

Field Tests of a Cultivator Proceeds between Row Soils in Vineyards

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Abstract. The article presents the results of theoretical and experimental testing of the machine made as a result of the research on the basis of the scheme and parameters of the cultivator, which processes the soil between rows and rows of vines with a low cost, including vine rows with soil hardness varying between 1.4-1.8 mPa, the circumference of the bushes and The required tractor power is 21.53-35.09 kW when the resistance changes in the range of 12.41-16.37kN when moving the range of working speeds in the range of 1.45-1.8 m/s. In the tillage system, it is important to loosen the rows between the vines without overturning them. Gray soil soils in Uzbekistan have different mechanical composition and are very poor in humus. Cultivation of the vineyard soil at a depth of 20-25 cm for many years leads to the formation of a plow heel, as a result of which the water-physical properties of the soil and the development of the root system deteriorate, which negatively affects the growth and yield of the plant. The leaves of the vines turn yellow, they drop their leaves early, the amount of fruits that can be obtained decreases, and accordingly the percentage of fruits that fall to the ground increases. A decrease in the water permeability of the soil prolongs the irrigation time, as a result of which water is used inefficiently. Deep softening improves the water permeability of the soil and, accordingly, increases the coefficient of effective plant use of moisture entering the soil.

1 Introduction

In the program of the strategy of economic and social development of Uzbekistan, it was defined as a component of the agricultural complex that supplies the population with freshly picked grapes. In fulfilling this task, one of the important issues is to get a high yield from vineyards and reduce its cost due to the technical and technological modernization of equipment for high-quality soil cultivation [1-23].

Deep loosening of the soil between the rows in vineyards is one of the effective agromeasures. From this soil water-air exchange. Soil moisture during the growing season was 3-4% higher when deep softening compared to normal processing. It should be understood in this way that less water is spent on evaporation, and moisture penetrates into the deep softened layer. In deep compaction, a one-meter layer is wetted, and in the template, only half the top layer is wetted. Deep softening caused an increase in the root system of the vine. One of the important issues in this is to determine the favorable time for deep washing [1-14].

One of the main issues in the technology of loosening the soil is to determine the possibility of simultaneous transfer between all rows. This issue is solved differently in different soil-climatic conditions and depends on the acceleration of root regeneration, deep loosening,

varieties, location of roots in soil layers, etc. In the conditions of Uzbekistan, the research of this issue was not resolved.

Based on the results of many years of research and development, a cultivator equipped with a side-turning working body was designed and manufactured in cooperation with the designers of "VMKV-Agromash" JSC, which processes the soil around vine rows and bushes [1-3].

Experiments were conducted in the experimental farm of academician Makhmud Mirzaev Research Institute of Horticulture, Viticulture and Winemaking in vineyards with medium loam soil. The vines were planted in a 3x2 pattern and established in 1986. T ok cultivator was used with TL-100 "New Holland" tractor [4-8].

2 Material and method

During the experiments, the general condition of the vineyard, the hardness of the soil, moisture, weed contamination, the depth of tillage with the vine cultivator, the loss of weeds, the granulometric characteristics of the softened soil and other indicators were determined.

General condition of the current was carried out using the organoleptic method.

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Soil moisture between vine rows and around bushes A rectangular (50x50 m) uncultivated plot of land was separated from the experimental plot, the soil was drilled from its corners and 5 diagonal intersections using a special drill (0-5, 5-10 and 15 cm deep). The soil was thoroughly mixed, aluminum placed in a prepared container, the mass at the time of drilling in laboratory conditions and after drying was weighed on a laboratory scale. The soil drying process was carried out in a special drying cabinet at a temperature of 105° for 8 hours. Absolute soil moisture was calculated using the following formula:

$$W=a/b \cdot 100, \% \quad (1)$$

where a is the mass of evaporated moisture (water) in the soil;

b is the mass of dry soil.

Hardness of vineyard t soil Soil hardness was determined using VISCHOM's soil hardness tester before sampling for moisture determination of contamination of the vineyard with weeds was determined before using the vine cultivator. In it, a field equal to the width of the working part of the flat mower (75 cm) and length of 1 m was measured in the space between the vine bushes on the ground where the machine is intended to go and return, and the number of weeds in it was calculated.

Tillage depth of vine cultivator was determined using a simple metal gauge (500x35x0.3). The measurement accuracy is ± 1 cm. Measurements were carried out during 3 trips and 3 returns of the cultivator. Measurements were repeated 50 times for each option to be measured. The distance between the measured options was 50 cm. The obtained numbers were processed by the method of mathematical statistics.

