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COMBINED AGGREGATE FOR MINIMUM SOIL PROCESSING

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ABSTRACT
The article presents the results of research conducted on multi-factor experiments of a combined aggregate pile receiver designed for minimal tillage of the soil.
KEYWORDS: *Installation angle relative to the direction of movement of the pile receiver, diameter of the pile receiver, height of the pile, speed of movement of the aggregate, degree of soil compaction.*

INTRODUCTION

Multi-factor experiments were performed on plan V3 using the method of mathematical planning of experiments to find the optimal values of the parameters of the combined aggregate [1,2], aimed at minimal tillage of the soil.

Table 1 shows the factors, their conditional designation, and the intervals of variation. They were determined based on the results of theoretical research and one-factor experiments.

1- Table
Factors, their conditional definition, range and level of variation

Naming of factors	Unit of measurement	Designation	Range	Level of factors		
				-1	0	+1
1. The mounting angle relative to the direction of movement of the pusher receiver	grad	X_1	10	20	30	40
2. Pink receiver diameter	mm	X_2	100	450	550	650
3. Aggregate speed of movement	km / h	X_3	1,5	5,0	6,5	8,0

In the multi-factor experiments, the evaluation criteria were the degree of soil compaction, ie the amount of fractions smaller than 50 mm, the height of the pile formed and the tensile strength of the softener.

The experiments were performed using a table of random numbers and the processing depth was set to 12 cm for all options.

The plan for conducting multifactorial experiments and their results are presented in Table 2.

The data obtained in the experiments were processed according to the program "regression analysis" developed in the laboratory of experimental planning of KXMITI [3]. 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 results of the experiment were processed in the specified order and the following regression equations were obtained, which adequately describe the evaluation criteria:

a) according to the degree of soil erosion (%)

$$Y_K = 78{,}833 + 0{,}986X_1 + 0{,}087X_2 + 1{,}579X_3 - 1{,}799X_1^2 \text{ ; (1)}$$

b) by the height of the pile formed (cm)

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$Y_h = 28{,}172 + 7{,}453X_1 + 1{,}197X_2 - 1{,}100X_3 - 6{,}477X_1^2 - 2{,}027X_2^2$; (2)

v) on the tensile strength of the softener (kN)

$$Y_P = 2{,}624 + 1{,}467X_1 + 0{,}360X_2 + 0{,}391X_3 + 0{,}480X_1^2 + 0{,}065X_3^2 . (3)$$

The analysis of the obtained regression equations shows that all factors had a significant impact on the evaluation criteria. An increase in the mounting angle of the pile receiver disc resulted in an increase and then decrease in the level of soil compaction, an increase in the height of the pile formed, and an increase in the traction resistance of the working body. As its diameter increases, the degree of soil compaction almost does not change, the height of the formed ridge first increases (up to 550 mm), then begins to decrease, and the resistance of the working body to gravity increases.

The experiments were carried out with pulse receivers with a diameter of 450, 550 and 650 mm at speeds of 6.0 and 8.0 km / h. In this case, the discs were set at an angle of 30° to the direction of movement and a processing depth of 17 cm. These results show that the increase in disc diameter from 450 mm to 650 mm did not significantly affect the quality of soil compaction. The pile height increased by 2.7–3.8 cm due to the increase in the volume of cultivated soil when the disc diameter increased from 450 mm to 550 mm, and remained unchanged when it increased from 550 to 650 mm. The total thickness of the softened layer also changed accordingly.

In the experiments, the mounting angle relative to the direction of movement of the pile receiver was changed from 15 ° to 40 ° at 5 ° intervals. The diameter of the piston receiver was kept constant and 550 mm, while the unit speed was assumed to be 6.0 and 8.0 km / h.

As the installation angle of the pile receiver increased from 15º to 40 °, the quality of soil compaction improved, ie the size of the pile soils with a size greater than 100 mm and a range of 100-50 mm decreased, and the amount of fractions smaller than 50 mm increased.

