RESULTS OF AN EXPERIMENTAL STUDY TO DETERMINE THE POSSIBLE VALUES OF TRAUMING SOFTWARE PARAMETERS

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ABSTRACT

The parameters of the comprehensive small-leveler levelers developed in the article, that is their installation angle with respect to the direction of movement, length, vertical distance from the lower edge of the levelers to the rod and the speed of the aggregate are determined by the heights of irregularities in the treated area. The results of multivariate experimental studies to determine the optimal values that provide the average quadratic deviation and soil density at the level of agro-technical requirements with low energy consumption are presented. The multivariate experiments were performed according to the Hartley-3 plan. The data obtained from the experiments were processed by the PLANEXP program developed in the experimental department of QXMITI and regression equations adequately representing the evaluation criteria were obtained. The Cochrane criterion was used to assess the homogeneity of the variance, the Student's criterion was used to assess the value of the regression coefficients, and the Fisher criterion was used to assess the adequacy of the regression models. The obtained regression equations show that the average square deviation of the heights of the irregularities in the zone treated by the straighteners is not more than ± 2 cm, the density of the soil in the zone treated by the straighteners is in the range of 1.1-1.2 g/cm3. the optimum values of the parameters of the solution are determined together with the condition that the gravitational resistance of the device is minimal.

KEYWORDS: *Comprehensive Small-Leveler, Trace Softener, Trace Softener leveler, Installation Angle Of The Leveler Relative To The Direction Of Movement, Length Of The Leveler, Vertical Distance From The Lower Edge Of The Leveler To The Barbell, Speed Of Movement, Standard Deviation Of Uneven Heights, Soil Density, Gravity. Standard Deviation of Roughness Heights*

INTRODUCTION

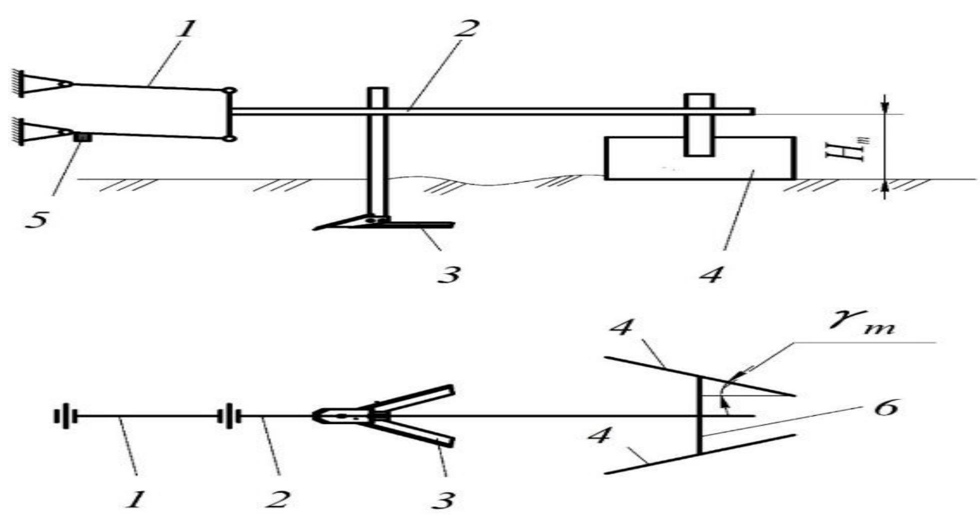
It is known that the main task in preparing the soil for planting is to level the surface of the field, compact it to the required level, and break up large lumps in it to form a fine soil layer **[1].** Currently, MV-6.0, MV-6.5 and other (mainly artificial) types of mowers are widely used in our country for this purpose **[2, 3].** However, because they are trailers, they are energy-intensive, inconvenient to use, have low maneuverability and productivity, and require a large turning area (and therefore a lot of time to walk alone). In addition, the existing mowers are used in high-power tractors ("Magnum" 8940, "PUMA", AXION 850, NEW HOLLAND T7060), which are now widely used in the country for basic and pre-sowing tillage. traces formed on the field surface by are not softened. This adversely affects the quality of seed sowing, germination, and plant development and crop yields **[4].**

Based on the above, the design and experimental version of a comprehensive suspension trowel small-leveler with trace softeners was developed at QXMITI **[5, 6].**

The track softener consists of a parallelogram mechanism 1, a rod 2, a flat cutting claw 3, a straightener 4 and a pillar of the parallelogram mechanism mounted on the front transverse beam of the wide suspension trowel. The flat cutting blade consists of a column and a chisel and knives mounted on it. During the operation of the grader, the flat cutting blade 3 softens the trail created by the tractor wheel to the specified depth, and the flattener 4 smooths the surface of the area softened by the flat cutting blade. As a result, high-quality seeds are sown and harvested throughout the field, and the conditions are created for the plants to grow and mature evenly and produce high yields.

