

STUDY OF THE NATURE OF CHANGES IN ENERGY AND QUALITATIVE INDICATORS OF THE WORK OF CULTIVATOR POINTED TILTS WITH VARIOUS DEGREES OF THEIR BLADE EDGES

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Improving the operational and quality characteristics of soil tillage working bodies is an important factor in ensuring high yields and rational use of energy resources. It is known that insufficiently high-quality soil tillage can reduce yields by 15-30%. At the same time, the efficiency of soil tillage machines is reduced due to the rapid wear of their working bodies. Thus, the level of wear of the latter directly affects the productivity of the units.

To determine the permissible level of wear of arrow-shaped cultivator tines, which can be expressed in the area worked or the distance traveled, it is necessary to take into account the degree of wear of the blades, which affects the main indicators of their work. The availability of such data allows us to substantiate the optimal service interval for arrow-shaped cultivator tines, that is, the period of their most effective use, which emphasizes the relevance of the conducted research.

According to the results of experimental studies, it was found that with an increase in the radius of the edge of the blade of the paw r from 0,1 to 0,5 mm at the speeds of movement of the arrow-shaped cultivator paw 6, 8 and 10 km/h, the specific resistance increases by 11,98%, 12,00% and 12,02%, respectively, and the increase in resistance is 0,185; 0,256 and 0,375 kN/m, respectively. The intensity of the increase in resistance with an increase in speed from 6 km/h to 8 km/h is 36-38%, and in the range from 8 km/h to 10 km/h – 47-49%.

To ensure the set depth of cultivation in accordance with agrotechnical requirements, it is necessary to check the depth of cultivation and adjust it every 75 km of the path traveled by the arrow-shaped cultivator tine or 9,36 hours of clean operation of the TIGER MATE 2-12 unit. The uniformity of the depth of the path remains within the permissible values ($v=37,5\%$) with a radius of the edge of the tine blade up to 0,5 mm. A satisfactory level of root system undercutting (94-96 %) is observed with a blade radius of 0,3-0,4 mm, provided that the recommended speed of movement of the unit is not less than 8 km/h.

Key words: cultivator, pointed cultivator paw, blade edge, operation, quality indicators, soil cultivation.

Eq. 5. Fig. 6. Table. 3. Ref. 13.

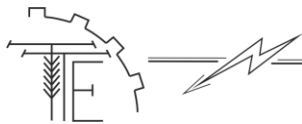
1. Problem formulation

One of the most important problems associated with the operation of agricultural machinery is the rapid wear and limited resource of replaceable working bodies, tillage, sowing machines and tools. Agricultural enterprises annually spend money on the purchase of cultivator paws and their replacement. Despite the use of high-carbon (0,4 ... 0,7% C) and manganese steels of grades 50, 60G, 65G, 70G for their manufacture, their wear resistance does not satisfy operators, especially on sandy, sandy soils, heavy loams.

If the cutting edges become blunt, the agrotechnical requirements for soil cultivation are violated (cultivation depth, weed cutting, etc.), and the yield of the crops being grown is reduced.

Premature wear of the working parts of cultivator units leads to the following negative consequences: thickening of the cutting blades leads to deterioration of weed cutting; reduction of the width of the paws affects the decrease in the productivity of the unit; wear of the edge of the blade of the cultivator paw leads to its pushing out of the soil and, as a result, to violation of the agrotechnical requirements imposed on the agrotechnological operation of soil cultivation.





Another problem that we propose for discussion in this publication is that the intensification of agricultural production processes requires increased requirements for materials, first of all, they must be durable and have high wear resistance.

The amount of abrasive wear of the paw in thickness can be represented as a function of the following factors [1]:

$$I_h = f(p, L, H_\mu, \tau, S), \quad (1)$$

where p – normal specific dynamic soil pressure; L – friction path; H_μ – hardness of the paw material; τ – abrasive wear indicator; S – friction area.

The intensity of wear of agricultural machinery parts depends on the mechanical composition of the soil. Namely, on soil moisture: in particular, on loamy black soil with a moisture content of up to 10%, the blades of the arrow-shaped tine blades of cultivators wear out approximately 7-8 times faster than at a humidity of 25-26%.

