Experimental Research Based on the Parameters of the Pneumatic Seeder

Mukhayyokhon Saidova[1][a], Tunahan Erdem[2][b], Sarvar Tursunbaev[1][c], Temurbek Ismoilov[3][d] and Sadbarxon Mavlanova[3][e]

[1]*Tashkent State Technical University, 100095 Tashkent, Uzbekistan*
[2]*Cukurova University, 01250, Adana, Turkey*
[3]*Namangan State University, 160107 Namangan, Uzbekistan*

Keywords: Pneumatic Seeder, Seed Spacing, Planting Accuracy.

Abstract: In the article, the authors analyzed the results of laboratory tests of a pneumatic sowing apparatus that accurately sows bare cotton seeds. The experiments were carried out on seeds of the “Sultan” variety. Tests to change the number of revolutions of the sowing disks in 2 different variants, the distance between slots, the coefficient of variation of the actual value of the interval between slots, the number of seeds falling into each slot, their standard deviation. The number of slots without seeds, the percentage of slots with seeds, and slot elongation were examined. The article presents conclusions based on the results obtained.

1 INTRODUCTION

In world practice, it has been proven that in pneumatic diluents it is most acceptable to use landing discs rotating along a vertically longitudinal surface, and most companies producing pneumatic diluents produce diluents equipped with just such discs. The research paper considers the main parameters of the landing disc, which rotates on a vertically longitudinal surface, that is, on a horizontal axis located transversely to the direction of movement of the seal (QXA-3-001 practical project, 2018; Ramesh et al., 2017; Xiangdong et al., 2017; Lu et al., 2022; Li et al., 2023; Verma et al., 2024).

It is known that in order to obtain higher crop yields, it is necessary to evenly distribute seeds throughout the field, that is, plant them evenly to the desired depth, ensuring a given range and distance to the node. In world practice, when using seeds prepared with high quality, seed sowing is used in a clear norm, one seed per slot.

In addition to the general requirements, specific planting requirements are developed according to the climate and soil of each area. In particular, the soil and climatic conditions of Uzbekistan are such that in the spring sowing period, after precipitation, in most cases tar appears in the soil, and seeds planted in one grain risk getting stuck under it, failing to split the resin.For this reason, when planting rotten seeds or other seed materials, it is advisable to sow them in a slot way, that is, laying 2-3 seeds in each slot (El-Sayad, 2012; Javellonar et al., 2016; Veerangouda et al., 2020; Alimova et al., 2022; Saidova et al., 2023; Saidova et al., 2024).

2 MATERIALS AND METHODS

Experimental studies according to GOST 31345-2017 "Agricultural machinery. Tractor tractors. Test methods", as well as UzDst 3193:2017. "Testing of agricultural machinery. The method of energy

[a] https://orcid.org/0009-0007-0870-4802
[b] https://orcid.org/0000-0002-1595-6852
[c] https://orcid.org/0000-0003-2516-3597
[d] https://orcid.org/0000-0003-0414-2148
[e] https://orcid.org/0009-0007-9824-8002

Saidova, M., Erdem, T., Tursunbaev, S., Ismoilov, T. and Mavlanova, S.
Experimental Research Based on the Parameters of the Pneumatic Seeder.
DOI: 10.5220/0014044700004738

In *Proceedings of the 4th International Conference on Research of Agricultural and Food Technologies (I-CRAFT 2024)*, pages 68-73
ISBN: 978-989-758-773-3; ISSN: 3051-7710

assessment of machines " (Uzdst 3193, 2017; GOST 31345-2017, 2018).

By changing the number of revolutions of the sowing discs of 2 different variants of the bare cottons seeds pneumatic sowing machine, the distance between the hives, the coefficient of variation of the actual value of the interval between the hives, the number of seeds that fell into each slot, their standard deviation, the proportion of slots into which the seed did not fall, the proportion of slots into which the seed fell were studied on a special stand, the length of the slots.

The laboratory stand is a model of the planting process, while in practice it moves across the field on the surface of unobstructed soil, while the landing device is freely accessible on the stand, and the "soil" in the form of a conveyor belt is movable (Fig. 1).

