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Combinational ability of varieties and self-pollinated lines of industrial hemp for seed and oil use in the topcross system

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Purpose. To determine the peculiarities of total combining ability (TCA) and variances specific combining ability (SCA) effects of maternal components and test varieties of intervarietal and linear-varietal hybrids of monoecious hemp on the basis of seed productivity and oil content, to determine the predominance of additive or non-additive gene effects and to identify components with the highest breeding value, to give a forecast of the effectiveness of selection in hybrid populations. **Methods.** Combining ability was determined in the system of complete topcrosses. The varieties 'YUSO 31', 'Demetra', 'Artemida', 'Aphrodita', 'Harmoniia', 'Hlesiia', 'Hlukhivski 33', 'Hlukhivski 51' and their self-pollinated lines of the fourth generation were used as maternal forms, which were crossed with three test varieties 'Hliana', 'Aphina' and 'Mykolaichyk' (48 hybrid variants in total). The results of measurements were interpreted by arithmetic mean, F-test (R. A. Fisher), least significant difference and ranked. **Results.** The study of hemp varieties and their self-pollinated lines by the parameters of combining ability as maternal components of crosses showed significant differentiation by the effects of TCA (from −22.60 to 21.40 by inflorescence length, from −10.35 to 15.15 by seed weight, from −3.91 to 3.23 by thousand seed weight, from −2.40 to 3.76 by oil content) and SCA variances (6.72–233.23; 3.25–78.29; 0.01–0.10 and 0.01–2.10, respectively). The highest SCA was observed in the maternal forms of 'Aphrodita', I_4 'Aphrodita', I_4 'Demetra' and I_4 'Hlukhivski 51' and the tester variety 'Aphina'. A comparison of the effects of TCA and SCA variances revealed that the 'Aphrodita' variety and its self-pollinated line I_4 were the best crossing components. **Conclusions.** In the analysed crosses, the additive effects of genes prevail in terms of thousand-seed weight and oil content, indicating the feasibility of selecting for phenotype. In contrast, non-additive effects prevail in terms of inflorescence length and seed weight, indicating the need for genotype selection. To increase seed productivity and oil content through combination breeding, it is advisable to use linear-varietal crosses where the maternal components have either high TCA and high SCA or medium TCA and high SCA.

Keywords: *Cannabis sativa L.; breeding; hybrid; total and specific combining ability, productivity; heterosis; additive effects of genes; non-additive effects of genes.*

Introduction

Industrial hemp (*Cannabis sativa* L.) is a valuable traditional fibre crop. It is usually cultivated until it reaches technical maturity in order to maximize the yield of high-quality stems and fiber. Two-sided cultivation (until biological maturity) using a sparse sowing method with 45 cm row spacing was usually employed to produce seed material for propagation within the seed production system. Seeds for food purposes were rarely used. In recent decades, however, there has been a significant increase in the cost of natural fiber production and a lack of processing plants, resulting in a decrease in production. At the same time, there has been a rapid increase in demand for hemp seeds as a source of valuable oil containing an optimal ratio of fatty acids, proteins, vitamins, and other nutrients [1–3].

A comprehensive study of the biologically active substances in hemp seeds of the domestic variety 'Hlesiia', hemp oil and cake [4], showed

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the presence of several valuable macro- and micronutrients in the raw materials under study, which can be arranged in descending order of content as follows: Ca, Mg, Si, Fe, Al, Mn, Zn, Sr, B, Cu, Ba, Cr, Ni, Se, Co, Mo, Cd, Be and I. Sixteen amino acids were identified, seven of which are essential (leucine, valine, threonine, lysine, methionine, isoleucine and phenylalanine), as well as two amino acids that are essential for children (histidine and arginine) [4]. The main fatty acids found in all samples were linoleic, oleic and linolenic acids. The samples also had a high content of α- and γ-tocopherol. The seeds and cake contained 32.8–34.6% protein.

