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SELECTION OF OPTIMAL PARAMETERS DOSATOR WITH HORIZONTAL DISC ON THE DEGREE OF DEVIATION FACTUAL LAW DISTRIBUTION OF SEED MAIZE FROM NORMAL

Victor Belodedov, Pavel Nosko, Pavel Fil, Marina Mazneva

Volodymyr Dahl East- Ukrainian National University , Lugansk, Ukraine
Lugansk National Agrarian University

Summary. Results of multifactorial experiments 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 degree of deviation factual law distribution of seed maize from normal and optimal value of each factor were determined.

Key words: degree of deviation factual law distribution of seed maize from normal, influence of factors, optimization.

INTRODUCTION

Degree the deviation factual law distribution of seed from normal, including exponents asymmetry A and excess E, directly influences on uniformity of distribution of seeds placing in a row [1, 5-20]. It is the major reserve of increasing of productivity grain and row-crop cultures by creation of conditions for the fullest using by plants of nutrients, moisture, warmth and sunlight. For row-crop cultures, except decreasing of productivity, non- uniformity of seeding leads to sharp increasing of “superfluous” plants. The aspiration to provide necessary density of plants become causes application of the increased norms of seeding, that leads to the over-expenditure of a sowing material.

OBJECTS AND PROBLEMS

The degree of deviation factual law distribution of seed from normal was calculated on the formula [4]:

$$y = f(A,E), \tag{1}$$

where: $A = \sum_1^N \left(x_i - \bar{x}\right)^3 / \left(ND^{3/2}\right)$; $E = \sum_1^N \left(x_i - \bar{x}\right)^4 / \left(ND^2\right)$ — exponents of asymmetry and excess accordingly; N — totality accidental values x_i (current importance of intervals between seed on the row); D — displace dispersion of intervals ($D = \sigma^2 = \sum_1^N \left(x_i - \bar{x}\right)^2 / N$); $\bar{x} = \upsilon_1$ — middle importance ($\bar{x} = \upsilon_1 = \sum_1^N x_i / N$).

When $A = E = 0$ statistical curve $p(x)$ coinside with normal distribution; when $A_1 > 0$ to stretch out [4] right-hand lot; when $A_2 < 0$ — to stretch out left-hand lot; when $E > 0$ peak of statistical curve $p(x)$ more sharp than by curve $p(x)$ normal distribution; when $E < 0$ curve $p(x)$ statistical distribution more slightly. When $A_1 > 0$ curve of distribution slope left-hand, a $\upsilon_1 < \upsilon_0$ (υ_0 — mathematical expectation of intervals, when $A = 0$) and $\upsilon_1 = \sigma / \upsilon_1 > V_0$ (V_0 — coefficient variation of intervals, when $\upsilon = V_0$ and σ (standard) — constant); when $A_2 < 0$, conversely, $v_2 = \sigma / \upsilon_2 < V_0$. From here it is possible with drowal, that sum absolute values $|A| + |-E|$ correspond increasing $V = \sigma / \upsilon_1$, and sum $|-A| + |E|$ — his decreasing; with register of exposition, when in the experiment was observed:

1. $A > 0$, $E > 0$, that $y = |A - E|$; 2. $A < 0$, $E < 0$, that $y = \|E| - |A\|$;
3. $A > 0$, $E < 0$, that $y = A + |E|$; 4. $A < 0$, $E > 0$, that $y = 1/\left(|A| + E\right)$. (2)

In the capacity of apparatus with a horizontal disc the sowing of a seeder of CKHK-type, which is installed on a special framework over a ribbon of the stand of a generally accepted construction was used. Three factors were varied: $x_1(D)$ — diameter of a seed tube, $x_2(h)$ — seed tube altitude, $x_3(v_0)$ — peripheral velocity of twirl of a seed disc.

Factors $x_1(D)$ and $x_2(h)$ were set by of round metal tubes and the factor $x_3(v_0)$ — change of a reduction ratio of the mechanism of the drive (replaceable starlets). 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 2 m/s. The calculated intervals between seeds at speed $v_0 = 0{,}275$ m/s was equated 200,0 mm; seeds of corn of “Dneprovskaya-247” sort of the thin a fraction by the SKV-153B seed disc were seeded; of 1,0 mm were used an insertion ring by thickness. Intervals of a variation of the factors, chosen a condition of technological working capacity of a dosator, are presented in tab.1.