As the speed of the cultivator increases, the sliding inside the soil layers decreases, while the sliding speed of abrasive soil particles on the surfaces of the wing blades increases, as a result, the intensity of abrasive wear increases.

At low speeds, the soil does not slide on the surfaces of the working body that are worn out, but is subjected to very significant deformations; the intensity of abrasive wear is the lowest.

The wear of the blades of the arrow-shaped tine blades of the cultivator occurs under conditions of dynamic and static penetration of abrasive particles into the metal. The intensity of abrasive wear is influenced by the degree of fixation of abrasive particles in the soil mass.

In addition, our research can be integrated into the general strategy of harmonious development of agriculture in Ukraine, aimed at increasing the environmental friendliness of agricultural products [2, 3].

2. Analysis of recent research and publications

Thorough theoretical and experimental studies have shown that soil is a very complex system with a corresponding composition of mineral elements (solid phase), internal atmosphere (gaseous phase) and a peculiar water regime (liquid phase) [3, 4]. Different combinations of these phases in the soil give different physical and mechanical characteristics, which are correlated with each other and almost all are determined by the mechanical composition.

In the works of O.V. Kozachenko, O.M. Shkregal, V.S. Kadenko, the issue of the significant influence of soil hardness on the intensity of wear of soil-tillage working bodies was investigated. It was established that the type of soil being cultivated significantly affects the amount of wear of cultivator tines. Depending on the type of soil, it was recorded that the pressure on the tip of the cultivator tines is 0,016...0,132 kg/cm²; on the middle part of the blade – 0,014...0,122 kg/cm²; on the heel of the paw – 0,017...0,130 kg/cm² [4].

Thus, the most favorable conditions for the operation of any tillage implements will be when the soil is in a state of maturity.

From the results of the analysis of the studies of Rybalko I. M., Tikhonov O. V., Zakharov A. V. [1] it was established that with increasing depth of tillage, the intensity of wear of working bodies increases due to an increase in the specific load. But it is worth noting that in the studies of other scientists it was proven that it is not the depth of tillage that affects the intensity of wear, but the hardness of the soil, which is greater in its lower layers [5, 6].

In our opinion, there is no functional dependence between the specific resistance and the depth of tillage. The type of this dependence is determined by the physical state of the soil and its hardness along the horizons of the arable layer. With increasing soil cultivation depth, provided that the lower layers are compacted, the wear intensity also increases due to an increase in the specific load, which is one of the main reasons for certain shortcomings in the operation of such machines.

3. The purpose of the article

There is a justification for the change in the energy and quality indicators of the work of the arrow-shaped cultivator paws with different operation of their blade edges.

Research objectives:

- to conduct research on the influence of the size of the worked edge of the tine blade on the depth and uniformity of soil cultivation on the experimental setup we developed;
- to provide practical recommendations on the optimal operating time between regular maintenance of the tine blades of the TIGER MATE 2-12 cultivator and to perform a feasibility study of the research results.



4. Results and discussion

Experimental studies aimed at identifying patterns of changes in the energy and quality indicators of the work of the arrow-shaped cultivator paws with different wear of their blade edges were carried out on the installation developed by us in Fig. 1 [7, 8]. The main emphasis is placed on the degree of grain damage by mechanical destruction depending on the speed of transportation.



Fig. 1. Installation for modeling the movement of working bodies of soil tillage machines [7]

The methodology for studying the nature and magnitude of wear of cultivator tines depending on the operating time is that the change in geometric parameters is taken as an indicator of the degree of wear of the tines blades. It is quantitatively expressed by the radius of the blade edge, r and the height of the back chamfer h (Fig. 2).

