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LABORATORY AND FIELD EQUIPMENT WORKINGOUT AND THE RESULTS OF EXPERIMENTAL STUDIES OF PRE- HARVESTING SUGAR BEET FIELD CONDITIONS

РАЗРАБОТКА ЛАБОРАТОРНО-ПОЛЕВОЙ УСТАНОВКИ И РЕЗУЛЬТАТЫ ЭКСПЕРИМЕНТАЛЬНОГО ИССЛЕДОВАНИЯ СОСТОЯНИЯ СВЕКЛОВИЧНОГО ПОЛЯ ПЕРЕД УБОРКОЙ

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Abstract: Described in the scientific literature the results of experimental studies and performance test of the technological process of sugar beet harvesting conducted in recent years have shown that modern sugar-beet harvesters manufactured in Europe and America work with significant losses of sugar-bearing plant materials. These losses are due to generally poor topping quality of sugar beet on a root. Therefore, nowadays the search of technical solutions enabling to avoid these losses is of great importance as it increases the yield of sugar-bearing plant materials per hectare of crops. The purpose of research is to reduce the losses of sugar-bearing plant materials in the course of separation process of sugar beet tops from heads of root crops on a root. While conducting research the methods of field experimental research on the measurement of physical parameters of the technological process were used, as well as methods of statistical processing of the measurement results with the use of computer. New experimental equipment was designed for the field experimental studies being equipped with modern electronic equipment with data transfer to a PC. As a result of the experimental investigation of the distribution heads heights above the ground of sugar beet roots confirmation has been received hypothesis that it does not deny the law of the normal distribution. The results of the multiple measurements enabled set limits of changes in their statistical characteristics, which are as follows: average statistical deviation $\sigma = 20 \dots 30$ mm, the expectation $m = 40 \dots 60$ mm. A new design of the laboratory equipment and results of the experimental studies, conducted on it, have given every reason to design and develop a new system of automatic adjustment of the height of cut tops, which can be used in designs of modern sugar-beet harvesting machines.

KEYWORDS: SUGAR BEET, HARVESTING MACHINES, EXPERIMENTAL STUDIES, LOSSES, SUGAR-BEARING PLANT MATERIAL, STATISTICAL DISTRIBUTION.

1. Introduction

The sugar beet production has undergone a substantial reduction in the world. There are many reasons for it, and this mechanism is rather complicated. The most significant among them need to be highlighted:

- hard competition in performance with other sugar crops;
- import of cheap sugar and chemical substitutes;
- the lack of exports to foreign markets;
- high cost of sugar beet under economic conditions of many countries compared with cereals;
- the absence of substantial support sugar of sugar beet producers.

Despite this decreasing, the world's production of sugar beet and, accordingly, the technical means for its mechanization remains relevant and cost-effective. That is why we compare the sugar beet production costs in Germany and Ukraine. As a result it was found that a profit of about 400-600 Euro per hectare of crops. Despite this, the problem on sugar-bearing plant material loss is quite severe and requires immediate solutions. Our task is to reduce these losses.

2. Preconditions and means for resolving the problem

2.1. Analysis of recent research and publications

An analysis of numerous designs of working bodies for removing sugar beet tops has been considered in detail in the works of scientists: L.V. Pogoreliy, V.M. Bulgakov, N.V. Tatyanko, R.B. Hevko, V.Ya. Martynenko, M.M. Khelemendyk, Ya.I. Kozibroda, S.V. Siniy, et al. But nowadays there are no designs of toppler that would satisfy the agro-technical requirements of sugar-bearing plant materials losses [1-6, 12-14].

We have concluded that modern machines mainly use cutting without copier, that is why it is necessary to determine the main factors of sugar-bearing plant materials losses to determine the main ways to reduce them.

2.2. Purpose of the study

Reducing the sugar-bearing plant materials losses in the separation process of sugar beet tops from root crop heads, creates the prerequisites for automatic correction of the foliage cutting height.

2.3 Materials and Methods

The object of this study is the process of topping on a root used cutting without copier. The study was conducted using methods of probability theory and mathematical modeling [10]. The results of the measurements have been processed by statistical methods using a personal computer. All experiments were carried out on the pre-developed plans experiments. Distribution of root crop heads was determined by means of specially designed laboratory equipment.

3. Results and discussion

To solve this problem of reducing the sugar-bearing plant materials losses we studied the availability of machinery in sugar beet producers, since the final state of height above ground distribution of root crop heads and their losses are formed during vegetation for the period from soil cultivation to the time of harvesting of root crops. It was established to ensure adequate machinery for soil preparation and sowing operations, as well as equipment for the protection and harvesting of sugar beet [7, 11].

Although, our task was to investigate the conditions of operation of equipment and quality of work in order to find out the problems. As for the sugar beet growth the primary parameters being formed by tillage operations are soil hardness and density, they were chosen as those under testing. The results of research showed that at sowing time these parameters did not meet to the agronomic requirements (fractional composition of the soil). In particular even the image (Fig. 1a), you can see a huge structural soil units being twice more than permissible requirements.

Therefore, the following colters and rollers operations (Fig. 2a and 2b) can not be performed according to agronomic requirements as for seeding depth, which results uneven heads height above ground of root crops. The above situation takes place in most companies. Thus at this production stage of sugar beet there is a problem that requires immediate solution, but it is impossible to do it quickly and effectively, as experience shows that any change in the technological or technical terms at the enterprise possessing of the acreage ten thousands hectares is possible to be realised for several years, but in most cases not possible at all. Despite the situation mentioned there is need to find ways of leveling influence of tillage on the harvesting process of sugar beet and weight loss of root crops.



Fig. 1. Typical condition of field surface before sowing sugar beet:
a – poor quality of the soil processing in terms of soil aligned and lumpiness; b, c – the work of sowing drills sections under unsatisfactory conditions

It was found that seeding quality indicators did not meet the agronomic requirements (sowing depth of the sugar beet crop ranges from 3.6 - 4.8 cm, which does not correspond to agro-technical requirements equal to $2 - 3 \pm 0.5$ cm).

We monitor machinery quality indicators for sugar beet harvesting. The main problems that were found in the course of study of the working environment are improper adjustment of topping and cleaning units of sugar-beet harvester. As a result, there were considerable excess of agronomic requirements as for the losses of sugar-bearing plant materials and residues of foliage as well as damage to root crops heads.

In the design of modern machines the rotor type topping units often used that cut off the head of root crops at the same level relatively to the surface of the soil. Selecting this cutting height is made according to the well-known recommendations, but in practice it is often difficult to adhere to it, sometimes even impossible, taking into account the probabilistic nature of the distribution of the heads height above ground of root crops.

Despite the information given consumers of sugar-beet harvesting equipment always have the problem of choosing the rational cutting height values under specific production conditions (various characteristics of sugar beet heads height above ground). In most cases, this problem can be solved by empirical methods (visual assessment of the work quality after a few working trips), which have to be repeated several times. This leads to unproductive expenditure of working time, which reduces harvesting performance. Under this conditions improper cutting height selection may take place increase in sugar-bearing plant materials losses.

Table 1. Holmer sugar-beet harvester performance under production conditions with extreme humidity of the soil

Indicators number	Indicators	Value, %
1.	Correctly topped roots	16
2.	Under topped roots	34
3.	Over topped roots	24
4.	Uncut roots	22
5.	Over topped roots below the sleeping cells level	2
6.	Severely damaged roots	68
7.	Slightly damaged roots	14
8.	Angled topped roots	14
9.	Roots with green heads	18
10.	Roots with broken tips	96
11.	Sugar-bearing plant materials losses at the cut heads	5,2
12.	Sugar-bearing plant materials losses due to cut heads	3,8
13.	Total sugar-bearing plant materials losses	9
14.	Tops contamination (according to the sugar factory data)	6...8

Therefore it is expedient to carry out the development of automatic regulator, which would provide solution to the problem of establishing the cutting height automatically in the process of sugar-beet harvester. For the development of this type of control it is necessary to determine the statistical distribution of the sugar beet heads height above ground. This problem has been considered by a number of scientists [6-9] and most of them prefer the normal law of distribution for it. The reliability of their results is in question because of the inability to obtain a large number of samples by manual sampling. Therefore, for assessment of parameters of the sugar beet field (plant distribution in a row, the distribution of heads height above ground, and the determination of losses when harvesting) laboratory and field equipment has been developed (Fig. 2).

Functional-block diagram of this equipment includes: input and output module, unit for measuring block control, sensor unit for the registration of sowing parameters. Algorithm of the program for control of measurement process height above ground of root crop heads is also developed. Structural scheme of laboratory and field equipment has been developed.

System of gyroscopes and accelerometers to study the fluctuations impact of sugar-beet harvester on the stability of working bodies was designed. Measuring unit design was developed as well as electronic module for control process of measurement locations parameter of sugar beet heads above the soil surface was worked out. The measuring unit contains the probes to indicate the presence of roots, probes to identify the position of the machine and height of roots head above the soil surface.



Fig. 2. Laboratory and field equipment in course of experimental studies

The basic causes of sugar-bearing plant materials losses (Table. 1):

- improper (unreasonable) adjustment of working bodies as well as technical and technological modes of operation of the equipment;
- untimely operations conduct in the process of sugar beet cultivation;
- baseless and unsuitable selected technological scheme of machines that are used for production of sugar beet (by types of working bodies).

All the above factors affect the yield of sugar beet and yield harvesting saving. To overcome this shortcoming, we propose the development of an automated system to establish the cutting height of sugar beet without copier. To achieve this goal, we have conducted research on the aforementioned laboratory equipment and received mechanical and technological prerequisites for establishing a system to prevent sugar-bearing plant materials losses.

Study of distribution of heads height above ground of root crops relatively to the level of the soil surface as a result of a large sample (50.0 thousand measurements) were processed using the developed program in Matlab software on the computer. According to the results of research it was found that the statistical distribution of heads height above ground of root crops corresponds to the normal distribution law. Change limits of statistical characteristics are as follows: the mean deviation $\sigma = 20 \dots 30$ mm, the expectation $m = 40 \dots 60$ mm.

The following parameters of sugar beet harvesting quality have been established: sugar-bearing plant materials loss - 4%, untopped roots - 2%, roots damage - 3%.

Using the developed mathematical model [5, 8], we have been received sugar-bearing plant materials losses depending on the cutting height of sugar beet head without copier.

The experimental studies have shown that it is possible to predict the mass loss of roots and tops contamination under specific conditions, having previously obtained the statistical distribution parameters (m , σ) as well as using a mathematical model presented in [5, 8]. This enables to automatically create the system for evaluating parameters of root crops and adjust height of the sugar beet topping in order to reduce sugar-bearing plant materials losses up to the level of agronomic requirements equals to 2%.

4. Conclusion

1. A new experimental equipment that allows carrying out field studies for plants distribution of sugar beet in a row, the heads height above the soil surface and possible loss of sugar beet at harvest.

2. As a result of the pilot study of heads height distribution of sugar beet heads above the soil surface confirmed the hypothesis that it obeys the normal distribution. The limits changes in the statistical distribution of characteristics that show the average deviation $\sigma = 20 \dots 30$ mm, the expectation $m = 40 \dots 60$ mm.

3. Experimental studies established the following best indicators of quality of sugar beet harvesting: sugar-bearing plant materials losses - 4%, tops on the remains of roots - 2%, roots damage - 3%.

4. The results of the pilot study have created the prerequisites for the creation of electronic system that automatically correct tops cutting height on the sugar-beet harvesters of modern technical level.

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THEORY FOR ATTACHMENT OF TRACTOR-DRIVEN SUGAR BEET HARVESTING MACHINES

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Abstract: An analytical study is related to giving proof and selection of the optimal parameters for the units, consisting of a tractor and a tractor-driven sugar beet harvesting machine. A mathematical model is built on the basis of this study and describes the conditions for effective attachment and give opportunity for determination of the working speed and productivity. The calculations allow finding the optimal parameters of the mentioned above aggregates in relation to productivity and energy consumption.

KEYWORDS: MACHINE AGGREGATE, TRACTOR, SUGAR BEET HARVESTING MACHINE, MATHEMATICAL MODEL, WORKING SPEED, PRODUCTIVITY, OPTIMAL PARAMETERS.

INTRODUCTION

High efficiency of the mobile agricultural machinery aggregates can be reached due to the achieving a proper ratio between the technical and operational parameters and external production conditions such as soil physical and mechanical properties, field slope, characteristics of the treated material, agrotechnical conditions of its treatment and etc.

Recently, the companies offer farmers a wide range of sugar beet harvesting machines, including tractor-driven ones. Typical machines can be two, three, four and six-row for harvesters.

The application of such types of machines increases the costs. Though, reducing the costs and resources consumption is a world tendency nowadays.

Analysis of the recent publications

A lot of research findings on the issue have been published, including recent ones, devoted to, for building of mathematical models related to the functioning of agricultural machines and machinery aggregates, [1-10].

The methods of building of mathematical models for tractor-driven agricultural machines, including sugar beet and flax harvesters are described in [2, 3, 6, 8].

Predicting the degree of rising productivity for the sugar beet harvesting machines, which depends on the relative capital inputs are presented in the fundamental manuscript, [11].

There is one part – a section of the optimal parameters for the tractor-driven sugar beet harvesting machines on the tractor power criteria is still not developed.

The effectiveness of tractor-driven sugar beet harvesting machines application should be estimated in combination with the power of a machine (the tractor). To determine its effectiveness is possible by using the quantity criteria, which describe their operational properties and technical perfection with sufficient degree of accuracy.

The number of such criteria should primarily include the productivity of the drawing unit, as well as, the productivity per 1 kW·h of the tractor power. Minimum of the operational costs and other parameters are also considered. [12].

Aim of the study

The purpose of the present study is the development of mathematical model related to the effective attachment of tractor-driven sugar beet machines, i.e. analytical determination of the aggregate's optimal parameters by using productivity and energy consumption criteria.

Methodology of the investigations

The method of building of calculated mathematical models for agricultural machines and units and their application are based on the presented study. The proper software has been developed.

Results and discussion

Well known analytical equations are used for the

development of new mathematical models for the effective mounting of tractor-driven sugar beet machines. Those equations are broadly used in scientific research and specific operational calculations.

The productivity of certain machinery units, consists of tractor and a tractor-driven machine. It is determined by already available relation, [13]:

$$W = 0,1B \cdot V_r, \text{ ha/h,}$$

where B is the machine width, m; V_r – working speed of the machine, km/h.

From equation (1), it is clear that the productivity increases in proportion to speed and the working width.

We have to mention that this is not a direct proportionality, because the both quantities are independent. When the working width increases, the velocity decreases and vice versa. The functional relations between the velocity and the working width determine the draft balance and the aggregate power balance.

The equation of the power balance in the case when the power unit consists of the tractor and tractor-driven sugar beet harvesting machine has the following expression, [14]:

$$N_e \cdot \chi = \frac{R_a \cdot V_r}{3600 \cdot \eta_t (1 - \delta)} = \frac{N_p \cdot B \cdot V_r \cdot H}{360 \cdot \eta_v}, \text{ kW,}$$

where R_a is the draft resistance of the tractor-driven harvesting aggregate, N; N_p – relative loss of energy when the process of sugar beet harvesting is executed, kW·s·kg⁻¹; H – the yield of sugar beet, t/ha; N_e – the nominal engine power, kW; χ – the coefficient of the engine loading; η_t – the tractor's transmission efficiency coefficient; η_v – the PTO efficiency coefficient; δ – the skidding.

The tractor-driven sugar beet harvesting machine draft resistance will be determined by the following ration:

$$R_a = R_i + R_f + R_m, \text{ N,} \quad (3)$$

where R_i , R_f – the tractor resistance to lifting and rolling, N;

R_m – drawing resistance of the sugar beet harvesting machine during operational time, N.

The left part of the drawing balance equation (2) numerically is equal to the tractor's drawing force and by this way insures overcoming of the resistance force, acting on the sugar beet harvesting aggregate. Namely:

$$R_i = mg \cdot \sin \alpha, \quad (4)$$

$$R_f = mg \cdot f \cos \alpha, \quad (5)$$

$$R_m = k \cdot B, \quad (6)$$

where: α – lifting angle, rad.; m – tractor's weight, kg; g – acceleration of the mass force, m/s²; f – resistance coefficient of the keel over the tractor; k – relative resistance of the sugar beet harvesting machine, N/m.

Coefficient k shows how all useful technical deformation which occurs during the harvesting period and movement resistance of the tractor driving a harvester change.

When the angle α value is low, then $\sin \alpha \cdot 100$ represents the percentage of the lifting, i .

Considering equations (3) and (4), (5), (6) the balance equation (2) can be presented in the following form:

$$N_e \cdot \chi = V_r \frac{(kB + mg \cdot \psi) \eta_v + 10 N_p B \cdot H \eta_t (1 - \delta)}{3600 \cdot \eta_t \eta_v (1 - \delta)}$$

where ψ – resistance coefficient which equals: $\psi = \sin \alpha + f \cos \alpha$.

Setting up the equation (7) in relation of V_r enables to determine the meaning of the sugar beet harvesting machine velocity on the field:

$$V_r = \frac{3600 \cdot \chi \cdot N_e \eta_t \eta_v (1 - \delta)}{(kB + mg \psi) \eta_v + 10 N_p B \cdot H \eta_t (1 - \delta)},$$

km/h.

The productivity can be calculated by the unit's working speed V_r obtained from the equation (8) and by using the relation (1).

While solving the equation (8), the coefficients χ , η_t and η_v should be given and the unit skidding must be determined.

Different empirical equations are in use when the tractor's skidding curve is determined during the field experiments.

In this case, to define the skidding the following relation is in use, [14] and has the following expression:

$$\varphi = \varphi_m - a e^{-b\delta}, \quad (9)$$

where φ is coefficient of split weight use; φ_m – the coefficient of the grip; a , b is permanent coefficients, which depend on the tractor's type and filed conditions.

In equation (9), the dependence between the δ unit skidding and the φ coefficient of coupling weight usage is given in the implicit form that is not convenient for carrying out the calculations.

With the help of algebraic transformation (9), we can get a formula for spilling, much more convenient for calculation

$$\delta = -\frac{1}{b} \ln \frac{\varphi_m - \varphi}{a}. \quad (10)$$

The variable φ in equation (10) can be calculated by using the expression:

$$\varphi = \frac{mg\psi + kB}{\lambda mg}, \quad (11)$$

where: λ is coefficient of the cleaved weight.

Equations (1), (8), (10) and (11) represent the mathematical model for adjustment of the tractor-driven sugar beet harvesting machine and allow to define analytically the velocity and productivity, with the aim to define the optimal value.