Soil fertility determined after soil cultivation with a vine cultivator. In this case, a space with a surface of 0.25 m² was allocated in the middle of the width between the rows of treated vines. A pre-prepared frame (0.5x0.5 m) was installed in this place, a soil sample was taken according to the working depth and sifted in a set of special laboratory sieves (with mesh size of 100, 50, 25 mm). Sampling was done every 10 m. The experiment was repeated 6 times. The mass of soil fractions that did not pass through the eyes of Galvir was weighed on a RP-100-Sh-13 scale. Aggregate composition of the soil (ε_n) was determined using the following formula:

$$\varepsilon_n=m/Q \cdot 100, \% \quad (2)$$

where m is the amount of soil particles with a size of 25-50 mm;

Q is the amount of soil sample taken for the experiment.

Rate of weed loss in treated soil a broad to flat cutter between vine bushes a square equal to the width of the working part (75 cm) and a length of 1 m was measured. The rate of weed loss was determined as the ratio of the number of weeds before tillage to the number of grass cut after tillage:

$$K=n_k/n_y \cdot 100, \% \quad (3)$$

where K is the level of weed cutting;

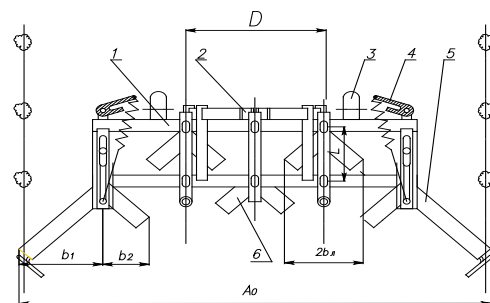
n_k - the number of cut weeds;

n_y - the total number of weeds.

The total number of weeds was counted before treatment, and the number of cut and uncut weeds was counted 3 days after treatment.

An experimental cultivator for soil cultivation between vine rows and bushes was developed for research in laboratory and field conditions.

The general scheme and appearance of the cultivator are presented in Figures 1 and 2. (This experimental cultivator was given the UK-3 model. In the following parts of the text, this experimental vine cultivator is referred to as the UK-3 cultivator).



1 – frame; 2 – hanger of the device; 3 – support wheel; 4 – turning mechanism of the working part; 5 – turning working part; 6 - central flat cutting working part

Fig. 1. General diagram of the UK-3 vine cultivator



Fig. 2. Overview of the UK-3 cultivator.

In this case, the turning working part of the UK-3 vine cultivator was installed so that it works at a depth of 10 cm, and the arrow-shaped working parts work at a depth of 15 cm. The operating speed of the unit is 1.65 ms⁻¹

The UK-3 vine cultivator was combined with the TL-100 "New Holland" tractor (Fig. 3).



Fig. 3. UK-3 vine cultivator integrated into the TL-100 "New Holland" tractor.

General description of the vineyard: area - 5 ha; vine variety-Taifi pink; height of vine branches - 110-120 cm; the width between vine rows is 3 m; the width between vine bushes is 2 m.

3 Results and discussion

The operation of the unit is as follows. The cultivator, which is prepared for use and installed in the soil at the specified tillage depth, is lowered into the working position after it is inserted between the rows of vines. The two smaller working parts, the central one with a wider coverage and the pivoting working parts, sink into the soil at a depth of 15 and 12 cm, respectively.

Due to the movement of the unit, the soil between vine rows and bushes starts to soften. In this case, the rotating working part of the cultivator interacts with the chains of the vine, which are located in a ball after a certain time. Under the influence of the resistance force of the rings, the working part is turned back. Its backspinning process continues until it is lost in the interaction. After passing through this state, the working part returns to its previous state under the influence of the spring of the turning mechanism. This process is repeated every time the turning working part meets the vine roots.

When the soil between the rows of vines is processed with bullet-shaped flat cutting working parts at a working speed of the aggregate of 1.45 m/s, 62.69% of the processed soil composition is soil fractions with a size smaller than 25 mm, 10.92% is 25-50 mm in size. soil fractions, the remaining 26.39% were soil fractions larger than 50 mm in size, i.e. lumps. When the working speed of the unit was increased to 1.55 m/s, the fractional composition of the treated soil changed. In this case, soil fractions with a size smaller than 25 mm made up 72.28%, the amount of soil fractions with a size of 25-50 mm was 15.08%, and the amount of soil fractions with a size larger than 50 mm was 12.64% [9].