Thus, breeding aimed at improving seed productivity and increasing oil content is becoming increasingly important for harvesting oil and obtaining competitive raw materials for use in functional food products [5]. At the same time, however, researchers note that there is limited scientific justification for the choice of breeding methods for industrial hemp seed and oil production [5]. Recently, advanced hemp breeding methods using genomics have emerged, including marker-assisted breeding, transgenesis, and genome editing [6], as well as somaclonal variation, mutagenesis, and polyploidisation *in vitro* [7]. However, the difficulty of cultivating cannabis *in vitro* for breeding purposes lies in the lack of direct correlation between *in vitro* and *in vivo* growth and development parameters, indicating that the performance of cannabis plants *in vitro* is not predictive of *in vivo* performance [8]. Classical methods of selection and hybridization remain the main approaches in breeding this crop, and including self-pollinated lines in crosses produces promising results [5].

Breeding hemp, a cross-pollinated plant species, has its own specific characteristics and is complicated by the search for parental components that ensure high productivity (heterosis) for one or more traits in successive generations. Inbred (self-pollinated) lines are often used as the basis for creating hybrids. Inbred lines used in crosses are subject to continuous improvement through selection or other methods [9]. The main feature of inbreeding that interests breeders is the reduction or loss of heterozygosity. Cross-pollinated crops that are heterozygous generally have greater adaptability to environmental factors than homozygous crops. However, self-pollination and the transition to homozygosity are accompanied by inbreeding depression, which disappears as a result of crosses.

In addition, it has been experimentally confirmed that some hemp traits (particularly biochemical traits) are more strongly influenced by environmental factors than others. Therefore, establishing their genetic control and the patterns by which genotypes are implemented in phenotypes in relation to environmental influences, as well as testing the crop under different environmental conditions, is an integral part of breeding programs to create new varieties [10]. Assessing the variance of breeding traits due to environmental factors and "genotype × environment" interactions has helped identify traits that are almost entirely genetically determined, such as the length of the growing season and the accumulation of tetrahydrocannabinol and cannabidiol. Traits that are strongly influenced by environmental factors and "genotype × environment" interactions include seed yield, plant height and water consumption [10]. The level of oil accumulation in hemp seeds and their fatty acid composition mainly depend on the genotype (variety) and air temperature after the flowering phase of the plants [11–13]. These quantitative traits are usually more variable than qualitative ones since hereditary differences are determined by many genes (polygenic) with a significant impact on trait development and different types of interaction between them. Quantitative traits are also highly dependent on external factors (environmental conditions).

The above features confirm the importance of studying the combinational ability of crossing components and identifying additive and non-additive genes. This allows us to develop strategies and tactics for attracting source forms based on selection by phenotype (manifested in specific environmental conditions) or genotype, with the aim of creating highly productive hybrids. When selecting parental pairs to create hybrids, it is necessary to predict not only the possibility of heterosis, but also ensure the hybrid inherits the desired traits and properties for economic value. The main requirement for the parental forms is that they have a high combining ability. The combinational value of any parental form can be expressed in two ways: as the average heterosis value for all hybrid combinations, or as the value for a particular cross. The former characterizes total combining ability (TCA) and is mainly determined by the additive effects of a given parental form's genes, while the latter characterizes specific combining ability (SCA) and is mainly determined by the non-additive effects of genes [14].

The aim of the research is to establish the peculiarities of the effects of TCA and SCA variances of maternal components, and to test varieties of intervarietal and linear-varietal hybrids of monoecious hemp based on seed productivity and oil content. The research also aims to determine the prevalence of additive or non-additive gene effects, identify components with the highest breeding value and forecast the effectiveness of selections in hybrid populations.