Figure 1 shows a schematic diagram of the developed track softeners.

This paper presents the results of experimental studies to determine the values of the parameters of track softener levelers, which provide the required level of work quality with low energy consumption.



1-parallelogram mechanism; 2 - barbell; 3 - flat cutting claw; 4 - leveler; 5 - the pillar of the parallelogram mechanism;6 - a cross beam connecting the levelers

Figure 1. Constructive scheme of trace softener

Materials and research methods

The mounting angle γ_t relative to the direction of movement of the track softeners, the vertical distance H_t from their lower edge to the rod and the velocity V of the aggregate (see Figure 1) In order to determine the effect of soil density and their resistance to gravity, multifactorial experiments were conducted according to the Hartley-3 plan **[7].**

The standard deviation of the heights of the unevenness of the field surface treated by the track softeners was determined by means of a rail mounted on the field surface over the entire width of its coverage after the device had passed. Fifty measurements were made with an accuracy of ± 0.5 cm**.**

The density of the soil was determined using a cylinder with a volume of 1131 cm^3.

The traction resistance of the track softeners was determined by means of strain gauges attached to a cross beam that connected them to each other.

Table 1 shows the factors, their definitions, variation intervals, and levels.

Table 2 shows the results of the multivariate experiments.

The data obtained from the experiments were processed according to the PLANEXP program developed by the experimental department of KXMITI. The Cochrane criterion was used to assess the homogeneity of the variance, the Student's criterion was used to assess the value of the regression coefficients, and the Fisher criterion was used to assess the adequacy of the regression models **[7].**

Research results and their discussion

The results of the experiment were processed according to the specified program and the following regression equations were obtained, which adequately represent the evaluation criteria:

- by the standard deviation of the heights of the irregularities on the surface of the zone treated by levelers, cm:

$$Y_1= +1{,}013 - 0{,}216X_1 - 0{,}073X_2 - 0{,}238X_3 + 0{,}215X_1X_1 + 0{,}015X_1X_2 -$$

$$- 0{,}017X_1X_3 + 0{,}040X_2X_2 + 0{,}000X_2X_3 + 0{,}168X_3X_3; \quad (1)$$

- by the density of the soil in the area treated by levelers, g/cm^3:

$$Y_2= + 1{,}083 + 0{,}104X_1 - 0{,}016X_2 + 0{,}000X_3 - 0{,}013X_1X_1 - 0{,}022X_1X_2 +$$

$$+ 0{,}015X_1X_3 - 0{,}037X_2X_2 - 0{,}020X_2X_3 - 0{,}025X_3X_3; \quad (2)$$

- on the tensile strength of the straighteners, N:

$$Y_3= + 384{,}559 - 7{,}667X_1 + 28{,}500X_2 + 22{,}633X_3 + 8{,}934X_1X_1 + 5{,}725X_1X_2 -$$

$$- 7{,}475X_1X_3 - 7{,}399X_2X_2 + 5{,}725X_2X_3 + 13{,}901X_3X_3. \quad (3)$$

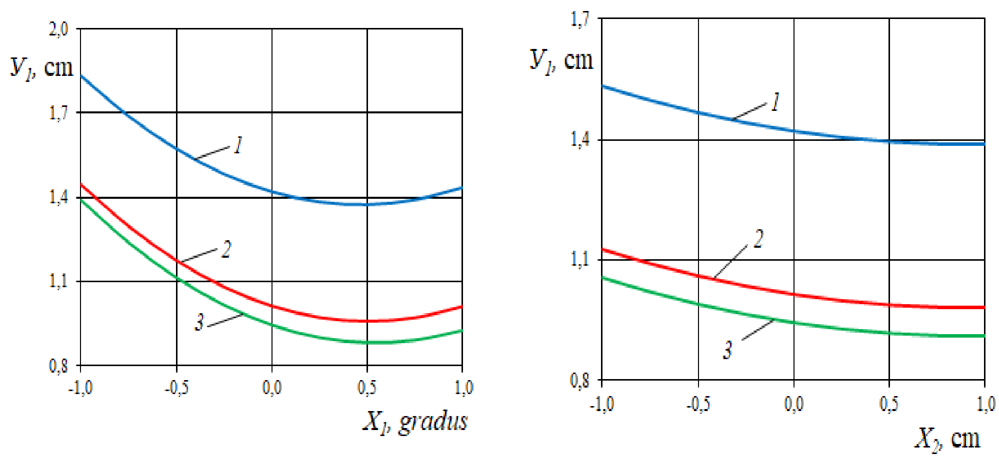
The analysis of the obtained regression equations (1) - (3) and the graphical relationships built on them (Figures 2-4) showed that all factors had a significant impact on the evaluation criteria.