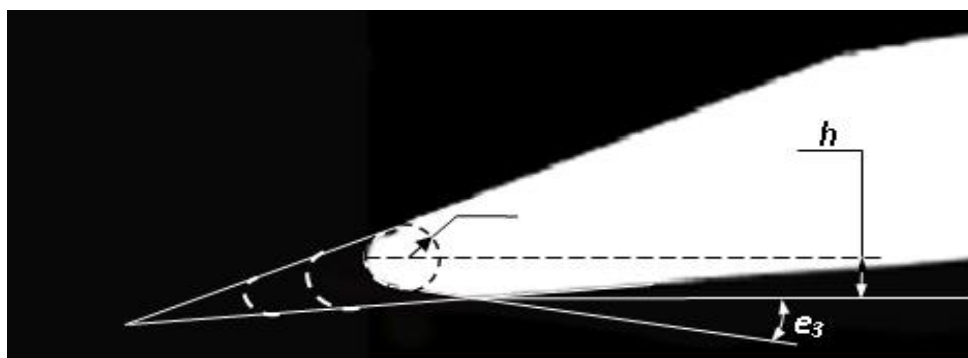


Fig. 2. Paw profile with characteristic wear and parameters by which the degree of wear is estimated: r – radius of the circle inscribed in the profile of the paw blade edge; h – height of the back chamfer; e_3 – back chamfer angle

The conditions for conducting experimental studies are determined in accordance with the described methodology, using such devices and equipment as: Revyakina Yu.Yu. hardness tester, equipment for determining soil moisture (metal cups, drying cabinet, electronic scales), and a 50-meter-long tape measure.

The study was conducted with a separate set of universal arrow-shaped claws with a gripping width of 0,26 m. The study was conducted at a speed of 8 km/h.

Each stand with a cultivator paw is set to the same depth of cultivation (0,10 m). The working time per one paw of the cultivator is 0,337 ha, 1,01 ha, 1,68 ha, 3,04 ha, respectively. After reaching the set working time of the paw, we take measurements.

To determine the size and nature of the paw blades, a special device has been developed that allows you to obtain plaster casts of the blade profile (Fig. 3). Plaster casts are taken from all paws that have worked out their specified working hours. They are then cut in a plane perpendicular to the one forming the blade.



Fig. 3. Device for removing plaster casts of cultivator blade blades.

Each footprint profile sample is scanned at ten times magnification to increase the accuracy of determining the activation parameters. Footprints of paw sets are taken every 0,337, 1,01, 1,68, 3,04 hectares of operation.

The degree of activation is estimated by the radius of the inscribed circle r into the edge of the paw blade, the height of the back chamfer h and the angle of inclination of the back chamfer e_3 .

Regarding the processing of the obtained values, methods and techniques of statistical processing of experimental data, comparison methods [9] were used.

The conditions for conducting the study are given in Table 1 [10, 11].

Table 1

Soil moisture, hardness and density in the arable layer horizons

№ experiment	Average hardness values c , Pa, density c_2 , g/cm ³ and humidity W , %								
	0-5 cm			5-10 cm			10-15 cm		
	c	c_2	W	c	c_2	W	c	c_2	W
1	6,3	1,11	28,0	8,7	1,31	28,9	20,7	1,34	31,2
2	4,5	1,05	28,3	9,8	1,26	28,6	15,0	1,36	31,9
3	5,2	1,08	27,8	11,4	1,28	29,2	16,8	1,32	31,2
Average	5,3	1,08	28,1	9,96	1,28	28,9	17,5	1,34	31,8

The soil type is medium-loamy black soil, the soil structure is fine-grained. Fig. 4 shows a photo of the paw blades according to the test results.



a



b



c

Fig. 4. Image of the claw blades:

a – working time 1.01 ha (set № 1); b – working time 1.68 ha (set № 2); c – working time 3.04 ha (set № 3)

Table 2 presents the results of field studies of blunting of the cutting edge of cultivator blade blades with increasing operating time.