Experimental data were treated accordingly with the certain methods, recommended for rotatable planning; Kohren criterion (characterizing homogeneous of variances), Student criterion (causing the significance of regression coefficients) and Fisher criterion (pointing out on the adequacy of model) were thus defined; the adequate regression model of the second order with variables in a code designation is a result view:

$$y = b_0 + b_3 x_3 + b_{13} x_1 x_3 + b_{22} x_2^2, \quad (3)$$

where: $b_0 = 1{,}0537$; $b_3 = 0{,}1215$; $b_{13} = -0{,}2062$; $b_{22} = 1{,}1339$.

Table 1. **Intervals of a variation of the factors $x_1(D)$, $x_2(h)$ and $x_3(v_0)$ for SKNK-type seeder dosator**

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, J	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 star point, $x_i = 1{,}682$	100,0	460,0	0,5
The lower star point, $x_i = -1{,}682$	20,0	250,0	0,05

Influence of each factor separately on response function was defined at levels of other factors, equal 0 and $\pm 1{,}682$. The equation (3) takes a view:

when $x_2 = x_3 = -1{,}682$: $y_{1.1} = 1{,}2281 + 0{,}3468x_1$,

when $x_2 = x_3 = 0$: $y_{1.2} = 1{,}0537$,

when $x_2 = x_3 = 1{,}682$: $y_{1.3} = 1{,}6369 - 0{,}3468x_1$,

when $x_1 = x_3 = -1{,}682$: $y_{2.1} = 0{,}266 + 0{,}1339x_2^2$,

when $x_1 = x_3 = 0$: $y_{2.2} = 1{,}0537 + 0{,}1339x_2^2$,

when $x_1 = x_3 = 1{,}682$: $y_{2.3} = 0{,}6748 + 0{,}1339x_2^2$,

when $x_1 = x_2 = -1{,}682$: $y_{3.1} = 1{,}4325 + 0{,}4683x_3$,

when $x_1 = x_2 = 0$: $y_{3.2} = 1{,}0537 + 0{,}1215x_3$,

when $x_1 = x_2 = 1{,}682$: $y_{3.3} = 1{,}4325 - 0{,}2253x_3$. (4)

Values of function $y_{1.1} - y_{3.3}$ according (4) are computed on the points $x_i = 0$; ± 1; $\pm 1{,}682$; calculation data are presented in tab.2.

Table 2. **The sequence of functions $y_{1.1} - y_{3.3}$ calculation**

x_i	x_i^2	$0{,}3468x_1$	$y_{1.1}$=1,2281+(3)	$y_{1.2}$=1,0537	$y_{1.3}$=1,6369-(3)	$0{,}1339\,x_2^2$	$y_{2.1}$=0,266+(7)
1	2	3	4	5	6	7	8
-1,682	2,829	-0,5833	0,6448	1,0537	2,22	0,3788	0,6448
-1,0	1,0	-0,3468	0,8813	1,0537	1,9837	0,1339	0,3999
0	0	0	1,2281	1,0537	1,6369	0	0,266
1,0	1,0	0,3468	1,5749	1,0537	1,29	0,1339	0,3999
1,682	2,829	0,5833	1,8114	1,0537	1,0536	0,3788	0,6448

Continuation of table 2

$y_{2.2}$=1,0537+ +(7)	$y_{2.3}$=0,6748+ +(7)	0,4683x_3	$y_{3.1}$=1,4325+ +(11)	0,1215x_3	$y_{3.2}$=1,0537+ +(13)	0,2253 x_3	$y_{3.3}$=1,4325- -(15)
9	10	11	12	13	14	15	16
1,4325	1,0536	-0,7877	0,6448	-0,2044	0,8493	-0,379	1,8115
1,1876	0,8087	-0,4683	0,9642	-0,1215	0,9322	-0,2253	1,6578
1,0537	0,6748	0	1,4325	0	1,0537	0	1,4325
1,1876	0,8087	0,4683	1,9008	0,1215	1,1752	0,2253	1,2072
1,4325	1,0536	0,7877	2,22	0,2044	1,2581	0,379	1,0535

According to the tab.2 is built a graphs, presented on the fig.1. From tab.2 and fig.1 is visible, that at levels of other factor, equal $x_1 = x_2 = x_3 = 1{,}682$, the response diminishes when factors x_1, x_3 increases (the lines $y_{1.3}, y_{3.3}$), and the function y grow up when x_1, x_3 increases (in case $x_1 = x_2 = x_3 = -1{,}682$; lines $y_{1.1}, y_{3.1}$); the degree of deviation isn't depend from x_1 (if $x_2 = x_3 = 0$); and it equal $y_{1.2} = 1{,}0537$.

