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Efficiency of use of selection-genetic parameters in selection of flux

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The purpose. To determine regularities of inheritance by hybrids of the 1-st generation and the level of heritability of attributes of seed productivity at hybrids of the 2-nd generation of flux for use in selection process and creation of new varieties. **Methods.** Extent of prevalence (hp) of elements of seed productivity was determined at 18 reciprocal hybrids of the 1-st generation by J. Briubecker formula; extent of heterosis — by F. Petz and K. Frey formula in presentation of L.S. Zenischeva. Factors of heritability in broad sense (H^2) were determined at 24 combinations of hybrids of the 2-nd generation by I. Mahmud and H. Kramer formula according to A.Ya. Al graduation. Statistical analysis of experimental data was spent by means of program MSTAT-C. **Results.** Types of inheritance and extent of heterosis at hybrids of the 1-st generation of flux by mass of seeds from a plant and elements of seed productivity (amount of boxes on a plant, amount of seeds in a box, mass of 1000 seeds) are specified. Hybrid combinations with effect of heterosis are fixed. Different level of heritability of attributes of seed productivity at hybrids of the 2-nd generation is established. Hybrid combinations with high factors of heritability of seed productivity (Redwood 65/Kirovogradsyi 2 — 0,88, Kirovogradsyi 2/Redwood 65 — 0,87, Kirovogradsyi 2/Redwing — 0,84, Redwing/Kirovogradsyi 2 — 0,82) and its elements on which it is possible to forecast high performance of selection in early generations are selected. The created high-heterosis combinations and combinations with high indexes of factors of heritability by elements of seed productivity are involved into selection process. **Conclusions.** Efficiency of use of selection-genetic parameters in selection of flux is established and the valuable initial stock is created.

Key words: *flux, element of seed productivity, hybrid of the 1-st generation, hybrid of the 2-nd generation, factor of prevalence, extent of heterosis, factor of heritability.*

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The effectiveness of breeding programs is largely determined by the study of the laws of inheritance of valuable economic features operating in hybrid populations. This allows for more effective selection, reduction of losses of valuable genotypes, reduction of losses by the rejection of invaluable material in the first stages of selection. The study of the heterosis effect is of great practical importance, since the selection of highly productive plants in self-pollinating crops is most likely in hybrids with high heterosis. For the flax culture, the effects of over-domination for signs of seed productivity are quite characteristic and noted by domestic and foreign researchers [1, 2, 3, 4, 5]. Effective selection of plants also requires simultaneous combination of two conditions: wide phenotypic variability of the population and high inheritance of the trait. Genotypic variability is important for selection, which is determined by the coefficient of inheritance, which reflects the proportion of genotypic variability in the general phenotypic variation of the trait. Investigating the magnitude of variability as the basis for predicting the improvement of valuable economic characteristics allows us to solve a number of questions of practical selection and, in general, to orientate the selection process to maximize the use of genotypic potential [6, 7].

The purpose of the research is to establish the patterns of inheritance by the first generation hybrids and to determine the level of inheritance of the seed productivity in hybrids of the second generation flaxseed oil for use in the breeding process.

Materials and methods. The research was conducted at the Institute of oilseeds of the NAAS. Direct and reverse crosses were carried out to establish the character of inheritance of signs of seed productivity. Parental components for cross-breeding were collectible samples of different ecological and geographical origin, contrasting on the studied features. The nature of the inheritance of performance elements was

determined in 18 reciprocal hybrids of the first generation with the degree of dominance (hp) according to the gradation [8]: -∞ <hp <1 – negative overdominance; -1 ≤hp <0,5 – negative dominance; 0,5 ≤hp≤ 0,5 – intermediate inheritance; 0,5 <hp≤ 1 – positive dominance; 1,0 <hp <+ ∞ – positive over domination. The degree of heterosis was determined by the formula F. Petz and K. Frey in the presentation of L.S. Zenishcheva [9].

Heritability factors in the broad sense (H^2) were determined in 24 combinations of hybrids of the second generation according to the formula I. Mahmud and H. Kramer [10]. According to the graduation of A. Ala [11], the coefficients of heritability were divided into: high – 0,66-1,0; average – 0,33-0,65; low – 0,0-0,32.

Results and discussion. Seed productivity of flax plant is determined by such signs as the number of bolls on the plant, the number of seeds in the box, the mass of 1000 seeds. It has been established that the sign «the number of bolls on the plant» is decisive in the formation of high seed productivity [12].