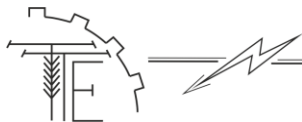


Table 2

Statistical characteristics of the change in the radius of the cutting edge of the blades depending on the operating time (distance traveled)

Indicators	Area worked by one paw (H=0.26m), ha			
	0,337	1,01	1,68	3,04
	Distance traveled L, km			
	50,0	125,0	200,0	275,0
Arithmetic mean radius r of the paw blades, cm	0,0096	0,0205	0,0306	0,0504
Standard deviation, mm	0,012	0,019	0,046	0,108
Coefficient of variation, %	5,88	6,58	7,58	9,76

It has been established that the dependence of the radius of the paw blades r on the operating time U (the distance traveled L) is nonlinear (Fig. 5) and is approximated by the dependencies:

$$r = 0,0041 + 0,0166U - 0,0004U^2; r = 0,0067 + 5E \cdot 05L + 4E \cdot 07L^2. \quad (2)$$

Fig. 5 graphically depicts the dependence of the paw blade operation r on the operating time U (L).

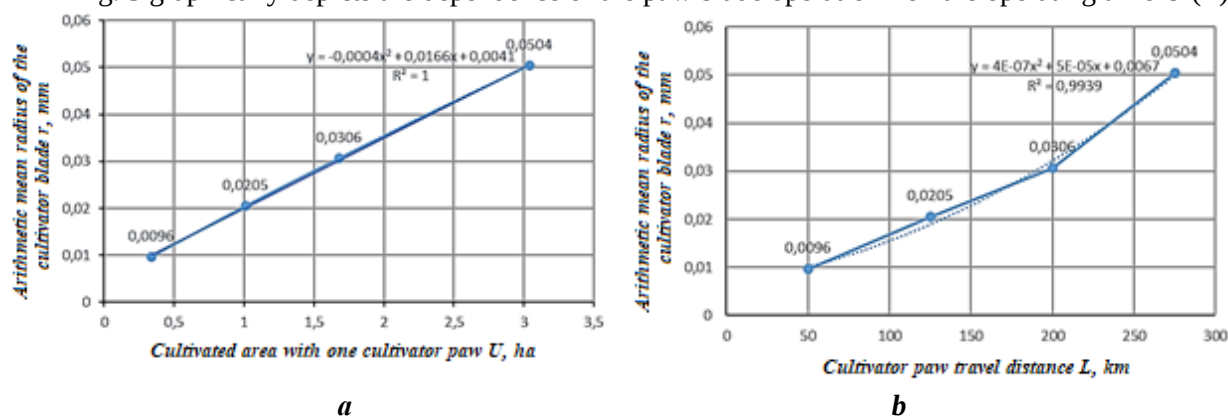


Fig. 4. Graph of dependence: a – radius of the operated blade r on the operating time U; b – radius of the operated blade r on the traveled distance L

The conditions for conducting laboratory experimental studies of the influence of the degree of wear of the tine blades on traction resistance were characterized by the following indicators: the condition of the soil on which the research was conducted, soil conditions (humidity, density, hardness) [10-12].

The most adequate pattern of increasing resistivity from the blade radius is described by a second-order polynomial:

$$k_r = 2,604 + 0,974V + 0,156r + 0,982V^2 + 0,487V \cdot r + 0,146r^2, \quad (3)$$

For economic calculations, it is advisable to use the dependence of the specific resistance on the distance traveled by the cultivator paw in kilometers. Since each value of the blade radius corresponds to a certain operating time, the mathematical models will be similar, but with different coefficients. After replacing the values of the blade radius with the corresponding distances of the cultivator paw passage, the results of the research will look like this: the mathematical dependence of the specific resistance on the distance traveled L is given in the form of a multidimensional second-order polynomial:

$$k_L = 2,628 - 0,541V + 0,00154L + 0,0585V^2 + 0,0005V \cdot L - 0,000021L^2 \quad (4)$$

After eliminating insignificant values, the regression equation will be written as follows:

$$k_L = 2,692 - 0,547V + 0,0585V^2 + 0,00061V \cdot L - 0,000017L^2 \quad (5)$$

The results of the conducted studies show that with increasing operating time and speed of movement of the cultivator paw, the specific resistance increases (Fig. 5 and 6). It should be noted that the intensity of the increase in resistance with increasing blade radius r (traveled path L) at speeds within 6-10 km/h does not significantly depend on the speed of movement of the paws. With an increase in the radius of the operated blade from 0,1 to 0,5 mm in the speed range of 6-10 km/h, the specific resistance increases in the range from 11,98 to 12,02%.