In the process of numerical calculations, it is necessary to pay attention on the agricultural requirements, related to the velocity of the sugar beet harvesting machines. It should be in the interval $1,5 \leq V_r \leq 4,0$ ms⁻¹ and the limitation caused by the tractor's cohesion on the soil surface, i.e. $\varphi < \varphi_m$.

The software has been developed for the implementation of the mathematical model in Math CAD media. This allows to calculate the operational parameters of several types of tractors and tractor-driven machines. It helps to choose suitable tractors for drawing the sugar beet harvesting machines and define the optimal field conditions.

It is possible to set up the mass m (engine's power N_e , coefficient λ , for each tractor's type. The coefficient's value of φ_m , a and b give specific levels for each field conditions. The sugar beet yield H , the relative losses during the technological process N_p , the maximum percentage of field slope i , the coefficient of resistance to tractor movement f and the PTO efficiency η_v for each numerical calculation have been mentioned at the very beginning. (8)

The transmission coefficient of efficiency η_t is changed in accordance to the tractor type, (for chain driving tractor it is equal to $\eta_t = 0,87$, and for wheeled tractors $\eta_t = 0,92$).

The relative resistance of the tractor-driven sugar beet harvesting machine k is setting up and ranges for each tractor type from 6000 up to 10000 N/m.

The change of working width for each sugar beet harvesting machine is between 0.90 m and to 2.7 m and has 0.45 m pitch i.e. it is changed from two-rows up to 6 rows as combination.

A separate file is created for each combination of the numerical calculations and consist of relative resistance for each working width for the sugar beet harvesting machines and corresponding velocity V_r , productivity W , drawing resistance

R_a , coefficient of using the attached weight φ and the skidding δ .

To calculate the parameters of the mathematical model a specific (average) values of the parameters were applied such as sugar beet yield $H = 30$ t/ha; relative energy losses accompany the sugar beet harvesting process $N_p = 1,75$ kWh/kg; the coefficients $\chi = 0,90$; $\eta_v = 0,95$; $f = 0,07$.

It is necessary to mention that sometimes the field slope is more than 5% and the relative resistance of the tractor-driven sugar beet harvesting machine (its average value) is

$k = 6000...10000$ N/m (the pitch of relative resistance change is $\Delta k = 1000$ N/m).

The technical data of the row-crop tractors which are used to drive sugar beet harvesting machines are presented in table 1, [14].

About 72 combinations have been developed for the placed input parameters and this allowed to obtain the optimal parameters for the tractor-driven sugar beet harvesting machine. They are attached to different types of tractors.

Table 1. Technical characteristics of the row-crop tractors

Drawing Class*, way of application	mg , kg	N_e , kW	φ_m	a	b
0.9 Wheel, universal soil tillage	3000	36,8	0,6	0,75	8,81
1.4 Wheel, universal soil tillage	3810	58,9	0,6	0,75	8,81
2 Chain, universal soil tillage	4580	51,5	0,67	0,753	47,6

*There is a specific tractors' classification which is based not on the engine power, but on the draft force of the tractor measured by 1000 kg·m/s². It is called 'Drawing Class'.

For tractor from class 0.9 has the maximum productivity $W = 0,60$ ha/h when the working width is $B = 0,9$ m; the pulling resistance of tractor-driven sugar beet harvesting machine is $k = 7000$ N/m and the velocity is $V_r = 6,63$ km/h.

In conclusion, the pulling class of the tractor ensures the maximum productivity when 2-row tractor-driven sugar beet harvesting machine is applied.

For the tractors 1.4 pulling class, the maximum productivity $W = 1,02$ ha/h can be obtained under two levels of the pulling resistance of the tractor-driven sugar beet harvesting machines $k = 7000$ N/m and $k = 9000$ N/m when the working width is $B = 1,80$ m and the velocity is $V_r = 5,68$ km/h and the working width is $B = 2,70$ m (six-row combination).

These indicators are obtained for the of 4-row tractor-driven sugar beet harvesting machine. In case of 2.7 m width and relative resistance of the tractor-driven sugar beet harvesting machine $k = 10000$ N/m, tractor from 1.4 class do not ensure the productivity caused by the lack of grip between the soil and the wheels.

For chain tractors from class two (2) the maximum productivity $W = 1,03$ ha/h will be when the working width is $B = 2,7$ m, the relative resistance of the sugar beet harvesting machine $k = 7000$ N/m and the velocity is $V_r = 3,80$ km/h.

In case of $B = 2,7$ m the working width and pulling resistance of the sugar beet harvesting machine $k = 10000$ N/m, the productivity is $W = 0,86$ ha/h and the working velocity is $V_r = 3,18$ km/h.

Conclusions

1. A new mathematical model for an effective attachment of the tractor-driven sugar beet harvesting machines has been developed. It which describes the conditions of the optimal attachment and gives an opportunity to define the velocity and the productivity of various machine combinations.

2. As a result of numerical modeling by using the PC program showed that the chain-moving tractor Class 2 will provide enough productivity working with tractor-driven sugar beet harvesting machine in two modes of the relative resistance which mean working in light and medium soils.

3. Wheeled tractors will ensure enough productivity when 2- or 4-row tractor-driven sugar beet harvesting machines are in use.

4. The results of the analysis and developed software for numerical modeling enable to define the optimal parameters for sugar beet harvesting machines, as well as for other combinations of tractor and harvesting machines. To define the optimal parameters is possible due to applying of the criteria of productivity and energy consumption.

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THE DESIGN AND THEORETICAL JUSTIFICATION OF A VIBRATORY DIGGER SHOVEL

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Abstract: In order to improve the technological process of potato harvester during operation in hard soil-climatic condition, vibratory digger shovel was created and mounted on exiting potato harvester produced by Grimme (RL 1700). Further laboratory and field experiments. Theoretically established mutual dependence between technology and design parameters of the vibratory digger shovel of potato harvester. Optimization of the parameters have been occurred by processing of the influencing factors using the theory of Similarity and dimensions.

KEY WORDS: POTATO DIGGER, VIBRATE DIGGER BLADE, PATATO HARVESTING TECHNOLOGY

1. Introduction

Among world's food products, potato after wheat, rice, and corn is the fourth well-known product. The annual production of potato is about 385 million tones around the world [1]. Potato crops has a key role to play in feeding the world's growing population. Harvesting potatoes is the most important process in the manufacture of its entire technology. For potato harvesting is spent 70% labor and 40-60% energy costs of the total costs of potato production [2]. Technological process of operation harvester involves cutting a potato rows, separation of tubers from the soil and placement them on the soil surface or gathering in a bunker, in case of combines. Cutting of potato ridges is the most important in operation of harvester, which largely determines performance of the following operations perfectly. Cutting of soil is the most energy-intensive process because requires considerable traction by the prime mover to pull plowshares through the soil. In many cases, over-sized tractors which are heavier and more powerful than necessary are often used - resulting is unnecessary soil compaction. One way alleviate this problem is to use vibrating digger blades which reduce draft and transfer some of the power requirements to the power take off. Another advantage of vibrating digger blade is the increased break-up of the soil which facilitate soil/potato separation and reduce damage to potatoes caused by soil clods.

Studies over the past 50 years have revealed that oscillation of a tillage tool can be very effective in decreasing draft force and improving the transfer of engine power to soil loosening [3,4].

The works has highlighted that the performance of oscillatory tillage depends upon the amplitude, frequency and oscillation angle. The effect of amplitude, frequency and oscillation angle β can be combined in a velocity ratio:

$$\lambda = \frac{\alpha \omega \cos \beta}{v} \quad (1)$$

Where, α - amplitude (m); ω - $2\pi f$ (angular velocity (rad/s); f = frequency (Hz); β = oscillation angle (deg); v -tractor velocity (m/s).

At the same time, due to climate change impacts harvesting tuber crops by machines is complicated, especially during work in heavy physical and mechanical composition soil. At harvesting time due to non-optimal conditions of soil increased traction resistance forces, not being sufficient break up of cut layer of soil, It significantly determines the reduction of quality indicators of harvesting technology. Digger blades of the existing harvesting machinery can not manage sufficient break up of soil, to compensate of this, it is made by increasing vibration Frequency and amplitude of the separators. Because of this increases mechanical damage of tubers by machine working body and also increases required power of the machine [5].

2. Precondition and means for resolving problems

In order to solve the current problems was developed design of a vibratory digger blade, which was mounted on exiting potato harvester produced by Grimme (RL 1700). The prototype has independent oscillatory input, which vibrate the hole "curve shape" blades horizontally. The oscillatory input is made of the eccentric shaft, with an attached digger blades. The direction of vibration and tilt angle of the blades can be changed from a special regulatory mechanism. It will be used in late field experiments to determine the effect of vibration on the dependent variables of draft, torque and soil break-up. Laboratory examination of mechanism is being at this time and field test is scheduled for later.

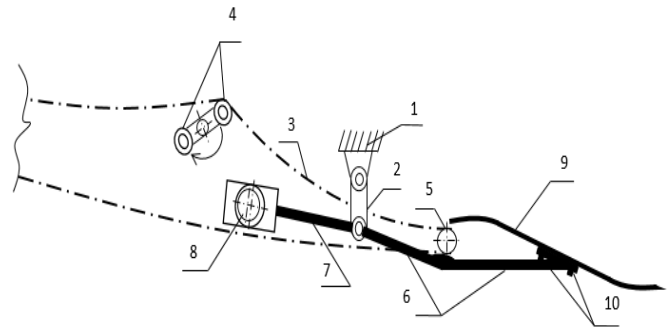


Fig. 1. Vibratory Digger Shovel

1-Cassis of Machine, 2-Link, 3-Elevator, 4-Shaker of Elevator, 5-Sprocket of Elevator, 6-Beam, 7-Beam of Vibration, 8-Eccentric Shaft, 9-'S'-Shape shovel, 10-Shovel Holders

Geometrical parameters of "S-shape" shovel defined in such a way that using of working surface of the concave-convex shape cut soil layer is suffering a compression deformation on concave section, while during transition to the convex section – stretch deformation. Thus soil deformation will be implemented in the opposite direction during the movement on the concave-convex surface.

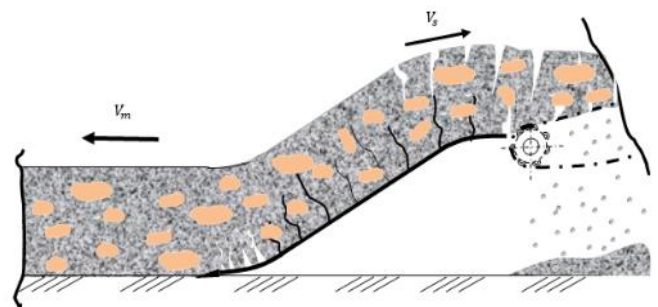


Fig. 2. Operation of S-Shape Shovel

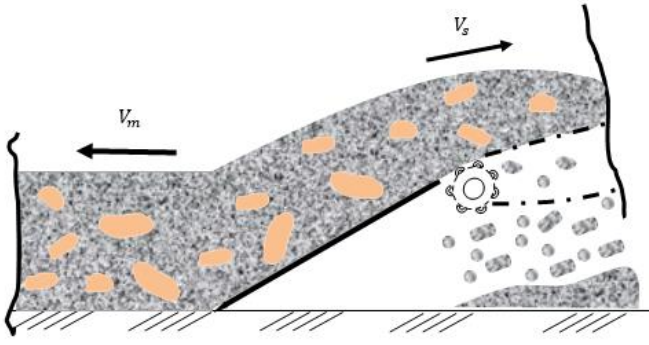


Fig. 3. Operation of Flat Shovel

Therefore, in addition to the effect of reducing energy intensity by chopping reduce the strain rate, this form allows to realize the effect “Baushinger”, thus achieving additional energy savings. Due to complexity of analytical modeling of the current processes in soil, defining of the concave-convex shapes for using potato digging should be experimentally.

To get the potato harvester work effectively geometrical parameters and working regimes of digger shovel would be selected correctly. In accordance with this determined equations of motion of the tip of the shovel [6]:

Displacement

$$x_x = ut + r(1 - \cos \omega t) \quad (2)$$

$$x_y = -r \sin \omega t \quad (3)$$

Velocity

$$v_x = u + r\omega \sin \omega t, \quad (4)$$

$$v_y = -r\omega \cos \omega t; \quad (5)$$

Acceleration

$$a_x = r\omega^2 \cos \omega t, \quad (6)$$

$$a_y = r\omega^2 \sin \omega t; \quad (7)$$

Where,

u – speed of machine, t – time, r – amplitude of vibration, ω – angular velocity of vibration.

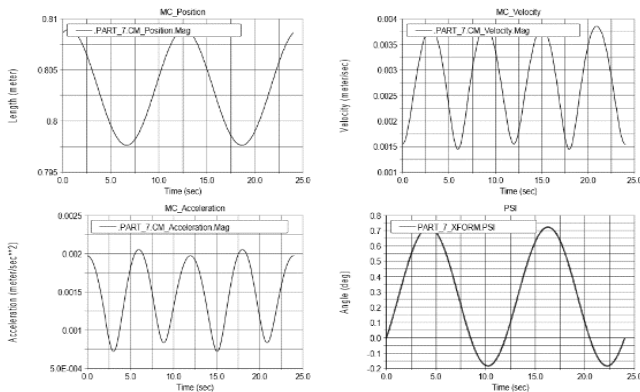


Fig. 4. Graphs of tip movement of the shovel

Investigation of similarity criterias were carried out for planning of experimental studies. The purpose of processing of the mathematical model was identifying such optimal values of regulatory factors, whereby the traction resistance force of harvester would be minimal.

Title	Symbol	Dimension	Dimension by LMT
Length of digger	L	M	L
Width of digger	B	M	L
Tilt angle of digger	θ	Rad	-
Frequency of oscillation	ω	Sec ⁻¹	T ⁻¹
Amplitude of oscillation	Q	MM	L
Soil density	ρ	Kg/m ³	ML ⁻³
Draft	F	N	MLT ⁻²
Moisture content of soil	W	-	-
Operational depth of digger	h	M	L
Acceleration of gravity	g	M/sec ²	LT ⁻²
Velocity of machine	V_m	M/sec	LT ⁻¹
Velocity of elevator	V_e	M/sec	LT ⁻¹

The functional relationship between the parameter of optimization and influencing factors looks like:

$$F = f(L, h, B, \omega, Q, \rho, W, g, V_m, V_e, \theta) \quad (8)$$

Basic values have been chosen - V , ρ and g , which dimensions can be represented as follows:

$$[\rho] = ML^{-3};$$

$$[g] = LT^{-2};$$

$$[B] = L;$$

Determinant indicators of the degrees of these variables is equal:

$$\Delta = \begin{vmatrix} 1 & -3 & 0 \\ 0 & 1 & -2 \\ 0 & 1 & 0 \end{vmatrix} = -2 \neq 0$$

When defining parameters are known from the basic selected values, similarity criteria can be expressed so:

$$f\left(\frac{\omega}{\rho^\alpha g^\beta V^\gamma}, \frac{V_m}{\rho^\alpha g^\beta V^\gamma}, \frac{V_e}{\rho^\alpha g^\beta V^\gamma}, \frac{L}{\rho^\alpha g^\beta V^\gamma}, \frac{h}{\rho^\alpha g^\beta V^\gamma}, \frac{Q}{\rho^\alpha g^\beta V^\gamma}, W, \theta\right) \quad (9)$$

Degree indicators of values of the equation (9) should be chosen so that, if inserting of dimensions instead of their values received complex should be remained dimensionless.

$$\frac{F}{\rho^\alpha g^\beta V^\gamma} = \frac{MLT^{-2}}{[ML^{-3}]^\alpha [LT^{-2}]^\beta [L]^\gamma} = M^{1-\alpha} L^{1+3\alpha-\beta-\gamma} T^{-2+2\beta} = L^0 M^0 T^0 = 1 \quad (10)$$

By the degree indicators of dimensions getting three algebraic equations:

Degree indicators for - M

$$1 - \alpha = 0;$$

Degree indicators for - L

$$1 + 3\alpha - \beta - \gamma = 0;$$

Degree indicators for - T

$$-2 + 2\beta = 0;$$

Solve these equations:

$$\begin{cases} 1 - \alpha = 0 \\ 1 + 3\alpha - \beta - \gamma = 0 \\ -2 + 2\beta = 0 \end{cases} \begin{cases} \alpha = 1 \\ \gamma = 3 \\ \beta = 1 \end{cases}$$

Putting of these values of the degrees to appropriate complex of equation (9), getting the following similarity criteria:

$$\pi_1 = \frac{F}{\rho g B^3} \quad (8)$$

In the same way:

$$\frac{\omega}{\rho^\alpha g^\beta B^\gamma} = \frac{T^{-1}}{[ML^{-3}]^\alpha [LT^{-2}]^\beta [L]^\gamma} = M^{-\alpha} L^{3\alpha - \beta - \gamma} T^{-1 + 2\beta} = L^0 M^0 T^0 = 1 \quad (11)$$

$$\begin{cases} -\alpha = 0 \\ 3\alpha - \beta - \gamma = 0 \\ -1 + 2\beta = 0 \end{cases} \begin{cases} \alpha = 0 \\ \gamma = -\frac{1}{2} \\ \beta = \frac{1}{2} \end{cases}$$

$$\pi_2 = \omega \sqrt{\frac{B}{g}};$$

Also,

$$\frac{V_m}{\rho^\alpha g^\beta B^\gamma} = \frac{LT^{-1}}{[ML^{-3}]^\alpha [LT^{-2}]^\beta [L]^\gamma} = M^\alpha L^{1 + 3\alpha - \beta - \gamma} T^{-1 + 2\beta} = L^0 M^0 T^0 = 1 \quad (12)$$

$$\begin{cases} \alpha = 0 \\ 1 + 3\alpha - \beta - \gamma = 0 \\ -1 + 2\beta = 0 \end{cases} \begin{cases} \alpha = 0 \\ \gamma = \frac{1}{2} \\ \beta = \frac{1}{2} \end{cases}$$

$$\pi_3 = \frac{V_m}{\sqrt{gB}}$$

Similarity criteria composed of the rest of the factors will be likewise:

$$\pi_4 = \frac{V_e}{\sqrt{gB}}; \quad \pi_5 = \frac{L}{B}; \quad \pi_6 = \frac{Q}{B}; \quad \pi_7 = \frac{h}{B};$$

$$\pi_8 = W; \quad \pi_9 = \theta;$$

$$\frac{F}{\rho g B^3} = f\left(\omega \sqrt{\frac{B}{g}}; \frac{V_m}{\sqrt{gB}}; \frac{V_e}{\sqrt{gB}}; \frac{L}{B}; \frac{Q}{B}; \frac{h}{B}; W; \theta\right) \quad (13)$$

$$F = \rho g B^3 f\left(\omega \sqrt{\frac{B}{g}}; \frac{V_m}{\sqrt{gB}}; \frac{V_e}{\sqrt{gB}}; \frac{L}{B}; \frac{Q}{B}; \frac{h}{B}; W; \theta\right) \quad (14)$$

The resulting overall view of criterion equation is the scientific basis of the pre-planned experiments to find the optimal conditions and modes of designed vibratory digger shovel.

