b), which is characteristic for the real agrotechnological conditions of the root crops production [10].

In this regard, we consider the solution of the complicated problem, assuming the following assumptions:

- the productivity of tops on the root crops of each i-th row is not the same, that is, the tops yield is unstable and has some fluctuations towards the increase or decrease of the yield from the mean value $U_{г.c}$;

- the variability of the change in the average value of the tops yield $U_{г.c}$ we denote by the expression ($\pm\Delta U_г$), where ($+\Delta U_г$) means the increase in the average tops yield $U_{г.c}$, and ($-\Delta U_г$) is $U_{г.c}$ decrease;

- the number of weeds on the area S_ϑ from which the weeds are cut, or the corresponding specific mass of weeds on the area S_ϑ of each i-th row spacing is the same.

Then we can denote that the total theoretical feed $\sum_{i=1}^{N}\Pi_{ki}(t)$ of plant components to the screw conveyor from N root crops rows taking into account the first equation (4) and the tops losses the during the process of its cutting and its movement to the screw conveyor during the time interval t is determined by the formula

$$\sum_{i=1}^{N}\Pi_{гi}(t)=\left(\frac{dL_\vartheta}{dt}\right)^2 b_k^2 t\Gamma_{k.c}\times\left[(U_{1г.c}\pm\Delta U_{1г})\mu_{1г}+(U_{2г.c}\pm\Delta U_{2г})\mu_{2г}+\ldots+(U_{Nг.c}\pm\Delta U_{Nг})\mu_{Nг}\right], \quad (8)$$

where $U_{1г.c}$, $U_{2г.c}$, …, $U_{Nг.c}$ – is the average tops yield of the 1st, 2nd, …., N-th root crops row, kg/m^2; $\pm\Delta U_{1г}$, $\pm\Delta U_{2г}$, …, $\pm\Delta U_{Nг}$ – is the interval of change in the average tops yield of the 1st, 2nd, …., N-th root crops row, kg/m^2; $\mu_{1г}$, $\mu_{2г}$, …, $\mu_{Nг}$ – is the correction factor of tops losses from the the 1st, 2nd, …., N-th root crops row.

Then the total theoretical feed $\sum_{i=1}^{N}\Pi_{ki}(t)$ of the plant components to the screw conveyor of the module for tops gathering from N root crops rows during the period of time t taking into account (6) and (8) is determined by the formula

$$\sum_{i=1}^{N}\Pi_{ki}(t)=\frac{dL_\vartheta}{dt}b_k t\left\{\begin{bmatrix}\frac{dL_\vartheta}{dt}b_k\Gamma_{k.c}(U_{1г.c}\pm\Delta U_{1г})\mu_{1г}+(U_{2г.c}\pm\Delta U_{2г})\mu_{2г}+\\+\ldots+(U_{Nг.c}\pm\Delta U_{Nг})\mu_{Nг}\end{bmatrix}+M_{б.c}\mu_б\right\}. \quad (9)$$

For the convenient practical application of the obtained dependence, we formalize the technological process of the tops gathering where we assume that the average tops yield of the 1st, 2nd, …., N-th root crops row is the same and equals $U_{г.c}$, and the interval of change in the tops yield of each N -th root crops row is equivalent and equals $\pm\Delta U_{г}$.

Then the real total theoretical feed $\sum_{i=1}^{N}\Pi_{ki}(t)$ of plant components to the screw conveyor of the module for tops gathering from N root crops rows during the period of time t taking into account (9) is determined by the final formula

$$\sum_{i=1}^{N}\Pi_{ki}(t)=\frac{dL_{\vartheta}}{dt}b_k Nt\left[\frac{dL_{\vartheta}}{dt}b_k\Gamma_{k.c}\left(U_{г.c}\pm\Delta U_{г}\right)\mu_{г}+M_{б.c}\mu_{б}\right]. \tag{10}$$

