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SOME RESULTS OF THE EXPERIMENT ON SCARIFICATION OF SEEDS OF FORAGE LEGUME (THE SAMPLE OF ALFALFA SEEDS)

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Scarification, Scarifier, Impact Speed, Impact Angle, Abrasive Surface Grit, Alfalfa Seeds.

ABSTRACT

If the hard seed (seed that is viable but has an impervious seed coat) content of legumes is greater than 20%, scarification should be considered. Scarification is the nicking of the seed coat to allow moisture to penetrate [1]. This type of seed treatment before sowing is of great importance, as it increases the yield of fodder plants by reducing the sowing rate of rare and expensive fodder seeds, reducing the cost of sowing, accelerating germination, and increasing the percentage of germination. This article reflects the results of a planned experiment to determine the effectiveness of scarification of a device for impacting alfalfa seeds, depending on factors such as seed impact speed, impact angle, and impact surface grit, presented a mathematical model of the relationship between these factors and determined their optimal values.

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Introduction.

Determination of the percentage of hard seeds in the seeds of leguminous fodder plants is essential for seed preparation for sowing. This is due to the fact that the hard shell of legume grass seeds does not allow air and moisture to pass through, because of this, these seeds do not swell and do not produce a crop. Therefore, it is necessary to create conditions for the penetration of air and moisture by scarifying the hard shell of hard seeds. According to research conducted in Russia, depending on the climatic conditions of the year of seed collection, the chemical composition of the soil, and the type of plant, about 30-70% of the seeds of legume fodder plants have a hard shell. Based on this, if the percentage of seeds with a hard shell in the seeds of fodder legumes can be reduced, then the cost of cultivation will be reduced and the efficiency of fodder plant cultivation will be improved.

Scarification is an operation in which the hard waterproof shell of the seed is slightly peeled off in order to speed up and facilitate the swelling and germination of the seed.

Seed scarification involves weakening the coating of the seed to encourage sprouting. This can be done in a number of ways, but the most common is mechanically breaking a seed's shell.

There are several ways to scarify seeds before sowing (Fig. 1).

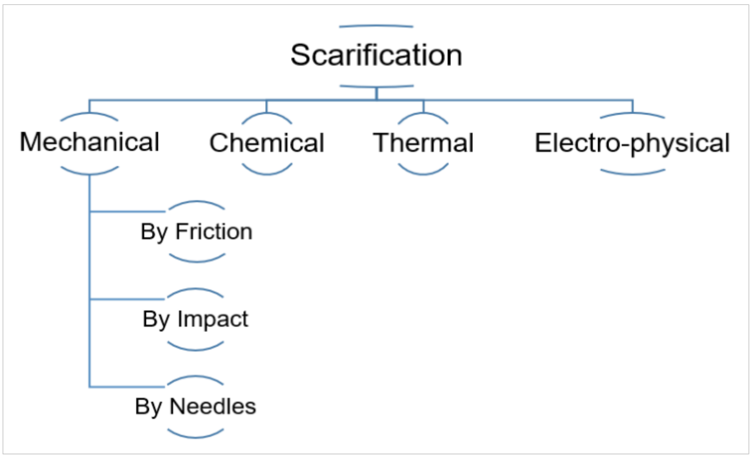

Figure 1. Classification of the main methods of scarification of seeds for sowing.

The simplest and most widely used method in industrial conditions is the method of mechanical action on the hard seed shell. Mechanical scarifiers according to technological characteristics are divided into friction, impact, and needles. There are disks, drums, needles, and pneumatic scarifiers.

Experimental design.

It was assumed that alfalfa seeds thrown and accelerated by a strong air flow with a light touch on the abrasive surface lose the tightness of the hard shell and a three-factor randomized experiment was carried out to determine the rate of scarification. The rate of scarification (C) was determined depending on three factors, such as the speed of movement of the seed (v), the angle of the velocity vector to the working surface along the normal to the impact (β), and the abrasive surface grit (z). The test black box is shown below (Fig. 2).

