Experimental Field Studies to Determine the Parameters of an Improved Pneumatic Seeder Apparatus

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Abstract: In the article, the authors analyzed the results of field experiments of a pneumatic seeder that accurately plants a bare cotton seed. The field experiments were conducted on earth with 2 different conditions, namely on a test site and on an inclined plane. The experiment was carried out with a change in the speed of the unit. The article presents the parameters of the planting disc used for slot sowing of seeds. The interval between slots, the number of seeds that got into each slot, as well as the degree of elongation of the slots were taken as an evaluation criterion when planting seeds in the slot. The results obtained on the basis of experiments have been analyzed, and the authors' conclusion is given in the article

1 INTRODUCTION

The world is leading in the development of energy-resource technologies and modern technical means for growing cotton. The volume of cotton fiber cultivation on a global scale is 23477 thousand tons, including in India - 6205, China - 5987, USA - 4555, Brazil - 1895, Pakistan - 1785, Australia - 1045, Turkey - 871, Uzbekistan - 838 and Turkmenistan - 296 thousand tons (Kathirvel et al., 2005; Javellonar et al., 2016; Xiangdong et al., 2017; Alimova et al., 2022). Seeder one of the important tasks is considered to be the improvement and development of new scientifically based energy-resource-saving ones that ensure high quality of work and efficiency. In this regard, certain successes have been achieved in developed foreign countries, including the USA, Turkey, India, China and other countries, with great attention being paid to the development and application of pneumatic sieves that accurately sow seeds (Singh et al., 2005; Ramesh et al., 2015; Veerangouda et al., 2020; Alimova, 2023).

The pneumatic seeder, which precisely sows bare seeds, is suspended and aggregated with tractors of class 0.9-1.4. It consists of a suspended structure, a frame, 4 sections for landing. Each section for planting will be equipped with a pneumatic seeding device. The seeding machine consists of an improved vertical disk, a housing, a feed chamber (seeding), a separator, a thinning chamber, an air duct, and round linings (Byler, 2003; Karimov et al., 2020; Saidova et al., 2024a; Djiyanov et al., 2024).

The distribution of seeds in rows (seeding step) is studied in seeders, which plant clearly and punctually. The implementation of an even distribution of seeds is emphasized in special standards. In this case, the distances between the sown seeds are determined by recording (measuring) (Norchayev et al., 2022; Irisov & Bekmurodov, 2023; Norchayev et al., 2024; Saidova et al., 2024b).

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2 MATERIALS AND METHODS

During the tests, a seeder equipped with a pneumatic seeding machine that accurately planted lint-free seeds was aggregated with a tractor TTZ-80.11 (Fig. 1) (Aslonov & Irisov, 2023; Tukhtakuziev et al., 2024a; Djiyanov et al., 2024; Tukhtakuziev et al., 2024b).

Figure 1: General view of an experimental instance of a pneumatic seeder that precisely seals seeds without feathers into a tractor.

3 RESULTS AND DISCUSSION

The parameters of the planting disc used to plant seeds in the slot, throwing 2 seeds into each slot: the diameter of the suction holes is 3.5 mm, the diameter of the circle in which the holes are located is 180 and 200 mm, the number of holes is 32x2 (32 groups, 2 holes in each group). In this case, the interval between the seeds in the planted row should be equal to 12.5 cm.The intervals between slots as an evaluation criterion for slotting seeds, the number of seeds that got into each slot, as well as the degree of elongation of the slots, was obtained. Besides, In field experiments, the depth of seeding was determined. To do this, 7 days after sowing the seeds, the sprouted seedlings were dug out and the depth of instillation was measured along the ethyl part of the roots.

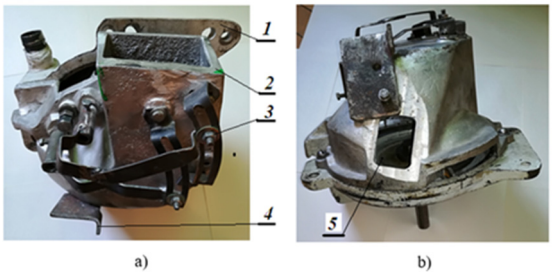

Figure 2: View of the landing gear assembled (the landing disc is not installed; the bottom cover is open): a) side view; b) bottom view: 1-fastener housing; 2-fastener cover; 3-gear adjustment mechanism; 4-cover of the hole for removing hardware; 5-hole for removing hardware.