3. Conclusion

- “S-shape” vibratory digger shovel was created and mounted on exiting potato harvester produced by Grimme (RL 1700), Further laboratory and field experiments.
- Theoretically established bilateral relations between technological and constructive parameters of the vibratory digging shovel.
- Influential factors analysis of traction resistance force was done by the theory of similarity and dimensions and composed criterial equations

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SEED DRILL WITH COULTERS IN THE TECHNOLOGY OF SEPARATE SOWING AND FERTILIZER INTRODUCTION

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In the northern regions of Kazakhstan sowing of the agricultural crops mainly is carried out by the drills and fertilizer cultivators from abroad. Depending on the culture and the soil drills are completed with different openers and sets of working bodies: one-disk, cultivator point with two-line or one-line openers, etc. They provide different ways to make the seeds and the fertilizers: fertilizing together with the sowing of seeds; fertilizer and seeds separately in different soil horizons; mineral fertilizers away from the row [1].

From the review of the design and technological schemes of core grain fertilizer drills it follows that in most parts of the designs of the planters SZTS-6 SZTS-12-ESS 2.1, John Deere, Amazonia, Massey, Fergysen, Astra 3,6, Astra Nova 5 4A -06; SZ-3,6A and others seed and fertilizer is carried out simultaneously in one row (one depth of the horizon). Most foreign planters are equipped with double disc coulters and one line press wheels, i.e. single node design [2]. The main drawback of this method is the insufficient effectiveness of fertilizers, especially at low soil moisture seed layer.

In other configurations, seeders, such as John Deere 1895, TUME Nova Combi, HORSCH Sprinter ST etc. the application of fertilizers and seeds is produced separately in different soil horizons. To make use of this method double opener Horsch "Duet" is used which provides broadband seeding at 18-20 cm depth of seeding up to 7 cm. The opener "Duet" is capable in one operation to sow, fertilize and at the same time cultivate the soil and effectively remove crop residues from horizon crop [3]. A distinctive feature of this opener is that it allows you to apply a system of simultaneous application of fertilizers in the soil just below the strip planting at a depth of 4-5 cm below the horizon. This eliminates the possibility of chemical burns of the seeds. However, the disadvantages of this type of opener is that it does not produce a continuous tillage and cropping of weeds, and also combines the operations of soil cultivation and seeding. As a result, an increasing number of manufacturing operations, and as a consequence, increase energy consumption for tillage.

Construction and fertilizers have a universal pneumatic seeders UPS and UPS -8 -6 Nova Combi firms, allowing to make fertilizers away from the row with the seeds with the required offset value [4]. For carrying out of this method additional openers are set which impair their patency at work on stubble, and increase the cost of the drill. The main operating element is a fertilizer distributing coulters unit. The planters also direct sowing Amazone DMC Primera such work items are chisel coulters with a distinct ability to penetrate into the soil. [5]. The disadvantages of these working elements is the complexity of their design, and power consumption of the process. In addition, the bulk of the seeds introduced with deviations from the desired depth, which often reach 0.03 m or more [6].

The main disadvantage of all the above drills is that fertilizers are used only in the case where the seed layer of soil humidity favors the formation of secondary root system, i.e. where the root system of plants is higher fertilizer layer. In other cases, when there is insufficient moisture seed layer, the root system of plants is below the layer sown and fertilizers are not used as a starter, in the initial period of plant development. In addition, there is evidence showing undesirable contact of mineral fertilizer with the seed, affecting seed germination.

In addition, for the separate application of fertilizers and sowing seeds different types of openers are used, including combined. Depending on the design of coulters, fertilizer may be sealed together or separately with seeds. The review of existing

designs openers used in the agricultural industry has allowed to establish a number of shortcomings, which greatly affect the quality of the crop, which in turn leads to lower yields.

Summing up the above analysis, we note the existing drills and working bodies to separate seed and fertilizer do not fully ensure the implementation of agro-technical requirements for the zone of Northern Kazakhstan. Therefore, the creation of stubble sowing and fertilizers with a separate seed and fertilizer is a major challenge. The novelty of the proposed seeder is that the implementation of the separate seed and fertilizer at planting is done at the expense of modernization and seed boxes are sealed parts. The formulation and fertilizers stubble seeder with a separate seed and fertilizer put the scheme tested in different soil-climatic zones of the CIS-planters cultivators type ESS, namely SZTS 2.0 while performing presowing loosening the soil, seeding, and fertilizers introduction and after sowing compacting.

A constructive and technological scheme of the proposed stubble seeders and fertilizers with a separate seed and fertilizer was developed. Features and fertilizers stubble seeder with a separate seed and fertilizer are: tray, which directs seeds and fertilizers separate thread; as opener stacked seed and fertilizer in different soil horizons and extended the lead packer section.

To improve the efficiency of fertilizers and crop yields, we developed an experimental cultivator tip opener to separate seed and fertilizer [7], which consists of a tubular bar, cultivator tip, two side plates, brackets, seed director and couplings. From the structural and process analysis technology separate seed and fertilizer the following design parameters of drill coulters are identified: diameter of seed director 25 mm, work of the seed director vertically 50 mm and the work of the seed director horizontally 50 mm, the distance from the lowest point of the seed director to the bottom of plate 105 mm, Figure 1.

It is known that at a minimum, and the traditional technologies of cultivation of agricultural crops sowing coulters make existing seed and fertilizer in one horizon. In this case the fertilizer used efficiently, since they are located above the plant root system and are not used as starting that adversely affect plant growth and productivity. In addition, the openers are used, which make fertilizer below the level of seeding, however, these workers are also very expensive and not adapted to the soil conditions of Northern Kazakhstan.

To solve these problems we have proposed Tine experimental opener for separate seed and fertilizer, with a diameter of seed director 25 mm, travel of seed director vertically 60 mm, seed director travel horizontally 70 mm, the distance from the bottom of feet to the bottom of plate 30 mm, Figure 2.

Separately, the technological schemes of the trays are justified, then trays were designed for crop seeds and fertilizers. The tray consists of two parts: the seed and fertilizer, each part ends with sleeves. The slope of the inside of the wall exceeds the value of the friction angle of the seed and fertilizer on the tray material. The design parameters of the tray with seed and fertilizer distributing machines: 300x210x48 mm and the diameter of the sleeve for joining *semyatukoprovodov* 26 mm. The distance between the points of connection to fertilizer box is 180 mm. Nine trays were prepared to separate seed and fertilizer for the pilot drill.

Based on the research and development, scientific and design organizations and firms of CIS and foreign countries, and as well as on the results of search experiments conducted in S.Seifullin KazATU experimental setup of stubble seeders and fertilizers with a separate seed and fertilizer was proposed.

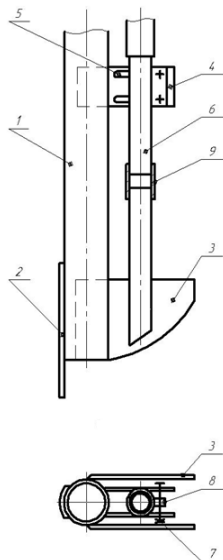


Figure 1- drill furrow-opener point for separate seed and fertilizer introduction

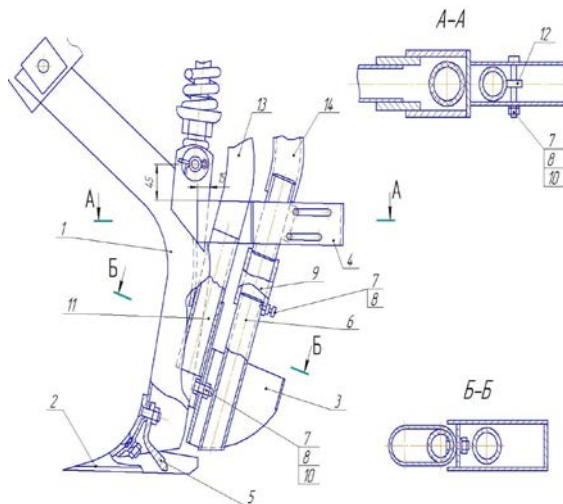


Figure 2 – Sweep cultivator for separate seed and fertilizer introduction

To obtain reliable results and conclusions on the justification of parameters of working organs of tine opener and preparing the recommendations to the production further research is necessary.

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THE DESIGN OF A TEST MODEL COMBINE HARVESTERS SHOWING THE LOCATION ELECTROMAGNETIC RADIATOR

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Abstract: *The program and methods of field research combine harvester equipped with a system of low-frequency electromagnetic radiation grain material; specification for the design of combine radiators with the system in different locations in the course of promoting the grain of the material from the hopper to the ISU.*

KEYWORDS: COMBINE HARVESTER, EXPOSURE GRAIN MATERIAL, PROGRAMME AND METHODS OF RESEARCH

1. Introduction

The monitoring of the application of various types effects on cereal grain showed that most a positive effect on grain low-frequency electromagnetic radiation: increased germination, increased vigor, increases the ability of seeds to the long-term storage by almost 40%. However, this result was achieved under stationary conditions on small batches of seeds. There is a need to check the effect of exposure to the effects of mobile applications, directly in the processor, working on the moving bed of grain material in different working bodies combine [1-4]. The development relates to methods for threshing crops by magnetic treatment of freshly threshed seed to change its biophysical, biochemical, physical and chemical properties and can be used in agriculture for seed magnetization during the threshing of different types of crops at harvest.

The research on the effects of magnetic field to the seed in the field. To this end, it developed a technological design for processing seeds Combine harvesters "Yenisei-1200 HM". The design of transporting the working bodies of the threshing mechanism to the grain tank were mounted 3 modules source of low-frequency electromagnetic oscillations to influence them in the moving portion of the freshly threshed grain. Electromagnetic radiation in the range of 10-20 minutes has the greatest impact on the quality of seed grain, which suggests that the irradiated grain enough going into the combine hopper and, accordingly, it is necessary to irradiate the other stages of the process of work the combine. Influence of electromagnetic radiation on the geometric parameters of the grain, its shape and weight of 1000 grains is not much. This is accompanied by the growth of the mass of plants grown from seeds magnetized. The irradiation of the grain using a device "Almag - 02" optimal mode corresponds to the program number 23 with the following parameters: the magnetic induction $B=6$ mTs, frequency - 16 Hz. It is advisable to proceed with field studies on the effect of irradiation on grain using other models of combine harvesters to harvest the different varieties and types of crops.

The program and methods of field research combine harvester equipped with a system of low-frequency electromagnetic radiation grain material; specification for the design of combine radiators with the system in different locations in the course of promoting the grain of the material from the hopper to the ISU.

2.1. Preconditions and means for resolving the problem

Increased agricultural production and the volume of production can be achieved through the use of proven practices and the development of scientific advice that is specifically designed for intensive plant cultivation technology. The use of such techniques would lead to increase yield and improve the quality of crops and, as a result, a significant increase in economic efficiency of agricultural enterprises. This cannot be achieved without the introduction of technology in the agricultural achievements of modern physics, chemistry, electronics and biology. Bringing innovative agricultural technologies will lead not only to a

significant reduction in energy costs and, accordingly, reduce the cost of production, but also to achieve the highest plant yield by increasing the potential productivity of varieties, seed quality and farming techniques of cultivation of plants [4].

For effective use of environmentally friendly sources of physical stimulation of plant growth, you need to install the particular impact of the types of natural stimulants, including natural and artificial sources of energy, magnetic field, electromagnetic radiation, on the condition of the plants; identify the relationship between the parameters of these sources of plant stimulating effect depending on their type and section type; dependence need to organize the plant response to the impact of a source to determine the mechanism of the effect of physical stimulation on the biochemical and biophysical processes in plants; identify factors that determine the completeness of the implementation of the genetic potential of seeds, increase the yield and resistance to environmental stress.

Many of [4], devoted to research of complex preplan effects on plant seeds in the laboratory. It uses laser light with a wavelength of 632.8 nm, a corona discharge electric field with strength of 1-5 kV/cm, gradient magnetic field with magnetic induction 2-20 mTs/cm. Also described exposure carried out in the field: magnetic field, electric corona field polarized red laser radiation and separately each individual factor, or in combination with each other. Some general regularities of the influence of physical factors on the rate of growth and development of higher plants have been established. So regardless of the current average value of a physical factor stimulation of plant growth reached +10 - + 40% relative to the control samples, not treated with a stimulant. There is a "non-specific biological response" to stimulate the action of weak physical factors of growth and development. Processing crops by natural stimulants may increase their productivity by increasing germination energy of seed germination and seedling [5-11 et al.]; by improving disease resistance, resistance (resistance) to the fungal, bacterial, etc., by disease seed disinfection [12-17 и др.]; variation of mineral composition [18,19], as well as the change in morphological and physiological characteristics that influence the transport properties, water absorption of seeds [20-23 et al.]. The effects are dependent on the processing method, the type and source of stimulation parameters.

2.2. Solution of the given problem

Positive results of electromagnetic processing grain materials achieved under stationary conditions on small batches of seeds. There is a need to check the effect of exposure to the effects of mobile applications, directly in the processor, working on the moving bed of grain material in different working bodies combine. Proposed by the authors method of threshing crops by magnetic treatment of freshly threshed seed to change its biophysical, biochemical, physical and chemical properties can be used in agriculture for seed magnetization during the threshing of different types of crops at harvest.

In the process of threshing crops include grain threshing division of straw mass on the productive and non-cereal part of the

crop during threshing, threshing drum beater type of classical performance, carried out at the same time magnetic treatment of freshly threshed productive part of the harvest in the pass-through mode.

Also, in the method of threshing crops productive magnetic treatment of the crop threshing process is carried out: fruitful initial velocity increases mass of 1.8 to 8.0 m / s in the threshing apparatus; increasing distance between pests ranging from 180 to 280 mm, respectively, and the number of pests from 6 to 12; increasing the length of the concave sweep; increasing drum diameter from 380 to 800 mm in length at a constant sweep concave.

And the threshing process is carried out: threshing drum of smaller diameter (380-500 mm) with the same length of concave and supply fruitful mass; with different profiles drum pests; open drum (free space between the whips and whips with under the whip) having an active angle of attack of 30-60 °; closed drum (solid cylinder) with attached to it the women without an active attack angle (less than 30 °); with increasing "live section" concave (ratio of the area under the holes to the total area of concave) 0 to 40%; when the distance between the concave strips from its beginning to the end of the variable, and, with a large distance in the first and last zones and smaller in the middle of the concave; so that a productive part of the harvest of different cultural influences various magnetic fields with the optimal settings for each of them [1-5].

Combine harvester and seed crops containing installed in series on the downstream side header, feeder, and a number of local self-government bodies of transporting workers (grain, augers, elevators, etc.) from the grind up the grain tank is modular transporting workers authorities, where each housing unit is equipped with a device of a magnetic field to influence them in the moving portion of the freshly threshed seed from ISU to combine grain tank in the pass-through mode. Wherein at least one module the device is provided with a magnetic field.

Purpose - to identify the effect of the effects of low-frequency electromagnetic radiation moving in the combine grain material layer. Aftereffect evaluated on physical and mechanical properties of the grain, seed quality and capacity for long-term storage.

The objectives and the research program:

1. Fixate characteristics agro background.

2. Взять пробы зерна из бункера на четырех режимах работы комбайна- 30,50,75 и 100% от номинальной нагрузки на комбайн.

Take a sample of the grain silo in the four modes combine - 30,50,75 and 100% of rated load on the processor.

Three 100 gram sample in 3 replicates.

3. Each feed grain weight per harvester combine to determine the speed of movement during the experiment, the loss of grains, cereals, grains and cleanliness bunker data recorded in Table 2.

4. Each feed grain mass to take a grain sample from the bunker on the three modes of electromagnetic irradiator system.

1st mode - emitters included only over shakes board, all the rest are off.

2nd mode - emitters included only a grain auger, all the rest are off.

3rd mode - enabled emitters are combine in the hopper; all others are turned off. At the same time samples are taken after the complete filling of the hopper.

4th enabled transmitter shakes on board and a grain auger.

5th mode - full emitters.

This mode combines work to the full capacity grain silo and samples are taken from three different places of the hopper. The experience is repeated three times. Since the research program provided for the gradual incorporation of radiators in all three base points, then we can determine the effectiveness of each place. The third place is characterized in that the grain long time exposure

occurs, and a thick fixed bed. Table 1 provides a summary quantitative assessment of three basic locations of electromagnetic emitters.

Figure 1 is a flow diagram indicating the combine basic locations of electromagnetic emitters.

Table 1 - Characteristics of the basic installation locations emitters

Basic installation location	Irradiates. material	The average density of the material, kg / m ³	The thickness of the irradiated material, mm	Movement speed layer, m / s	Approximate time finding material in the irradiated area.
№1 shake over board cleaning	grain with chaff	200-250	40-60	to 1,0	0,5-3 sec.
№2 a grain auger	refined grains	750-800	60-80	3-5	2-8,0 sec.
№3 combine in a bunker	refined grains	750-800	800-1000	0	10-40 min.

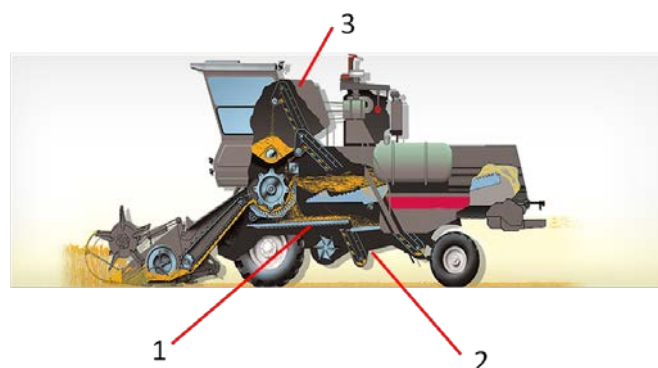


Figure 1 - РСМ " Нива-Эффект " (1, 2, 3- base emitter location)

The methodology of field trials

1. Sampling of irradiated grains under different schemes enable emitters to base their locations should be carried out by fixing the supply of grain mass in the harvester during the experiment, as well as grain loss and fragmentation. This requirement is for two reasons. First - it is necessary to respect the reality of the process under study combine work and to ensure the accuracy of the results. The second - the change in the supply of grain mass in the processor means changing the number of irradiated material, and hence the degree of his exposure to electromagnetic radiation. Maybe for sample analysis results obtained so that effectively irradiate only at low feed rates, or vice versa - no feeding.