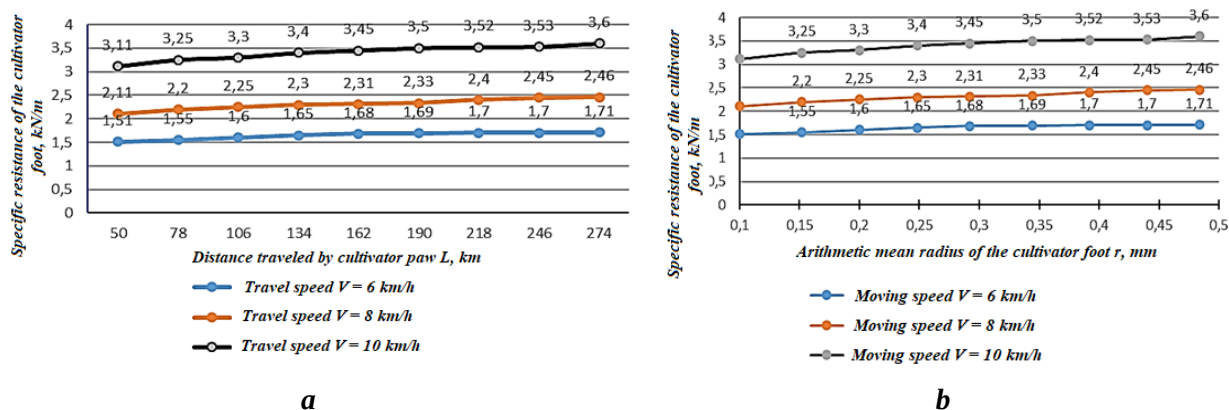
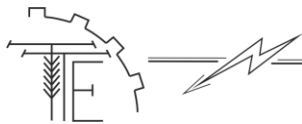


Fig. 5. Graph of dependence: a) specific resistance k of cultivator tines on the traveled path L ; b) specific resistance k of cultivator tines on the blade radius r

But the absolute values of the increase in specific resistance with increasing wear vary significantly. As can be seen from Figure 5, the increase in specific resistance k of the cultivator tines is 0,185; 0,256 and 0,375 kN/m, respectively, for speeds of 6, 8 and 10 km/h.

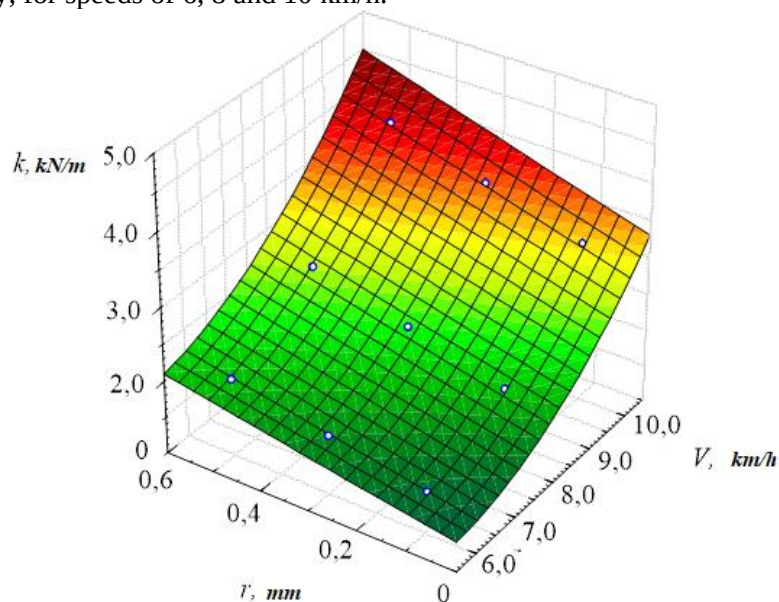


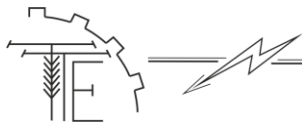
Fig. 6. Response surface of the influence of the speed of movement V of the unit and the radius of the paw blade r on the resistivity k

In order to assess the reliability of the obtained dependencies 4 and 5, we will compare the theoretical values of the increase in resistance to the operated blade with the experimental ones. For this, we will assume the initial radius of the blade edge of the paw $r=0,1$ mm. And the resistance due to the increase in the radius will correspond to the difference between its values at a given blade radius and the initial one. The increases in specific resistance calculated in this way are given in Table. 3.

