

## OPTIMIZATION OF THE MAIN PARAMETERS OF A PNEUMATIC SEEDING DEVICE FOR HILL SEEDING OF MUNG BEANS

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**Abstract** The article presents the results of the optimal parameters and operating modes of a pneumatic sowing machine for nested sowing of mung bean seeds.

**Keywords:** pneumatic seeder, optimization, mung bean seed, precise hill seeding, sowing disk, regression equation

Among legume crops, mung beans rank second in the world after soybeans in terms of cultivated area. In terms of nutritional value, mung beans surpass wheat, beans, peas, green peas, and rye by 1.5–2.0 times, and in digestibility they are 1.5 times higher [1].

The precise seeding rate and method of mung beans are among the most important factors determining yield. Numerous scientific sources report the advantages of hill seeding of mung beans compared to row (drill) seeding [2]. In addition to the main sowing season, mung bean cultivation is also considered efficient as a secondary crop on irrigated fields after harvesting autumn cereals.

Depending on the density of mung bean stands per hectare and the variety, the optimal row spacing is 60 cm, the seed spacing within the row is 5–10 cm, and the average seeding rate is set at 16–18 kg/ha. To ensure these indicators, experimental studies on hill seeding of mung beans were carried out. In the experiments, the installation height of the seeding device was set at 5.0 mm.

The main factors significantly influencing the quality indicators of hill seeding of mung beans include the number of suction hole groups on the sowing disk, their deviation angle relative to the radial axis, and the forward speed of the seeder. The optimal values of these parameters were determined according to the Hartley-3 design (Table 1).

In multifactor experiments, the evaluation criteria were defined as high accuracy of hill seeding and minimal scattering of seeds into the furrows. The experiments were conducted using a table of random numbers.

Table 1.

Factors, their designations, ranges of variation, and levels (for hill seeding of mung beans)

Factor name	Unit of measurement	Factor designation	Range of variation	Factor levels		
				-1	0	+1
1. Number of hole groups	pieces	X <sub>1</sub>	4	38	42	46
2. Deviation angle of hole groups relative to the radial axis	degrees	X <sub>2</sub>	10	10	20	30

3. Seeder forward speed	m/s	$X_3$	0,3	1,6	1,9	2,2
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The experimental results were processed according to the established procedure, and the following regression equations were obtained, which adequately describe the evaluation criteria:

Accuracy of hill seeding, %

$$Y_1 = 91,845 + 3,450 X_1 - 4,417 X_3 - 8,531 X_1^2 - 2,317 X_1 X_2 + 1,750 X_1 X_3 - 1,115 X_2^2 - 1,965 X_3^2 \quad (1)$$

Minimum seed scattering (hill length), cm

$$Y_2 = 2,648 - 0,100 X_1 + 0,150 X_2 + 0,161 X_3 + 0,399 X_1^2 - 0,250 X_1 X_3 + 0,215 X_2^2 + 0,117 X_2 X_3 + 0,082 X_3^2 \quad (2)$$

The analysis of the obtained regression equations shows that all factors had a significant effect on the evaluation criteria.

Based on the regression equations (1) and (2), the criterion “Y1” (the accuracy of hill seeding of mung bean seeds) should not be less than 85%, while the criterion “Y2” (the scattering of seeds) should have a minimum value.

Taking these conditions into account, the optimal values of the factors that ensure compliance with these requirements were determined for the range of the aggregate’s movement speed from **1.6 to 2.2 m/s** [3]. The obtained results are presented in Table 2.

Table 2.

Rational values of parameters

$V_c (X_3), \text{ m/s}$		$n (X_1), \text{ mm}$		$\gamma (X_2), \text{ deg}$	
Coded	Natural, m/s	Coded	Natural, mm	Coded	Natural, deg
1	2,24	0,2762	38,3813	0,4747	24,74
0	1,94	0,4324	43,7299	0,9211	29,21
-1	1,66	0,8523	45,4094	0,1832	21,83

Thus, at seeder travel speeds of **1.6–2.2 m/s**, in order to ensure the required seeding accuracy of mung bean and minimize seed scatter, the number of suction hole groups on the seed disc should be within the range of **38.4–45.4 pcs**, and the angle of deviation of the hole groups relative to the radial axis should be within **21°–29°**.

### Conclusion

Based on the above, the installation height of the pneumatic seed metering device is accepted as **50 mm**, the number of suction hole groups as **42 pcs**, and the angle of deviation of the hole groups relative to the radial axis as **25°**.

### References

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