2. The process of sampling and processing should be carried out in accordance with current standards in the Republic of Kazakhstan on the test methods of harvesting. In this document, it marked only the specific features of tests in connection with a new focus of research

3. Evaluation combine functional parameters are performed in the optimal timing for agronomic harvesting zones. In the absence of the required area of soil fertility tests are carried out in real conditions prevailing in agreement with the developer of the manufacturer. These indicators with the quality of the test machine are compared only with indicators of the quality of analog.

4. To determine the functional parameters selected portion sizes which may allow for testing of all scheduled modes. For each mode field harvester portion should have a length, on which a

machine manages to dial a predetermined speed and the process enters a steady mode.

5. Tests carried out on the harvester thresher one main culture in the area, the culture, for which they are designed according to TK, TU.

6. Prior to the testing machine shall be run, and adjusted according to the operating instructions and work at least 10 hours. Adjust the speed of the machine and the working bodies in the tests performed in the intervals between accounts plots. Accounting logging site experienced by the machine should be held at a constant speed.

7. The same combine, but with disabled irradiators used as an analogue.

2.3. Results and discussion

All grain samples on all radiators operating modes are stored in separate samplers (sacks, bags, etc.) and used in the future for the laboratory analysis of the quality of grain and subsequent seeding into the soil for the assessment of crop quality.

Careful selection and individual samples of grain (seed) and their subsequent analysis should allow answering four questions:

- whether the electromagnetic radiation affects the quality of the grain?

- if there is enough time for irradiating the grain in the successive three places or enough of any one or two?

- where effectively install electromagnetic emitters?

- on a feed grain mass efficiently produce electromagnetic radiation of grain (whether, in general, the value of feed grain weight per combine).

Requirements to test modes

1. Quality indicators implementation process of work the combine should be determined in the four working speeds at which performance is achieved within 30, 50, 75, 100% of the nominal.

2. Rated W_H combine performance is determined by the formula:

$$W_H = 1,44 q_k, t/h$$

where q_k - a potential capacity of the combine at a ratio of weight to the weight of the grain straw 1.5.

Depending on the used combine takes the following bandwidth: for « Niva-Effect » - 5,6 kg/s; « Yenisei-1200NM » - 5,8 kg/s; « Vector-420 » - 8.8 kg/s; « Don-1500B » - 9.5 kg/s; « Akros - 540 » - 10.5 kg/s; « Torum-740 » - 12.6 kg/s.

3. In the course of the experiments are not allowed to change the settings of the working bodies grind at all speeds combine movement.

4. When sampling to assess the grain loss is recommended to use special wooden frame size 4400x1500 mm covered with rubberized canvas. Frames are thrown to the ground under the harvester in the region of space between the rear wheels combine and bottom stacker. Frames are emitted every 5 meters at an equal distance.

5. Each experiment included a system of electromagnetic emitters combine to work to complete filling of the grain silo.

6. Each sampling of spent grain is placed in a separate package (sampler), together with a label indicating the experience of the hotel.

2.4. Conclusion

To date, to increase the yield of crops most widely used stimulant physical energy, which laid the basis for the action of magnetic and electromagnetic fields. At the same time a lot of attention is paid to a high-frequency, low-frequency radiation sources taxi. The problems of achieving optimum results stimulate seed germination, plant growth and development requires deliberate action on the productivity of plants. To do this, you need to install

all the conditions of action of stimulating factor on the planting material, including its morphological and biophysical parameters, the choice of the emission source, its operating parameters, and stimulation modes. It is important that all these factors are interrelated. Knowledge about these factors and the relationships between them allow you to control the processes of growth and development of crops, thus yielding crops.

The program and methods of field research combine harvester equipped with a system of low-frequency electromagnetic radiation grain material; specification for the design of combine radiators with the system in different locations in the course of promoting the grain of the material from the hopper to the MCU.

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THE RELATIONSHIP BETWEEN THE AGE OF COMBINE HARVESTER AND GRAIN LOSSES FOR PADDY

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Abstract: Rice harvesting became recently a problem due to shortage of labor and, consequently, the increase of wages in Turkey. The aim of the study was the determination of relationship of combine harvester age and the grain losses during on paddy harvest. This study was conducted at the paddy production field planted with Karacadağ variety in Çınar District of Diyarbakır Province in 2013. The New Holland Combines which has same brand but different ages in series of 2002 model TC 56, 2006 model TC 56, 2007 model TC 56 and 2013 model TC 5070 were used in the field experiments. The header losses, which include shatter losses and cutter bar losses, threshing and separation losses, and cleaning losses were measured in the study. The total of these losses was evaluated as combine loss. According to the results, the harvest loss due to combine changed between 6.67% to 9.23%. The lowest harvesting loss was obtained in 2013 model TC 5070 combine series. This was followed by 2002 model TC 56 with 7.32% loss. This results show that the harvesting loss was not directly depended on combine age, it was affected by the factors such as combine adjustment and maintenance, operator skill, product yield, field conditions.

Keywords: PADDY, COMBINE HARVESTER, GRAIN LOSSES

1. Introduction

Rice (*Oryza sativa* L.) is an important staple food and main source income for about half of the world population and at least cultivated in more than 100 countries in the world and it will continue to be a main stay of life for future generations (Badawi, 2001; Sessiz et al., 2011). Therefore, rice has got strategic importance for human diet. Turkey is one of the rice grower countries. Although rice cultivation area of Turkey fluctuates from year to year, it was cultivated over an area of 115.850 hectares with average rice yield of 7.940 kg per hectare and an annual production of 920.000 tons in 2015 (Anonymous, 2016). All of agricultural region in Turkey, rice can be grown. In this region, 95 % of rice cultivation area and production was performed in Şanlıurfa, Diyarbakır and Mardin provinces (especially, Karacadağ region). But, the average yield (4.770 kg/ha) in this region is much less than other rice growing regions of Turkey.

In the Southeastern part of Turkey, agriculture is one of the most important economic sectors and generally public's economy heavily dependent on agriculture products and also, majority of the population is engaged in agriculture. Rice growing is generally performed in stony areas in this region. Therefore, agricultural technology application is limited. Usage of agricultural mechanization equipment, pesticide and fertilizer application are limited and crop yield is low. Harvesting and threshing operations are known as crucial and influential processes on quantity, quality and production cost of rice. Rice harvesting is performed heavily by manually. Manual harvesting of rice with sickles in the traditional way is a time-consuming and labor intensive job (Esgici, 2012). In an unfavorable climate with less labor, losses may be unavoidable. After harvesting, the reaped plant left on the field to reduce crop moisture content, and then bundled together and transformed to outside of the field for threshing operations. Rice threshing is done either by cereals thresher or by stationary combine harvesters in Southeastern region of Turkey. Recently, paddy harvesting has become a serious problem for farmers in this region due to shortage of labor. Labor shortage, rainfall and wage rise over work peak time will cause delay in harvesting operations and increase of grain and panicle shattering in consequence occurring the severe grain losses (Esgici, 2012; Alizadeh and Allameh, 2013). Undoubtedly, manual harvesting of rice is such a troublesome, time-consuming and costly operation that it needs about 100-150 labor hours to harvest one hectare of paddy field. As resulting in labor shortages during the peak farming seasons causes delay in rice harvesting both quantitative and qualitative losses. In order to overcome this situation, using of combine harvesters would be an effective

solution to reduce production cost and enhance labor productivity. However, the combine harvesters cause negative impacts on the quantity and the quality of paddy grains which seriously affect the profitability of the crop. Because, the most losses are caused by improper adjustment of the machines according to crop conditions or due to improper machine ground speeds. Losses in rice production due to use of unsuitable machinery and techniques are occurring estimated 25% to 30% during harvesting season in southeastern part of Turkey. Whereas, the goal of good harvesting is to maximize grain yield and to minimize grain losses and quality deterioration. This value is quite a lot. It must be reduced to a reasonable level. If harvest losses reduced, the farmer's income will be increased. To reduce these losses, harvesting parameters need to improve for combine harvesters. Therefore, combine harvesters' adjustment and the ability of the operator play important role in rice harvesting (Hofman et al., 1978; Jung, 1981; Fouad et al., 1990; Badawi, 2001; Lesoing, 2001; Sessiz et al., 2006; Baran et al., 2012).

Considering the importance of grain loss in the header unit of the combine harvester, the amount of loss and causes of losses must be scientifically investigated through proper adjustment of operating conditions. The main objective of the study is determination of relation between the different aged combine harvester which has same brand and the grain losses during on paddy harvest. Consequently, determination of optimum conditions in harvest paddy for combine harvester will minimize the grain losses.

2. Materials and Methods

Combine test were conducted at the paddy production field of a commercial farm cultivating Karacadağ variety in Çınar District of Diyarbakır Province in 2013. The New Holland Combine harvesters which has same brand but different ages in series of 2002 model TC 56, 2006 model TC 56, 2007 model TC 56 and 2013 model TC 5070 were used in the field experiments (Figure 1). The average values of grain and stalk moisture content were changed between 24.00%-28.85% and 61.00% -71.93% during harvesting, respectively.



Figure 1. View of combine harvester operation in paddy field.

The conventional combine harvester is less suitable for rice harvesting. Therefore, before starting tests, in order to avoid of wrapping of straw and the clogging of sieve, rasp-bar threshing beaters were changed with spike tooth beater (Figure 2). Combine speed was determined for each plot by using stop watch to monitor time required to travel 35 m. Beater speed were setting of gears in the header drive unit. Header and hood height were regulated with hydraulic system in the combine cab. Field experiments were replicated three times at each plot (Chegini, 2013). The operating parameters of combine harvesters during the rice harvesting were chosen as 750-800 rpm beater rotational speed, 750 rpm fan speed and 20-25 cm high of plant. Combine ground speeds of 3.2 km h⁻¹ was determined. The reel speed was automatically synchronized to ground speed.



Figure 2. A spike- tooth that used for threshing unit.

In general, crop loss occurs from natural phenomena before harvest besides physiological, mechanical and physical parameters during harvesting. This publication reports only on the physical characteristics.

Therefore, before harvesting experiment, some important properties related to crop were measured in terms of plant height, number of plant per unit area, number of seed per m², length of panicle, number of grain in each panicle, grain and straw moisture content and weight of 1000 grains. To determinate the plant properties in each experiment plots, 25 panicle were selected for measurement. The average physical properties of crop are presented in Table 1. Grain and stalk moisture content (wb) were determined by oven-drying method at harvest time according to ASAE standard (Anonymous, 2003). For each sample, 25 g weight with a balance to the nearest 0.01 g. Rice seeds and stalks was dried by using air

method at 130 °C for 18 h (ASAE S352.2FEB03, 2003; Sessiz et al., 2011).

To determine quantitative loss before and after harvesting, a 1m×1m metal frame was used and thrown out randomly four replicate for each plot. Then, the all grains inside the frame were gathered, weighted and recorded. To determine percentage of broken, cracked and husked grains, four samples of 50 g rough rice was randomly taken from the grain tank of combine harvesters and separated manually and weighted. Then, all losses were determined separately. The percentage total grain losses were the sum of pre-harvest losses, header bar losses, threshing losses, straw walker losses and shoe losses. Also, to measurement of header losses during harvesting operation, the combine harvesters were allowed to move forward for 50 m to attain a steady constant speed and it was suddenly stopped. The header unit was lifted up and the machine was moved back for about 5m. The quadrate with an area of 1 m² was placed in front of the parked machine and the grains and panicles were manually picked up. The panicles were then manually threshed and the header losses were determined by weighing the fallen grains and panicle grains collected. The percentage of harvesting loss computed by following equation (Alizadeh and Allameh, 2013; Bawatharani et al., 2015).

$$HL = \frac{W_{gt} - W_{go}}{Y} \times 100$$

Where;

HL : harvest loss, %
W_{gt} : total harvest loss, g m⁻²
W_{go} : pre-harvest loss, g m⁻²
Y : grain yield, g m⁻²

Table 1. Mean values of some agronomic properties of rice plant during harvesting for each plot.

Properties of plant	TC-56 (2002)	TC-56 (2006)	TC 56 (2007)	TC 5070 (2013)
Plant height, cm	93.50	87.90	86.20	85.90
Panicle length, cm	14.10	13.90	16.40	13.80
Weight of 1000 grain, g	32.30	32.72	32.27	32.86
Panicle number per m ²	379.00	344.00	327.00	312.00
Grain losses, gr m ⁻²	550.00	616.6	423.00	470.00
Seed moisture content, %w.b.	26.00	25.12	28.85	24.00
Stem moisture content, % w.b	66.00	67.63	71.93	61.00

Figure 3 shows the sampling points around the combine harvester. The methods determining the various losses are as below.

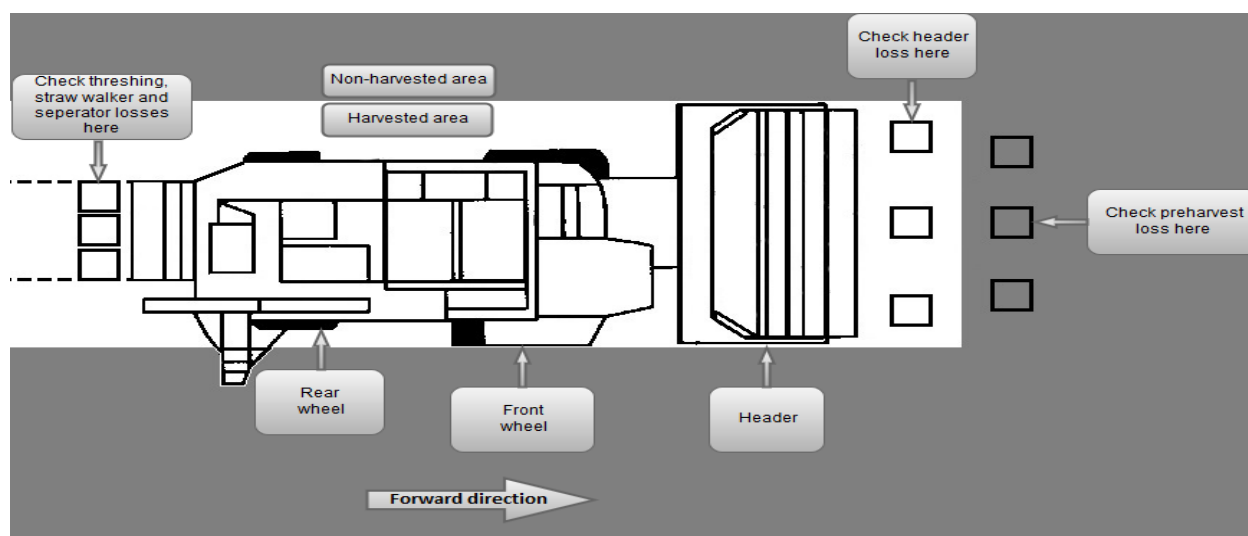


Figure3.Measurement of grain losses and sampling points around the combine harvester.



Figure 4 . Measurements of rice grain losses in paddy field.

3. Results and Discussion

The average results of grain losses for same brand but different ages in series combine harvester are separately summarized in Table 2. The total grain losses in the field are consisted of pre-harvest loss, header loss, threshing loss, straw walker and separator loss. The machine losses includes in header loss, threshing loss and separator loss (Roy et al., 2001). The table shows that grain losses varied greatly among combine harvesters. While the highest header losses were obtained in model of 2013 TC 5070 series as 22.08 kg da⁻¹, the lowest value were obtained in model 2000, TC 56 series, as 18.76 kg da⁻¹. In model of 2006, TC 56 series, grain losses were obtained as 21.53 kg da⁻¹. In model of 2007, TC 56 series, grain losses were observed as 19.35 kg da⁻¹. The header losses shows that combine harvester not adjusted accordingly. The structural and operational parameters of combine harvester need to be adjusted accordingly for reduced grain losses. Because, the lowest grain losses were observed at the older combine harvester of 2002 model. Therefore, grain losses not only depends on combine age but also field and crop conditions, plant densities, adjustment of header, forward speed, ability of operator affecting on grain losses.

Table 2. Average grain losses for each combine harvester per m²

	TC56 (2002)	TC56 (2006)	TC 56 (2007)	TC5070 (2013)
Field yield, kg da ⁻¹	550.00	470.00	423.00	616.60
Pre-harvest grain losses, gr m ⁻²	2.53	3.16	2.40	7.73
Header losses, gr m ⁻²	18.76	21.53	19.35	22.08
Threshing-separation and cleaning losses, gr m ⁻²	18.39	19.72	14.65	10.68
Total machine losses, gr m ⁻²	37.15	41.25	34.00	32.76
Total grain losses, gr m ⁻²	39.68	44.41	36.40	40.49
Total losses (Pre-harvest + machine losses), %	7.32	9.23	9.22	6.67

However, while the highest header losses were found at combine of model 2013, the lowest threshing-separation and cleaning losses were determined the on the same combine harvester as 10.68 kg da⁻¹. The values were found approximately 50% lower according to the others combines. It can be said that threshing-separation and cleaning losses is higher at new combine harvester than older. According to these results, the lowest total machine losses (32.76 gr m⁻²) and percentage of total grain losses (6.67%) were determined in TC 5070 model in 2013. There was not any difference between 2006 and 2007 models combine harvesters. This results was found compatible with Mesquita et al. (2006). They found that combines more than 15 years old left significantly more seeds in the field than units up to 5 years old. On the other hand, field losses for machines up to 5 years old did not differ significantly from those occurring with combines between 5 and 15 years old. They also concluded that field losses appeared to be more related to factors such as operator skills, maintenance, and crop conditions than combine age. With careful maintenance, adjustment and operation, harvest losses should be reduced lowest value.

4. Conclusions

From these results we conclude that the grain losses varied among combine harvesters. While the lowest total machine losses were determined in TC 5070 model of 2013 year as 32.76 gr m⁻², the highest value were observed in TC 56 model of 2006 year as 41.25 gr m⁻². As a result of this study, it is seen that the machine grains losses are not directly depend on the age of combine harvester. On the other hand grain losses are related with field yield,

the field operation conditions, machine adjustment and especially maintenance of machine and ability of operator.