A pneumatic landing device 4 was installed on this test bench. To create a vacuum, an exhauster 5 was installed, which is powered by an electric motor 6. The pneumatic landing device is connected to the exhauster by an air wire. The electric motor 2, which is powered by direct current, and the circuit extension act as a landing gear drive. Rheostat 3 allows you to change the number of revolutions transmitted to the lander.

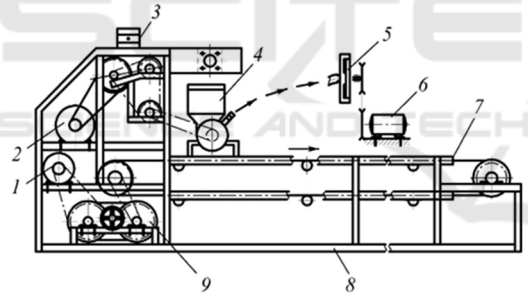

Figure 1: Scheme of the laboratory stand for testing the planting apparatus.1, 6 – AC electric motors; 2-DC electric motors; 3-rheostat; 4-pneumatic landing apparatus; 5-extractor; 7-conveying belt; 8-frame; 9-variator.

Experimental studies were carried out with a single-row layout of the lander in the following order (Fig. 2).

- the seeds are placed in the hopper of a pneumatic seeding machine;
- solidol is applied to the conveyor belt so that the seeds from the sowing machine can stick to the tape;
- adjustment of the set values of the unit speed was carried out using a variator;
- when adjusting or changing the distances between the seeds in the slot, the number of revolutions of the disc of the sowing machine changed;
- the number of revolutions of the disc of the seeding machine is determined using a tachometer through the valve of the disc of the seeding machine;
- the laboratory stand has been launched. From the sowing machine, the seeds fell onto the surface of the conveyor belt. The stand was stopped when the surface of the tape was completely covered with seeds along the length;
- the number of seeds in the slots that appeared on the surface of the tape, the distance between the slots and their elongation were measured;
- counted the number of seeds that got into the slots;
- the distance between the slots was measured using an electronic vernier caliper.

Figure 2: General view of laboratory stand equipped with improved pneumatic planting apparatus.

The set of numbers obtained as a result of measurements was processed by mathematical statistics methods and the average values of random variables (Mmed), the mean square deviation (±σ) and variational coefficients (V) were determined. They were entered into the appropriate tables and analyzed.

In the punched planting method, the accuracy of sowing and the set distance between seeds (pitch) were taken into account, which corresponded to the criterion for evaluating the quality of sowing.If the sowing step between the seeds was less than half of the specified distance, then one seeder and two seeders were accepted.It was believed that if the step between the sown seeds is one and a half times larger than the specified step, then empty slots remain.This method was used to evaluate the performance of various seeding machines (Testing of agricultural

machinery, 1991; Testing of agricultural machinery, 2001; Karimov et al., 2020; Irisov et al., 2023). Using this method of estimating the location of seeds, it is possible to quantify the quality of the sown seeds and visually assess the deviation for a given planting accuracy. This method makes it much more difficult to estimate the location of the seeds (Tukhtakuziev et al., 2020; Norchayev et al., 2022; Alimova, 2023; Aslonov & Irisov, 2023; Tukhtakuziev et al., 2023; Djiyanov et al., 2024; Mirzakhodjaev et al., 2024).

3 RESULTS AND DISCUSSION

All studies were carried out with seeds of the “Sultan” variety in good condition. The data obtained during the experimental studies were processed in accordance with the methods used in the study of technological processes in agriculture.

Laboratory experiments were conducted according to GOST 31345-2007, accepted among the CIS countries, "Tractor seeders. The method was carried out on the basis of the requirements established in accordance with the "interstate standard", in particular in standard 6.3.2 "determination of the quality indicators of the seeding apparatus during bench tests" and 6.3.6 "determination of the distribution of seeds (slots) in a row".

Experimental studies were carried out through the following planting discs.

Option 1 is a planting disc with a circular hole (3.5 mm in diameter);

Option 2 is a planting disc with two circular holes (3.5 mm in diameter).

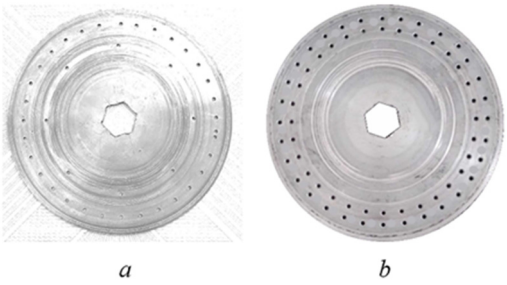

Figure 3: Planting discs with holes of different sizes.