From the regression equation (1) and the graphical dependences shown in

Figure 2, it can be seen that at all three speeds (X_3) the roughness of the surface of the zone treated by them increases with increasing angle of installation (X_1) relative to the direction of motion of the planes. the mean square deviation of the heights (Y_1) decreased first, then increased, and with the increase of the vertical distance (X_2) from the lower edge of the straighteners to the rod, this figure decreased.

TABLE 1 INTERVALS AND LEVELS OF CHANGE OF FACTORS

№	Naming of factors	Factors			Level of factors		
		Unit of measure	Conditional designation	Variation interval	-1	0	+1
1.	The mounting angle of the planes relative to the direction of movement, γ_t	degree	X_1	10	20	30	40
2.	The vertical distance from the bottom edge of the straighteners to the barbell, H_t	cm	X_2	3	38	41	44
3.	Aggregate speed, V	km/h	X_3	1	6	7	8



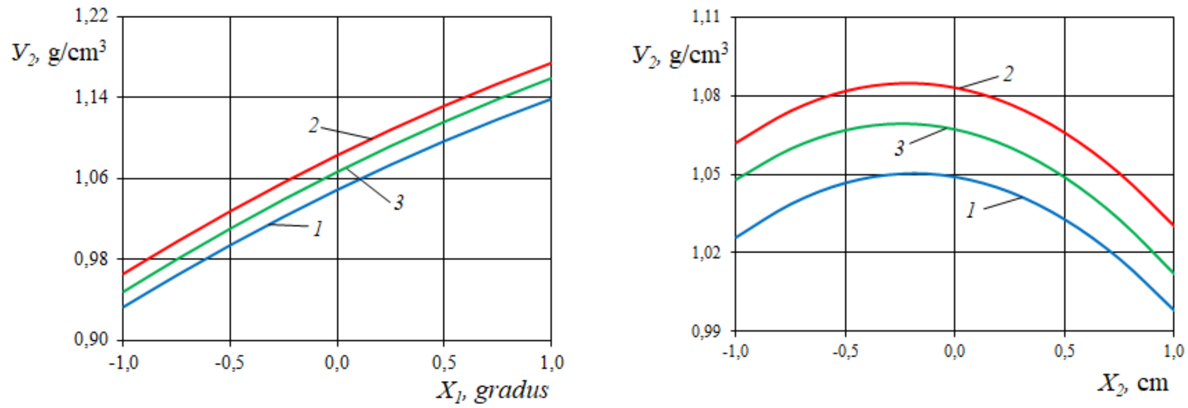
1, 2 and 3 - when the speed (X3) is 6, 7 and 8 km / h, respectively

Figure 2. Graphs of the change of the standard deviation of the heights of the irregularities on the surface of the zone treated by the planers depending on X_1 and X_2

TABLE 2 PLAN AND RESULTS OF MULTIVARIATE EXPERIMENTS

t/r	X_1	X_2	X_3	The standard deviation of the heights of the irregularities on the surface of the zone treated by the planers, cm				Density of soil in the zone treated by levelers, g/cm^3				Gravity resistance of straighteners, N			
				1	2	3	med	1	2	3	med	1	2	3	med
1	-1	-1	+1	1,520	1,530	1,510	1,520	0,907	0,912	0,893	0,904	410,7	412,7	404,4	409,267
2	+1	-1	-1	1,530	1,540	1,530	1,533	1,119	1,125	1,102	1,115	349,9	351,6	344,5	348,667
3	-1	+1	-1	1,790	1,800	1,770	1,787	0,949	0,954	0,934	0,946	395,8	397,4	390,6	394,600
4	+1	+1	+1	0,910	0,910	0,900	0,907	1,073	1,079	1,056	1,069	448,8	450,7	442,8	447,433
5	-1	+0	+0	1,440	1,460	1,430	1,443	0,970	0,975	0,955	0,967	402,5	404,6	396,4	401,167
6	+1	+0	+0	1,010	1,020	1,010	1,013	1,178	1,184	1,160	1,174	387,1	389,1	381,3	385,833
7	+0	-1	+0	1,130	1,130	1,120	1,127	1,066	1,071	1,050	1,062	349,9	352,0	344,1	348,667
8	+0	+1	+0	0,980	0,990	0,970	0,980	1,034	1,040	1,018	1,031	406,9	408,7	401,4	405,667
9	+0	+0	-1	1,420	1,430	1,410	1,420	1,071	1,077	1,054	1,067	377,1	378,7	371,7	375,833
10	+0	+0	+1	0,940	0,950	0,940	0,943	1,053	1,059	1,0	1,0	422,	424,	416,	421,10