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ИЗСЛЕДВАНЕ И ОПТИМИЗИРАНЕ НА ТЕХНИЧЕСКОТО ОБСЛУЖВАНЕ НА МАШИНИ С ПЕРИОДИЧНО ИЗПОЛЗВАНЕ

RESEARCH AND OPTIMIZATION AND MAINTENANCE OF PERIODICALLY USED MACHINES

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Abstract: The development and implementation of repair and servicing work during the period when the equipment with regular use is in a state of readiness for use is one of the areas to ensure a high level of reliability of the machines.

A mathematical model is developed to optimize the frequency of prophylactic effects of complex systems with periodic use of the type of self-propelled harvesting equipment in agriculture. The influence of the main parameters of the model on the optimal frequency of preventive effects and are edified y numerical values for combine harvesters' series "SK-5" and "Don 1500".

Известно е, че едно от направленията за осигуряване на високо равнище на надеждност на техническите системи с периодично използване е разработването и провеждане на ремонтнообслужващите работи в периода, когато системата се намира в състояние на готовност за използване. В земеделието към тази група сложни системи са машините, които се използват за прибиране на зърнено-житни, бобови, технически и др. култури. Те работят обикновено по 15-20 дни и след това се използват в следващия сезон или в същия сезон, но след 30-45 дни. Разглежданите земеделски машини се характеризират с три периода на използване [1;2]: период на готовност за използване; период на подготовка за използване; период на използване по предназначение.

През периода на подготовка на машините за използване трябва да се проведат всички ремонтнообслужващи въздействия в такъв обем, че да осигурят възможно най-високо равнище на надеждност по време на работа в кампаниите, а в периода на използване по предназначение, следва да се провеждат несложни профилактични въздействия.

Целта на разработката е да се предложи математически модел за оптимизиране на периодичността на профилактичните въздействия на сложни системи с периодично ползване от типа на самоходната прибираща техника в земеделието.

За критерии за оптимизация на периодичността на профилактичните въздействия (τ) използваме средните специфични разходи $\Phi(\tau)$, които са сума от следните средни специфични загуби:

➤ загуби поради откази с последствие (принудително спиране на работа на полето, неизлизане на машините на полето и т.н.)

$$\Phi_1 = P_{on} \cdot \omega_o(t, \tau),$$

където P_{on} е вероятността за откази с последствия;

$\omega_o(t, \tau)$ - математическото очакване на броя на отказите за единична работа при периодичност на профилактичните въздействия τ .

➤ загуби, поради престой на машините за възстановяване на работоспособността им след възникнали откази

$$\Phi_2 = k \frac{t_b}{t_p} \omega_o(t, \tau),$$

където t_b е средното време за отстраняване на отказите;

t_p - средното време на работа на машините;

k - коефициентът, отчитащ интензивността на работа на машините.

➤ загуби, поради престой за регламентирани профилактични работи

$$\Phi_3 = k \frac{t_{np}}{t_p} \omega_{np}(t, \tau),$$

където t_{np} е средното време за едно профилактично въздействие, отнесено към един час работа на машините;

$\omega_{np}(t, \tau)$ - математическо очакване на профилактичните въздействия за единица работа, при периодичност τ .

По такъв начин критерият за оптимизация приема следния вид:

$$\Phi(\tau) = P_{on} \omega_o(t, \tau) + k \frac{t_b}{t_p} \omega_o(t, \tau) + k \frac{t_{np}}{t_p} \omega_{np}(t, \tau)$$

Намирането на оптималния срок на провеждане на профилактичните въздействия (τ) се извършва от условието за минимум на $\Phi(\tau) \rightarrow \min$.

Известно е, че ако машините се използват без да се провеждат профилактични въздействия ($\Phi_3 = 0$), то сумарните загуби ще бъдат $\Phi = \Phi_1 + \Phi_2$, а въвеждането на профилактични въздействия ще бъде целесъобразно само, ако с тях се предотврати възникването на значителна част от отказите на машините по време на работа, т.е.

$$(\Phi_1 + \Phi_2)_{\tau=\infty} > (\Phi_1 + \Phi_2 + \Phi_3)_{\tau=\tau_{opt}}$$

Ако с провеждане на профилактичните въздействия се постига пълно възстановяване на машините, а при отстраняване на отказите се извършва само ремонтно въздействие, което не изменя потока на отказите, то

$$\Phi(\tau) = \left(P_{on} + k \frac{t_b}{t_p} \right) \frac{\int_0^{\tau} \lambda(t) dt}{\tau} + k \frac{t_{np}}{t_p}.$$

Тогава, ако приравним производната на $\Phi(\tau)$ на нула, ще получим

$$\tau \lambda(\tau) - \int_0^{\tau} \lambda(t) dt = \frac{k t_{np}}{P_{on} t_p + k t_b}.$$

От тук, ако приемем, че $\lambda(t) = a_0 + a_1 t$, ще получим

$$\tau_{opt} = \sqrt{\frac{2 k t_{np}}{a_1 (P_{on} t_p + k t_b)}}.$$

От анализа на влиянието на коефициента k върху оптималната стойност на оптималната периодичност на профилактичните въздействия (τ_{opt}) следва, че с повишаване на интензивността на използване на машините, намалява времето за профилактичните въздействия и се увеличават загубите поради ремонт или профилактични въздействия. Коефициентът k е равен на отношението на средната дневна

отработка на машините към сумата от средната дневна отработка и чакането на машината в изправно състояние за започване на работа.

Коефициентът k може да се изменя в границите $0 < k < 1$ и $k = 1$ при безпричинен престой на машините.

Увеличаването на времето на престой на машините в изправно състояние води до намаляване стойността на коефициента k и позволява да се намалят загубите на машините поради престои за ремонт или профилактика. Това е вярно, тъй като ремонтните и профилактични работи в този случай могат да се изпълнят по време на престоеите.

Въз основа на факторния анализ на параметрите на оптимизационния модел установяваме, че с увеличаване на k и t_{np} оптималната периодичност τ_{opt} се увеличава; с увеличаване на t_b , P_{on} и a_1 - τ_{opt} намалява.

При изследване равнището на надеждност на зърнокомбайните СК-5 и Дон 1500 установихме, че $t_p = 8h$; $t_{np} = 0,4h$; $a_1 = 0,15h$; $P_{on} = 0,06$ и $t_b = 0,6h$ и $k = 0,7$ [3]. Тогава

$\tau_{opt} = 2,54$, а това означава, че средно 2-3 пъти дневно е необходимо да се проведе профилактичен преглед, който се състои в почистване на въртящите механизми от растителни остатъци, прах, почва и др.

Изводи:

1. Разработен е математически модел за оптимизиране периодичността на профилактичните въздействия на сложни системи с периодическо използване.

2. Установено е, че оптималната периодичност на профилактичните въздействия на зърнокомбайните СК-5 и Дон 1500 е 2,54

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THE RELATIONSHIP BETWEEN MECHANIZATION AND COTTON GINNING INDUSTRY

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Abstract: Irrigated agriculture has brought mechanization applications and thus has increased cotton production area, yield and production quantity in Southeastern part of Turkey. This increase has led to the development of ginning industry in the region. Also it has become important to standardization the cotton ginning and baling. In this study, were investigated and evaluated current situation of the ginning factories in Diyarbakir province. The study was conducted by applying the survey methods to the visited factories. In the survey, respondents were asked questions regarding general information about the factory, current situation, capacity, raw material procurement, marketing, sales and general problems. In study, 50 factories were investigated, which were registered to Diyarbakir Chamber of Trade and Industry. The results obtained from the study show that the 17 factories have closed for several reasons. In particular, it was found that ginning factories do not operate efficiently with regard to the labour force employed and the amount of capital invested. In addition, it was determined what processed and baled cotton sold out of the province of Diyarbakir. Also, it was determined that factories had difficulties working low capacity, were between 60-120 days of annual working time, lack of qualified employee, financial difficulties, couldn't find quality cotton, insufficient agricultural supports and unstable pricing policies.

Keywords: COTTON MECHANIZATION, GINNING INDUSTRY

1. Introduction

Turkey is one of the important countries in terms of the magnitude of total cotton production and it is Europe's largest textile manufacturer and ranks seventh in the world cotton production. The Turkish textile industry continues to be the one of the leading sectors in the Turkish economy providing 17.5 percent of total exports in 2014. A total of 53.000 companies operate in the sector, providing a total of about 0.4 million jobs in the garment production alone (Paulson and Sirtioğlu, 2015). Cotton is cultivated primarily in the Aegean Region, Çukurova Basin and Southeast Anatolia Region. With GAP (Southeastern Anatolian Project) irrigation project in Turkey, the irrigated farmland and cotton production in Southeast Anatolia region has developed rapidly since 2000. That is, cotton production area was shift Aegean and Çukurova region to Southeastern Anatolia region and last 15 years and nowadays, more than half of the national cotton production is produces in Southeastern Anatolia region. The increase in cotton production has increase provided the development of the cotton industry (Sessiz and Esgici, 2015). The ginning rate averages about 41 percent in the Aegean region, about 39 percent in the GAP and 38 percent in Cukurova (Basal ve Sezener, 2012). Therefore, cotton plant has strategic importance for the region's cotton ginner and agricultural mechanization improvement. Major cotton producer provinces in this region are Şanlıurfa, Diyarbakır and Mardin. Cotton production figures of region's are given in Table 1.

Table 1. Cotton production and yield in Southeastern Anatolia Region, Turkey (Turkish Statistical Institute, 2015).

	Production area (ha)	Production (tones)	Yield (kg/ha ⁻¹)
Adıyaman	7.950	34.872	4390
Batman	80.00	321	4010
Diyarbakır	30.899	141.289	4570
Mardin	8.655	41.319	4770
Şanlıurfa	206.035	916.298	4450
Gaziantep	6.605	32.368	4900
Kilis	39.00	139	3550
Şırnak	4.202	20.636	4910
Siirt	50.00	223	4460
Total	264.517	1.187.465	4490
Turkey	430.000	1.639.055	3811

As shown in Table 1, total cotton production of Turkey is 1.639.055 tons obtained from 430.00 ha total cultivated area, meanwhile 1.187.465 tons and 264.517 ha for Southeastern Anatolia region respectively. GAP region produces 61.5 % of Turkey's total cotton production area in the 2015 (TUIK, 2015). This has led to the development of industries based on cotton in the

region. This production ratio in region is important for region's development, human resources development and rural development. Therefore, increasing cotton production and yield, reducing of cotton losses and protection of fiber quality are very important for sustainability of the production in Diyarbakır province. Cotton industry is mainly composed of cotton ginning factories.

Also, there are close relationship between mechanization practices and cotton ginner and cotton industry. Agricultural mechanization has been developed depends on cotton production and textile industry in province of Diyarbakır. Mechanization applications and number of technological equipment have increased in throughout the province with cotton crop. Rise in number of especially powerful and new tractors, pneumatic planter, mounted and self-propelled sprayers for defoliant applications, self-propelled cotton pickers have occurred. However, there are some problems in the cotton production. Production costs have risen sharply, but at the same time cotton prices have declined, so it is seen a significant decrease in the area under cotton cultivation (Adanacioglu and Olgun, . 2011). Corn production areas increases in all province of the region as an alternative crop of cotton, depends on increase in the cost of cotton production in the last few years. This negative situation has affected farmers and industrialists who invest in technological machines such as seeders and self-propelled cotton pickers in the cotton industry.

Despite these adversities, Government provides grant support to industrialists and this has led to the opening of new factories. The one hand while new cotton ginner factories are opened, on the other hand the many ginner are closed. Increasing operating costs such as price instability and fluctuation of prices, ruinous prices, amount of production cotton seed do not meet the demand of the industry sector, increases the production costs of the cotton that purchasing from outside the region, purchase requirement new ginning machines due to become mandatory bale standards, made strict controls for bale standardization cause to become idle and close factories.

In the Southeast Anatolia Region, most of the cotton ginner are located in province of Şanlıurfa and Diyarbakır. These two provinces are two important cotton producers and considerable amounts of cotton are cultivated last 15 years. However, there are many problems related to production and processing of cotton.

The objective of this study was to determine the relationship between mechanization applications in the cotton farming and cotton ginner. In addition to determine current situation analysis and problems, solution for problems, and future activities in Diyarbakır.

2. Material and Methods

The study is mainly based on survey data. The data were obtained from 50 cotton ginner in the 2015 ginning season in Diyarbakır province of Turkey. Before starting this study, the ginner that are registered to Diyarbakır Chamber of Trade and Industry were determined. Then all cotton ginner were visited for interview in the survey. Visits were took place with authorities or owners of the factories to get information about cotton ginner. Prepared questionnaire was filled with the data about the factories and were evaluated. Briefly, general information about the factory, current situation, capacity situation, raw material procurement, sales and marketing situations and about the general problems was questioned.

3. Results

3.1 General properties of cotton ginner

All of Turkey's estimated 500 gins are privately owned. The majority of the gins in the Aegean region are roller gins, more suitable for longer staple cotton, while about half of the gins in Çukurova and the Southeast are roller gins and half are saw gins. However, the recent increase in machine harvesting has triggered the construction of new saw gins (Paulson and Sirtioğlu, 2015). In 2015, there were 50 ginning factories registered to Diyarbakır Chamber of Trade and Industry. However, it was determined that 33 of these factories are active, while 17 of the factories are closed due to various reasons. All of the ginning factories that surveyed and active was established since 1990. 14 factories (42%) were established between years 1990 and 2000, 19 factories (58%) were established after 2000 that period increased of cotton production areas. The number of these ginning factories in Diyarbakır is adequate, but it was found that not to be integrated plant. Therefore, a planned industrialization based on cotton plant is not realized.

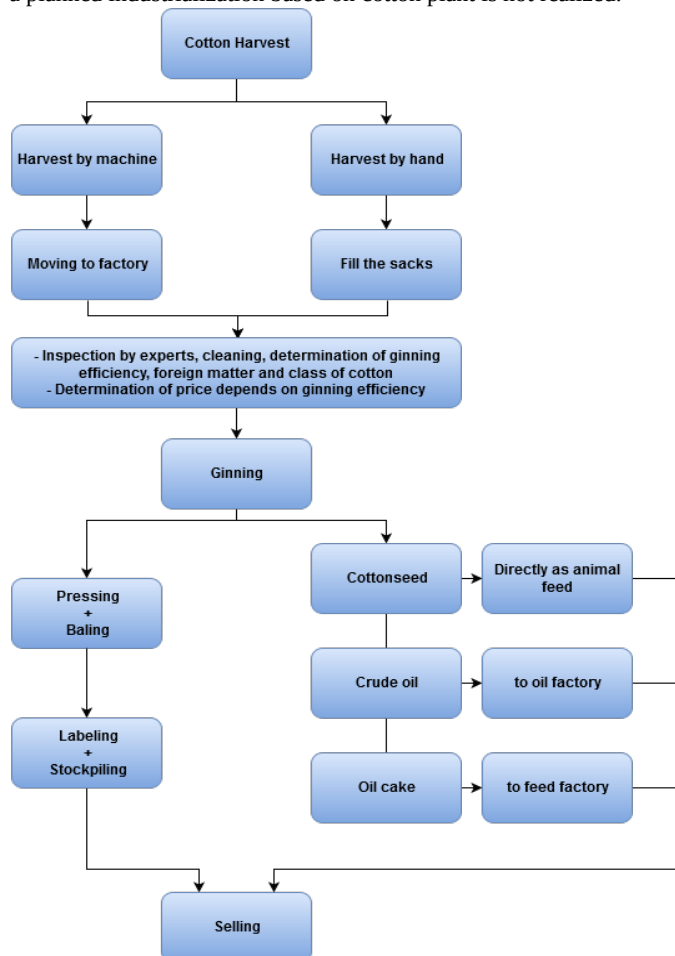


Fig 1. The general flow of cotton after harvest in Southeastern part of Turkey.

This situation negatively affects investment to mechanization equipment of cotton farmers. Therefore, while decreasing annual

use time of the machines, increasing production costs and mechanization equipment are becoming idle. Only 3 of the 33 active factories saw-gin type, other factories are roller-gin type. In other words, 91% of factories have got roller-gin type machines. 9% have got saw-gin type ginning machines. The general process of cotton from harvest to selling in Diyarbakır is shown in Figure 1. After harvest, cotton grower typically sells seed cotton a private ginner.

3.2 Working Capacity and Capacity Utilization in the Ginneries

In factories, the number of ginning units depending on the factory size ranges from 100 to 150 units for 97% and from 150 to 200 units for 3%. 33% of the proprietors had sublet due to they are not managed. 66% of factories are managed by owners.

Factories that analyzed in terms of area size had major differences. The total area of 70% of factories ranges from 10.000 to 25.000m², 30% of factories ranges from 26.000 to 50.000m². Annual capacity of factories ranges from 10.000 to 30.000 tons year⁻¹. Daily capacity of factories ranges from 50 to 100 tons day⁻¹ depending on economic and technological characteristics of factory. However, all of the factories are operated at low capacity. Effective working times are 4 months a year on an average depending on factory's capital and cotton stock. Annual working days were denoted by authorities between 60-90 days year for 73% of factories. The main reasons works with low capacity of factories are lack of raw materials (seed cotton), redundancy capacity and number of factories, inadequate capital.

One of the main factors affecting cost is harvest. Harvest usually is done with machine. 61% of the proprietors have their own cotton harvest machines and they are also farmers. There aren't cotton harvesters of 30% of the proprietors. 64% of the proprietors who have cotton harvester stated that much clean of cotton harvesting with machine than hand-picking. Other 36% of the farmers who haven't cotton harvester stated that much clean of cotton with hand-picking than harvest with machine.

All authorities said they have obtained cotton from province and neighboring provinces. Obtained cotton's fiber ratio is between 32-35%, seed rate between 50-55% and foreign matter ratio between 5-8%. After the ginning process, the cotton lint (fiber) is pressed into bales of between 200 and 230 kg in size.

3.3 Staff Situation

Factories were analyzed in terms of number of employees and were determined that number of employees between 10 and 12, number of administrative personnel between 2 and 5. However, it was seen that consist of family members majority of administrative personnel. Most of the factories stated that they don't need engineering services. 85% of the factories stated that they only needed cotton experts and technical staff for maintenance-repair of ginning machines.

Factories works for 1 or 2 shifts and the total time is 16 or 18 hours per day. The number of shift is increased in the intense works period. Almost all of the factories close by ending stocks. During non-working period are made preparation for next season.