Table 3

Increase in the specific resistance of cultivator tines with increasing blade radius according to experimental data

Blade blunting radius r , mm	Specific resistance k (kN/m) at travel speeds V (km/h)			Increase in specific resistance (kN/m) at travel speeds V (km/h)		
	6	8	10	6	8	10
0,1	1,543	2,130	3,131	0	0	0
0,3	1,673	2,280	3,416	0,130	0,150	0,285
0,5	1,728	2,386	3,506	0,185	0,256	0,375



From the data presented in the table, it is clear that the increase in resistance with increasing blade radius significantly depends on the speed of movement. It is quite difficult to analytically take into account the effect of speed of movement on the soil resistance of the blade, therefore it is impossible to assess the accuracy of the correspondence between theoretical and experimental results.

Comparison of theoretical and experimental results allows us to identify the reliability of the nature of the influence of individual indicators on the initial parameter. For example, in the case when the blade profile is reduced to the working planes of two triangular wedges, the probable specific resistance due to the upper chamfer is about 50 N/m, and the lower one is 100 N/m, i.e. their sum is 150 N/m. The obtained value of the specific resistance is less than the experimentally obtained value at $r=0.5$ mm (for speeds of 6, 8 and 10 km/h), the resistance (increase in resistance with an increase in r from 0,1 to 0,5 mm) is 185, 256 and 375 N/m, respectively.

The difference between the experimental and theoretical values of resistance can be partially explained by the influence of the increase in the speed of movement.

From the above analysis, it can be concluded that it is impossible to theoretically determine the resistance of the blade with sufficient accuracy for practical use. The obtained equations can only be used to establish the influence on the resistance of individual parameters of the blade and the operating modes of the units.

The cultivator paws throughout the entire period of operation must provide high-quality soil cultivation with minimal energy consumption. However, as a result of wear and dulling, the working parameters of the blades change, which leads to a deterioration in their performance in the technological process of field cultivation. Therefore, the question arises of determining the limit parameters of blade wear, after which further operation of the blades becomes ineffective and inappropriate, and it is proposed to carry out regular maintenance [13].

The main qualitative indicators of the work of the tines are the depth of cultivation, the uniformity of the depth of the course and the degree of cutting the roots of weeds.

Depth of cultivation. It is not a limiting parameter of the working life of the tines to failure, since the design of the cultivator can compensate for the decrease in the depth of cultivation by appropriate adjustment. Thus, this indicator does not limit the amount of permissible wear.

Since the current agrotechnical requirements are designed for modern cultivators, we can assume a satisfactory indicator of cutting the roots of weeds of 94-96%. Taking into account the results of theoretical calculations and experimental research data, the maximum permissible value of the blade radius is $r=0.4$ mm, while the indicator of cutting the roots of weeds is not less than 96%.

5. Conclusion

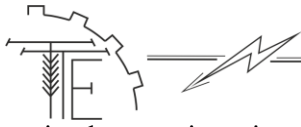
According to the results of the conducted studies of the operating conditions and modes, types and causes of failures of the TIGER MATE 2-12 cultivator and cultivator tines in particular during their operation, it was established that the main cause of failures is the rapid dulling of the edge of the tines blades. Due to the diversity and specificity of the operating conditions of the cultivator tines, a scientifically substantiated permissible value of dulling of the tines blades has not been established. The analysis of existing studies has shown the prospects of solving the multi-criteria problem associated with determining the optimal permissible value of dulling of the tines blade edge by taking into account the qualitative and energy indicators of their operation.

When the radius of the edge of the blade of the paws r increases from 0,1 to 0,5 mm at the speeds of the cultivator paw movement of 6, 8 and 10 km/h, the specific resistance increases by 11,98, 12 and 12,02%, respectively, and the increase in resistance is 0,185; 0,256 and 0,375 kN/m, respectively. The intensity of the increase in resistance with an increase in speed from 6 km/h to 8 km/h is within 36-38%, and in the range from 8 km/h to 10 km/h - 47-49%.