Research materials and methods

The research was conducted from 2021 to 2024 at the Institute of Bast Crops of the NAAS of Ukraine in Hlukhiv, Sumy Region (geographical coordinates: 51°39′ N and 33°59′ E). The effects of TCA and SCA variances were determined using the complete topcross system according to the methodology of P. P. Litun and M. V. Proskurnin [14]. The following varieties of domestic breeding were used as maternal forms: 'YUSO 31', 'Demetra', 'Artemida', 'Aphrodita', 'Harmoniia', 'Hlesiia', 'Hlukhivski 33' and 'Hlukhivski 51', as well as their self-pollinated lines of the fourth generation (I_4). These were crossed in isolated nurseries with three test varieties, 'Hliana' (tester 1), 'Aphina' (tester 2) and 'Mykolaichyk' (tester 3), which had different levels of hybridization combining ability. The male flowers on the maternal plants were sterilised using the gametocides 2-chloroethylphosphonic acid (0.6% aqueous solution) and/or dibutyl phthalate (2% aqueous suspension) as they appeared.

The F_1 offspring were cultivated in an evaluation nursery with a plant nutrition area of 30 × 5 cm (1 m² plot area, six replications) and analyzed for the primary breeding traits that determine the suitability of the material for creating seed-oil varieties for economic use: inflorescence length and weight of a thousand seeds (indirect traits), as well as seed weight per plant and oil content in seeds (direct traits). The oil content of the seeds was determined in six replicates using a Soxhlet extractor with an organic solvent (diethyl ether) and by measuring the weight of the degreased residue.

During the years of research, weather conditions were characterized by variability and deviations from long-term averages, which had a positive or negative impact on the successful growth and development of hemp. Conditions in 2022 were generally favorable for high yields of this crop, whereas in 2023 they were only partially favorable. The average daily air temperature in 2024 was significantly higher than the long-term average (18.2 °C during the growing season, compared to 16.0 °C), particularly in June, July and August when the hemp flowered and formed seeds. However, there was insufficient precipitation (221 mm in 2023 and 190 mm in 2024 compared to a long-term average of 317 mm). Sufficient atmospheric moisture was observed in April, June and July in these years. August was particularly dry. These conditions enabled a comprehensive evaluation of the hybrids in terms of their breeding trait expression in changing agroecological conditions.

Results and discussion

Topcross intervarietal and linear-varietal hybrids in F_1 were characterized by variability in breeding traits that determine high seed productivity and oil content. Inflorescence length ranged from 50 cm (I_4 'Hlukhivski 33' / 'Hliana') to 172 cm (I_4 'Demetra' / 'Aphina'), seed weight per plant from 4.9 g (I_4 'Harmoniia' / 'Mykolaichyk') to 64.6 g (I_4 'Aphrodita' / 'Aphina'), and weight of a thousand seeds from 14.0 g (I_4 'Harmoniia' / 'Hliana') to 22.1 g (I_4 'Aphrodita' / 'Aphina'), and oil content in seeds ranged from 30.5% ('Artemida' / 'Hliana' and I_4 'Artemis' / 'Hliana') to 43.5% ('Demetra' / 'Aphina'). In terms of the level of trait manifestation, first generation hybrids usually exceeded the original parental forms. Based on analysis of variance using the F-test (R. A. Fisher), significant influences of the sources of variance of the hybrids, the maternal forms and the test varieties on the variability of the quantitative breeding traits of hemp plants were established. This provided grounds for establishing the TCA and SCA of the studied maternal components (varieties and their self-pollinated lines) and the testers.

In accordance with the average deviation from the overall average of all hybrids obtained through crosses involving a particular tester, the value of each maternal form was determined by the effects of TCA in the first generation, which differed significantly in three-tester crosses.