3.4 Marketing and Sales, Capital Situation and Future Activities

30% of the factories supplies cotton from Diyarbakır. Other 70% supplies cotton from neighboring provinces. Authorities said that they purchased cotton cash (21%), on trust (49%) and installment (30%). They said also all of the ginning cotton sells out of the region, all sales made by them, they made cash selling. In addition, it was determined that produced cottonseed sold to Diyarbakır (30%), to region (67%), and to out of region (3%).

Ginning factories continue their activities that 79% of them with equity capital, 21% of them with joint capital. Unconsciously made

investments seen becoming idle sometime later. Already 1/3 of factories have been closed, 1/3 have been given rent. It was seen that are also farmer almost all of factories who continue activities. These factories have made serious capital investments with mechanization. Therefore, 88% of the proprietors have stated that they intend to change the scope. More than half of these factories (60%) are located outside of zoning area. Furthermore, there are no licenses due to be installed in convenient place to agriculture.

4. Conclusion

With the beginning of irrigation, depending on GAP project cotton production areas have increased, mechanization application and diversity of machine have increased in Diyarbakır. As a result of this, there are considerable increases in the industry based on cotton since 2000.

Although Diyarbakır province has a considerable amount of cotton production, it was determined that cotton ginners have inadequate technical capability and capacity utilization is very low. The results obtained from the study show that unit production costs of ginning factories are high and that they have low operating profits. In particular, it was found that ginning factories do not operate efficiently with regard to the labor force employed and the amount of capital invested. Therefore, mechanization level has been negatively affected.

It is not possible to find a solution for these problems instantly. Searching permanent solutions with well analyze of the problems is important. The development of the industrial sector and expansion into foreign market should be supported and it should be allowed a planned development in the industry based on cotton. Cotton price should be provide consistency and should be continue to grant support. At the same time mechanization tools and management support should be provided to both factories and cotton growers.

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QUALITY CONTROL OF TECHNOLOGICAL PROCESSES EXECUTED BY MACHINERY AND EQUIPMENT IN AGRICULTURE

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Abstract: A model of a machine operation with account for systematically important factors has been proposed. It is dealt with practical methods for quality assessment of agricultural machinery and its technological processes.

The obtained results afford evaluation of the Forage Shredder technological reliability during its operation as component of a flow line.

KEY WORDS: TECHNOLOGICAL PROCESS, CONTROL, PROBABILITY, RANDOM VARIABLE REALIZATION, OPTIMIZATION

Introduction

The majority of technological operations in agricultural production are executed by machinery. The objective of equipment performance improvement is related to provision and maintaining of its technological reliability.

In view of the specific conditions of equipment operation, and mainly of their stochastic nature, the most objective and proper assessment of its operational and technological reliability can be obtained with the use of theory of effective operation of equipment as a dynamic system.

Successful performance of tasks by equipment and hence its operational effectiveness lies in conformity of the machine's operational results to the required level.

Background

It is reasonable to define operation of technological equipment or its process notwithstanding its designation and physical nature as "input-output".

In view of such definition, the analysis, synthesis and optimization of equipment parameters or its processes are being performed on the basis of relations between input and output variables.

External disturbances (operation conditions) and control actions (of an operator) are considered as input variables. Agrotechnical, energetical, technical-and-economic indexes of the machine operation are considered as output variables.

Such scheme is a model of agricultural equipment operation and it determines its presentation as a system that transforms input variables into output variables (Figure 1)

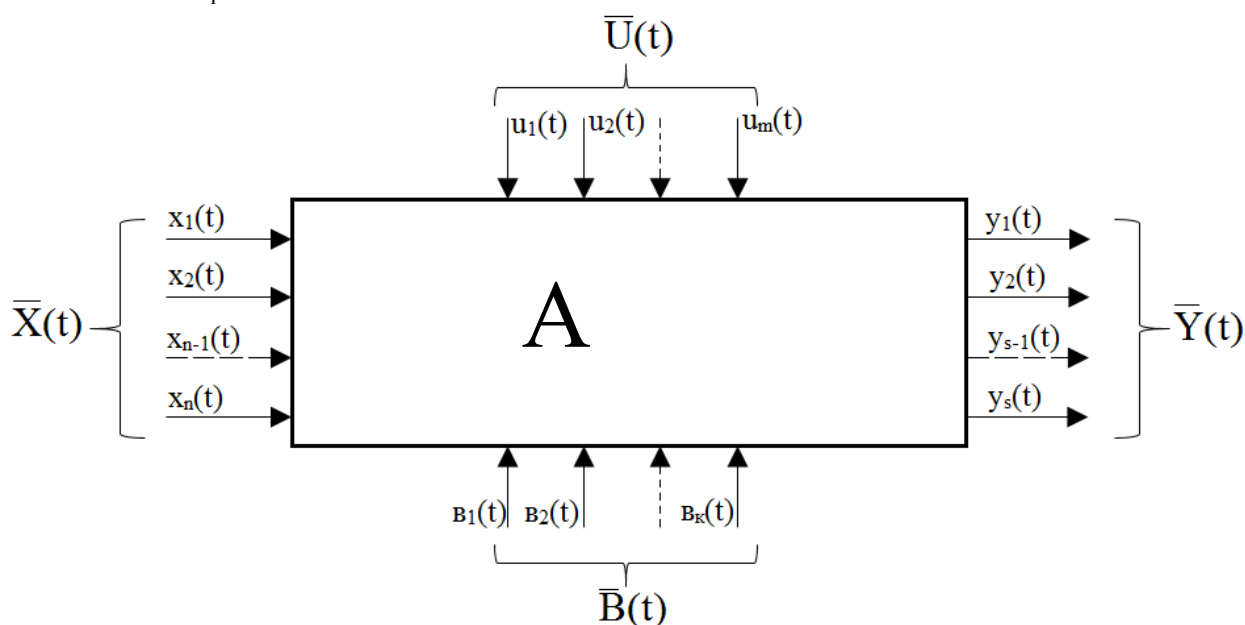


Fig. 1 - Model of agricultural equipment operation

Here $\bar{X}(t)$ – is a vector function of input parameters;
 $\bar{B}(t)$ – is a vector function of external disturbances;
 $\bar{U}(t)$ – is a vector function of control actions;
 $\bar{Y}(t)$ – is a vector function of output variables.
 A - operator of transformation

Results:

The research object is a Straw Shredder-Feeder as a component of a flow line designed for forage preparation.

Evaluation of dosage unit optimization criterion is the probability of presence of a random process within the tolerance range P_Δ . Here,

the greater P_Δ , the better and more uniform the forage feed is. Physical meaning of P_Δ probability lies in the fact that it shows a share of realization time, during which the process is located within the tolerance range.

Studies of dosing and distribution processes show that deviations from average value of a certain forage dose are distributed according to the Gaussian law, that's why the tolerance is symmetrical with respect to the average value.

Realization of a random cut straw feed process $X_i(t)$ is graphically presented in Figure 2, where the defined point X_j shows all components of the random process.

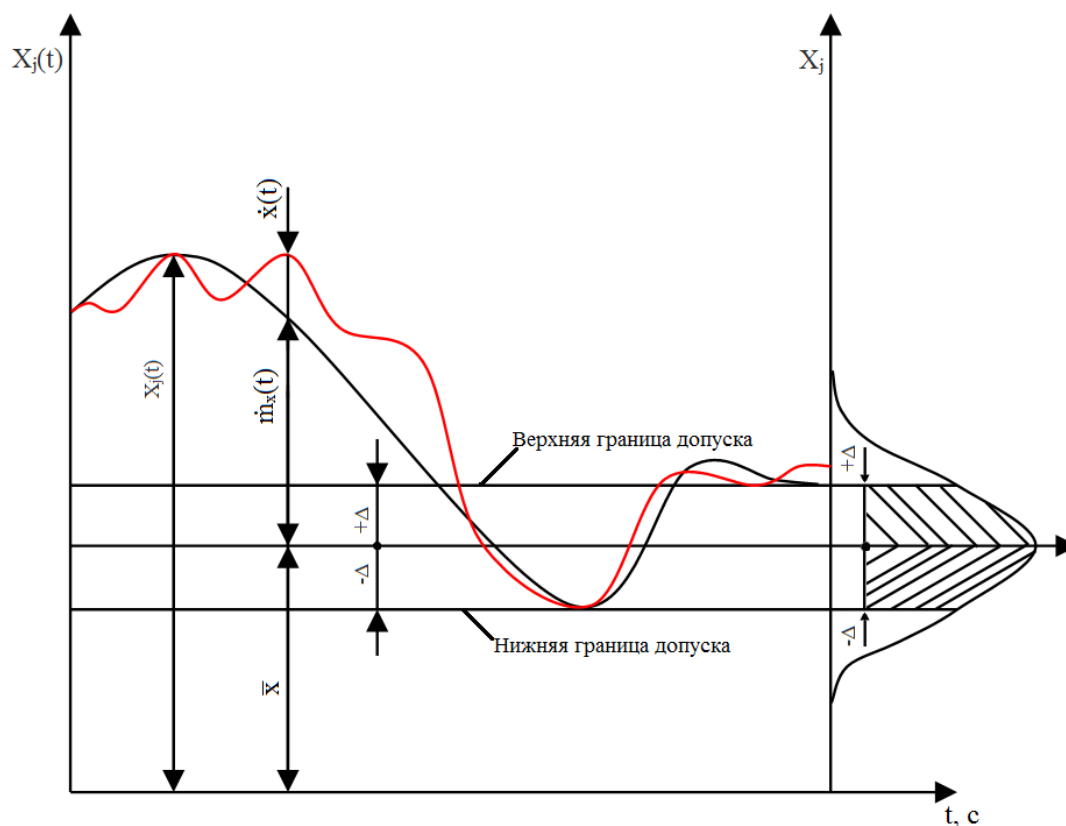


Fig. 2 - Realization of a random straw feed process

On the right part of Fig. 2 there is a probability density plot $f(x)$ of normal distribution of a random variable (feed's deviation from average value). Graphical probability P_{Δ} is shown as a shaded area under the density curve.

Analytical probability is determined by the formula

$$P_{\Delta} = 2\phi\left(\frac{\Delta}{v}\right),$$

Where ϕ - Laplace's function, taken from tables considering $\frac{\Delta}{v}$;

figure 2 is a tolerance's symmetry with respect to the average value of the feed;

v - root-mean-square deviation of a random process for the period of realization, classified as average value $\bar{X}$, i.e.

$$v = \frac{S}{\bar{X}}$$

Minimum 60 measurements of random process ordinates are required for such calculation and S should be determined as follows

$$S = \sqrt{\frac{\sum_{i=1}^m (x_i - \bar{X})^2}{m-1}},$$

Where x_i is the current value of straw feed,

$i = 1, 2, \dots, j, \dots, m$;

m is the ordinate value taken for the calculation.

For the purpose of calculation we took a section on the diagram showing cut straw feed by the Shredder, which is recorded by a special purpose cut process flow meter.

Average feed value in this mode of feeder operation is $\bar{X} = 2400$ kg/h,

$S = 680$ kg/h. As per agritechnical standards, tolerance for dosage is $\Delta = 0,15$;

$$v = \frac{680}{2400} \approx 0,28,$$

Probability of the straw feed process presence within the technological tolerance range.

$$P_{\Delta} = 2\phi\left(\frac{0,15}{0,28}\right) \approx 0,4,$$

This means that the shredder provides 40% of cutting in time within 15% tolerance in this mode of operation.

Length of the random process realization is limited in time, thus significant deviations of feed from the average value should be expected at continuous service. Extreme deviations of feed (maximum $Q_{\max}$ and minimum $Q_{\min}$) can be determined as per three sigma rule: $Q_{\max} = \bar{X} + 3S$ и $Q_{\min} = \bar{X} - 3S$. Such approach provides reliability of the conclusion with a probability of 0,9973.

By substituting the experimental values, we have

$$Q_{\max} = 4440 \text{ kg/h,}$$

$$Q_{\min} = 360 \text{ kg/h.}$$

Conclusion

Shredder-Feeder feeds the cut straw at a highly uneven pace. Measures of the equipment's optimal control in the course of technological operations performance should be provided for when installing the equipment into the feed line.

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NEW APPROACH TO THE CHOICE OF WAY OF MECHANICAL PROCESSING OF SOIL IN THE SOUTH OF UKRAINE

НОВЫЙ ПОДХОД К ВЫБОРУ СПОСОБА МЕХАНИЧЕСКОЙ ОБРАБОТКИ ГРУНТА В УСЛОВИЯХ ЮГА УКРАИНЫ

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Abstract: At a choice of an optimum way of machining of soil each land owner pursues one main aim - creation an optimum arable layer for cultivation of crops. Cultivation of soil finds the display in three systems: moldboard tillage, moldboardless tillage and no-till. The advantages and shortcomings are inherent in each system. The right choice will provide preservation and improvement of physical and chemical properties and increase of fertility of soil, and it is one of the most important problems in the production of agricultural crops. The purpose of researches is improvement of quality of mechanical cultivation of soil, decrease in power expenses as a result of use of the boardless-subsoiler implement which can carry out at the same time two operations: loosening of surface layer of soil and decompaction of its lower layer. Scientists of university developed and patented soil-cultivating working body which carries out the moldboardless tillage of upper layer with a simultaneous decompaction of the lower layer by means of subsoiler. The offered boardless-subsoiler implement by loosening the top layer of soil and decompaction of the lower horizon, allows to keep crop residues on a surface of a tilled field and to loosen the lower layers of soil, providing the necessary water-air regime. Mechanical cultivation of the soil this boardless-subsoiler implement respond to criteria of quality of soil cultivation. Extent of crushing of the soil is lie in limits of necessary value, the sizes of structural units of the soil is 8-10mm. Forming of a necessary equilibrium condition of the soil on a depth of cultivation supports good germination of a root system and to increase in productivity of the grown-up cultures. Such processing most meets the agrotechnical requirements at growing crops such as sunflower, corn, sugar beet. The offered way of soil cultivation provides fuel savings of up to 10 kg per hectare due to reduction of number of operations. The energy intensity of technology process decreases to 50% due to reduction of number of technology operations for the preparation of the soil.

KEYWORDS: SOIL, BOARDLESS PLOUGH, DEEP-RIPPER, MOLDBOARDLESS TILLAGE, HUMUS, FERTILITY.

1. Introduction

At a choice of an optimum way of machining of soil each land owner pursues one main aim - creation an optimum arable layer for cultivation of crops. Improvement of soil structure, physical and chemical properties and providing the necessary water-air regime is an important factor of high-quality soil cultivation that finally renders assistance to soil fertility increase.

The leading role in increase of soil fertility belongs to biological processes which activity depends on water-air regime and respectively from tillage method. Therefore a right choice of a way of processing is the most important means of regulation of life activity of soil microflora of its number and specific structure.

For any soil type three layers are characteristic [1]: arable; "plow sole" – that appears from the influence of plowshares and blades of soil-cultivating tools; subarable layer. "Plow sole" that is formed during operation of plows and edges of soil-tilling implements increases soil density in this layer to $1,7 \text{ gr}\cdot\text{cm}^{-3}$ [2] that much more optimum values of $1,1-1,3 \text{ gr}\cdot\text{cm}^{-3}$. Layer thickness of "plow sole" can reach 17 cm, depending on: type of working bodies; mass of the tool; number of cultivations; moisture content; soil structure [3]. Such compaction of layers worsens soil structure, reduces humus content and reduces the number of pores, which are the main ways to move water and air in soil. [4, 5]. Roots of cultural plants are not able to overcome such soil compaction and penetrate more deeply for reach water in deeper layers. All of this negatively influences on soil fertility and reduces productivity of agricultural crops.

Near the soil compaction from tillers additional influence on this process provide multiple passes through the field of mobile energy tools, as well as agricultural machinery. The total area of their traces on the treated area greater than an area of 1.5-2 [2], that leads to decrease in productivity of grain crops on these fields to 40...65% [6].

The right choice will provide preservation and improvement of physical and chemical properties and increase of fertility of soil, and it is one of the most important problems in the production of agricultural crops. The correct choice of the method of mechanical cultivation, which takes into account: soil type; species of units; the total number of passes of units across the field; region of Ukraine,

will ensure the preservation and improvement of physical and chemical properties and improve soil fertility, and this is one of the most important problems in the production of agricultural crops.

2. Preconditions and means for resolving the problem

2.1. Analysis of recent research and publications

Cultivation of soil finds the display in three systems: moldboard tillage, moldboardless tillage and no-till [1]. The advantages and shortcomings are inherent in each system are also used they taking into account climatic zones and soil types. It is established [2] that expenditure of energy on soil cultivation makes nearly 40%, and manning to 25% of all amount of field work.

Estimating efficiency of the considered methods of cultivation of the soil it is necessary to specify the following. At present in most agricultural enterprises the soil cultivation by means mouldboard implements is held. This operation is carried out in the fall and used for loosening of upper arable layer, to full closing of the straw residues and organic fertilizers. To negative factors of this tillage method can be attributed the appearance of "plow sole" due to influence of plow ploughshares and appearance on a field surface of soil blocks, therefore the necessary carrying out additional technology operations for preparation of a field for seeding crops seeds. This leads to increasing in energy consumption per hectare of cultivated area. Soil density in the horizon after thrice pass of a plow increases to $1,7 \text{ gr}\cdot\text{cm}^{-3}$ [7], that does not allow a root system of the grown-up cultures to get reserves of soil moisture in a subarable layer.

The mouldboardless tillage method of soil cultivation is loosened well by upper layer, thus the processed surface smooth and does not need carrying out additional operations. At such processing on a surface of a field remains to 80-85% of [8] straw and stubble remains which render assistance for good snow retention, to accumulation and conservation of water and reduction of blowing and washout of the soil units. Mouldboardless soil cultivation the increases organic substance hymification coefficient in compared with a plowed land on 25... 30% [8], and increase in accumulation

of humus what are the base of soil fertility. Therefore this reception of soil cultivation finds the greatest application in poorly snow-covered and droughty southern regions of Ukraine. To shortcomings of this tillage method it is necessary include is appearance of compacted subarable soil layer from influence of blades of mould-boardless implement (as at plowing of the soil) and some increase of a contamination of crops.

As for the no-till soil cultivation method, last years this technology finds more and more broad application. The non-interference in the soil ecosystem enables more slowly to reduce the precious natural resource - soil fertility. However this technology demands big financial costs for application of means of protection from weeds and for ensuring life activity of the growing plants.

The above methods of mechanical cultivation of the soil (moldboard and mouldboardless) have one common fault which follows from an essence of intensive agriculture is a compaction of subarable layer of the soil which demands carrying out its opening and loosening.