The prepared a-shaped disk was mounted on an additionally machined pneumatic landing gear and mounted on a universal stand. During the experiments, the linear speed of the conveyor belt was increased to 2.1 m/s. This corresponds to the speed of the unit in the field, equal to 7.57 km/ h (MTZ-80x5 tractor - reduced speed). The number of revolutions of the sowing disc was adjusted depending on the required value of the distance between the seeds.

The holes for planting seeds in one row have a diameter of 3.5 mm, the diameter of the circle in which the holes are located is 180 mm, the number of holes is 32, the number of revolutions of the disk is 31.5 ail/min, the linear speed of the conveyor belt is 2.1 m/s, the degree of thinning in the pneumotype is 40 mbar. With these parameters, the distance between the seeds in a row should be 10 cm.

Based on the initial temporary requirements, when sowing seeds in rows and lowering one into each slot, the coefficient of variation of the actual values of the intervals between seeds should not exceed 15%, the number of seeds laid per unit length should be provided with an accuracy of at least 95%.

The results of experiments on sowing seeds in one row are presented in Table 1. Vmed = 2,1 m/s; d = 180 mm; z = 32 piece; dm = 3,5 mm; P = 40 mbar; The variety of seeds is "Sultan".

The results obtained in experiments on planting seeds in one row are as follows: the planting accuracy was 97.1%, the coefficient of variation was 13.0%.

In the experiments, two cases of fertilization per slot were noted, which amounted to about 8.1%. Cases where there were two seeds in one slot instead of one are also observed in modern overseas seeders, and no restrictions are imposed on the initial requirements. So we can say that at the Meyer level. Further experiments were aimed at determining the performance indicators of the pneumatic landing device during slot landing. The intervals between slots, the number of seeds dropped per slot, as well as the degree of elongation of the slots were taken as criteria for evaluating the slotting of seeds. In accordance with the temporary preliminary requirements, it is required that the coefficient of variation of the actual value of the interval between cells does not exceed 25%, that 85% of the generated cells are filled at a given value and that the number of cells is one more, equal or one less so that the cells are filled, stretched, does not exceed the sum of the seed lengths.

The experiments were carried out in the following modes and parameters: the speed of movement of the conveyor belt (seeder) is 2.1 m/s, the rotation speed of the sowing disc is 31.5 and 19.7 rpm, the degree of thinning in the pneumotype is 40 mb, the diameter of the planting disc - circles with holes in the planting disc are 180 and 200 mm, the number of holes - in this case, the distance between the slots should be 12.5 cm (31.5 rpm) and 20 cm (19.7 rpm).

Table 1: Results of planting seeds in one row.

Working mode	Specification	Distance between seeds, cm			
		I	II	III	Med.
n = 31,5 rpm l_y = 10 cm	M_{med}, см	10,1	10,5	10,4	10,3
	b±, см	1,35	1,15	1,53	1,34
	V, %	13,3	11,0	14,7	13,0
	Share of seedless slots ($\geq l_y$ x 1,5), %	2,9	2,0	2,7	2,5
	Share of two-seeded slots ($\leq l_y$ / 2), %	2,6	12,5	9,3	8,1
	Share of 3 seed slots and more, %	0	0	0	0

Table 2: Results of slot seeds in two.

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		13,1	1,37	10,4	19,2	1,91	10,0
Number of seeds falling into the slots, pcs		2,1	0,33	15,7	2,1	0,38	17,6
Stretching of the slots, cm		0,9	0,70	81,2	0,9	0,76	85,0
Distribution of slots by seed, %	0				1,2		
	1	9,0			4,7		
	2	76,0			75,2		
	3	13,4			15,3		
	4	1,6			3,6		
Planting accuracy (the amount of slots in which the number of seeds corresponds to standard (2±1 pcs.), %		98,4			95,2		
Share of slots no more than 2 cm in length, %		93,4			91,6		
The amount of slots falling between the intervals, %		4,1			4,7		

The results of the experiments carried out are presented in Table 2. V_{med} = 2,1 m/s; d_1 = 200 mm; d_2 = 180 mm; z = 32x2 piece; d_m = 3,5 mm; P = 40 mbar; The variety of seeds is "Sultan".