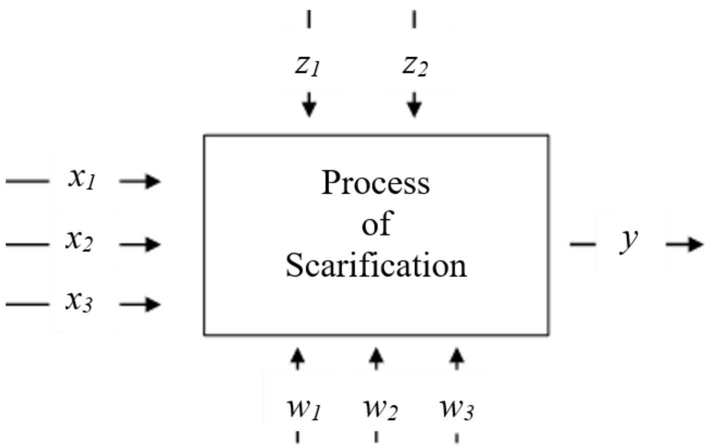

Figure 2. Black box for planned testing.

Of this:
Controlled factors:
x_1 – speed of alfalfa seeds – v, $[m/s]$;
x_2 – collision angle – β, $[deg]$;
x_3 – the abrasive surface grit – z, [μm];
Controllable but unmanaged factors:
w_1 – crop seed moisture;
w_2 – the movement of crop seed around its own axis;
w_3 – temperature of crop seeds;
Unmanaged factors:
z_1 – ambient air temperature,
z_2 – ambient air humidity.

The experimental plan consists of a three-factored (n = 3) factorial design with five levels. Levels of variation and codes of the independent variables of x_1, x_2, and x_3 for the rate of scarification are presented in Table 1.

Table 1. Levels and codes of the independent variables of v, β and z.

		-1.68	-1	0	+1	+1.68	Δ
Speed of seed, [m/s]	x_1	8.2	15	25	35	41.2	10
Impact angle, [degree]	x_2	34.8	45	60	75	85.4	15
Grit of abrasive surface, [μm]	x_3	23.2	30	40	50	46.8	10

Table 2. Real and coded values for independent variables Speed of alfalfa seeds (x_1), Collision angle (x_2), and Grit of abrasive surface (x_3) for the rate of scarification (y).

№	$v, [m/c]$	β, [deg]	z, [μm]	$v, [m/c]$	β, [deg]	z, [μm]	C, [%]
	x_1	x_2	x_3	x_1	x_2	x_3	y
1	1	1	1	35	75	50	62
2	1	1	-1	35	75	30	60
3	1	-1	1	35	45	50	66
4	1	-1	-1	35	45	30	75
5	-1	1	1	15	75	50	70
6	-1	1	-1	15	75	30	60
7	-1	-1	1	15	45	50	60
8	-1	-1	-1	15	45	30	53
9	1.68	0	0	41.8	60	40	55
10	-1.68	0	0	8.2	60	40	55
11	0	1.68	0	25	85.4	40	50
12	0	-1.68	0	25	34.8	40	63
13	0	0	1.68	25	60	46.8	63
14	0	0	-1.68	25	60	23.2	80
15	0	0	0	25	60	40	90
16	0	0	0	25	60	40	80
17	0	0	0	25	60	40	70
18	0	0	0	25	60	40	70
19	0	0	0	25	60	40	70
20	0	0	0	25	60	40	90

Optimization parameters:
y – Rate of Scarification, C, (C→100%);
The Rate of Scarification:

$$C=\frac{k_1-k_2}{k_1}$$

Of this:

k_1 – number of seeds with a hard shell before processing, pieces;
k_2 – number of seeds with a hard shell after processing, pieces.
Grain materials and equipment used for the experiment:

- Alfalfa seeds sort: Burgaltai.

Testing instruments.

The seed throwing test equipment has a gas injection compressor, a gas collection pipe, a pressure gauge and a working surface capable of changing the impact angle (Fig. 3).

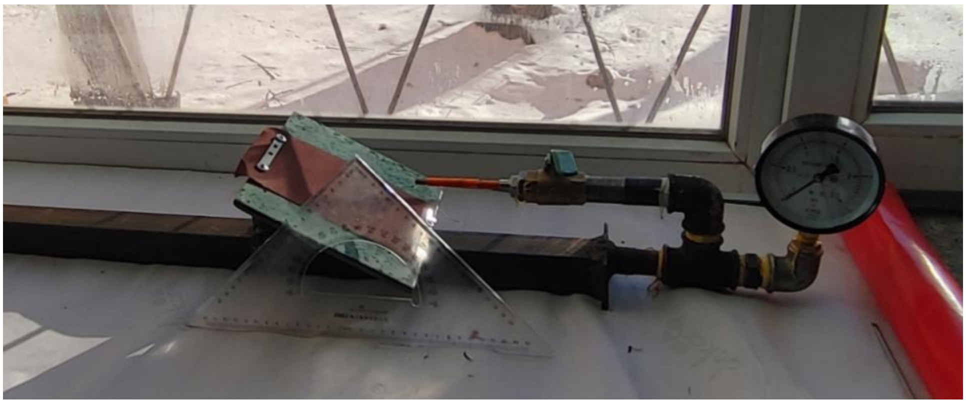

Figure 3. The seed throwing test equipment.