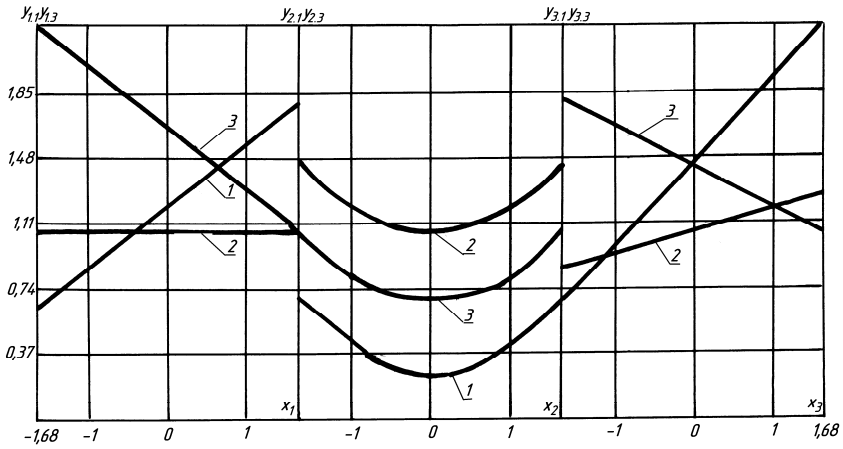

Fig.1. The graph of functions $y_{1.1}$ - $y_{3.3}$ (the degree of deviation factual law distribution of seed maize from normal)

From the factors x_2 the response is depend curvilinely (lines $y_{2.1} - y_{2.3}$) with the minimum of importance when $x_2 = 0$.

Optimization of the parameters the dosator with horizontal disc on the degree of deviation.

Minimum of function y observes in experiment №19 of matrix planning: $y'_{min} = 0{,}51$; $x_1 = x_2 = x_3 = 0.$; Make a matrix for calculation of minimum importance of the response function y by quantization of independent variables (tab.3), [2, 3].

Table 3. **Calculation of response Y_{min} minimum**

№№		b_0 1,0537	x_1	x_2	x_3	b_3 0,1215	b_{13} -0,2062	b_{22} 0,1339	$\hat{y}$
1	2	3	4	5	6	7	8	9	10
1	x_i	1	0	0	0				0,51
2	x_i		-1,682	0	-1,682				
3	$b_i x_i$	1,0537	0	0		-0,2044	-0,5833	0	0,266
4	x_i	1	-1	-1	-1				
5	$b_i x_i$	1,0537				-0,1215	-0,2062	0,1339	0,8599

The tab. 3 is constructed as follows: in the left column independent arguments x_i and their products on regress coefficients b_i are located; in heading — coefficients of regress and their numerical importance. In line 1 conditions of expense (that is to say importance of factors x_i) and minimum importance of function response y from a planning matrix are represented; further in even lines importance of arguments are represented, and in odd – their products on appropriate coefficients of regress. In the right extreme column importance of function $\hat{y}$, foretell by the equation of regress, are placed. From it is visible, that $y_{min} = 0{,}266$, that is to say by the coordinates of a special point S factorial space take conditions of line 2 of tab.3:

$$y_s = 0{,}266;\ x_{15} = x_{35} = -1{,}682;\ x_{2s} = 0. \tag{5}$$

The corner of turn coordinate axes [2, 3]:

$$tg\,2a = b_{13}/(b_{11} - b_{33}) = -0{,}2062/(0-0) = -\infty;\ 2\alpha = arctg(-\infty) = -90^\circ;\ \alpha = -45^\circ \tag{6}$$