Thus, taking into account equation (10), the second feed $\Pi_k^{\bullet}$ (kg/s) of the plant components to the screw conveyor is determined by the expression

$$\Pi_k^{\bullet}=\vartheta b_k N\left[0{,}82\cdot10^{-3}\vartheta b_k\Gamma_{k.c}^{*}\left(U_{г.c}^{*}\pm\Delta U_{г}\right)+0{,}9M_{б.c}\right]. \tag{11}$$

Fig. 3a shows the dependences of change of the second feed $\Pi_k^{\bullet}$ (kg/s) of the plant components to the screw conveyor as the functional $\Pi_k^{\bullet}=f_{\Pi}(\vartheta;+\Delta U_{г})$ and $\Pi_k^{\bullet}=f_{\Pi}(\vartheta;-\Delta U_{г})$; Fig. 3b represents two-dimensional section of dependences $\Pi_k^{\bullet}=f_{\Pi}(\vartheta;+\Delta U_{г})$ and $\Pi_k^{\bullet}=f_{\Pi}(\vartheta;-\Delta U_{г})$ constructed according to (11).

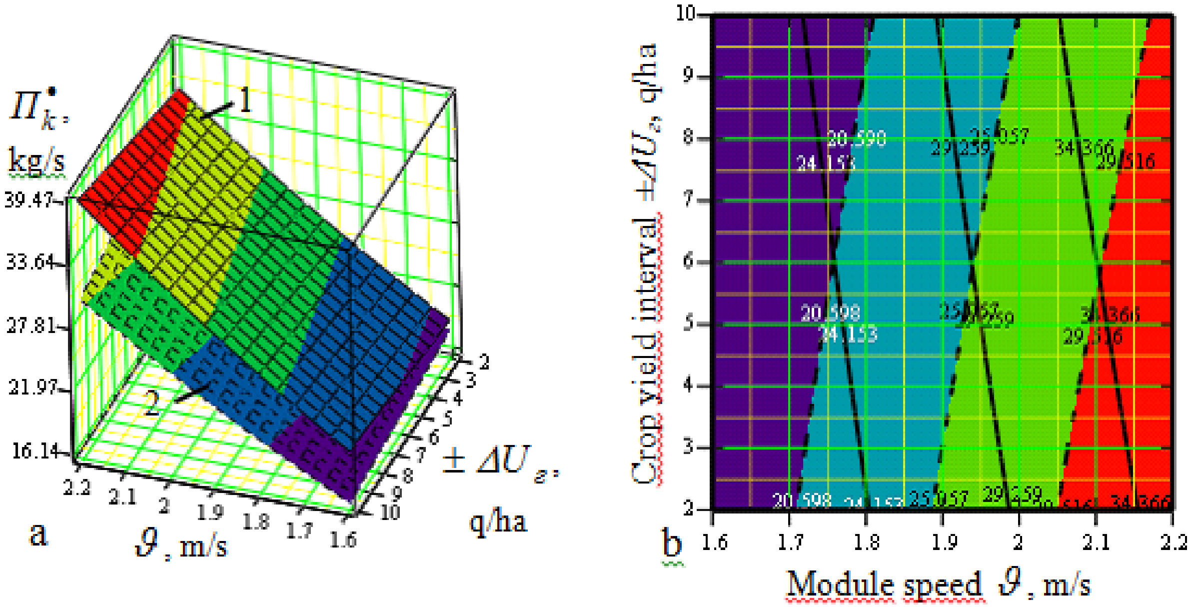

Figure 3. Dependence of the change of the second feed of plant components $\Pi_k^{\bullet}$ to the screw conveyor (a) as a functional: 1 – $\Pi_k^{\bullet}=f_{\Pi}(\vartheta;+\Delta U_{г})$; 2 – $\Pi_k^{\bullet}=f_{\Pi}(\vartheta;-\Delta U_{г})$; b – two-dimensional dependence cross-section $\Pi_k^{\bullet}=f_{\Pi}(\vartheta;+\Delta U_{г})$ and $\Pi_k^{\bullet}=f_{\Pi}(\vartheta;-\Delta U_{г})$