When the speed of the aggregate was increased from 1.55 m/s to 1.75 m/s, the composition of soil fractions did not change. When the aggregate speed was increased from 1.45 m/s to 1.75 m/s, the amount of soil particles with a size of 25-50 mm in the treated soil increased from 10.92% to 16.26%, and the amount of particles larger than 50 mm It decreased from 26.39% to 11.13%. These show that the increase in aggregate speed up to a certain level has a positive effect on the quality of soil compaction and less formation of lumps.

The working speed of the unit is 1.45 to 1.75 m/s. The change in the interval did not significantly affect the loss of weeds between rows and vines, the loss of weeds was 97.5-98.8% and 88.4-88.0%.

Figure 4 shows the scheme of the protective zone of the current that remained untreated after two passes of the aggregate between the current bushes.

This indicates that there is a zone around the trunk of the vine that is left untreated, resulting from the movement of the turning working part along a specific trajectory. The uncultivated area around the vine is a very small area. Experiments have shown that this cultivator

can treat 96.2-96.7% of the total surface area of the vine rows and bushes, and 86.6-90.5% of the protective zone.

Thus, it is desirable for the unit's working speed to be at least 1.55 m/s for high-quality soil treatment between vine rows.

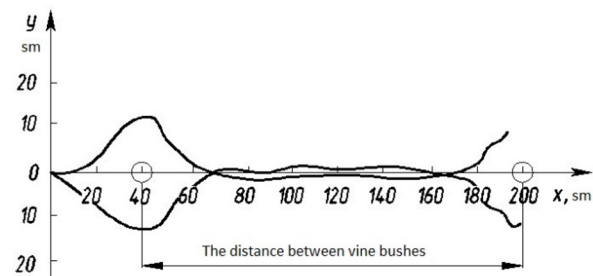


Fig. 4. The diagram of the protective zone between the working part of the turning and the vine bushes after two passes (going and returning) of the UK-3 cultivator.

The traction resistance of the UK-3 cultivator was determined at the working speeds of the unit of 1.45, 1.65, 1.75 and 1.95 m/s when working the soil between the vine rows at a depth of 12.0 cm and the soil between the vine bushes at a depth of 10 cm. Average arithmetic values of the data obtained on the basis of experiments are presented in Table 1.

When the vineyard soil belongs to the light type, that is, the hardness of the soil varies in the range of 0.9-1.3 MPa, when the working speed of the unit is changed from 1.45 ms⁻¹ to 1.95 ms⁻¹, the traction resistance of the cultivator is 12-19% decreased [9].

Table 1. Indicators of variation of UK-3 cultivator traction resistance depending on aggregate movement speed.

T/r	Type of work performed	Processing giving depth, cm	The movement of the unit launch speed, ms ⁻¹			
			1.45	1.65	1.75	1.95
1	When working the soil between vine rows when the hardness is 1.4-1.8 MPa, kN	12	12.41	13.71	15.71	16.37
2	When the hardness is 0.9-1.3 MPa, when working the soil between rows, kN	12	10.49	12.06	12.72	14.23
3	When working the soil between vine rows and bushes when the hardness is	10	14.55	15.59	17.93 --	18.32

	1.4-1.8 MPa, kN					
4	the aggregate between the rows of the tree, k N	-	1.17	1.21	1.46	1.51

When the soil between the vine rows and the vine bushes was treated simultaneously with the UK-3 cultivator, its traction resistance increased compared to the traction resistance when only the soil between the vine rows was treated. When the unit moved at a speed of 1.45 ms⁻¹, its traction resistance was 14.55 kN, while the working speeds increased to 1.65, 1.75 and 1.95 ms⁻¹, the traction resistance of the cultivator was 15.59, 17.93 and increased to 18.32 kN.