The air flow velocity was measured with the anemometers shown in Figure 4, and seed germination was determined using a digital microscope.

Figure 4. The anemometers and digital microscope used in experiments.

Results.

Before the experiment, when determining the number of seeds with a hard shell according to the GOST 12039-82 method [2], it was 45%.

Non-germinated seeds were considered hard-shelled seeds. Figure 5 shows the difference between germinated seeds and hard-shelled seeds.

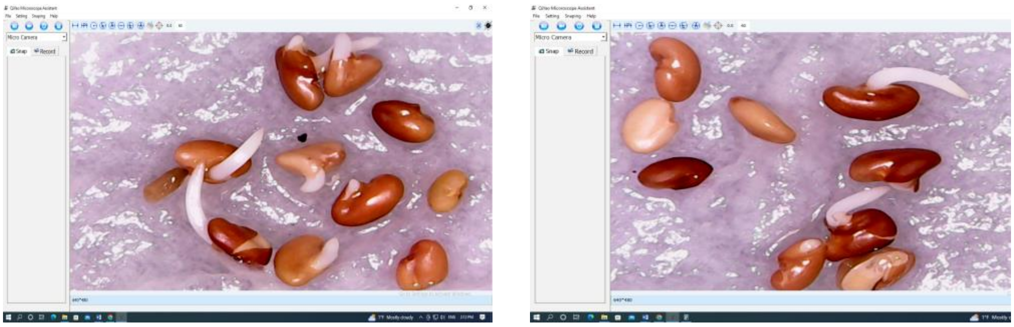

Figure 5. The germinated and non-germinated hard-shell seeds.

Table 3. ANOVA showing the variables as linear, quadratic, and interaction terms on the rate of scarification.

Factor	ANOVA;Var.: y; R-sqr= .7082; Adj: .44558 (2**(3) central composite n_C=8, 3 factors, 1Blocls, 20 Runs; MS Residual=72.18502 DV: y				
	SS	df	MS	F	p
(1)x1 (L)	49.498	1	49.4977	0.63405	0.444366
x1 (Q)	791.629	1	791.6285	10.14052	0.009746
(2)x2 (L)	51.955	1	51.9546	0.66552	0.433619
x2 (Q)	681.882	1	681.8815	8.73469	0.0144
(3)x3 (L)	1.814	1	1.8135	0.02323	0.88189
x3 (Q)	4.494	1	4.4945	0.05757	0.815221
1L by 2L	162	1	162	2.07517	0.18028
1L by 3L	72	1	72	0.9223	0.359517
2L by 3L	24.5	1	24.5	0.31384	0.587664
Error	780.659	10	78.0659		
Total SS	2473.8	19			

Table 4. Results of analysis of curvilinear regression equation between the rate of scarification (y) and speed of seed (x_1), impact angle (x_2), and grit of abrasive surface (x_3).

Factor	Regr.Coefficients;Var.: y; R-sqr= .7082; Adj: .44558 (2**(3) central composite n_C=8, 3 factors,1 blocls, 20 Runs; MS Residual=72.18502 DV: y					
	Regression Coeff	Std. Err.	t(10)	p	-95.% Cnf.Limt	+95.% Cnf.Limt
1	2	3	4	5	6	7
Mean/Interc.	-110.697	88.765	-1.2470	0.24078	-308.478	87.08425
(1)x1 (L)	6.852	2.12932	3.2180	0.00920	2.108	11.59668
x1 (Q)	-0.074	0.02327	-3.1844	0.00974	-0.126	-0.02226
(2)x2 (L)	3.813	1.58538	2.4052	0.03698	0.281	7.34576
x2 (Q)	-0.03	0.01027	-2.9554	0.0144	-0.053	-0.00747
(3)x3 (L)	-0.551	2.76663	-0.1990	0.84622	-6.715	5.61376

Table 4.

