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SELECTION OF BATCHER WITH HORIZONTAL DISK PARAMETERS WHILE MAIZE SOWING

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Summary. Results of multifactorial experiment by rotatable planning matrix for three factors: _height and diameter of seed tube, rotary speed of seed disk are presented. Experiment results were analyzed according to generally accepted methods. Adequate model was received. Influence of each factor on "double" intervals formation and optimal value of each factor were determined.

Key words: amount of "doubles", influence of factors, optimization.

INTRODUCTION

The quantity of the intervals tending to zero ("double" intervals or "doubles") is one of the single-seed sowing quality characteristic. It is controlled by agrotechnical demands. The level of crop yield depends on the amount of "doubles".

OBJECTS AND PROBLEMS

The quantity of the intervals tending to zero (i.e. "doubles") was evaluated by a factor:

$$Y = K_1 / K, \tag{1}$$

where: K_1 - amount of the intervals tending to zero, i.e. intervals which length is not more than 0,1 M (M – average length intervals),

K - amount of the intervals measured in the experiment.

Seed distributor of combined mounted maize seeder (i.e. "sowing machine SKNK-type") was used as a batcher with horizontal disk.

The seed distributor was placed in special frame above a conventional construction stand tape.

Three factors were varied: $x_1(D)-$ diameter of a seed tube, $x_2(h)$ - seed tube altitude, $x_3(V_0)-$ a peripheral velocity of twirl of a feed disc. Factors $x_1(D)$ and $x_2(h)$ were set by statement of round metal handsets, and the factor $x_3(V_0)$ - was set by change of a reduction ratio of the mechanism of the drive (replaceable sprocket wheels).

Levels of factors varied according to central composition rotatable uniforms-planning of the second order for three factors [2].

Speed of driving of a ribbon of the stand was fixed and equal to 2 m/s. The calculated interval between seeds at speed of 0,275 m/s was equal to 200 mm; maize seeds of "Dneprovskaya-247" breed of the third fraction were sowed by the SKV-153B feed disc. An insertion ring by width of 1 mm was used. Intervals of factors variation, chosen from a condition of technological working capacity of a batcher, are presented in tab. 1.

Table 1. **Intervals of variation of the factors** $x_1(D)$, $x_2(h)$ **and** $x_3(V_0)$ **for SKNK – type seeder batcher**

Characteristics	Factors		
	$x_1(D)$, mm	$x_2(h)$, mm	$x_3(v_0)$, m/s
The basic level, $x_i=0$	60,0	350,0	0,275
The interval of variation, I	23,8	59,5	0,134
The upper level, $x_i=1$	83,8	409,5	0,409
The lower level, $x_i=-1$	36,2	290.5	0,141
The upper sidereal point, $x_i=1{,}682$	100,0	460,0	0,5
The lower sidereal point, $x_i=-1{,}682$	20,0	250,0	0,05

Experimental data were treated with the certain methods recommended for rotatable planning; Kohren criteria (characterizing homogeneity of variances), Student criteria (causing the significance of regression coefficients) and Fisher criteria (specifying model adequacy) were thus defined; the adequate regression model of the second order with variables in a code designation is gained as a result of:

$$Y=b_0+b_1x_1+b_{12}x_1x_2, \qquad (2)$$

where $b_0=0{,}0452$; $b_1=-0{,}0078$; $b_{12}=-0{,}0071$.

Agency of each factor was defined separately on response function at values of other factors, equal + -1,682 and 0. The equation (2) takes a form:

when: $x_2 = -1{,}682$: $Y_{1.1} = 0{,}0452 - 0{,}0078x_1 - 0{,}0071x_1 \cdot (-1{,}682) = 0{,}0452 + 0{,}00414x_1$;

when: $x_2 = 0$: $Y_{1.2} = 0{,}0452 - 0{,}0078x_1$;

when: $x_2 = 1{,}682$: $Y_{1.3} = 0{,}0452 - 0{,}0078x_1 - 0{,}01194x_1 = 0{,}0452 - 0{,}01974x_1$;

when: $\tilde{o}_1 = -1{,}682$: $Y_{2.1} = 0{,}0452 - 0{,}0078(-1{,}682) - 0{,}0071(-1{,}682)x_2 = 0{,}05832 + 0{,}01194x_2$;

when: $x_1 = 0$: $Y_{2.2} = 0{,}0452$;

when:

$$x_1 = 1{,}682:\ Y_{2.3} = 0{,}0452 - 0{,}01312 - 0{,}01194x_2 = 0{,}0321 - 0{,}01194x_2. \quad (3)$$

Values of functions $Y_{1.1} - Y_{2.3}$ according to (3) are computed on points $x_i = \pm 1{,}682$ and 0; calculation data are presented in tab. 2.