4 CONCLUSIONS

According to the results of the experiment, the following conclusion can be drawn:

1. The number of rotations of the planting disc was 31.5 rpm, in the option where the specified interval was 12.5 cm: the interval between the slots was on average 13.1 cm, the vibrational coefficient of the actual value of the interval between the slots was equal to 10.4%. The average number of seeds per slot was 2.1, with an average quadratic deviation of 0.33. The distribution of slots by seed was as follows: the proportion of unfertilized slots – 0%, the proportion of 1 – seeded slot – 9.0%, 2 – 76.0%; 3 – 13.4% and 4-1.6%. The share of 2±1 seed slots was 98.4% (according to the standard should not be less than 80%). The lengthening of the slots was on average 0.9 cm. It is required that the lengthening of the slots according to Standard does not exceed the sum of the lengths of the seeds that actually fell on them. Considering that the average length of the seed we have is 9.1 mm, the length of the slots should not exceed 1.82 cm or 2 cm when rounded (in experiments, based on GOST (standard), the measurement accuracy was taken 0.5 cm). According to the results of the experiment, the amount of slots no more than 2 cm in length was 93.4%.
2. The number of revolutions of the landing disc was 19.7 rpm in the variant where the specified interval was 20 cm: the interval between the grooves averaged 19.2 cm, the coefficient of

variation of the actual value of the interval between the grooves was 10.0%. The number of seeds in the slot in this variant also averaged 2.1 pieces, with an average square deviation of 0.38. The distribution of slots by seed was as follows: the proportion of unfertilized slots – 1.2%, the proportion of 1 – seeded slots – 4.7%, 2 – 75.2%; 3 – 15.3% and 4-3.6%. The share of 2±1 seed slots was 95.2%. The lengthening of the slots was on average 0.9 cm, the amount of slots no more than 2 cm in length was 91.6%.

REFERENCES

Alimova, F.A., 2023. Mathematical modeling of small soil channel laboratory stand drive and evaluation of its energy state. *IOP Conference Series: Earth and Environmental Science*, 1284, 012031. https://doi.org/10.1088/1755-1315/1284/1/012031.

Alimova, F., Primqulov, B., & Boboniyozov, E., 2022. Parametres of the strip-tilling working bodies for re-crops sowing. *AIP Conference Proceedings*, 2637, 050007. https://doi.org/10.1063/5.0118617.

Aslonov, N., & Irisov, K., 2023. Mathematical model of resistance to spreading forces using a bulldozer blade. *E3S Web of Conferences*, 390, 01032. https://doi.org/10.1051/e3sconf/202339001032.

Djiyanov, M., Xalilov, R., & Isakova, F., 2024. Justification of commercialization of export-oriented harvesting apparatus for intensive processing of cotton boxes. *BIO Web of Conferences*, 85, 01034. https://doi.org/10.1051/bioconf/20248501034.

El-Sayad, Y.A., 2012. Design and fabricate a metering device of vacuum seeder to suit egyptian cotton. *Egyptian Journal of Agricultural Research*, 90(4), 1723-1742. https://doi.org/10.21608/ejar.2012.164070.

GOST 31345-2017. Agricultural machinery. Tractor seeders. Test methods. Moscow: Standartinform, 53 p.

Irisov, K.D. & Bekmurodov, I.R., 2023. Theoretical aspects of substantiating the parameters of the working body of an environmentally comfortable spraying unit. *IOP Conference Series: Earth and Environmental Science,* 1284, 012041. https://doi.org/10.1088/1755-1315/1284/1/012041.

Javellonar, R.P., Delaraga, L.V. & Alegato, O.R., 2016. Design, development and evaluation of a disc-type corn seeder. *Ilocos Journal of Science*, 61.

Karimov, R., Bobojanov, M., Tairova, N., Xolbutayeva, X., Egamov, A. & Shamsiyeva, N., 2020. Non-contact controlled voltage stabilizer for power supply of household consumers. *IOP Conference Series: Materials Science and Engineering*, 883, 012120. DOI: 10.1088/1757-899X/883/1/012120.