1	2	3	4	5	6	7
x3 (Q)	0.007	0.03041	0.2399	0.81522	-0.06	0.07505
1L by 2L	-0.03	0.02083	-1.4405	0.18028	-0.076	0.0164
1L by 3L	-0.03	0.03124	-0.9603	0.35951	-0.1	0.0396
2L by 3L	0.012	0.02083	0.56021	0.587664	-0.035	0.05807

The analysis of variance (ANOVA) after deleting the non-significant terms is given in Table 3. The determination coefficient (R^2 = 0.71) indicates that a variance of only 29% is not explained by the model.

The probability value F (shown in Table 4) is less than 0.05 which indicates that the model is significant.

$$y=6.852x_1-0.074x_1^2+3.813x_2-0.03x_2^2 \quad (1),$$

$$\text{Rate of scarification}=6.852(v)-0.074(v)^2+3.813(\beta)-0.03(\beta)^2 \quad (2),$$

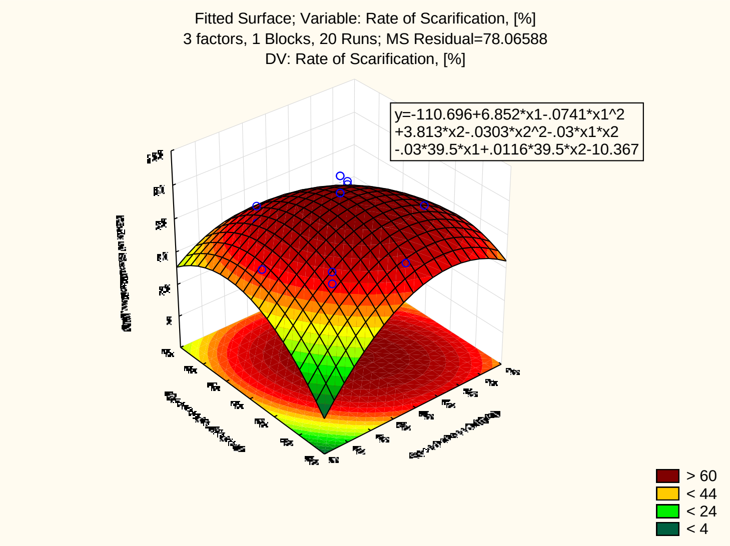

Figure 6. 3-D plots for the rate of scarification as a speed of seed and impact angle, [degree].

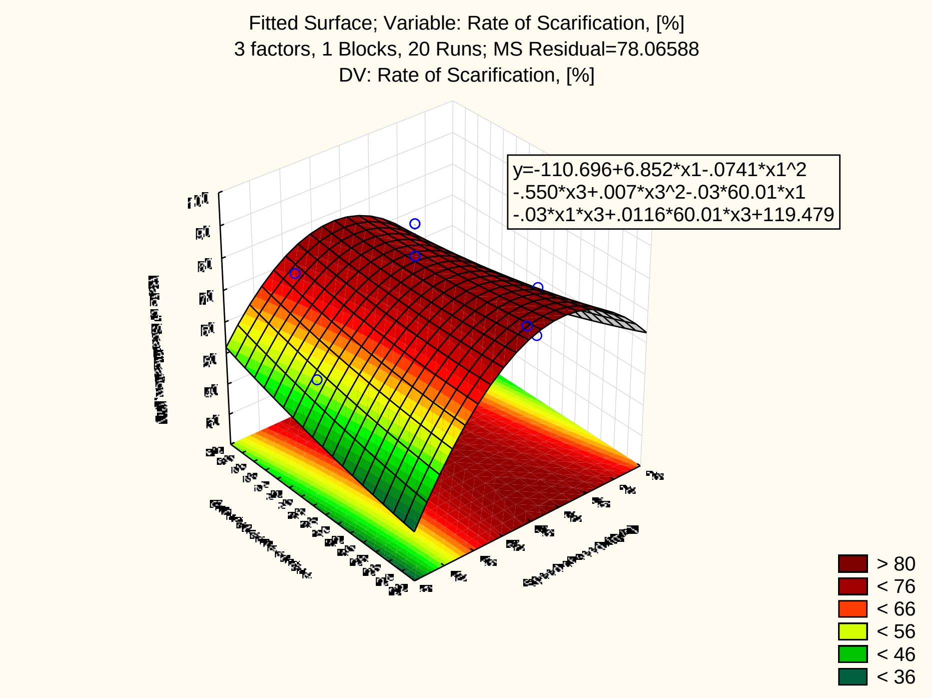

Figure 7. 3-D plots for the rate of scarification as a speed of seed and grit of abrasive surface.