According to the tab. 2 a graph presented in fig. 1 is plotted. It can be seen, that the response depends rectilinearly on both factors ($\tilde{o}_1$(D), $\tilde{o}_2$(h)); the response is diminishing when the 2 factor is equal to upper stellar point (lines $Y_{1.3}$, $Y_{2.3}$ accordingly), the response is rising when other factor is equal to bottom stellar point (lines $Y_{1.1}$, $Y_{2.1}$). At $\tilde{o}_2$(h)=0 the response is diminishing growth $\tilde{o}_1$(D) (lines $Y_{1.2}$); at $\tilde{o}_1$(D)=0 factor $\tilde{o}_2$(h) does not depend on “doubles” (lines $Y_{2.2}$).

Table 2. **The sequence of functions $Y_{1.1} - Y_{2.3}$ calculation**

x_i	0,0414 $\tilde{o}_1$	$Y_{1.1}$ =0,0452+(2)	0,0078 $\tilde{o}_1$	$Y_{1.2}$ =0,0452-(4)	0,01974 $\tilde{o}_1$
1	2	3	4	5	6
-1,682	-0,00696	0,03824	-0,01312	0,05832	-0,0332
-1	-0,00414	0,04106	-0,0078	0,053	-0,01974
0	0	0,0452	0	0,0452	0
1	0,00414	0,04934	0,0078	0,0374	0,01974
1,682	0,00696	0,05216	0,01312	0,03206	0,0332

$Y_{1.3}$ =0,0452-(6	0,01974 $\tilde{o}_2$	$Y_{2.1}$ =0,05832+(8)	$Y_{2.2}$ =0,0452	$Y_{2.3}$ =0,0321-(8)
7	8	9	10	11
0,0784	-0,02	0,03832	0,0452	0,0521
0,06494	-0,01194	0,04638	0,0452	0,04404
0,0452	0	0,05832	0,0452	0,0321
0,02546	0,01194	0,07026	0,0452	0,02016
0,012	0,02	0,07832	0,0452	0,0121

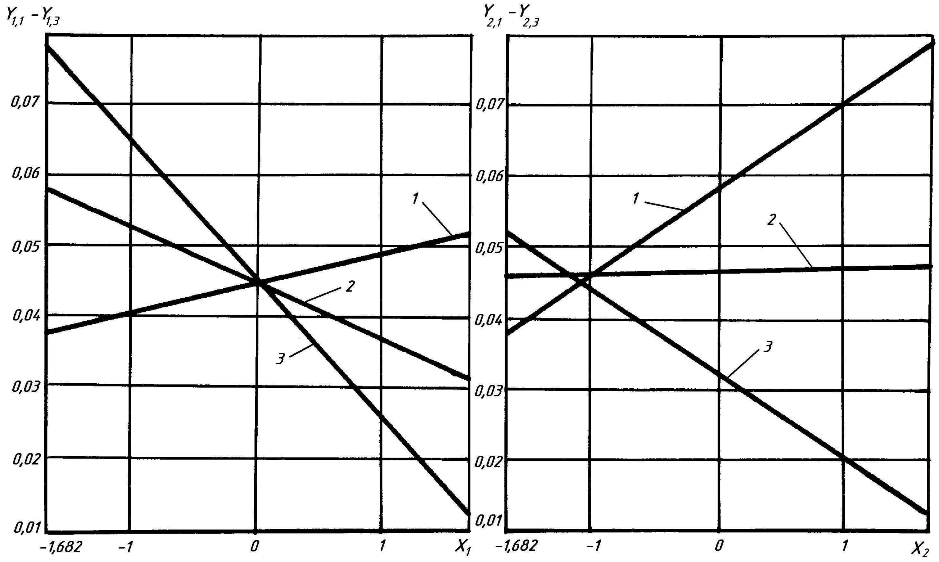

Fig. 1. Graph of functions $Y_{1.1} - Y_{2.3}$

Optimization of response function parameters $Y = f(x_1, x_2)$.

The least value of response function on a scheduling matrix is observed in experience №10 (x_1 =1,682; $x_2 = x_3$ =0). We make a matrix for calculating of the minimum value of the response Y by quantization of explanatory variables [2] (tab. 3).