										37	50	5	4	4	0
11	+0	+0	+0	1,010	1,020	1,010	1,013	1,087	1,093	1,071	1,084	385,8	387,8	380,0	384,533

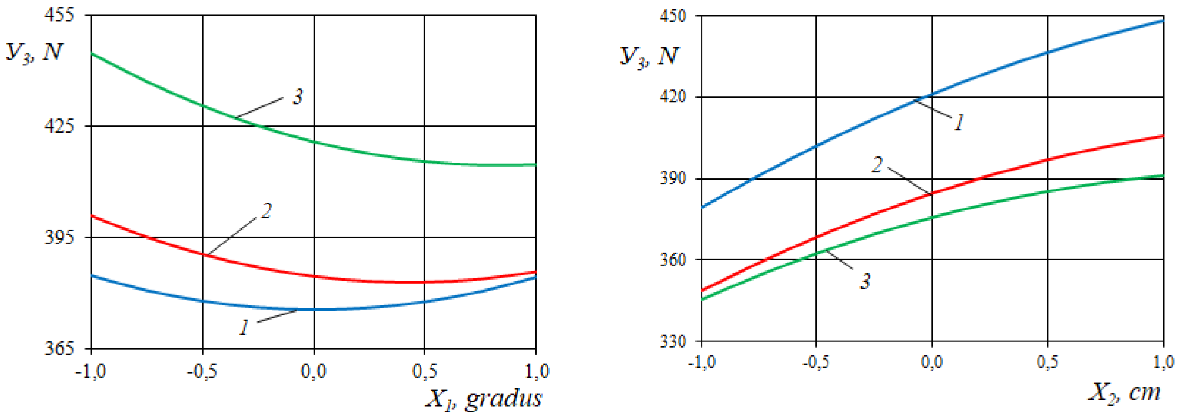


1, 2 and 3 - when the speed (X3) is 6, 7 and 8 km / h, respectively

Figure 3. Graphs of changes in soil density in the cultivated zone depending on X_1 and X_2

From the regression equation (2) and the graphical dependences shown in Figure 3, it can be seen that the increase in the installation angle (X_1) relative to the direction of movement of the levelers led to an increase in the soil density (Y_2) in the area they worked. As the vertical distance (X_3) from the bottom edge of the levelers to the bar increases, the soil density (Y_2) first increases and then decreases.

(3) From the regression equation and the graphical dependences shown in Fig. 4 show that the increase in the mounting angle (X_1) relative to the direction of motion of the straighteners decreases their gravitational resistance (Y_3) first and then increases, from the lower edge of the straightener. an increase in the vertical distance to the bar (X_3) led to an increase in this criterion.



1, 2 and 3 - when the speed (X_3) is 6, 7 and 8 km / h, respectively

Figure 4. Graphs of the change in gravity of the rectifier depending on X_1 and X_2

To determine the values of the parameters that provide the required level of work quality with low power consumption, the regression equations (1) - (3) were solved together at 6 and 8 km/h according to Excel's "solution search" [11]. When solving the regression equations together, the criterion Y_1, that is the standard deviation of the heights of the irregularities on the surface of the zone treated by the straighteners, should not exceed ± 2 cm, the criterion Y_2, that is the density of soil in the zone treated by the straighteners 1.1 It is accepted that the range should be in the range of -1.2 g/cm^3 and the criterion Y_3, that is the minimum resistance to gravity of the straighteners. The results obtained are presented in Table 3.

TABLE 3 OPTIMAL VALUES OF COMPREHENSIVE MOLAR-LEVELING TRACK SOFTENERS

V(X_3)		γ_t(X_1)		H_t(X_2)	
Coded	Natural, km/h	Coded	Natural, cm	Coded	Natural,gradus
-1	6	0,837	38,778	-0,115	40,655
0	7	0,274	34,556	0,037	41,111
1	8	0,391	35,432	-0,002	40,994

In order to ensure the required level of work with low energy consumption at operating speeds of 6-8 km/h, the leveling angle of the track softeners is in the range of 35º33′-38º47′ and the vertical distance from the lower edge of the straighteners to the barbell should be in the range of 40,65-41,11 cm.

CONCLUSION

According to the results of multi-factor experiments, the leveling angle of the track softeners relative to the direction of their movement is 35^{o}33'- 38^{o}47' to ensure the required quality of work at low operating speeds of 6-8 km/h and the vertical distance from the lower edge of the straighteners to the bar should be in the range of 40,65-41,11 cm. At these values of the factors, the average square deviation of the heights of the irregularities in the zone treated by the levelers is ± 0,95-1,25 cm, the density of the soil is 1,10-1,11 g/cm^3 and the tensile strength of the levelers is 357,4-376,4 N is formed.

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