As a result of processing the data obtained based on the determination of the traction resistance of the UK-3 cultivator using the Excel program of the Windows XP operating system:

- when the hardness is 1.4-1.8 MPa, when cultivating the soil between the rows of vines, it represents the change of the traction resistance of the cultivator depending on the aggregate movement speed

$$R = 0.016 V^2 + 0.528 V + 14.96 \quad (4)$$

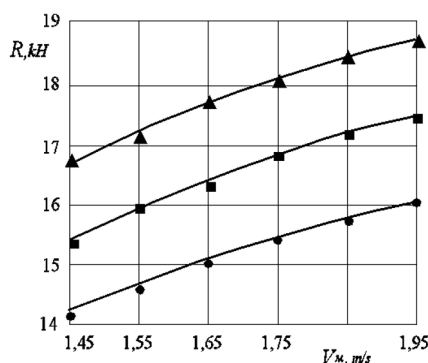
- when the hardness is 0.9-1.3 MPa, which represents the change of the traction resistance of the cultivator depending on the speed of the aggregate movement during tillage between the current rows

$$R = -0.022 V^2 + 0.529 V + 13.68 \quad (5)$$

- when the hardness is 1.4-1.8 MPa, when cultivating the soil between vine rows and bushes, it represents the change of the traction resistance of the cultivator depending on the aggregate movement speed

$$R = -0.025 + 0.580 V + 1V^2 6.21 \quad (6)$$

- empirical formulas were obtained. These formulas represent the laws of change of the traction resistance of the cultivator depending on the aggregate working speed.



- ● - ● - when processing the soil between the vine rows with a hardness of 0.9-1.3 MPa;

- ■ - ■ - when processing the soil between the vine rows with a hardness of 1.4-1.8 MPa;

- ▲ - ▲ - when processing the soil between vine rows and around vine bushes with a hardness of 1.4-1.8 MPa

Figure 5. UK-3 cultivator traction resistance graph as a function of aggregate movement speed.

Thus, the UK-3 cultivator is in the range of 12.41-16.37 kN when working on soils between rows of vines with high hardness, and in the range of 10.49-14.23 kN when working on light, fine soil, when working on soils between rows of vines and vine bushes and its tensile strength was observed in the range of 14.55-18.32 kN.

Table 2 shows the data on the power consumption of the UK-3 cultivator attached to the TL-100 "NewHolland" tractor when working the suspended unit in the soil between the vine rows and bushes [9].

The unit consumes 21.2 kW of power when working with a working speed of 1.45 ms⁻¹ on soil with a hardness of 1.4-1.8 MPa. When the operating speeds of the unit are increased from 1.45 ms⁻¹ to 1.65, 1.75 and 1.85 ms⁻¹, the power used for its work also increases and is 24.27, 29.13 and 33.30 kW (Figure 7).

A similar situation is observed when the hardness of the soil between the rows of vines is 0.9-1.3 MPa, that is, when the unit works on the soil at working speeds of 1.45, 1.65, 1.75 and 1.95 ms⁻¹, according to its work Power consumption is 15.52, 17.98, 21.46 and 28.02 kW. This shows that 15.85-26.79% less power is used compared to the power used for tilling the soil with high soil hardness.

is increased from 1.45 to 1.95 ms⁻¹, the power used for its work also increases and from 21.3 kW to 35, reaches up to 09 kW.

consumes 17.6, 20.0, 27.7 and 33.31 kW, respectively, to move between the current lines at a speed of 1.45, 1.65, 1.75 and 1.85 ms⁻¹.

Table 2. Power spent on soil cultivation between vine rows and vine bushes of the unit consisting of TL-100 "NewHolland" tractor + UK-3 cultivator.

N o	Indicator s	Processing depth, cm	Movement speed m/s	Power, kW					
				Effective, N _{eh}	In the main working parts of the motion transmitter, N _{tr}	Power consumed in transmission, N _b	When shaking, N _b	In his action, N _n	Tortishka, N _τ
1	When working the soil between vine rows when the hardness is 1.4-1.8 MPa	12.0	1.45	32.15	28.45	3.70	0.35	6.90	21,20
			1.65	36.69	32,47	4.22	0.54	7.66	24,27
			1.75	43.70	38.68	5.02	0.92	8.63	29.13
			1.95	49.27	43.61	5.66	1.31	9.00	33.30
	When the hardness is 0.9-1.3 MPa, the	12.0	1.45	27.41	24,26	3.15	0.43	8.31	15.52
			1.65	32.11	28.42	3.69	0.64	9.78	17.98
			1.75						
			1.95						