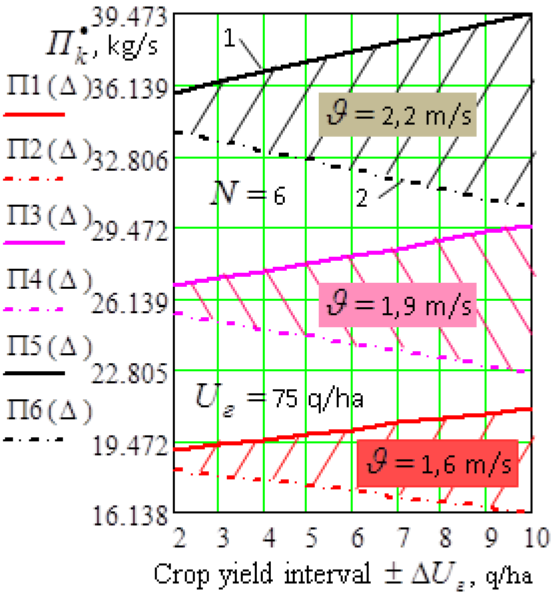

Figure 4. Dependence of the change of the second feed of plant components $\Pi^{\bullet}_{k}$ to the screw conveyor as a functional: 1 – $\Pi^{\bullet}_{k} = f_{\Pi}(+\Delta U_{\text{г}})$; 2 – $\Pi^{\bullet}_{k} = f_{\Pi}(-\Delta U_{\text{г}})$

Based on the given dependencies analysis (Figure 3) it was determined that within the limits of the tops yield change $\pm\Delta U_{\text{г}} = 2\ldots10$ dt/ha the second feed of plant components $\Pi^{\bullet}_{k}$ to the screw conveyor is within the limits of change range: provided $\Pi^{\bullet}_{k} = f_{\Pi}(\vartheta;+\Delta U_{\text{г}})$ from 19,5 to 39,5 kg/s; provided $\Pi^{\bullet}_{k} = f_{\Pi}(\vartheta;-\Delta U_{\text{г}})$ from 16 до 34 kg/s. These statements are also characteristic for the graphic dependencies behavior shown in Fig. 4, while the average value of growth (increase) or decrease (reduction) of the second feed of plant components $\Pi^{\bullet}_{k}$ to the screw conveyor within the limits of yield interval change equals 2,0 kg/s – for $\vartheta = 1{,}6$ m/s, 2,4 kg/s – for $\vartheta = 1{,}9$ m/s, 3,3 kg/s – for $\vartheta = 1{,}6$ m/s.

Conclusions. The analytical and applied model of the feed of plant components cut from the root crops heads to the screw conveyor by plant-top removing module is developed and determined on the analytical level change limits of the second feed of the plant components $\Pi^{\bullet}_{k}$ to the screw conveyor on the analytical level can be used for further substantiation of the structural and kinematic parameters of the operating parts of the module for tops gathering on the basis of the screw conveyor calculating efficiency analysis.

References

1. Rybak T.I, Tson O.P. Ohliad hychkovydaliaiuchykh aparativ buriakozbyralnyi mashyn ta shliakhy yikh vdoskonalennia. Visnyk Kharkivskoho natsionalnoho tekhnichnoho universytetu silskoho hospodarstva imeni Petra Vasylenka, no 134. "Tekhnichnyi servis mashyn dlia roslynnytstva". Kharkiv, Virovets A.P. "Apostrof", 2013, pp. 203 – 207 [In Ukrainian].
2. Martynenko V.Ia, Holovko S.I. Vyznachennia deiakykh kinematychnykh parametriv aparativ dlia zrizuvannia hychky tsukrovykh buriakiv. Visnyk natsionalnoho tekhnichnoho universytetu "Kharkivskyi politekhnichnyi instytut". Kharkiv, 2002, no. 7, pp. 97 – 100 [In Ukrainian].
3. Smal M., Herasymchuk O. Konstruktyvno-tekhnolohichnyi analiz obrizuvachiv holovok koreneplodiv tsukrovykh buriakiv. Innovatsion texnologiylar. Qarshi muchandislik-igtisodivot istituti, Qarchi, 2014, no. 2 (14), pp. 29 – 36 [In Ukrainian].