Li, K., Li, S., Ni, X., Lu, B., & Zhao, B., 2023. Analysis and experimental of seeding process of pneumatic split seeder for cotton. *Agriculture,* 13(5), 1050.

Lu, B., Ni, X., Li, S., Li, K., & Qi, Q., 2022. Simulation and experimental study of a split high-speed precision seeding system. *Agriculture*, 12(7), 1037. https://doi.org/10.3390/agriculture12071037.

Mirzakhodjaev, S., Djiyanov, M., Nurmikhamedov, B., & Mamasov, S., 2024. Results of frontal plug tests combined with active working body. *BIO Web of Conferences*, 85, 01035. https://doi.org/10.1051/bioconf/20248501035.

Norchayev, D.R., Xaliqulov, M.A., Turkmenov, X.I., Shermuxamedov, X.P., & Ibragimova, G.N., 2022. Acceptable solutions for harvesting root crops in the soil climate of the Republic of Uzbekistan. *IOP Conference Series: Earth and Environmental Science*, 1076, 012029. https://doi.org/10.1088/1755-1315/1076/1/012029.

QXA-3-001 Practical project, 2018. Development of an energy resource-efficient pneumatic sealant that plants seeds of crops in specific norms. Gulbahor, 97 p.

Ramesh, M.B., Veerangouda, M., Reddy, B.S., Anantachar, M., & Sharanagouda, H., 2017. Simulation of Design and Operational Parameters of Pneumatic Seed Planter for Cotton Using ANSYS Software. *Agricultural Engineering Today*, 41(4), 37-45.

Saidova, M., Alimova, F., Tursunbaev, S., Kulmuradov, D., & Boltaeva, M., 2023. Influence of the shape of the disc slots of the seeder on the suction force of the vacuum for precise sowing of seeds. *IOP Conference Series: Earth and Environmental Science*, 1284, 012014. https://doi.org/10.1088/1755-1315/1284/1/012014.

Saidova, M., Tursunbaev, S., Boltaeva, M., & Isakulova, N., 2024. Comparison of pneumatic sowing machines by the number of seeds in the slots of the discs and the distance between the slots. *BIO Web of Conferences,* 105, 01004. https://doi.org/10.1051/bioconf/202410501004.

Testing of agricultural machinery, 1991. Sowing machines. The program and test methods. - RD.10.5.1.-91 //Official publication – Moscow. 100 p.

Testing of agricultural machinery, 2001. Sowing machines. The program and test methods. - Uz RH 63.06: 2001 //The publication is official. - Tashkent, 95 p.

Tukhtakuziev, A., & Rasuljonov, A. R., 2020. Ensuring the stability of the processing depth of suspended soil mounted machines. *IOP Conference Series: Earth and Environmental Science*, 614, 012156. DOI: 10.1088/1755-1315/614/1/012156.

Tukhtakuziev, A., Rasuljonov, A.R., Turkmenov, H.I., Irgashev, A.A., & Barlibaev, S., 2023. Ensuring the stability of the suspended chisel-cultivator processing depth. *E3S Web of Conferences*, 390, 01038. https://doi.org/10.1051/e3sconf/202339001038.

Uzdst 3193: 2017. Testing agricultural techniques. Method of energy evaluation of machines. - Tashkent, 21 p.

Veerangouda, M., Maski, D., Desai, B.K., & Doddagoudar, S.R., 2020. Study on some engineering properties of cotton seeds in relation to the development of a tractor operated seed dibbler. *Journal of Pharmacognosy and Phytochemistry*, *9*(5), 1836-1839.

Verma, K., Mohanty, S. K., Dash, R. C., Mishra, J., Behera, A., & Rath, I., 2024. Optimization of Power Tiller Operated Pneumatic Planter under Laboratory Conditions for Enhancing Cotton Planting Efficiency. *Journal of Experimental Agriculture International*, *46*(5), 526-537. https://doi.org/10.9734/jeai/2024/v46i52407.

Xiangdong, N.I., Guojie, X.U., Qi, W.A.N.G., Xiaorui, P.E.N.G., Jian, W.A.N.G., & Bin, H.U., 2017. Design and experiment of pneumatic cylinder array precision seed-metering device for cotton. *Nongye Jixie Xuebao/Transactions of the Chinese Society of Agricultural Machinery*, *48*(12).