The coefficients of regress in initial form are finded on the formulas:

$$B_{11} = b_{11}\cos^2\alpha + b_{13}\cos\alpha\sin\alpha + b_{33}\sin^2\alpha = -0{,}2062\cdot(0{,}707)^2 = 0{,}1031;$$

$$B_{33} = b_{11}\cos^2\alpha - b_{13}\cos\alpha\sin\alpha + b_{33}\cos^2\alpha = -0{,}2062\cdot(0{,}707)^2 = -0{,}1031; \tag{7}$$

The initial form haves view [2, 3]:

$$Y - 0{,}266 = 0{,}1031X_1^2 - 0{,}1031X_3^2, \tag{8}$$

from here:

$$X_3 = \sqrt{X_1^2 - (Y - 0{,}266/0{,}1031)}. \tag{9}$$

The coordinates of the new centre $S(-1{,}681; -1{,}682)$; as signs of coefficients B_{11}, B_{33} are different ($B_{11} = 0{,}1031;\ B_{22} = -0{,}1031$), then lines of an equal exit – hyperboles, and surface of response is the hyperbolic parabolic [2, 3]. Coordinates of hyperbolic were determined according (9) by an exit $y = 0{,}5;\ 0{,}25;\ 0;\ -0{,}05;\ -0{,}1;\ -0{,}25;\ -1{,}5$ (tab. 4).

Table 4. **The sequence of calculation coordinates lines of equal exit for function** Y

y=0, 5	$x_1(\pm)$	x_1^2	$x_3(\pm)$	y=0,25	$x_3(\pm)$	y=0	$x_3(\pm)$
1	2	3	4	5	6	7	8
S'= (0,5- -0,266)=0,234	1,682	2,829	0,75	S'= (0,25- -0,266)=0,016	1,687	S'= (0-0,266)/0,1031= =-2,58	2,33
	1,0	1,0	-		1,0		1,89
	0,5	0,25	-		0,516		1,68
	0,25	0,0625	-		0,28		1,63
	0	0	-		0,126		1,6

y=-0,05	$x_3(\pm)$	y=-0,1	$x_3(\pm)$	y=-0,25	$x_3(\pm)$	y=-0, 5	$x_3(\pm)$
9	10	11	12	13	14	15	16
S'= (-0,05- -0,266)/ /0,1031= -3,065	2,43	S'= (-0,1- -0,266)/ /0,1031=- 3,55	2,53	S'= (0,25- -0,266)/ /0,1031=- 5,005	2,80	S'= (-0,5- -0,266)/ /0,1031=- 7,43	3,20
	2,02		2,13		2,45		2,90
	1,89		1,95		2,30		2,77
	1,82		1,90		2,25		2,74
	1,75		1,88		2,24		2,73

In old system of coordinates $x_1 o x_3$ (fig. 2) the square with the side $2 \cdot 1{,}682$ is construction and the new centre S(-1,682;-1,682) is mark with axes $X_1 X_3$, which are turned on a corner $\alpha = -45^\circ$ to (6). According to fig. 2; the response Y diminished which coordinate x_2 increases.

CONCLUSIONS

1. The degree of deviation factual law distribution of seed from normal was calculated on the formula [4]:

$$y = f(A,E), \tag{1}$$

where: $A = \sum_1^N \left(x_i - \bar{x}\right)^3 / \left(ND^{3/2}\right)$; $E = \sum_1^N \left(x_i - \bar{x}\right)^4 / \left(ND^2\right)$ — exponents of asymmetry and excess accordingly; N — totality accidental values x_i (current importance of intervals between seed on the row); D — displace dispersion of intervals ($D = \sigma^2 = \sum_1^N \left(x_i - \bar{x}\right)^2 / N$); $\bar{x} = \upsilon_1$ — middle importance ($\bar{x} = \upsilon_1 = \sum_1^N x_i / N$).

When in the experiment was observed:

1. $A > 0$, $E > 0$, that $y = |A - E|$; 2. $A < 0$, $E < 0$, that $y = \big||E| - |A|\big|$,

3. $A > 0$, $E < 0$, that $y = A + |E|$; 4. $A < 0$, $E > 0$, that $y = 1/\left(|A| + E\right)$.

Experimental data were treated accordingly with the methods of rotatable planning; the adequate regression model of second order with variables in a code designation is a result view:

$$y = b_0 + b_3 x_3 + b_{13} x_1 x_3 + b_{22} x_2^2, \tag{2}$$

where: $b_0 = 1{,}0537$; $b_3 = 0{,}1215$; $b_{13} = -0{,}2062$; $b_{22} = 1{,}1339$; x_1, x_2 — diameter and altitude of a seed tube, x_3 — peripheral velocity of twirl of a seed disc.