4. Tsen O.P., Popovich P.V., Tsen A.B. Rezultatyi eksperimentalnyih issledovaniy aktivnyih ploskih nozhey sveklouborochnyih mashin. Materialyi III Vserossiyskoy nauchno-tehnicheskoy konferentsii “Sovremennaya tehnika i tehnologii:problemyi, sostoyanie i perspektivyi”. Rubtsovsk, Rubtsovskiy industrialnyiy institut, 2013, pp. 135 – 138 [In Russian].
5. Zubkov V.E. Razrabotka universalnogo separatora korneklubneplodov ot komkov pochv. Naukoviy vIsnik NAU, Kyiv, 1998, vol. 9, pp. 204 – 209 [In Russian].
6. Protsenko O.O., Palamarchuk V.I., Kozachuk A.M. Dovidnyk z mekhanizatsii vyrobnytstva tsukrovykh buriakiv, 2-e vol. Kyiv, Urozhai, 1987, 264 p. [In Ukrainian].
7. Zubenko V.F., Onopriienko V.T., Fedchuk V.V. Dovidnyk buriakovoda. Za red. V.F. Hubenka, 2-e vol., pererob. i dop. Kyiv. Urozhai, 1986, 232 p. [In Ukrainian].
8. KD 46.16.01.005 – 93 “Vyprobuvannia silskohospodarskoi tekhniky. Osnovni polozhennia”. Kyiv, 34 p. [In Ukrainian].
9. Baranovskyi V.M., Solomka V.O., Onyshchenko V.B. Rezultaty doslidzhennia impulsu syly udaru ta kuta vidbyvannia koreneplodiv. Visnyk KhNTUSH. “Tekhnichnyi servis APK, tekhnika ta tekhnolohii u silskohospodarskomu mashynobuduvanni”, 2005, vol. 39, pp. 299 – 307 [In Ukrainian].
10. Tunik I.H. Rozrobka ta obgruntuvannia parametriv doochysnykh transporteriv buriakozbyralnykh mashyn : Diss. kand. tekhn. nauk. Lutsk, 2000, 149 p. [In Ukrainian].

Список використаної літератури

1. Рибак, Т.І. Огляд гичковидаляючих апаратів бурякозбиральних машин та шляхи їх вдосконалення [Текст] / Т.І. Рибак, О.П. Цьонь // Вісник Харківського національного технічного університету сільського господарства імені Петра Василенка. – Випуск 134. «Технічний сервіс машин для рослинництва». – Харків : Віровець А.П. «Апостроф», 2013. – С. 203 – 207.
2. Мартиненк, В.Я. Визначення деяких кінематичних параметрів апаратів для зрізування гички цукрових буряків [Текст] / В.Я. Мартиненко, С.І. Головко // Вісник національного технічного університету «Харківський політехнічний інститут». – Харків, 2002. – Вип. 7. – С. 97 – 100.
3. Смаль М. Конструктивно-технологічний аналіз обрізувачів головок коренеплодів цукрових буряків [Текст] / Марія Смаль, Олег Герасимчук // Innovatsion texnologiylar. – Qarshi muchandislik-igtisodivot istituti : Qarchi, 2014. – № 2 (14). – С. 29 – 36.
4. Цень, О.П. Результаты экспериментальных исследований активных плоских ножей свеклоуборочных машин [Текст] / О.П. Цень, П.В. Попович, А.Б. Цень // Материалы III Всероссийской научно-технической конференции «Современная техника и технологии: проблемы, состояние и перспективы». – Рубцовск : Рубцовский индустриальный институт, 2013. – С. 135 – 138.
5. Зубков, В.Е. Разработка универсального сепаратора корнеклубнеплодов от комков почв [Текст] / В.Е. Зубков // Науковий вісник НАУ. – К. : НАУ, 1998. – Т. 9. – С. 204 – 209.
6. Довідник з механізації виробництва цукрових буряків [Текст] / О.О. Проценко, В.І. Паламарчук, А.М. Козачук та ін.; за ред. О.О. Проценка. – 2-ге вид., перероб. і доп. – К. : Урожай, 1987. – 264 с.
7. Довідник буряковода [Текст] / В.Ф. Зубенко, В.Т. Онопрієнко, В.В. Федчук та ін.; за ред. В.Ф. Губенка. – 2-ге вид., перероб. і доп. – К. : Урожай, 1986. – 232 с.
8. КД 46.16.01.005 – 93 “Випробування сільськогосподарської техніки. Основні положення” [Текст]. – К. – 34 с.
9. Результати дослідження імпульсу сили удару та кута відбивання коренеплодів [Текст] / В.М. Барановський, В.О. Соломка, В.Б. Онищенко [та ін.] // Вісник ХНТУСГ. «Технічний сервіс АПК, техніка та технології у сільськогосподарському машинобудуванні». – 2005. – Вип. 39. – С. 299 – 307.
10. Тунік, І.Г. Розробка та обґрунтування параметрів доочисних транспортерів бурякозбиральних машин [Текст]: дис…канд. техн. наук: 05.05.11. – Луцьк : ЛДТУ, 2000. – 149 с.

