RESEARCH ARTICLE

Combined Unit Providing Minimum Work With Soil

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Abstract

The article presents the results of multifactorial experiments of a combined aggregate rice harvester designed for minimal tillage.

Keywords: Installation angle of the pick-up in relation to the direction of movement, pick-up diameter, pick-up height, unit speed, soil compaction level

Introduction

Research is being conducted to develop resource-saving technologies for preparing cotton fields, especially fields with or cleared of cotton stalks, for planting seeds by removing the husks in one pass, and new scientific and technical foundations for combined units that implement them. The technological work process of the combined tillage unit is as follows: In one pass of the unit, the bottom of the previous season's fields is loosened with deep looseners to a depth of 30-40 cm and fertilized in a single pass using a ribbon method, With the help of plowshares, old plowshares are pushed onto these softened and fertilized areas, and new plowshares are formed, that is, in place of the previous season's plowshares, softened and fertilized plowshares are formed, and plowshares are formed in place of the plowshares. Therefore, in order to find the optimal values of the parameters of the combined aggregate [1,2,3,] cotton receiver oriented to the minimum tillage, multifactorial experiments were conducted according to the V3 plan using the method of mathematical planning of experiments.

Research Methodology

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

Table 1. Factors, their conditional determination, range and level of variation

Naming of factors	Unit of measurem ent	Definition	Distance	Factor level		
				-1	0	+1
1. The angle of installation of the receiver relative to the direction of movement	city	X_1	10	20	30	40
2. Pink receiver diameter	mm	X_2	100	450	550	650
3. Unit speed	km/h	X_3	1,5	5,0	6,5	8,0

When conducting multifactorial experiments, the level of soil compaction, that is, the amount of fractions smaller than 50 mm in size, the height of the pile formed, and the tensile strength of the softener were taken as evaluation criteria. Experiments were conducted using a random number table and the tillage depth was set at 12 cm for all options.

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

The data obtained in the experiments were processed according to the "regression analysis" program developed in the experiment planning laboratory of QMITI. [4,5,6,7]. The Cochrane criterion was used to evaluate the homogeneity of the variance, the Student's criterion was used to evaluate the value of the regression coefficients, and the Fisher criterion was used to evaluate the adequacy of the regression models. [8,9,10].

Results and discussion

The results of the experiment were processed in the indicated order, and the following regression equations were obtained that adequately describe the evaluation criteria:

a) according to the level of soil fertility (%)

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

b) by the height of the produced bush (cm)

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

v) by tensile strength of softener (kN)

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

Analysis of the obtained regression equations shows that all factors had a significant impact on the evaluation criteria. Increasing the installation angle of the ridge collector disk first increased and then decreased the degree of soil compaction, increased the height of the ridge formed, and increased the traction resistance of the working body. As its diameter increases, the degree of soil compaction remains almost unchanged, the height of the formed mound first increases (up to 550 mm), then begins to decrease, and the drag resistance of the working body increases.

The experiments were conducted with 450, 550 and 650 mm diameter ploughshares at speeds of 6.0 and 8.0 km/h. The discs were set at an angle of 30° to the direction of travel and at a working depth of 17 cm. [11,12].

From these results, it can be seen that increasing the disc diameter from 450 mm to 650 mm did not have a significant effect on the soil compaction quality. When the disk diameter increased from 450 mm to 550 mm, the height of the spike increased by 2.7-3.8 cm due to the increase in the volume of the cultivated soil, and when it increased from 550 to 650 mm, it remained unchanged. The total thickness of the softened layer also changed accordingly.

In the experiments, the angle of installation of the hopper relative to the direction of movement was changed from 15° to 40° in 5° intervals. The diameter of the hopper was kept constant and equal to 550 mm, and the speed of movement of the unit was assumed to be 6.0 and 8.0 km/h.

By increasing the installation angle of the tiller relative to the direction of movement from 15° to 40°, the quality of soil crushing improved, that is, the amount of fractions larger than 100 mm and in the range of 100-50 mm in the tilled soil decreased, and the amount of fractions smaller than 50 mm increased.

Increasing the diameter of the pick-up from 450 mm to 650 mm led to a proportional increase in its pulling resistance.At a working speed of 6 km/h, the traction resistance increased from 1.28 kN to 2.37 kN, and at a speed of 8.0 km/h, it increased from 1.83 kN to 2.55 kN. This can be explained by the increase in the volume of soil interacting with the disc diameter. Increasing the speed from 6.0 km/h to 8.0 km/h led to a slight improvement in the quality of soil crushing, that is, an increase in the amount of fractions smaller than 50 mm. This can be explained by the fact that the impact forces exerted on the soil by the working body increase with increasing speed. The regression equations (1), (2), (3) were solved under the condition that the "YK" criterion should be not less than 80 percent, the "Yh" criterion should be at least 24 cm, and the "YP" criterion should have a minimum value. It was determined that the installation angle of the nozzle relative to the direction of movement of the unit at speeds of 6.0-8.0 km/h should be 28-330, and the diameter should be 515-570 mm.

In order to create agrotechnically demanded husks, it is necessary to use a husk collector in the form of spherical discs with a diameter of 550 mm. Changing the angle of installation of the rear picker relative to the direction of movement from 15º to 40º leads to an improvement in the quality of soil penetration and an increase in its traction resistance. The height of the ridge and the total thickness of the softened layer increase as this angle changes from 15º to 30º, but remain unchanged between 30º and 40º. Increasing the unit's travel speed from 6.0 km/h to 8.0 km/h improves the quality of soil mixing and increases the traction resistance of the working body. In order to create agrotechnically required pulses with low energy consumption, it is necessary to use a pulse receiver in the form of spherical discs with a diameter of 550 mm.

Conclusion

In order to ensure that the combined aggregate collects cotton at the level of agrotechnical requirements with low energy consumption at speeds of 6-8 km/h, the diameter of the cotton pickers should be in the range of 515-570 mm and they should be installed at an angle of 28-330 with respect to the direction of movement.

Table 2. A plan for conducting multifactorial experiments and their results

				y_1				y_2				y_3			
№	X_1	X_2	X_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

As the speed increased, the degree of soil compaction and the drag resistance of the working body increased, while the height of the ridge decreased.

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