Significant (at the 0.05 level) positive effects of TCA were found in the following maternal components:

– 'Demetra' (g_i = 14.06), I_4 'Demetra' (21.40), 'Aphrodita' (12.06), I_4 'Aphrodita' (10.40), 'Harmoniia' (9.06) and I_4 'Hlukhivski 51' (20.06) for inflorescence length;

– I_4 'Artemida' (g_i = 5.11), 'Aphrodita' (13.75), I_4 'Aphrodita' (15.15) and I_4 'Hlesiia' (9.61) for the trait of seed weight per plant;

– I_4 'Demetra' (g_i = 2.39), I_4 'Artemida' (1.03), 'Aphrodita' (1.53), I_4 'Aphrodita' (3.23) and I_4 'Hlukhivski 51' (2.53) for the weight of a thousand seeds;

– I_4 'YUSO 31' (g_i = 1.13), I_4 'Demetra' (3.76), 'Aphrodita' (0.90), I_4 'Aphrodita' (2.90) and I_4 'Hlukhivski 51' (0.86) for oil content (Table 1).

Table 1

Estimates of the TCA (g_i) effects on the breeding traits of maternal components of intervarietal and linear-varietal hybrids of industrial hemp

Variety, self-pollinated line	Traits			
	Inflorescence length, cm	Seed weight, g	Weight of 1000 seeds, g	Oil content, %
'YUSO 31'	−1.27	−3.35	−1.07	−1.00
I_4 'YUSO 31'	−8.27	2.91	−0.54	1.13
'Demetra'	14.06	−2.82	−0.37	−2.40
I_4 'Demetra'	21.40	−4.68	2.39	3.76
'Artemida'	−2.27	2.81	−0.27	−1.10
I_4 'Artemida'	−3.27	5.11	1.03	−0.94
'Aphrodita'	12.06	13.75	1.53	0.90
I_4 'Aphrodita'	10.10	15.15	3.23	2.90
'Harmoniia'	9.06	−10.02	−3.91	0.30
I_4 'Harmoniia'	4.73	2.11	−3.67	0.53
'Hlesiia'	−18.60	−6.75	−1.91	−0.14
I_4 'Hlesiia'	2.06	9.61	−0.17	−0.84
'Hlukhivski 33'	−20.27	−10.35	−0.24	−1.67
I_4 'Hlukhivski 33'	−22.60	−8.95	0.53	−1.27
'Hlukhivski 51'	−17.27	−6.72	0.93	−1.04
I_4 'Hlukhivski 51'	20.06	2.18	2.53	0.86
$LSD_{0.05}$	5.79	3.18	0.97	0.73

Thus, 'Aphrodita' and I_4 'Aphrodita' had the highest TCA for all the studied traits, as well as I_4 'Demetra' and I_4 'Hlukhivski 51' (except for seed weight). High negative effects of the TCA were found to be significant at the 0.05 level in the varieties 'YUSO 31', 'Hlesiia', 'Hlukhivski 33', I_4 'Hlukhivski 33' and 'Hlukhivski 51'. These varieties are not desirable for inclusion in crosses to create initial breeding material for seed and oilseed production for economic use. Self-pollinated lines were characterized by higher positive effects of TCA and less frequently showed negative values than their original varieties, indicating their significant value in combination breeding and the benefits of line-variety hybridization over intervening hybridization. It can be assumed that new polygenic complexes formed in this case, determining the high combinational ability.

Tester 2 exhibited high positive effects of TCA (significant at the 0.05 level) for all traits studied. Tester 1 exhibited high negative effects (significant except for seed weight), and Tester 3 exhibited mostly medium positive effects (insignificant). See Table 2 for details.