Producers of farm implements suggest to use subsoilers which allow to loosen soil on depth from 45 to 60 cm. As independent operation deep loosening is performed instead of a plowed land. And as additional, after work of plows or boardless tolls, for a loosening of the lower layers of the soil which is necessary to forming of a normal root system of plants.

Mechanical cultivation of soil surface layer and deep loosening of the lower layer are carried out as independent operations which using different soil-cultivating workers of bodies at present. It increases energy costs of technology process of preparation of the soil.

The existing soil-tilling implements do not provide for one pass of the tool necessary quality of soil cultivation on a depth across the all surface of field. Therefore there is a need for development of such soil-tilling implement which provides for one pass of the unit agrotechnology quality of soil cultivation across the field.

2.2. Purpose of the study

The purpose of researches is improvement of quality of mechanical cultivation of soil, decrease in power expenses as a result of use of the boardless-subsoiler implement which can carry out at the same time two operations: loosening of surface layer of soil and decompaction of its lower layer.

3. Results and discussion

Traditional intensive mechanical cultivation of the soil, this is when particles are formed on the surface of 0.1 ... 1 mm. They are capable to move easily on a field surface under the influence of the wind. Methods of soil cultivation at which on a surface of field do not remain straw and stubble residues lead to annual irrevocable loss of the soil 1 tonn·ha⁻¹ [9].

Therefore mechanical cultivation has to provide the minimum destruction and milling of upper soil layer. It causes reduction of water and wind erosion and renders assistance to growth of humus contents to 3,5... 4% that increases soil fertility [4].

Climatic conditions of the South of Ukraine, this is small quantity of snow during the winter period, insufficient amount of precipitation, availability strong winds and storms. Therefore it is reasonable to apply such way of mechanical soil cultivation which can satisfy agronomical requirements to quality. That is preservation on the untreated surface field of straw, stubble remains and a simultaneous deep loosening of the lower soil layer for best absorption of moisture and providing the optimum water-air regime.

Efficiency of the offered way of tillage is estimated by expression [10]:

$$E = P_D - C, \quad (1)$$

where: P_D – produced products, Euro; C – expenses (labor, money, energy, materials), Euro · ha⁻¹.

There is a need for development of working body design which

for one pass would carry out two technology operations. Scientists of university developed and patented soil-cultivating working body (Fig.1.) which carries out the moldboardless tillage of upper layer with a simultaneous decompaction of the lower layer by means of subsoiler.

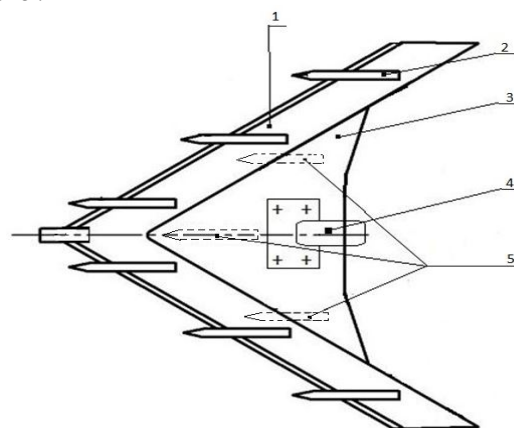


Fig. 1. Soil-cultivating working body (boardless-subsoiler implement): 1 – boardless plow; 2 – wedge-shaped plates; 3 – housing; 4 – blade holder; 5 – subsoilers

Process of mechanical cultivation of the soil by offered soil-tilling implement is represented in Fig. 2.

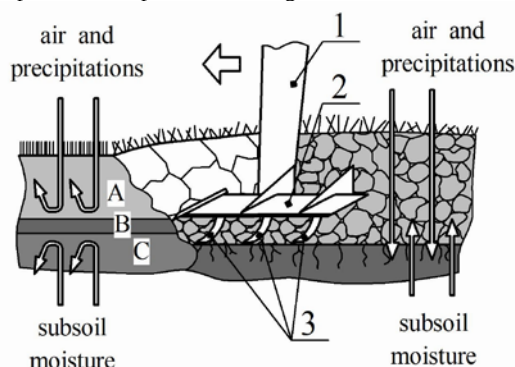


Fig. 2. Scheme of soil cultivation of boardless-subsoiler implements: A – soil layer which is processed by traditional soil-tilling implement; B – layer compacted with a plow; C – lower layers of the soil

The offered way of mechanical cultivation of the soil allows to receive the necessary density of the soil on all depth of the processed layer, which provides the necessary water-air mode in the soil, good root system growth of the cultivated plants for one pass of the tool across the field (Fig. 3).

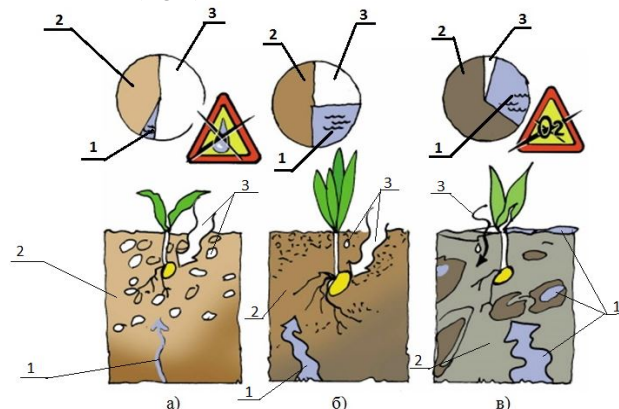


Fig. 3. Effect of structure and density of soil on the growth of plant roots: 1 – water; 2 – soil; 3 – air; a – insufficient access of water; b – optimum density on depth, enough water and air; c – increased soil density, upper layers are oversaturated by water, oxygen access is limited.

From Fig. 3 we see that soil compaction leads to reduction of amount of pores therefore access of water and air to a root system of plants which slows down their normal growth becomes complicated and, respectively, reduces productivity of agricultural cultures.

4. Conclusion

1. The offered boardless-subsoiler implement by loosening the top layer of soil and decompaction of the lower horizon, allows to keep crop residues on a surface of a tilled field and to loosen the lower layers of soil, providing the necessary water-air regime. This leads to soil fertility improvement.

2. Mechanical cultivation of the soil this boardless-subsoiler implement respond to criteria of quality of soil cultivation. Extent of crushing of the soil is lie in limits of necessary value, the sizes of structural units of the soil is 8-10mm.

3. Forming of a necessary equilibrium condition of the soil on depth of cultivation renders assistance to good germination of a root system and to increase in productivity of the cultivated plants.

4. Developed processing method of mechanical soil cultivation mostly meets the agrotechnical requirements at cultivation of such cultures, as sunflower, corn, sugar beet.

5. The proposed method of soil cultivation provides fuel savings of up to 10 kg per hectare at the expense of reducing the number of operations.

6. Power consumption of technology process decreases to 35% due to reduction of number of technology operations by soil preparation.

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STRUCTURE OF QUALITY AND DEPENDABILITY OF MACHINEN

СТРУКТУРА НА КАЧЕСТВОТО И НАДЕЖДНОСТТА НА МАШИНИТЕ

G.Tasev, N.Ivanova, K.Georgieva

Abstract: Developed structure and proposed qualifications of the properties and performance of the quality and reliability of machinates. Ssuggested new classification of numerical and functional characteristics of indicators of quality and reliability of production.

KEYWORDS: QUALITY, RELIABILITY, FEATURES , PERFORMANCE , FEATURES

The quality and dependability of production are expressed through a big number of characteristics, attributes and indicators. Their usage without systematic grouping and classification is connected with definite difficulty. In the literature on the question and the normative – technical documentation the attributes, characteristics and indicators of the quality and dependability are not systematized and are not connected with one another and the indicators and characteristics are mixed and are expressed only as indicators.

With the help of the systemic approach the quality and dependability could be structured in three hierarchical levels: attributes, indicators and characteristics, whereas the attributes are expressed by indicators and the indicators – by characteristics.

Quality is an accumulation of attributes which satisfy the needs and/or the requirements of the consumers and the **dependability** – complex attribute for the preservation of the level of quality in fixed borders, time, regime and condition. The basic elements of the conceptual definition for quality are the attributes, needs and requirements. The attributes of quality are expressed by

specific and complex indicators and the indicators by numeral and functional characteristics.

The needs of the consumers are various and complex. Depending on the cultural level they are expressed through different needs which can be defined or presupposed. The needs are defined, written in contracts or normative documents, the needs of the market, the development of the needs of the people and society are presupposed.

The requirements of the consumers are distincted with great variety and can be expressed in a different way (by contracts for orders and deliveries, normative documents) or to remain latent. As a whole, these requirements are formulated in the modern systems of quality management: the systems of a series of standards ISO – 9000 – 2000 and the system for total quality (TQM).

The basic elements of the conceptual definition for dependability are the level of quality, the defined borders, time, regimes and conditions. (Figure 1)

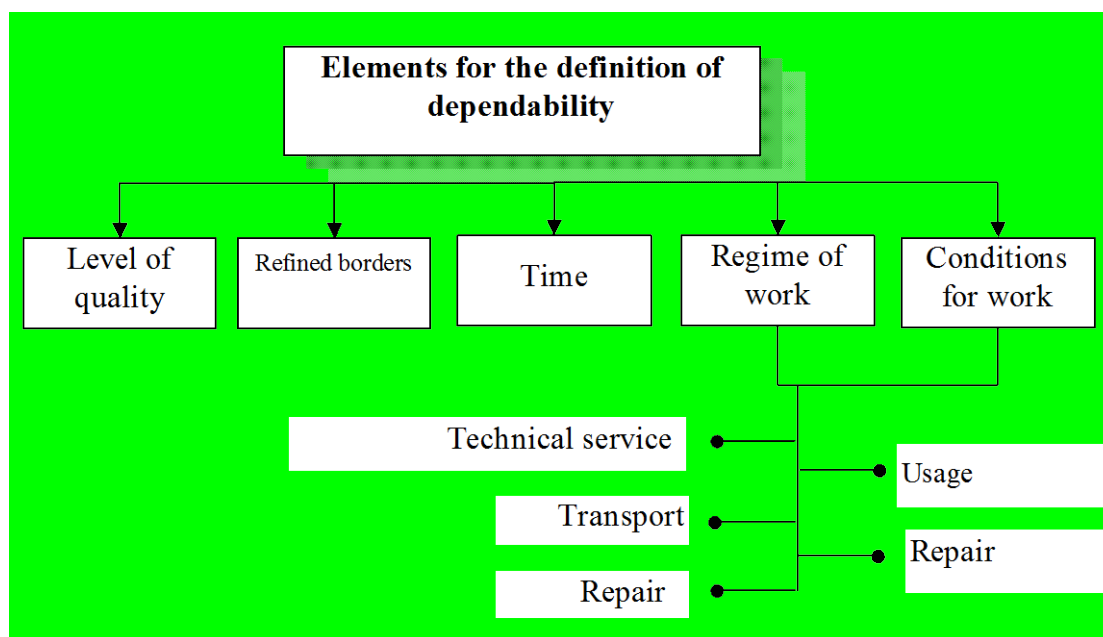


Fig.1. Elements for the definition of dependability of production

The attributes of quality are those attributes of production which satisfy the needs and/or requirements of the consumers. In the most common case the quality has four groups of attributes: technico-economic, social, bioecological and dependable (Figure 2). The first three groups of attributes define the level of quality and the dependable ones – the alteration (or preservation) of this level with time. The technical-economic attributes express directly the level of quality and are divided in three groups:

technical, technological and economic. Each one of the groups contains in itself the following attributes and indicators: **technical**: functional, structural, geometrical, constructive, for technical perfection;

technological: technology of design, manufacture, exploitation, repair and maintenance, transportation; **economic**: economy of design, manufacture, exploitation, repair and maintenance, transportation.

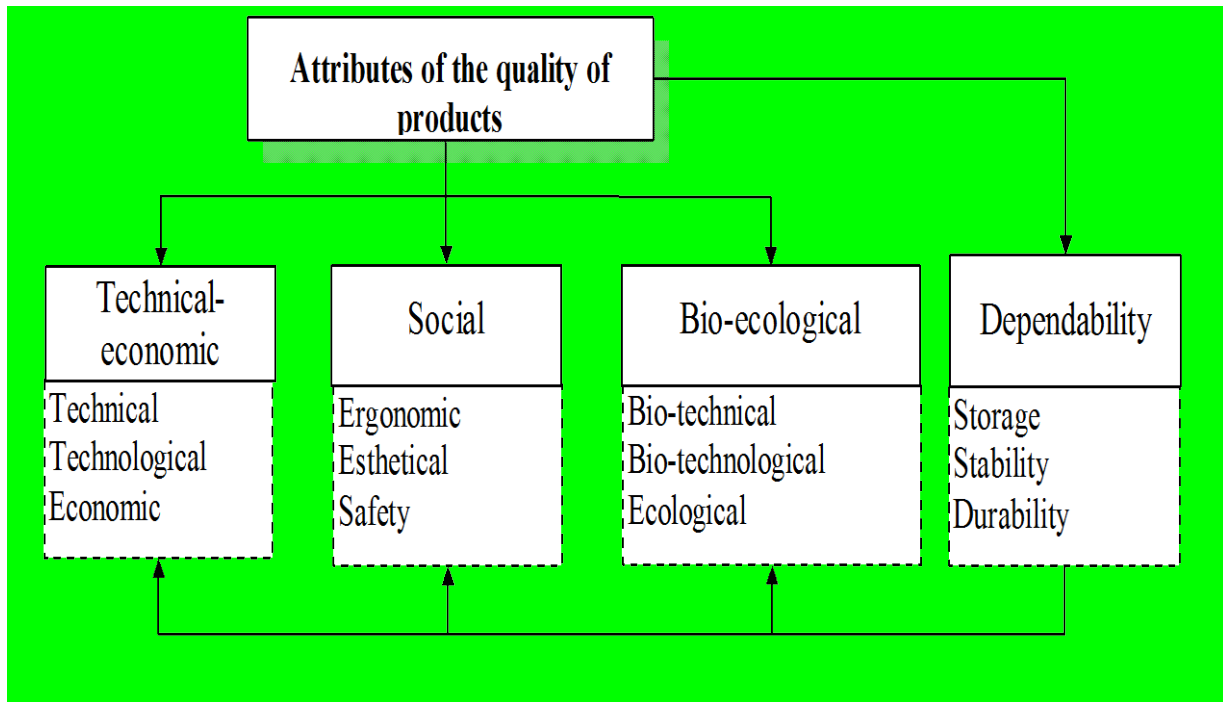


Fig.2. Structure and interconnection of the quality attributes

And if all other indicators are expressed by their names, then the indicators for technical perfection include the patent-law indicators which indicate defense for patents and patent frequency of production. The indicator for patent protection characterizes the exclusive right for manufacturing of a given production and the indicator for patent purity – the possibility for its unhindered realization in the country and abroad.

The influence of production on people is defined by the social attributes of the quality which comprise four subgroups: ergonomic, esthetic, organoleptic and safety. Each one of these attributes are expressed by the following indicators: ergonomic – hygienic, anthropometrical, physiological, psychophysiological; esthetic – informational expressiveness; rationality of form, compositional unity, colour decision, perfection of execution; organoleptic – indicators perceived by eyesight, ear sight, smell, sensitivity and taste; safety – mechanical, technical, electrical, chemical and physical.

The influence of the object on the biological species and the environment is defined by the bio-ecological attributes of

quality which includes three subgroups: bio-technical, bio-technological and ecological and indicators for the attributes of each of the subgroups are: bio-technical, bio-technicality for plants, animals and microorganisms; ecological – ecological conditions for the air, water, soil, the flora and the fauna.

Dependability is a complex attribute, which can include flawlessness, durability, repair suitability, storage and stability in parts or in combination depending on the kind of production.

The production for one – time-only use has only one of the attributes of dependability – storage and the irreparable objects – two attributes: flawlessness and storage. The object under repair can have four attributes: flawlessness, durability, repair suitability and storage and the processes and systems – all five attributes.

The attributes of dependability are expressed by specific indicators express only one attribute and the complex ones – more than one qualities (Figure 3 and 4).

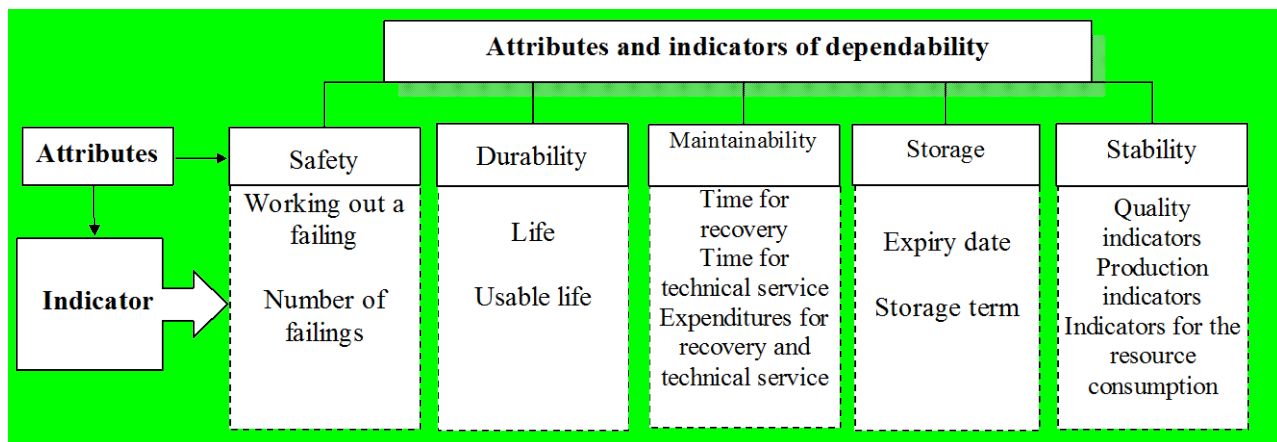


Fig.3 Attributes and indicators for the dependability of production

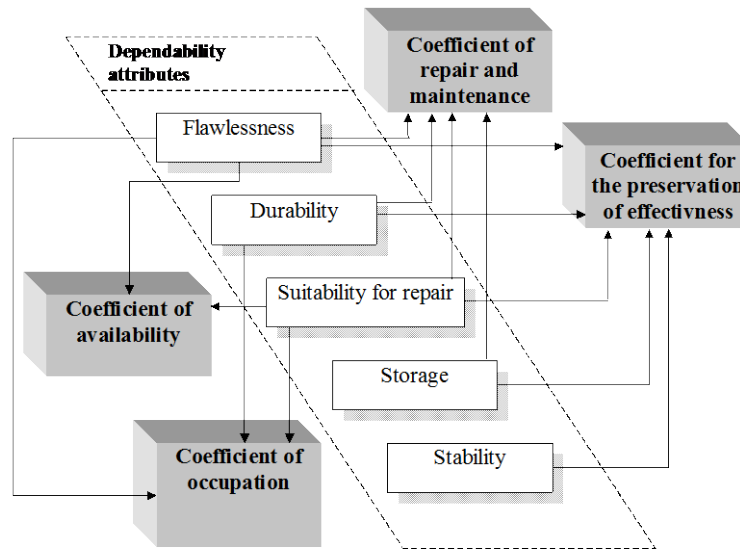


Fig.4. Nature and contents of the complex indicators of dependability of production

Stability is an attribute of the processes and/or systems to preserve their condition with time. Three types of indicators

characterize the attribute stability: stability of quality; stability of productivity; stability of the expenditure of resources.