Adhere to the limit values of wear to the permissible blade radius of 0,3-0,4 mm, which corresponds to an operating time of 190-211 km in the traveled path or 347,7-386,1 hectares per paw with a working width of 0,26 m.

To maintain the established depth of cultivation within the agrotechnical requirements, it is necessary to check the depth of cultivation every 75 km of the path traveled by the hoe, or 9.36 hours of pure cultivator operation; the uniformity of the depth of the path is maintained at an acceptable level ($v=37,5\%$) with a radius of the edge of the hoe blade up to 0.5 mm; an acceptable degree of root undercutting (94-96%) is observed with a blade radius of 0,3-0,4 mm, while the recommended speed should be at least 8 km/h.

It is recommended that for the accepted soil conditions and the cost of fuel and maintenance work, the



optimal operating time between regular maintenance is 190...211 km of the path traveled by the TIGER MATE 2-12 cultivator, or 347,7-386,1 hectares of cultivated area, or approximately 23,75...26,37 hours of pure work, which corresponds to the radius of the edge of the used tine blades of 0,34-0,37 mm.

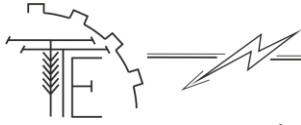
References

1. Rybalko, I.M., Tikhonov, O.V., & Zakharov, A.V. (2023). Research on the nature of wear of cultivator tines. *Technical Progress in APV: Materials of the All-Ukrainian Scientific and Practical Conference* (May 9-10, 270–272). Kharkiv: DBTU. [in Ukrainian].
2. Padalka, V., Lyashenko, S., Burlaka, O., Sakalo, V., & Padalka, Y. (2021). Modeling of resonance phenomena in self-oscillating system of agricultural machines. In *Modern Electrical and Energy Systems* (September 21–24). URL: http://mees.ieee.org.ua/wp-content/uploads/2021/09/Program_MEES_2021.pdf [in Ukrainian].
3. Voytyuk, D.G., Derkach, O.P., Gumenyuk, Y.O., Marus, O.A., Chuba, V.V. (2022). *Machines and equipment for crop production: A textbook for performing laboratory work for students of specialty 133 "Industrial mechanical engineering"*. Kyiv: FOP Yamchynskyi O.V. [in Ukrainian].
4. Kozachenko, O.V., Shkregal, O.M., Kadenko, V.S. (2021). *Ensuring the efficiency of the working bodies of cultivators* (Monograph). Kharkiv: PromArt. [in Ukrainian].
5. Zakharov, A., Rybalko, I., Tikhonov, O., Saychuk, O. (2023). Research on the wear capacity of soils and its influence on the durability of working bodies of tillage machines. *Scientific Bulletin of the Tavria State Agrotechnological University*, 13(1). URL: <https://doi.org/10.31388/sbtsatu.v13i1.359>. [in Ukrainian].
6. Borak, K.V. (2021). *A comprehensive approach to increasing the durability and wear resistance of working bodies of soil-tillage machines* (Author's abstract of the dissertation for the degree of Doctor of Technical Sciences, specialty 05.05.11 "Machines and means of mechanization of agricultural production"). Kyiv. [in Ukrainian].
7. Installation for modeling the movement of working bodies of soil tillage machines. Patent №. 34499. Ukraine. MPK A01B 39/00. № 20803911. Filed March 28, 2008. Published August 11, 2008, Bulletin № 15. [in Ukrainian].
8. Lyashenko, S.V., Lyashenko, S.S. (2024). *Design of a torsion-impact soil cultivator. Mechanical and technological justification of an energy-saving device for tillage without a tiller in the conditions of the Poltava region* (2nd ed., rev. and suppl.). Poltava: Astraya Production Association. ISBN 978-617-8231-72-9. [in Ukrainian].
9. Horvat, A.A., Molnar, O.O., Minkovych, V.V. (2019). *Methods of processing experimental data using MS Excel: Tutorial* (Yu. Yu. Zhiguts & I. I. Nebola, Eds.). Uzhhorod: Goverla. ISBN 978-617-7825-00-4. [in Ukrainian].
10. Derzhspozhyvstandart of Ukraine. (2009). *Soil quality. Determination of soil hardness by Revyakin hardness tester (DSTU 5096:2008)*. Kyiv. [in Ukrainian].
11. Derzhspozhyvstandart of Ukraine. (2010). *Soil quality. Conducting field experiments. Basic requirements (DSTU 7080:2009)*. Kyiv. [in Ukrainian].
12. Derzhspozhyvstandart of Ukraine. (2013). *Agricultural machinery. Methods for determining test conditions (DSTU 7435:2013)*. Kyiv. [in Ukrainian].
13. Bondarev, S.A. (2013). Justification of the limit blade wear of tillage tools. *Technology Audit and Production Reserves*, 5(2(13)), 8–10. DOI: <https://doi.org/10.15587/2312-8372.2013.18359> [in English].