Table 3. **Determination of response function Y minimum value**

№ п/п	b_0 0,0452	b_1 $-0,0078$	b_{12} $-0,0071$	b_2 0	$\hat{y}_3$
1	2	3	4	5	6
1	x_i	1,682		0	0,017
2	x_i	1,682		1,682	
3	$b_i x_i$	-0,01312	-0,02	0	0,012
4	x_i	1,682		1	
5	$b_i x_i$	-0,01312	-0,01194	0	0,02014

Tab. 3 is constructed as follows: in the left column, independent arguments X and their products on regress factors b_i are located in; in heading - factors of regress and their numerical value. In line 1 experiment conditions (that is values of factors x_i) and the minimum value of function of the response Y from a planning matrix are resulted; further in even lines values of arguments, and in odd - their products on corresponding factors of regress are resulted. In the right column values of function Y, predicted by the regression equation are placed. It can be seen smooth decrease of function y (lines 3,5). From a line 2 of tab. 3 we write out coordinates of a special point of factorial space:

$$Y_s = 0{,}012;\ x_{1s} = x_{2s} = 1{,}682. \tag{4}$$

The two-dimensional section of function Y, necessary for research of "almost stationary area" was carried out under factors x_1, x_2, with model (2) use.

The angle of coordinate axes rotation [2]:

$$tg2\alpha = b_{12} / (b_{11} - b_{22}) = -0{,}0071 / 0 = -\infty;\ 2\alpha = -90^\circ;\alpha = 45^\circ. \tag{5}$$

Coefficients of regression in canonical form is determined by relations [2, 3]:

$$B_{11} = b_{11}\cos^2\alpha + b_{12}\cos\alpha\sin\alpha + b_{22}\sin^2\alpha = -0{,}0071\frac{\sqrt{2}}{2}\left(-\frac{\sqrt{2}}{2}\right) = 0{,}0035. \tag{6}$$

$$B_{22} = b_{11}\cos^2\alpha + b_{12}\cos\alpha\sin\alpha + b_{22}\sin^2\alpha = -0{,}0035. \tag{7}$$

Canonical form looks like [2, 3]:

$$Y - Y_S = B_{11}X_1^2 + B_{22}X_2^2;\ Y - 0{,}012 = 0{,}0035X_1^2 - 0{,}0035X_2^2. \tag{8}$$

From here:

$$X_1 = \sqrt{Y/(0{,}0035) - 3{,}43 + X_2^2}. \tag{9}$$

Co-ordinates of the new centre S (1,682; 1,682); whereas signs of factors B_{11}, B_{22} are various (B_{11}=0,0035; B_{22}=-0,0035), lines of an equal response - hyperboles; and a response surface is the hyperbolic parabolic [2]. Co-ordinates of hyperboles according to (9) were determined by an response Y =0,0035; 0,012; 0,0005; 0,007. The sequence of calculation is presented in tab. 4.

Table 4. **The sequence of function Y equal lines co-ordinates calculation**

Y	$X_2(\pm)$	X_2^2	$X_1(\pm)$	Y	$X_1(\pm)$	Y	$X_1(\pm)$
1	2	3	4	5	6	7	8
	1	1	-		1		-
	1,5	2,25	-		1,5		0,9
0,0035	2	4	1,25		2,0	0,07	1,6
	2,5	6,25	1,95	0,012	2,5		2,2
	3	9	2,56		3		2,75

In previous system of coordinates $x_1 0 x_2$ (fig. 2) the square with the party $2 \cdot 1{,}682$ is plotted. The new centre is S (1,682; 1,682). The new coordinate axes x_1, x_2 are turned on a corner $\alpha = -45^{\circ}$ clockwise, the angle of coordinate axes rotation is designated according to (5). According to fig. 2 the response increases at increasing x_2.

CONCLUSIONS

1. After processing of the results of experiment put on a rotatable planning matrix of the second order for three factors the experiments reproducibility by Kohren criterion ($G_{\exp} = 0{,}218; G_{tabl.} = 0{,}7977$), significance of regression coefficients by a Student t-test and model adequacy by a Fisher's test ($F_{\exp} = 0{,}327; F_{tabl.} = 2{,}2$) are determined.

Mathematical model in the form of regress of the second order is received:

$$y = b_0 + b_1 x_1 + b_{12} x_1 \cdot x_2 ,$$

where $b_0 = 0{,}0452$; $b_1 = -0{,}0078$; $b_{12} = -0{,}0071$.