УДК 631.31

АНАЛІТИЧНО-ПРИКЛАДНА МОДЕЛЬ ПРОЦЕСУ ПОДАЧІ ЗРІЗАНИХ РОСЛИННИХ КОМПОНЕНТІВ ДО ГВИНТОВОГО КОНВЕЄРА ГИЧКОЗБИРАЛЬНОГО МОДУЛЯ

Тимофій Рибак; Ганна Цьонь; Микола Сташків; Олег Цьонь

Тернопільський національний технічний університет імені Івана Пулюя, Тернопіль, Україна

Резюме. *Досліджено проблему, що полягає у необхідності вдосконалення існуючих та розробленні принципово нових гичкозбиральних механізмів і машин, оскільки важкі та змінні умови їх технологічної роботи йнедостатнє пристосування існуючих конструкцій гичкозрізувальних пристроїв до цих змін не дозволяють отримати високі агротехнічні показники, що регламентуються для процесу збирання коренеплодів. Згідно з аналізом останніх досліджень та публікацій існує потреба у детальнішому описуванні за допомогою математичного моделювання процесів, які відбуваються при збиранні гички з коренеплодів. Технологічний процес роботи модуля для збирання гички коренеплодів у першу чергу регламентується та значною міюиі залежить від технологічного подавання зрізаних ножами роторного гичкоріза рослинних компонентів до гвинтового конвеєра. Тому запропоновано аналітично-прикладну модель подавання зрізаних рослинних компонентів з головок коренеплодів гичковидаляючим модулем до гвинтового конвеєра, проаналізовано та визначено на теоретичному рівні можливі межі зміни технологічного подавання зрізаних ножами роторного гичкоріза рослинних компонентів до гвинтового конвеєра. Перевага запропонованої математичної моделі у порівнянні з традиційними полягає в урахуванні факторів впливу, таких, як урожайність гички у рядку, питома маса бур'янів у рядку, густота насаджень коренеплодів, швидкість руху корензбиральної машини. Запропоновані аналітичні залежності та функціональні закономірності зміни технологічного подавання гички від параметрів насаджень коренеплодів і технологічних показників роботи модуля можуть бути використані для подальшого обґрунтування конструктивно-кінематичних параметрів робочих органів модуля для збирання гички на основі аналізу розрахункової продуктивності гвинтового конвеєра.*

Ключові слова: *гичка, коренеплоди, різання, гвинтовий конвеєр, технологічний процес, ніж.*

Отримано 22.05.2018