2	vine is used for tilling the soil between the rows	10.0	1.7 5	37,2 2	32,9 4	4,2 8	1,0 0	10,4 8	21,4 6
			1,9 5	46,7 9	41,4 1	5,3 8	1,6 0	11,7 9	28,0 2
			1,4 5	32,5 4	28,8 0	3,7 4	0,3 7	6,90	21,5 3
			1,6 5	37,3 3	33,0 4	4,2 9	0,6 3	7,63	24,7 8
3	When working the soil between vine rows and bushes when the hardness is 1.4-1.8 MPa	-	1,7 5	44,8 5	39,6 9	5,1 6	0,9 0	8,60	30,1 3
			1,9 5	51,4 3	45,5 2	5,9 1	1,4 6	8,97	35,0 9
			1,4 5	9,97	8,82	1,1 5	0,0 6	7,00	1,76
			1,6 5	11,2 0	9,92	1,2 9	0,0 8	7,83	2,00
3	Aggregate hardness is 1.4-1.8 MPa during direct movement between current rows	-	1,7 5	13,1 3	11,6 2	1,5 1	0,1 0	8,85	2,70
			1,9 5	14,3 2	12,6 7	1,6 5	0,1 2	9,24	3,31

The data on the power consumption of the unit consisting of the TL-100 "NewHolland" tractor and the UK-3 cultivator during processing between the current rows were processed using the "Excel" program of the Windows XP operating system. Its results are shown in Figure 7.

Based on the resulting calculations, the following empirical formulas were derived:

- when the hardness is 1.4-1.8 MPa, which represents the power consumed by the aggregate during tillage between the current rows and its change depending on the speed of movement:

$$N_e = 0.107 V^2 + 3.507 V + 33.6 \quad (8)$$

- when the hardness is 0.9-1.3 MPa, which represents the power consumed by the aggregate during tillage between rows and its change depending on the speed of its movement:

$$N_e = 0.25 V^2 + 3.05 V \quad (9)$$

- when the hardness is 1.4-1.8 MPa, which represents the power consumed by the aggregate in tilling the soil between rows and bushes and its change depending on the speed of movement:

$$N_T = 0.285 V^2 + 1.285 V + 24.1 \quad (10)$$

current lines and its change depending on the speed of movement:

$$N_T = 0.285 V^2 + 1.485 V + 20.3 \quad (11)$$

Empirical formulas were obtained.

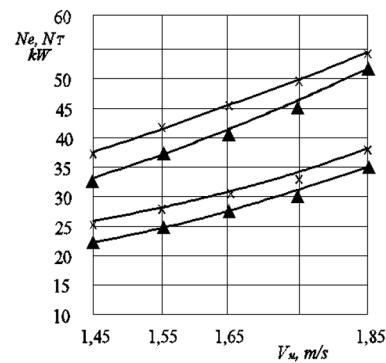


Fig. 7. The power consumed by the unit changes depending on the speed of movement.

These formulas represent the laws of change of the power consumed by the aggregate, depending on the working speed.

Thus, in order for the unit equipped with the UK-3 cultivator to process the soil between the rows of vines, the hardness of which varies in the range of 1.4-1.8 MPa, with working speeds of 1.45, 1.65, 1.75 and 1.85 m/s, 21.20, 24.27, 29.13 and 33.30 kW, respectively, when working the soil between the current rows with hardness varying between 0.9-1.3 MPa, 15.52, 17.98, 21, respectively, 46 and 28.02 kW, when processing the soil between vine rows and bushes, the hardness of which varies between 1.4-1.8 MPa, consumes 21.53, 24.78, 30.13 and 35.09 kW, respectively. When moving between the current lines, 1.76, 2.00, 2.70 and 3.31 kW of power was consumed at the indicated speeds [9].

4 Conclusion

In order for the unit equipped with the UK-3 cultivator to process the soil between the rows of vines with a hardness varying between 1.4-1.8 MPa with working speeds of 1.45, 1.65, 1.75 and 1.95 ms, respectively 21,20, 24,27, 29,13 and 33,30kW, the hardness varies in the range of 0,9-1,3 MPa in soil cultivation between rows, 15,52, 17,98, 21,46 and 28, respectively, 02 kW consumes 21.53, 24.78, 30.13 and 35.09 kW, respectively, when working with the soil between vine rows and bushes, the hardness of which varies between 1.4-1.8 MPa. When moving between current lines, it shows that it can consume 1.76, 2.00, 2.70 and 3.31 kW at the specified speeds.

With working speeds of 1.45-1.75 ms-1 in the range of 12.41 - 16.37 kN when working on soils with high stiffness between rows of vines, and in the range of 10.49 - 14.23 kN in light, fine soil, while tilling the soil between vine rows and vine bushes, it resists pulling in the range of 14.55 - 18.32 kN, and the unit consumes power from 21.3 kW to 35.09 kW.

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