Table 2

Estimates of the TCA (g_i) effects of the testers

Variety, self-pollinated line	Characteristics			
	Inflorescence length, cm	Seed weight, g	Weight of 1000 seeds, g	Oil content, %
Tester 1	−14.60	−6.42	−0.48	−3.42
Tester 2	10.96	9.69	0.36	2.21
Tester 3	3.64	−3.27	0.12	1.21
$LSD_{0.05}$	10.34	7.05	0.34	2.03

The following maternal components have a high SCA variances (above average):

– I_4 'YUSO 31' (σs_i^2 = 57.43), I_4 'Demetra' (139.55), 'Aphrodita' (90.80), I_4 'Aphrodita' (93.57), I_4 'Hlesiia' (233.23) and 'Hlukhivski 33' (103.53) (on the basis of inflorescence length);

– 'Artemida' (σs_i^2 = 44.36), 'Aphrodita' (30.99), I_4 'Aphrodita' (27.86), I_4 'Harmoniia' (78.29), I_4 'Hlesiia' (39.18) and I_4 'Hlukhivski 51' (31.82) for seed weight per plant;

– 'YUSO 31' (σs_i^2 = 0.03), 'Harmoniia' (0.05), I_4 'Hlesiia' (0.05), 'Hlukhivski 33' (0.10) and I_4 'Hlukhivski 33' (0.04) by weight per thousand seeds;

– 'Artemida' (σs_i^2 = 1.93) and I_4 'Artemida' (2.10) by oil content (Table 3).

Table 3

SCA (σs_i^2 variances) of maternal components of intervarietal and linear-varietal hybrids of industrial hemp by breeding traits

Variety, self-pollinated line	Traits			
	Inflorescence length, cm	Seed weight, g	Weight of 1000 seeds, g	Oil content, %
'YUSO 31'	6.71	7.58	0.03	0.01
I_4 'YUSO 31'	57.43	3.29	0.02	0.01
'Demetra'	13.71	5.39	0.02	0.04
I_4 'Demetra'	139.55	4.15	0.01	0.07
'Artemida'	11.53	44.36	0.01	1.93
I_4 'Artemida'	17.82	9.31	0.01	2.10
'Aphrodita'	90.80	30.99	0.01	0.01
I_4 'Aphrodita'	93.57	27.86	0.01	0.01
'Harmoniia'	7.88	1.17	0.05	0.01
I_4 'Harmoniia'	34.05	78.29	0.01	0.03
'Hlesiia'	15.61	3.25	0.01	0.04
I_4 'Hlesiia'	233.23	39.18	0.05	0.20
'Hlukhivski 33'	103.53	7.61	0.10	0.01
I_4 'Hlukhivski 33'	13.94	6.86	0.04	0.03
'Hlukhivski 51'	48.76	6.43	0.02	0.20
I_4 'Hlukhivski 51'	10.12	31.82	0.01	0.01
Average	56.14	19.22	0.03	0.29

Thus, 'Hlesiia' had the best SCA for three traits, as did 'Artemis', 'Aphrodita', I_4 'Aphrodita' and 'Hlukhivski 33' for two traits. The maternal components of 'Demetra', 'Hlesiia' and 'Hlukhivski 51' had values of SCA variances that were lower than average for all four of the studied traits. In some crosses, the varieties had a higher SCA than their original forms, while in others, the self-pollinated lines did. The 'ideal' component of the crosses was 'Aphrodita' and its fourth-generation self-pollinated line, which had high positive TCA and high SCA variances.

According to the traits of inflorescence length, high (above the average value) SCA variances had tester 2 (σs_i^2 = 163.9) and tester 3 (150.63), seed weight – tester 2 (52.23), weight of a thousand seeds – tester 1 (0.06) and tester 2 (0.05), oil content – tester 1 (1.05). Thus, tester 2 (variety 'Aphina') has a high positive TCA and SCA and can be successfully used as a pollinator in hemp crosses (see Table 4).