The number of capsules on the plant showed a high level of dominance of the best parental form in the vast majority of hybrid combinations, namely in 14 of the 18 studied (77,7%): positive superdomination was observed, the degree of which varied from hp = 1,16 to 2, 68. In one hybrid combination (5,6%), the positive dominance of the trait (hp = 0,60) was noted, in one (5,6%) – intermediate inheritance (hp = 0,29) and in two (11,1%) combinations the number of capsules was less than the worst parental form, so there was a negative dominance (hp = 0,75 ... -0,88).

Table 1 shows first generation hybrid combinations in which the effect of heterosis with indices ranging from 2,32% to 38,70% is found. The highest heterosis was observed in the combination: K 1542 / Redwood 65 – 38,70% and reverse Redwood 65 / K 1542 – 17,83%, K 7679/14201 D – 16,96%.

1. Hybrid F_1 flax oil with the effect of heterosis on the basis of «the number of boxes per plant»

Combination of crosses	Number of boxes per plant, pcs.			hp	Degree of heterosis, %
	P_1	P_2	F_1		
K 1542 / Redwood 65	23,0±0,67	12,4±1,07	31,9±1,85	2,68	38,70
Redwood 65 / K 1542	12,4±1,07	23,0±1,67	27,1±1,38	1,77	17,83
K 7679 / 14201 D	16,2±1,37	22,4±1,82	26,2±3,05	2,23	16,96
K 6501 / Mif	19,6±1,04	26,4±1,05	28,9±1,54	1,74	9,47
Mif / K 6501	26,4±1,05	19,6±1,04	29,0±1,61	1,76	9,85
Santa Catalina / Cyan	17,7±0,75	23,5±1,46	25,4±1,21	1,60	8,09
Cyan / Santa Catalina	23,5±1,46	17,7±0,75	24,7±1,11	1,37	5,11
Avangard / K 3172	22,2±1,94	15,5±1,04	23,5±1,13	1,39	5,86
K 1542 / Redwing	23,0±1,67	13,2±1,05	24,2±1,64	1,24	5,22
Redwing / K 1542	13,2±1,05	23,0±1,67	23,8±1,38	1,16	3,48
K 6080 / K 4382	19,3±0,56	25,9±1,86	27,1±1,18	1,36	4,63
K 4382 / K-6080	25,9±1,86	19,3±0,56	26,5±1,29	1,18	2,32
17 D / Santa Catalina	21,2±2,51	17,2±1,87	22,0±2,17	1,40	3,77
Redwing / Kirovogradskyj 2	13,2±1,05	24,2±1,78	25,1±1,51	1,16	3,72

By the number of seeds in the box, the main type was intermediate inheritance – 12 hybrids out of 18 studied, or 66,6%. The coefficient of degree of dominance at that was 0,24 ... 0,50. Positive dominance was observed in one hybrid F_1 (5,6%) (hp = 0,57), in two (11,1%) hybrid combinations there was a positive super-domination (hp = 1,10 ... 1,14) and in three (16,7%) – the negative domination of the sign (hp = -0,94 ... -1,00). The heterosis effect is noted in two hybrid combinations – Avangard / K 3172 and K 1176 / K 4382 with a degree of heterosis of 1,12%.

The predominant type of inheritance of the mass of 1000 seeds was intermediate inheritance, which was observed in 50% of hybrids of the first generation (hp = -0,41 ... 0,50). Overdominance by type of large-seed parent component was noted in three hybrid combinations (16,7%), hp was 1,24 ... 1,89; positive dominance

was observed in six hybrids (33,3%) with hp = 0,56 ... 1,00. On this basis, no negative dominance and overdominance was detected. Heterosis was manifested in three hybrids of the first generation: Redwing / Redwood 65 (12,12%) and reverse Redwood 65 / Redwing (6,06%) and in combination K 6080 / K 1353 (4,21%). These combinations are promising for breeding use in order to improve the seed productivity of flaxseed oil (tabl. 2).