An increase in the diameter of the piston receiver from 450 mm to 650 mm resulted in an increase in proportion to its gravitational resistance. Gravity resistance from 1.28 kN to 2.37 kN at operating speed of 6 km / h, at a speed of 8.0 km / h, it increased from 1.83 kN to 2.55 kN. The increase in disc diameter can be explained by an increase in the volume of soil interacting with it.

An increase in speed from 6.0 km / h to 8.0 km / h has led to a slight improvement in the quality of soil compaction, ie an increase in the amount of fractions smaller than 50 mm in size. This can be explained by an increase in the impact forces applied to the ground by the working body with increasing speed. (1), (2), (3) regression equations «Y_K» the criterion should not be less than 80 percent, «Y_h» The criterion should be at least 24 cm, «Y_P» the criterion is solved on the condition of having a minimum value, the angle of installation of the unit relative to the direction of movement of the pile receiver in the range of speeds 6.0-8.0 km/h 28-33^0, and the diameter was found to be in the range of 515–570 mm.

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2- Table
Plan for conducting multifactorial experiments and their results

№	X_1	X_2	X_3	y_1				y_2				y_3			
				1	2	3	Ўр	1	2	3	Ўр	1	2	3	Ўр
1	-1	-1	-1	74,44	74,31	74,58	74,44	12,50	12,10	11,80	12,13	0,94	0,95	0,96	0,95
2	+1	-1	-1	76,18	76,35	76,49	76,33	26,70	27,10	27,30	27,03	3,87	3,88	3,89	3,88
3	-1	+1	-1	74,30	74,39	74,47	74,38	14,50	14,20	14,80	14,50	1,68	1,67	1,66	1,67
4	+1	+1	-1	76,45	76,58	76,73	76,58	29,20	29,40	29,70	29,43	4,61	4,60	4,59	4,60
5	-1	-1	+1	77,55	77,71	77,38	77,54	9,90	9,80	10,10	9,93	1,74	1,72	1,73	1,73
6	+1	-1	+1	79,32	79,46	79,59	79,45	24,80	24,60	25,10	24,83	4,67	4,66	4,65	4,66
7	-1	+1	+1	77,78	77,65	77,82	77,75	12,60	12,10	12,20	12,30	2,45	2,44	2,46	2,45
8	+1	+1	+1	79,83	79,70	79,55	79,69	27,10	27,30	27,20	27,20	5,39	5,38	5,37	5,38
9	-1	+0	+0	76,11	75,98	76,25	76,11	14,00	14,50	14,20	14,23	1,63	1,64	1,62	1,63
10	+1	+0	+0	78,02	78,15	77,90	78,02	29,40	28,90	29,10	29,13	4,58	4,57	4,56	4,57
11	+0	-1	+0	78,85	78,57	78,72	78,71	25,30	24,80	24,60	24,90	2,26	2,27	2,25	2,26
12	+0	+1	+0	78,86	79,05	78,95	78,95	27,10	27,60	27,40	27,36	2,97	2,98	2,99	2,98
13	+0	+0	-1	77,28	77,39	77,18	77,28	29,00	29,50	29,30	29,26	2,30	2,29	2,28	2,29
14	+0	+0	+1	80,31	80,46	80,38	80,38	27,00	27,20	27,10	27,10	3,08	3,08	3,07	3,08

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With increasing speed, the degree of soil erosion and the resistance of the workingbody to gravity increased, and the height of the pile decreased.

CONCLUSION

1. In order to create piles of agro-technical requirements with low energy consumption, it is necessary to use a pile picker in the form of spherical discs with a diameter of 550 mm.

2. An increase in the speed of the unit from 6.0 km / h to 8.0 km / h leads to an improvement in the quality of soil compaction and an increase in the traction resistance of the working body, the height of the pile and the overall height of the softened layer does not change.

3. The combined aggregates should be in the range of 515-570 mm in diameter and should be installed at an angle of 28-330 to the direction of movement to ensure that the aggregate is obtained at the level of agro-technical requirements with low energy consumption at speeds of 6-8 km / h.

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