Table 4

SCA (variances σs_i^2) of testers

Variety, self-pollinated line	Traits			
	Inflorescence length, cm	Seed weight, g	Inflorescence length, cm	Oil content, %
Tester 1	16.84	15.10	0.06	1.05
Tester 2	163.60	52.23	0.08	0.52
Tester 3	150.63	18.76	0.02	0.54
Medium	110.39	28.70	0.05	0.70

Having analysed the SCA variances, we can conclude that it is advisable to approach the development of breeding material for a particular economic use – in this case, seeds and oilseeds – as well as the prediction of trait manifestation, breeding characteristics and genetics, in a differentiated manner, taking SCA into account. Maternal components should have either a high TCA and a high SCA or a medium TCA and a high SCA. Depending on the purpose of creating the original breeding material, high SCA may be required for only one desired trait. Low and medium SCA variances indicate that the form with such indicators stably transmits the studied trait to hybrids, while high SCA variances indicate that a large proportion of heterotic hybrids can be predicted in the offspring.

By comparing the effects of the TCA and SCA variances, it was found that in the analysed crosses the additive effects of genes prevail in terms of thousand-seed weight and oil content (this indicates the expediency of phenotype selection), and non-additive effects – in terms of inflorescence length and seed weight (this indicates the need for genotype selection). This pattern is fully consistent with the fact that the expression of the last two traits depends on the area of plant nutrition, i.e. the influence of environmental factors on the implementation of the genotype is pronounced. Non-additive effects of genes are more common in intervarietal crosses, while additive effects are more common in hybrid combinations involving self-pollinated lines. If the studied traits are dominated by additive effects of genes determined by the joint action of alleles of one locus, and the phenotypic expression of the trait value mainly reflects its genotypic expression, then the selection will be effective, and the use of this maternal component in breeding, in particular hemp, will be appropriate (Table 5).

Table 5

The prevalence of additive (A) or non-additive (N) effects of genes by breeding traits in maternal components

Variety, self-pollinated line	Traits			
	Inflorescence length, cm	Seed weight, g	Inflorescence length, cm	Oil content, %
'YUSO 31'	N	N	A	A
I_4 'YUSO 31'	N	N	A	A
'Demetra'	A	N	A	A
I_4 'Demetra'	N	A	A	A
'Artemida'	N	N	A	N
I_4 'Artemida'	N	N	A	N
'Aphrodita'	N	N	A	A
I_4 'Aphrodita'	N	N	A	A
'Harmoniia'	A	A	A	A
I_4 'Harmoniia'	N	N	A	A
'Hlesiia'	A	A	A	A
I_4 'Hlesiia'	N	N	A	A
'Hlukhivski 33'	N	A	A	A
I_4 'Hlukhivski 33'	A	A	A	A
'Hlukhivski 51'	N	A	A	A
I_4 'Hlukhivski 51'	A	N	A	A

It is important to establish the characteristics of the components of crosses for TCA and SCA, the ratio of their effects and variances in F_1, and the type of gene action (additive or non-additive), in order to predict the manifestation of heterosis and the genetic characteristics of the source material. This information is also useful for determining the effectiveness of selections in hybrid populations based on quantitative traits, and for justifying further breeding directions, as has been proven on the example of many agricultural crops [15–17], including industrial hemp [18]. When using the hybridisation method, breeders carry out a large number of cross combinations, but successful hybrids are rare. Using parental forms with high TCA in crosses increases efficiency [14].

Intervarietal hybridisation remains the main method of creating hemp starting material and, subsequently, varieties. However, the offspring of such hybrids are usually heterogeneous in terms of breeding trait expression, necessitating long-term improvement selection. In contrast, with linear-varietal hybridisation, the offspring are more homogeneous and stable in terms of the expression of breeding traits, and the need for improvement selection is minimal. The effectiveness of incorporating self-pollinated lines into crosses has been demonstrated by a number of competitive industrial hemp varieties [19]. At the same time, the monoecious form of hemp guarantees high seed productivity and oil content [20].