2. Hybrid F_1 flax oil with the effect of heterosis on the basis of «the number of seeds in the box» and «weight of 1000 seeds»

Combination of crosses	Number of seeds in a box, pc.			hp	Degree of heterosis, %
	P_1	P_2	F_1		
Avangard / K 3172	8,9±0,19	7,5±0,20	9,0±0,21	1,14	1,12
K 1176 / K 4382	6,8±0,26	8,9±0,23	9,0±0,17	1,10	1,12
	Weight of 1000 seeds, g				
Redwing / Redwood 65	4,8±0,26	6,6±0,15	7,4±0,17	1,89	12,12
Redwood 65 / Redwing	6,6±0,15	4,8±0,26	7,0±0,15	1,44	6,06
K 6080 / K 1353	9,5±0,15	6,2±0,14	9,9±0,15	1,24	4,21

According to the types of inheritance of seeds from the plant in F_1 hybrids, the positive overdomination was the main one, which manifested itself in 55,6% of the hybrids under investigation, the degree of dominance being hp = 1,18 ... 4,39. Six combinations (33,3%) showed positive dominance – hp = 0,61 ... 0,98 and in two (11,1%) – negative dominance of the sign – hp = -0,61 ... -0,73. Negative overdominance and intermediate inheritance on this basis was not found. In 12 hybrids of the first generation, heterosis appeared, the degree of which was 3,19-49,50%. The highest degree of heterosis was in the combinations: Redwing / K 1542 – 37,39% and reverse K 1542 / Redwing – 40,87%, K 7679/14201 D – 39,60% and return 14201 D / K 7679 – 49,50 %, 17 D / Santa Catalina – 49,18% (tabl. 3).

3. Hybrid F_1 flax oil with the effect of heterosis on the basis of «mass of seed from a plant»

Combination of crosses	Mass of seed from a plant, g			hp	Degree of heterosis, %
	P_1	P_2	F_1		
Redwood 65 / K 1542	0,64±0,07	1,15±0,15	1,32±0,27	0,82	14,78
K 1542 / Redwood 65	1,15±0,15	0,64±0,07	1,40±0,10	0,98	21,74
Redwing / K 1542	0,39±0,04	1,15±0,15	1,58±0,14	2,13	37,39
K 1542 / Redwing	1,15±0,15	0,39±0,04	1,62±0,05	2,24	40,87
Redwing / Kirovogradskyj 2	0,39±0,04	1,32±0,09	1,43±0,19	1,21	8,33
Kirovogradskyj 2 / Redwing	1,32±0,09	0,39±0,04	1,67±0,15	1,72	26,52
K 7679 / 14201 D	0,70±0,25	1,01±0,21	1,41±0,19	3,59	39,60
14201 D / K-7679	1,01±0,21	0,70±0,25	1,51±0,11	4,23	49,50
17 D / Santa Catalina	1,22±0,10	0,66±0,13	1,45±0,48	1,82	49,18
K 6501 / Mif	1,06±0,10	1,88±0,21	1,94±0,25	4,39	3,19
K 6080 / K 4382	1,44±0,15	0,68±0,10	1,51±0,19	1,18	4,86
K 4382 / K 6080	0,68±0,10	1,44±0,15	1,68±0,10	1,63	16,67

In determining the heritability of the seeds of flaxseed oil productivity, it was established that the heritability factors varied greatly from low values –(H^2 = 0,04) to high (H^2 = 0,88), which indicates a different degree of efficiency of selection by crossing combinations of this characteristic. Hybrid combinations were distinguished by high coefficients of heritability: Redwood 65 / Kirovogradskyj 2 – 0,88, Kirovogradskyj 2 /

Redwood 65 – 0,87, Kirovogradskyj 2 / Redwing – 0,84, Redwing / Kirovogradskyj 2 – 0,82, K 4054 / Cyan – 0,65. For these combinations, it is possible to predict the high efficiency of selection in the early generations.

By the number of boxes on the plant, the heritability coefficients had a wide range of variation, depending on the combination of crossing-from low values – (H^2 = 0,07) to high (H^2 = 0,78), so the efficiency of selection is not the same for all combinations. High coefficients of heritability are established in five combinations: Redwing / Kirovogradskyj 2 – 0,78, K 3172 / Avangard – 0,71, Kirovogradskyj 2 / Redwood 65 – 0,69, Redwood 65 / Kirovogradskyj 2 – 0,67, 14201 D / K 7679 – 0,66. For these combinations, it is possible to predict effective selection of plants, starting with F_2 and F_3.

By the number of seeds in the capsule, the heritability coefficients had stably high and average values – (from 0,43 to 0,93) in all combinations. High coefficients of heritability (0,68-0,93) were found in 16 combinations of 24. The coefficient of variation of the trait was average (14,1%), which indicates a slight effect of paratypic factors on this feature.

By weight of 1000 seeds, heritability for all combinations was high (0,68-0,97), while the level of phenotypic variation of the trait was insignificant (7,9%). This indicates a high degree of genetic conditionality of this trait and a high efficiency of selection (tabl. 4).