2. Influence of each factor x_1, x_2 on "doubles" quantity was defined at value of other factor equal $\pm 1{,}682$ and 0. After substitution in model (2) $Y_{1.1} - Y_{1.3}$ function system is gained and the response at values of other factors, equal to $\pm 1{,}682$; ± 1 and 0 (table 2) is defined. Figure 1 is built by table 2 and equation 3 data. It can be seen from the figure that the dependence of "doubles" quantity upon diameter $x_1(D)$ and height $x_2(h)$ of seed tube is rectilinear. It decreases when other factor is equal to upper stellar point (lines $y_{1.3}, y_{2.3}$) and it is increases when other factors are equal to bottom stellar point (lines $Y_{1.1}, Y_{2.1}$). At $x_2(h) = 0$ the response is decreasing while $x_1(D)$ (lines $Y_{1.2}$) increasing; at $x_1(D) = 0$ the "doubles" quantity does not depend on seed tube height $x_2(h)$ (line $Y_{2.2}$).

3. While optimization of seeds distribution process parameters minimum "doubles" quantity is defined according to the planning matrix ($Y = 0{,}017$ when $x_1 = 1{,}682$; $x_2 = x_3 = 0$) in experience №10. Minimum response value was diminished by quantization of independent variables (tab. 3). It can be seen from the table 3, that coordinates of factorial space special point is:

$$y_S = 0{,}012 ; \; x_{15} = x_{25} = 1{,}682 .$$

Research of a response surface was carried out by two-dimensional section with factors x_1, x_2. Canonical form of the model (2) is:

$$Y - Y_S = B_{11} x_1^2 + B_{22} x_2^2 ; \quad Y - 0{,}012 = 0{,}0035 x_1^2 - 0{,}0035 x_2^2 .$$

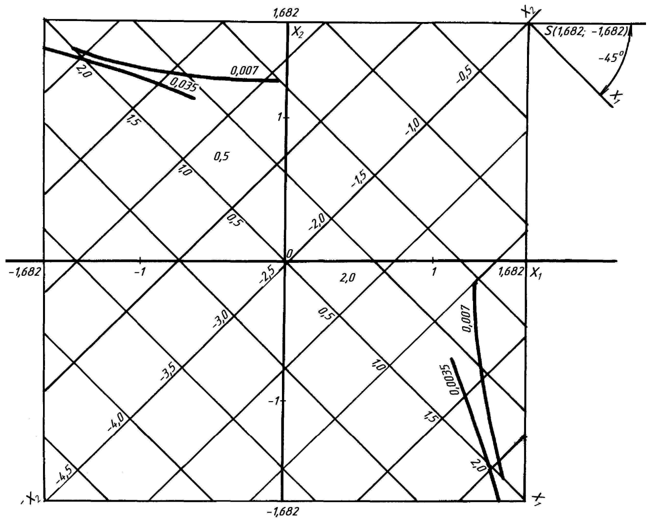

Fig. 2. Two-dimensional sections of “almost stationary” function Y (“doubles”) area by x_1, x_2 when $x_{3s} = 0$ (lines of an equal exit — hyperbolas — are shown)

Coordinates of new center S are (1,682; 1,682).

Equal exit lines are hyperboles and response surface is hyperbolic paraboloid (fig. 2) as coefficient B_{11}, B_{22} signs are different ($B_{11} = 0{,}0035$, $B_{22} = -0{,}0035$). It can be seen from figure 2 that “doubles” quantity increases at growth of x_2.

REFERENCES

1. Basin. V. and others (1987). Machines for exact seeding of tilled crops: designing and calculation. – K.: Technics. 151.
2. Melnicov S. and others(1979). Experiment planning in researches of agricultural processes. – M.: Kolos. 200.
3. Nalimov V. Chernova N. (1965) Statistical methods of planning of extreme experiments. – M.: Nauka. 340.

ВЫБОР ПАРАМЕТРОВ ДОЗАТОРА С ГОРИЗОНТАЛЬНЫМ ДИСКОМ ПРИ ПУНКТИРНОМ ПОСЕВЕ КУКУРУЗЫ

Белодедов В., Носко П., Филь П., Мазнева М., Бойко Г.

Аннотация. Приведены результаты многофакторного эксперимента, поставленного по матрице ротатабельного планирования для трех факторов: высоты и диаметра семяпровода и скорости вращения высевающего диска. Результаты экспериментов обработаны в соответствии с общепринятой методикой. Получена адекватная модель. Определено влияние каждого фактора в отдельности на количество "двойников" (то есть интервалов между семенами, близких к нулю) и оптимальное значение факторов.

Ключевые слова. Количество "двойников", влияние факторов, оптимизация.