Conclusions

Studying cannabis varieties and their self-pollinated lines for their combining ability as components of intervarietal and linear-varietal crosses revealed significant differentiation in terms of the effects of TCA and SCA variances. The highest TCA was observed in the maternal forms of 'Aphrodita', 'I_4 Aphrodita', 'I_4 Demetra' and 'I_4 Hlukhivski 51', as well as in the tester variety 'Aphina'. The most effective cross components were 'Aphrodita' and its self-pollinated line I_4. Comparing the effects of TCA and SCA variances revealed that the additive effects of genes prevail in terms of thousand-seed weight and oil content, indicating the feasibility of selecting for phenotype. Conversely, non-additive effects prevail in terms of inflorescence length and seed weight, indicating the need for genotype selection. To increase seed productivity and oil content through combination breeding, it is advisable to use linear-varietal crosses where the maternal components have either high TCA and high SCA or medium TCA and high SCA. For synthetic populations, we recommend lines with high or medium TCA and only low SCA.

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Міщенко С. В.[1, 2 *], Кабанець В. М.[2], Кириченко Г. І.[2], Марченко Т. Ю.[3, 4], Лайко Г. М.[2] Комбінаційна здатність сортів і самозапилених ліній промислових конопель насіннєво-олійного напряму використання в системі топкросів. *Plant Varieties Studying and Protection*. 2025. Т. 21, № 1. С. 39-45. https://doi.org/10.21498/2518-1017.21.1.2025.327500

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Мета. Установити особливості ефектів загальної комбінаційної здатності (ЗКЗ) та варіанс специфічної комбінаційної здатності (СКЗ) материнських компонентів і сортів-тестерів міжсортових та лінійносортових гібридів однодомних конопель за ознаками насіннєвої продуктивності й олійності; визначити адитивні чи неадитивні ефекти генів і виділити компоненти, які мають найвищу селекційну цінність для прогнозування ефективності доборів у гібридних популяціях. **Методи.** Комбінаційну здатність визначали в системі повних топкросів. Материнськими формами слугували сорти 'ЮСО 31', 'Деметра', 'Артеміда', 'Афродіта', 'Гармонія', 'Глесія', 'Глухівські 33', 'Глухівські 51' та їхні самозапилені лінії четвертого покоління, які схрещували з сортами-тестерами 'Гляна', 'Афіна' та 'Миколайчик' (загалом 48 варіантів гібридів). Результати інтерпретували за середнім арифметичним, F-критерієм (Р. А. Фішера), найменшою істотною різницею та ранжували. **Результати.** Дослідження сортів конопель та їхніх самозапилених ліній як материнських компонентів схрещувань за параметрами комбінаційної здатності показало значну диференціацію за ефектами ЗКЗ (від –22,60 до 21,40 за ознакою довжини суцвіття, від –10,35 до 15,15 за масою насіння, від –3,91 до 3,23 за масою тисячі насінин та від –2,40 до 3,76 за ознакою вмісту олії) та варіансами СКЗ (6,72–233,23; 3,25–78,29; 0,01–0,10 і 0,01–2,10 відповідно). Найвищу ЗКЗ мали материнські форми 'Афродіта', I_4 'Афродіта', I_4 'Деметра' й I_4 'Глухівські 51', а також сорт-тестер 'Афіна'. На основі порівняння ефектів ЗКЗ і варіанс СКЗ встановлено, що найліпшими компонентами для схрещувань є сорт 'Афродіта' та його самозапилена лінія I_4. **Висновки.** У проаналізованих схрещуваннях адитивні ефекти генів переважають за ознаками маси тисячі насінин і вмісту олії (що свідчить про доцільність проведення доборів за фенотипом), а неадитивні – за довжиною суцвіття та масою насіння (це доводить необхідність доборів за генотипом). Для комбінаційної селекції на підвищення насіннєвої продуктивності й олійності доцільно використовувати лінійносортові схрещування, водночас материнські компоненти повинні мати високі ЗКЗ та СКЗ або середню ЗКЗ і високу СКЗ.

Ключові слова: *Cannabis sativa L.; селекція; гібрид; загальна та специфічна комбінаційна здатність; продуктивність; гетерозис; адитивні ефекти генів; неадитивні ефекти генів.*

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