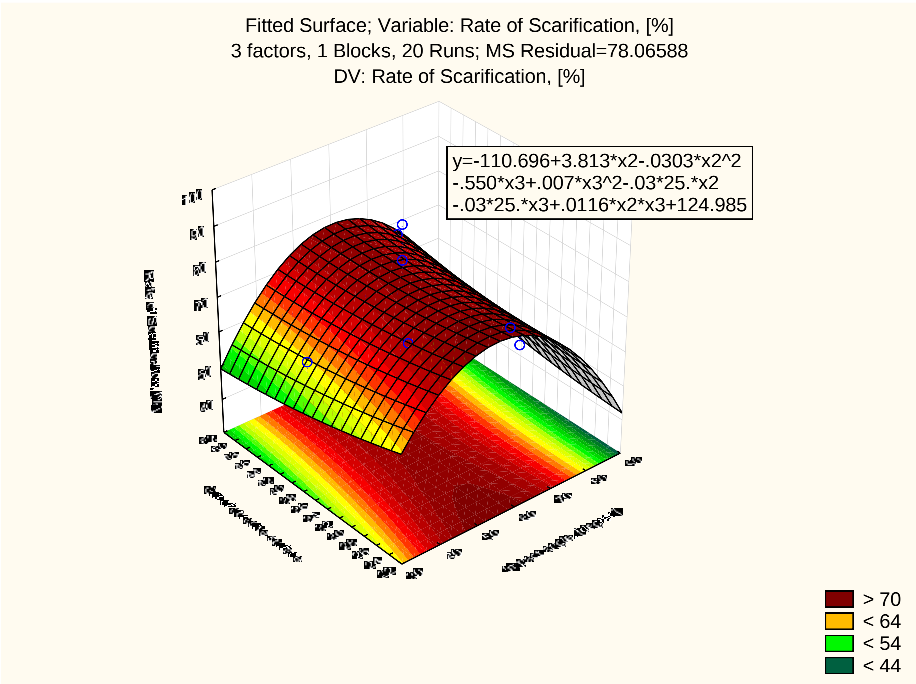

Figure 8. 3-D plots for the rate of scarification as an impact angle, [degree], and grit of abrasive surface.

Conclusion.

1. Has have been created a mathematical model (2) of the process of wiping and scarifying alfalfa seeds by impact.
2. In this experiment, the optimal values of the scarification rate of alfalfa seeds is 81.65%.

In the experimental process of scarification of alfalfa seeds by impact-collision, the optimal values of the input factors are the impact speed x_1=28.8 m/s, the impact angle x_2=54.6 degrees and the grit of the abrasive surface for impact x_3=23 μm.

REFERENCES

1. Maskulov D. I. Substantiation of design and technological parameters and development of a goat's rue seed scarifier. 2021. Ufa.
2. Mokiev V. Yu. Substantiation of the constructive-technological scheme and main parameters of the wiping-scarifying device for grass seeds. 2017. Kirov.
3. Verbovsky A.V. Mokiev V. Yu. Substantiation of the parameters and modes of operation of the disk scarifier for pre-sowing treatment of seeds of perennial leguminous grasses. 2009. Novosibirsk.
4. Mokiev V. Yu. Analysis of devices for wiping and scarification of grass seeds.
5. Lukin A. N. Parameters of a pneumatic scarifier for pre-sowing treatment of seeds of perennial legumes. 2013. Novosibirsk.
6. Yarkova N. N., Federova. Seed production of agricultural plants. 2016. Perm.
7. Koobonye M., Maule B.V., Mogotsi K. Mechanical scarification, and hot water treatments enhance germination of Leucaena Leucocephala (Lam.) seeds. Livestock Research for Rural Development, 2018, 30(1).
8. Luo J., Sun J., Yang L., (...), Li W., Dong Z. Design and experiment of type 9BQS-3.0 pneumatic scarifying and sowing compound operation machine. Nongye Jixie Xuebao /Transactions of the Chinese Society for Agricultural Machinery, 2013, 44(SUPPL.1), c. 51-55.
9. Luo J., Sun J., Yang L., (...), Li W., Dong Z. Design and experiment of type 9BQS-3.0 pneumatic scarifying and sowing compound operation machine. Nongye Jixie Xuebao /Transactions of the Chinese Society for Agricultural Machinery, 2013, 44(SUPPL.1), c. 51-55.
10. Nagar R.P., Meena S.S. Effect of physical and chemical scarification and aging on hardheadedness in Clitoria ternatea. Range Management and Agroforestry, 2015, 36(1), c. 79-83.