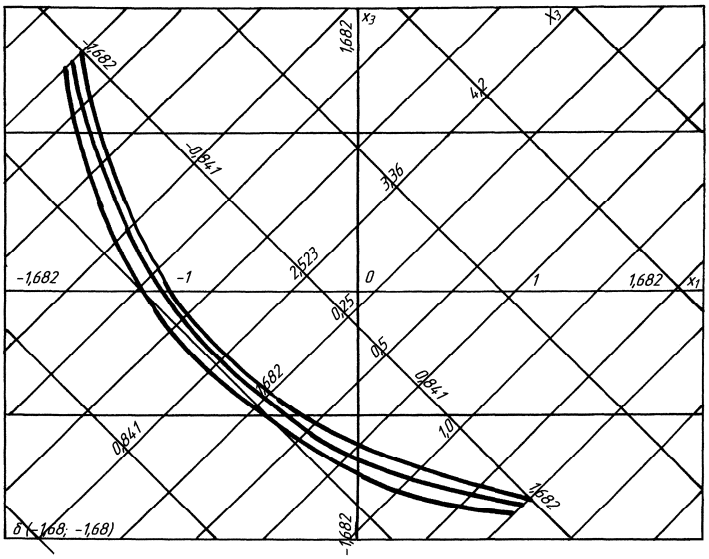

Fig.2. The two-dimensional sections of function *Y* (the degree of deviation) in "almost stationary area" along factors x_1, x_3, when $x_2 = 0$ (lines of a equal exit – hyperboles are shown)

2. Influence of each factor on the degree of deviation was defined at levels of other factors, equal ±1,682 and 0; it is presented in tab.2 and in fig. 1. From them it is visible, that at levels of other factors, equal $x_1 = x_2 = x_3 = 1{,}682$ the response is diminishes when factors x_1, x_3 increases (the lines $y_{1.3}, y_{3.3}$), and the function y grow up when x_1, x_3 increases (in case $x_1 = x_2 = x_3 = -1{,}682$; lines $y_{1.1}, y_{3.1}$); the degree of deviation isn't depend from x_1 (if $x_2 = x_3 = 0$); and it equal $y_{1.2} = 1{,}0537$. From the factor x_2 the response is depend curvilinely (lines $y_{2.1} - y_{2.3}$) with the minimum of importance, when $x_2 = 0$.

3. Coordinates of special point factorial space were determined by quantization of the independent variables (tab.3); from it visible, that $y_{min} = 0{,}266$, that is to say by the coordinates of the special point S factorial space take conditions of line 2 of tab. 3:

$$y_s = 0{,}266; \; x_{1s} = x_{3s} = -1{,}682; \; x_{2s} = 0. \qquad (5)$$

The two – dimensional sections of function Y, necessary for research of "almost stationar area", was carried out at factors x_1, x_3 with using of model (3). Coordinates of lines equal exit (tab.4) were defined from initial form (9), they are presented on fig.2. According to fig.2 the response diminished when coordinate X_3 increases.

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ВЫБОР ОПТИМАЛЬНЫХ ПАРАМЕТРОВ ДОЗАТОРА С ГОРИЗОНТАЛЬНЫМ ДИСКОМ ПО СТЕПЕНИ ОТКЛОНЕНИЯ ФАКТИЧЕСКОГО ЗАКОНА РАСПРЕДЕЛЕНИЯ СЕМЯН КУКУРУЗЫ ОТ НОРМАЛЬНОГО

Виктор Белодедов, Павел Носко, Павел Филь, Марина Мазнева

Аннотация. Представлены результаты многофакторного эксперимента, поставленного по матрице ротатабельного планирования для трех факторов: высоты и диаметра семяпровода, а также скорости вращения высевающего диска. Результаты экспериментов обработаны в соответствии с методикой, характерной для ротатабельного планирования, получена адекватная математическая модель процесса, по которой установлено влияние факторов и оптимальные условия высева.

Ключевые слова: степень отклонения фактического закона распределения от нормального, влияние факторов, оптимизация.