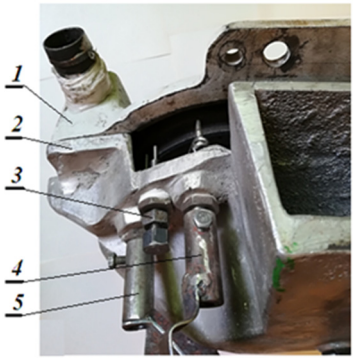

Figure 3: Assembled state of the landing discs (the landing disc is not installed): 1-the body of the device; 2-the cover of the device; 3-the central unloader; 4-radial unloaders.

Figure 4: Planting disc.

Table 1 shows the results of experiments conducted at a unit speed of 1.45 m/s. V_{med} = 1.45 m/s; d_1 = 200 mm; d_2 = 180 mm; z = 32x2 pieces; d_m = 3.5 mm; P = 40 mbar; i = 0.389; l_y = 12.5 cm; The variety of seeds is "Sultan".

As can be seen from the data in the table, when the unit was operating at a speed of 1.45 m/s, the distances between the slots averaged 11.9-12.0 cm, the coefficients of their variation were 12.4-13.2%. With a given number, i.e. the proportion of slots sown in two, 67.4-74.5%, the proportion of slots sown in 2 ± 1 pieces was almost 98%. The length of the nests ranged from 0.6 to 1.0 cm, and the proportion of nests no longer than 2 cm was about 77.6-89.4%. All these indicators meet the preliminary time requirements.

The results obtained in the variants with a total velocity of 2.1 m/s are shown in Table 2.V_{med} = 2,1 m/s; d_1 = 200 mm; d_2 = 180 mm; z = 32x2 pieces; d_m = 3.5 mm; P = 40 mbar; i = 0.389; l_y = 12.5 cm; The variety of seeds is "Sultan".The place where the experiment was conducted: Inclined plane.

Table 1: The results of experiments conducted at a unit.

Specification		n = 31,5 rpm; l_y = 12,5 cm			n = 19,7 rpm; l_y = 20 cm		
		M_{med}	± σ	V, %	M_{med}	± σ	V, %
Interval between slots, cm		12,0	1,49	12,4	11,9	1,56	13,2
Number of seeds falling into the slots, pcs		1,9	0,37	19,9	1,9	0,39	19,9
Stretching of the slots, cm		0,6	0,76	118,9	1,0	1,03	102,3
Distribution of slots by seed, %:	0	2,1			2,0		
	1	17,0			16,3		
	2	74,5			67,4		
	3	6,4			14,3		
	4	0			0		
Planting accuracy (the amount of slots in which the number of seeds corresponds to standard (2±1 pcs.), %		97,9			98,0		
Share of slots no more than 2 cm in length, %		89,4			77,6		
The amount of slots falling between the intervals, %		2,1			2,0		

Table 2: Results of sowing seeds in two slot fields.

Specification		M_{med}	± σ	V, %
Interval between slots, cm		12,1	1,72	14,3
Number of seeds falling into the slots, pcs		1,7	0,54	32,4
Stretching of the slots, cm		0,4	0,63	146,3
Distribution of slots by seed, %:	0	3,7		
	1	30,4		
	2	59,3		
	3	5,9		
	4	0,7		
Planting accuracy (the amount of slots in which the number of seeds corresponds to standard (2±1 pcs.), %		95,6		
Share of slots no more than 2 cm in length, %		83,2		
The amount of slots falling between the intervals, %		3,7		

As can be seen from the table data, in this case, the distances between them on average are 12.1 cm, the coefficient of variation has become equal to 14.3%. The proportion of nests sown in 2 ± 1 pieces, i.e., the sowing accuracy was 95.6%.The lengthening of the nests turned out to be better than the previous version – 0.4 cm, and the proportion of nests no longer than 2 cm was 83.2%. These indicators also meet the preliminary time requirements.

4 CONCLUSIONS

1. For cotton seeds, the optimal parameter is that the holes in the pneumatic planting disc have a diameter of 3.5 mm.
2. The pneumatic seeding machine fully meets the temporary initial requirements for timely sowing of seeds one at a time: the seeding accuracy was more than 95% in laboratory and field conditions.
3. The performance indicators of the pneumatic seeding machine during nest planting correspond to the temporary initial requirements. The coefficient of variation of the actual values of the intervals between the slots was 10.0-10.4% in laboratory conditions, 14.3% in the field. The percentage of nests in which the number of seeds in the nest met the initial requirements (2 ± 1 pcs.), that is, the planting accuracy, was 95.2-98.4% and 95.6%, respectively. The degree of elongation of the formed nests was about 0.4-0.9 cm, and this corresponded to the initial requirements.

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