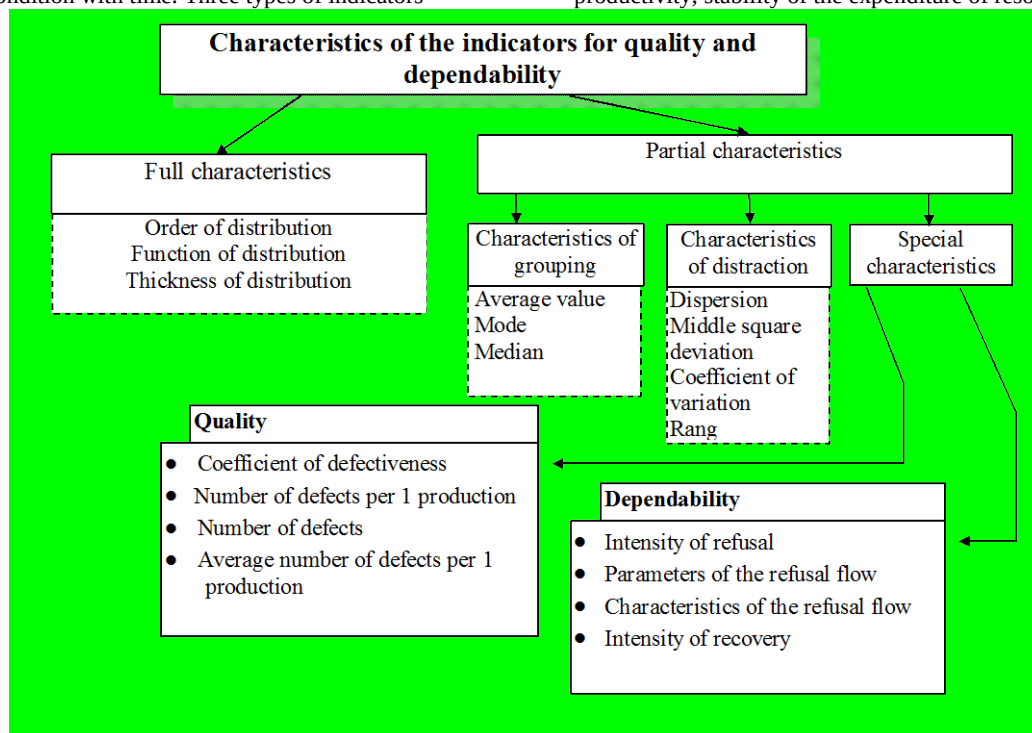


Fig.5. Characteristics of the indicators for quality and dependability of production

The indicators of quality and dependability can be constant and occasional quantities. As constant quantities the indicators of quality and dependability have only one characteristic – their value and as occasional quantities – characteristics that can be divided to: characteristics of grouping; characteristics of distraction, quant characteristics, special characteristics and full characteristics (Figure 5). The first two groups are number characteristics and the last three groups – functional characteristics.

Depending on the type of production (the object) and the character of tasks – they choose one or another of the attributes, indicators and characteristics.

Deductions:

1. The elements of the conceptual definitions for quality and dependability of production are found out.

2. The structure is worked out and a qualification of the attributes and indicators of quality and dependability of production is suggested.
3. The numerical and functional characteristics of indicators for quality and dependability of production are defined.

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TENDENCIES OF DEVELOPMENT OF REGIONAL SYSTEMS FOR MONITORING AND ANALYSIS OF AGRICULTURE INDUSTRY

ТЕНДЕНЦИИ РАЗВИТИЯ РЕГИОНАЛЬНЫХ СИСТЕМ МОНИТОРИНГА И АНАЛИЗА АГРОБИЗНЕСА

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Abstract: The main issues considered in this topic are: Regional systems for monitoring and analysis of agricultural industry; The structure of databases and perspectives of technological development marketing system „Agromonitor“.

1. Introduction

In the conditions of the global economic crisis and increased risks, it is impossible to imagine any country's food safety and security without the usage of regional systems of information provision in agriculture industry. At present, similar systems are not used at all in some places, while the existing operating systems need technological improvement.

2. Problem discussion

Like the other branches of economy, in the agriculture sector of any region a lack of specific information needed for specific customers is a problem. This problem is caused by need of modernization and improvement of most of information systems for agribusiness. The targets of these systems, schemes of collection, analysis and dissemination of information should be improved. Management and service units are clumsy and inflexible; they are ineffectively adapted to the level of potential users.

Despite of fact that characteristics of agrarian sectors of specific regions are reflected in the structures of information systems of these local regions, it is necessary to establish a generalized model of information systems adapted for any region with some considered changes and acceptable for users of different levels.

3. Objective and research methodologies

Based on the system analyses of research objects have been developed following:

A) Main elements of data bases of system for monitoring and analyses of agribusiness:

- Market demands on traditional cultures produced in the region, the estimate volume of such production and their influence on pricing process within domestic and export markets;
- Data on optimal conditions for the cultivation of priority cultures;
- Data related to the region's zone, soil, climate, ecology, reclamation and other data;
- Information related to the opportunities of introducing new types of seed and plant material, grafting components, animals, birds and plants in the region;
- Information related to agricultural equipment, modern technologies, fertilizers, chemicals, medicines, pesticides, their prices and import opportunities;

- The opportunities to satisfy world markets demand on deficit products with products produced in the region.

B) Situation analysis and possible changes forecast subsystems, which reveal and represent to customers such factors, as follows:

- Estimate production volume of a product and market demand on it;
- Opportunities to create „comfortable“ conditions for the production of competitive product in local region or within a specific area;
- Opportunities of optimal compliance of deficit introduction cultures cultivation conditions with the natural conditions of a local zone or area;
- Operating resources, available reserves and deficit with a local zone;
- Forecasts related to the productivity benchmark indices, opportunities of prevention of diseases and pests;
- The latest technologies approved throughout the world, recommendations and other.

4. Conclusion

The region's food safety, the population's social conditions, general economic background, investment environment and agricultural biodiversity indices will be improved, the working efficiency of electronic trade systems will be increased, the resources necessary to the production of priority cultures and the introduction of certain unique species in other areas will be determined.

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SHOOT CULTURE OF *IN VITRO* MICROTUBERISATION OF POTATO (*Solanum tuberosum* L.)

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Abstract: This paper presents results of shoot culture of *in vitro* microtuberisation of potato. Were researched induction of callus and roots of shoot explants on seed varieties of potatoes like: *Dido* and *Marabel* and mercantile varieties of potatoes like: *Agria BE* and *Agria SR*.

During this research the initial explants – sprouts, further are transfer (passages) to new nutrient medium, fresh, with new hormonal composition. These explants transferred to the new fresh medium are called shoots.

Key words: *explants, shoots, potato, in vitro, medium*

Introduction

Potato is the fourth important crop in the world after wheat, rice and maize. Potatoes are thought to have originated from high - mountain ranges of the Andes in South America. This crop is grown in 180 countries worldwide. According to the FAO statistic (<https://faostat.fao.org>), the largest producer of potatoes is Asia, then Europe, South America and North and Central America.

The very early beginning of potato cultivation in Macedonia is dating back 150-170 years ago. Today in the country, potatoes are grown on more than 13,000 hectares with an average yield of 20-40 t/ha, and every year the area of potato cultivation is extended (Statistical Yearbook of Republic of Macedonia, 2014).

According to the research Nistor et al. (2010), the genotype of potato under *in vitro* conditions have a positive impact of obtaining microtubers. In their research they perceived that, first needs to have a healthy material for obtaining microtuberisation in the laboratory, then with healthy material will be planted on medium and will get also healthy reclaimed microtubers.

For obtaining microtubers influenced by many factors: external factors (temperature, light, heat), type of medium, the contents of the medium, genotype, explants used for tuberization, their physiological maturity and the effect of regulators of growth (Dobranszki, 2008).

Microtuberisation of potato (*Solanum tuberosum* L.) is a complex evolutionary process that is influenced by photoperiod (Seabrook et al., 1993), temperature (Leclerc et al., 1994), sources of carbohydrates (Simko, 1994), inorganic nutrition (Sarkar and Naik, 1998) and even the physiological age of the parent tuber (Villafranca et al., 1998).

These factors directly or indirectly influence the formation of *in vitro* microtubers by regulating the effects of the application of exogenous growth substances or by endogenous changes in the hormonal balance (Ewing and Struik, 1992).

In vitro cultures are produced that can be used for rapid multiplication (*in vitro*), microtuberisation (*in vitro*), as well as producing minitubers (in glasshouses, greenhouses) (Struik and Lommen, 1990).

Material and methods

The experiment was conducted in the Laboratory of Plant Biotechnology, Faculty of Agriculture, Goce Delcev University – Stip, Macedonia. The following potato varieties were used as starting material for the experiment:

- seed potatoes: *Dido*, *Marabel*, *Agria*, *Ambition* and *Agriko*;
- mercantile potatoes: *Agria SR*, *Agria BE* and *Andrea*.

The variety *Agria SR* is cultivated in Strumica region, while the variety *Agria BE* is cultivated in Berovo region. The two regions differ in altitude, soil types and climate, thus the commercial potatoes of the same variety were treated as different starting material.

Shoot culture

During the research initial explants – sprouts further transferred (passaged) to new nutritional medium, i.e. the fresh new medium with new hormonal composition. These explants passaged on fresh medium are called shoot culture. First shoots passaged was made on a new medium enriched with cytokinins and auxin.

The combination of cytokinin and auxin was very effective for organogenesis under *in vitro* conditions in different potato genotypes (Gudeva Koleva et al., 2012).

Data analysis

All data were subjected to statistical analysis with IBM SPSS Statistical 21, one-way ANOVA and Duncan *posthoc* test, with the level of significance 0.05%.

Results and discussion

In recent time are used many synthetic auxin and cytokinins for obtaining undifferentiated callus tissue, which is widely used in cultures *in vitro* and in cultures that breed generative (Grbic et al., 2007; Grbic, 2007).

From Table 1 can be seen that the genotype *dido* (30 mm) and *agria SR* (27,65 mm) have a length of sprout that is significantly greater than the length of the sprout genotype *marabel* (18,68 mm).

As for the thickness of the sprouts, genotypes that were tested showed no significant difference in the values obtained.

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In Table 1 shows the results of the formation of callus in mercantile potato genotypes: agria, agria BE and agria SR and seed potato: dido and marabel.

Shoot explants					Formation of callus			
Genotype	MS medium (mg/L)	Number of shoots	Length of shoot (mm)	Thickness of shoots (mm)	Height of callus (mm)	Thickness of callus (mm)	Number of callus	% of callusing
<i>Seed potato</i>								
<i>Dido</i>	2 BAP + 1 IAA	17	30,00a	1,00a	1,45a	1,38a	18	72,61ab
<i>Marabel</i>	2 BAP + 1 IAA	16	18,68b	1,18a	0,94b	1,43a	16	93,75a
<i>Mercantile potato</i>								
<i>agria BE</i>	2 BAP + 1 IAA	44	22,31ab	1,0a	1,18ab	1,25a	22	50,44b
<i>agria SR</i>	2 BAP + 1 IAA	20	27,65a	1,01a	0,71b	0,59b	11	80,00ab

Table 1. Formation of callus –shoot explants

Genotype agria BE (22) formed the most calluses, apart other genotypes: agria SR (11), marabel (16) and dido (18).

The highest callus from 1,45 mm had genotype dido, which values significantly different from the amount of callus at genotype marabel (0,94 mm) and agria SR (0,71 mm).

Genotype agria SR (0,59 mm) in thickness of the callus showed statistical minimum value to the values of other genotypes: agria BE (1,25 mm), marabel (1,43 mm) and dido (1,38 mm).

During induction of the callus medium MS + 2 mg / L BAP + 1 mg / L IAA at all potato genotypes showed callusogenesis. The biggest values showed genotype marabel (93,75%) value which is significantly better than genotype agria SR (80,00%), and genotype dido (72,61%) and genotype agria BE (50,44%).

In vitro regenerants obtained by micropropagation of potato are less transmissible of bacteria, fungi and viruses. *In vitro* regeneration of potatoes proved one of the most widely used technique in several countries worldwide. This method has great

advantages in the creation of new genotypes unlike conventional breeding. According to this survey import of potatoes with much positive results decreased by 50% (Karim, 2009).

To get well entrenched, callusogenesis and the formation of shoots should investigate which hormone, growth regulator would be best for these parameters (Karim, 2009).

The results of the percentage of rooting in shoot culture are shown in Table 2.

At genotypes marabel and agria SR were formed lowest number of roots (2 per shoot) apart genotype dido which have 8 roots and genotype agria BE had 14 roots per shoot.

With the longest roots featured shoots of genotypes marabel and dido (15,00 mm) that was significantly with highest value than 3,50 mm at genotype agria SR.

In percentage of rooting no significant differences in the values of all tested genotypes: marabel (31,25%), agria BE (30,03%), agria SR (29,58%) and dido (26,90%).

Shoot explants					Formation of roots			
Variety	MS medium (mg/L)	Number of shoots	Length of shoot (mm)	Thickness of shoots (mm)	Number of shoots which formed roots	Number of roots	Length of root (mm)	% of rooting
<i>Seed potato</i>								
<i>Dido</i>	2 BAP + 1 IAA	17	30,00a	1,00a	4,50	8	15,00a	26,90a
<i>Marabel</i>	2 BAP + 1 IAA	16	18,68b	1,18a	5,00	2	15,00a	31,25a
<i>Mercantile potato</i>								
<i>agria BE</i>	2 BAP + 1 IAA	44	22,31ab	1,10a	13,21	14	8,00ab	30,03a
<i>agria SR</i>	2 BAP + 1 IAA	20	27,65a	1,01a	5,91	2	3,50b	29,58a

Table 2. Formation of roots – shoot explants

Callusogenesis and rhizogenesis in shoot culture

During the research performed to examine the impact of hormonal medium MS + 2 mg / L BAP + 1 mg / L IAA of shoots

culture of potato till the process of callusogenesis. The impact is determined by the percentage of callused explants.

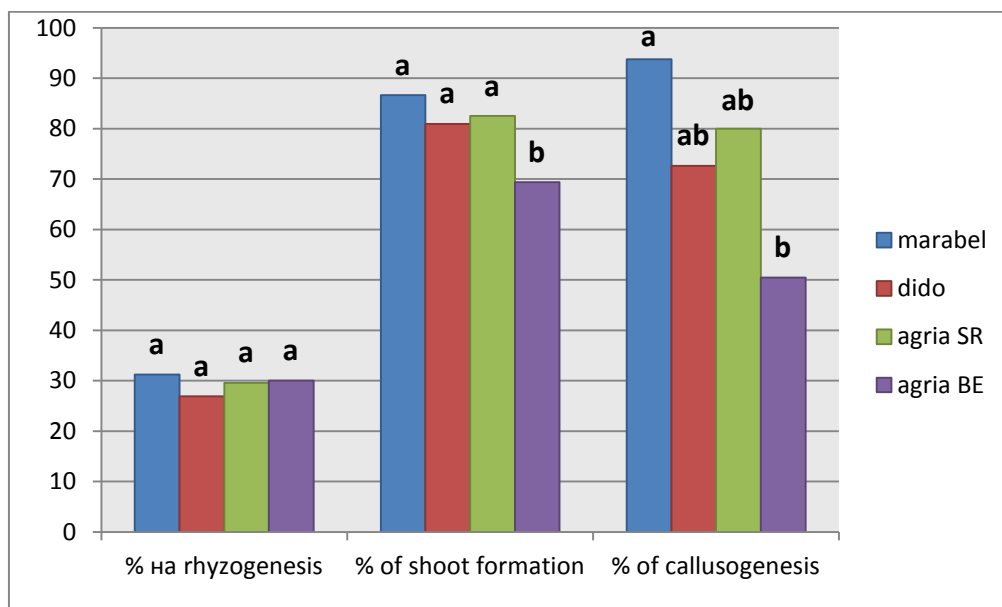
The impact of the above medium and hormonal composition of the process of rhizogenesis is determined with the percentage of rooted explants.

Also was examined the percentage of shoot formation of genotypes: marabel, dido, agria SR and agria BE, which were transferred on the same medium MS + 2 mg / L BAP + 1 mg / L IAA.

From the results (Graph 1) are obvious:

- No significant differences in values at the percentage of rooting. The percentage of rooting varies from 26.90 to 31.25%;

- At the percentage of shoots formation have significant differences between genotypes. Genotypes marabel (86,66%), dido (80,95%) and agria SR (82,50%) showed values significantly different from genotype agria BE (69,41%) of formed shoots;
- In proportion to the formation of calluses we have significant differences in values among genotypes. The least percentage of callusogenesis (50.44%) features agria BE genotype is significantly lower value of 93.75% of formed calluses at genotype marabel (Figure 1).



Graph 1. Callusogenesis, rhizogenesis and shoots formation of shoots culture on MS + 2 mg/L BAP + 1 mg/L IAA

Figure 1. a) Formation of shoots, roots and callus from mercantile genotype *agria BE* on medium MS + 2 mg/L BAP + 1 mg/L IAA, b) Formation of shoots, roots and callus from seed genotype *marabel* on medium MS + 2 mg/L BAP + 1 mg/L IAA

Conclusion

The best shown medium MS + 2 mg / L BAP + 1 mg / L NAA, which genotype dido, marabel, agria SR and agria BE showed good induction of callus and roots. On this medium those 4 genotypes are shown the best results of making callus, roots and also shoot culture. Were presented % of rhysogenesis, % of shoot culture and % of callusogenesis.

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