4. Hybrid F_2 flax oil with high heritability coefficients on the basis of seed productivity

Combination of crosses	The mass of seeds from the plant	Number of boxes per plant	Number of seeds in a box	Weight 1000 seeds
Redwood 65 / Kirovogradskyj 2	**0,88**	**0,67**	**0,77**	**0,81**
Kirovogradskyj 2 / Redwood 65	**0,87**	**0,69**	**0,91**	**0,97**
Kirovogradskyj 2 / Redwing	**0,84**	0,28	**0,71**	**0,95**
Redwing / Kirovogradskyj 2	**0,82**	**0,78**	**0,78**	**0,85**
K 4054 / Cyan	0,65	0,63	**0,92**	**0,90**
Cyan / K 4054	0,44	0,64	**0,84**	**0,86**
K 3172 / Avangard	0,16	**0,71**	**0,77**	**0,72**
Avangard / K 3172	0,29	0,17	**0,82**	**0,89**
K 7679 / 14201 D	0,42	0,27	**0,71**	**0,94**
14201 D / K 7679	0,57	**0,66**	0,62	**0,88**
K 1158 / Cyan	0,53	0,51	**0,93**	**0,91**
Cyan / K 1158	0,24	0,60	0,56	**0,97**
K 7493 / Cyan	0,34	0,53	**0,73**	**0,84**
Cyan / K 7493	0,53	0,64	0,52	**0,82**
Redwing / K 1542	0,40	0,63	**0,85**	**0,87**
K 1542 / Redwing	0,25	0,51	**0,90**	**0,92**
Redwood 65 / K 1542	0,37	0,19	**0,77**	**0,68**
K 1542 / Redwood 65	0,11	0,07	**0,75**	**0,77**
Cyan / Glenelg	0,59	0,48	0,63	**0,82**
Glenelg / Cyan	0,41	0,42	0,44	**0,79**
17 D / Santa Catalina	0,19	0,58	**0,68**	**0,76**
Santa Catalina / 17 D	0,10	0,43	0,65	**0,78**
K 1614 / 1706 U	0,04	0,39	0,43	**0,75**
1706 U / K 1614	0,21	0,23	0,46	**0,81**

Hybrid combinations with high levels of heterosis and inheritance rates of seed productivity were used in the breeding process. Table 5 shows the characteristics of the best lines, which exceeded the standard grade Southern night at the yield of seeds at 0,2-2,5 t/ha, the content of oil in the seeds – by 2,0-4,4%.

5. Characteristics of the best lines separated from hybrid combinations

Line number	Combination of crosses	Duration of the vegetation period, days	Plant height, see	Yield, t / ha	Oil content,%	Weight of 1000 seeds, g
40003	Redwood-65 / К 1542	88	55,8	1,6	48,0*	6,6
40004	14201 D / К 7679	90	61,3	1,5	47,9*	7,4
40019	Cyan / Santa Catalina	87	50,7	1,3	48,2*	7,6
40028	К 1614 / 1706 У	88	57,5	2,7*	47,0*	8,9
40041	К 4054 / Cyan	88	53,5	2,7*	48,5*	7,7
40043	К 7679 / 14201 D	87	58,9	2,9*	47,5*	7,5
40055	Santa Catalina / 17 D	86	52,3	2,7*	47,1*	7,9
40061	К 3172 / Avangard	82	53,7	3,8*	48,1*	7,8
40062	Cyan / К 1158	84	52,5	1,5	47,9*	6,5
40095	Avangard / К 3172	85	54,2	3,4*	46,1*	7,1
Standard – Pyvdenna nych		***89***	***56,7***	***1,3***	***44,1***	***7,2***
LLD_{05}		*4,2*	*3,4*	*0,65*	*1,09*	*0,49*

Conclusions

1. The patterns of inheritance in the first-generation hybrids have been determined and highly hybrid hybrid combinations of flaxseed oil on the weight of the seeds from the plant and the elements of seed productivity (number of boxes per plant, number of seeds in a box, weight of 1000 seeds).

2. The level of inheritance of seed productivity in hybrids of the second generation of oil flax is determined and hybrid combinations with high coefficients of inheritance of seed productivity (Redwood 65 / Kirovogradskyj 2 – 0,88, Kirovogradskyj 2 / Redwood 65 – 0,87, Kirovogradskyj 2 / Redwing – 0,84, Redwing / Kirovogradskyj 2 – 0,82, К 4054 / Cyan – 0,65) and its elements are highlighted.

3. Effectiveness of the use of breeding genetic parameters in the selection of flaxseed olive was established and valuable source material.

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