ДОСЛІДЖЕННЯ ХАРАКТЕРУ ЗМІНИ ЕНЕРГЕТИЧНИХ ТА ЯКІСНИХ ПОКАЗНИКІВ РОБОТИ СТІЛЧАСТИХ ЛАП КУЛЬТИВАТОРА ІЗ РІЗНИМ СТУПЕНЕМ СПРАЦЮВАННЯМ ЇХ КРАЙОК ЛЕЗ

Загально визнано, що важливою умовою підвищення економічної ефективності землеробства є забезпечення високопродуктивних і якісних показників роботи сільськогосподарських машин та знарядь. Підвищення культури землеробства тісно пов'язано із якістю виконання технологічного процесу обробки ґрунту. Підвищення експлуатаційних та якісних показників роботи ґрунтообробних робочих органів є запорука отримання високих врожайів та збереження енергоресурсів.

В Україні майже 70 % території знаходиться під сільськогосподарськими угіддями, що становить близько 42 млн гектарів, з яких 33 млн га – це орні землі. Відомо, що неякісний обробіток ґрунту зменшує врожайність від 15 до 30 %. Якість роботи машин для обробки ґрунту



погіршується внаслідок швидкого спрацювання їх робочих органів. Таким чином, від величини спрацювання останніх залежатиме ефективність роботи агрегатів.

Для визначення допустимого спрацювання, яке можна виразити обробленою площею або пройденим шляхом, необхідно знати, як впливає ступінь спрацювання на основні показники роботи лап. Наявність такої інформації дозволить обґрунтувати оптимальний наробіток між технічними обслуговуваннями культиватора, тобто період найбільш ефективного використання культиваторних лап, що і підтверджує актуальність досліджень.

За отриманими результатами експериментальних досліджень встановлено, що при збільшенні радіуса крайки леза лап r від 0,1 до 0,5 мм на швидкостях руху культиваторної лапи 6, 8 і 10 км/год питомий опір зростає відповідно на 11,98, 12 і 12,02 %, а приріст опору становить відповідно 0,185; 0,256 і 0,375 кН/м. Інтенсивність приросту опору при збільшенні швидкості від 6 км/год до 8 км/год знаходиться у межах 36-38 %, а у межах від 8 км/год до 10 км/год – 47-49 %. Для дотримання встановленої глибини обробітку в межах агротехнічних вимог необхідно через кожні 75 км пройденого шляху лапою, або 9,36 години чистої роботи культиватора TIGER MATE 2-12 перевіряти глибину обробітку; рівномірність глибини ходу зберігається на допустимому рівні ($\sigma=37,5\%$) при радіусі крайки леза лапи до 0,5 мм; прийнятний ступінь підрізання коренів (94-96%) спостерігається при радіусі леза 0,3-0,4 мм, при цьому рекомендована швидкість має бути не менше 8 км/год.

Ключові слова: культиватор, стрілчаста лапа культиватора, крайка леза, спрацювання, якісні показники, культивація ґрунту.

Ф. 5. Рис. 6. Табл. 3. Літ. 13.

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