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Evaluation of Performance and Estimation of Combining Ability in Flax Crop by Using Factorial Mating Design

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ABSTRACT

A field experiment was carried out at agricultural field in al-Alam the coordinates of (N 43.835672 - E 34.777260) district/Salahuddin Governorate during (2021 - 2022) A.D season to study, with the aim of evaluating the genotypes and positions in a crop using factorial mating and in these eight flax genotypes were used in this study it is (Sakha 1, Sakha 2, Sakha 3, Sakha 5, Sakha 6, Giza 8, Syrian local and Thorshansity72). and the first parents (males) and the remaining three (females) were chosen to obtain (15) hybrids If the selection was made on the basis of the genetic base of the genotypes, planted randomly and at different dates in the field, and the experiment was applied using a RCBD and with three replications, results and statistical analysis showed the superior genotype (Sakha1) for the traits of the number of capsules per plant (65.66) and the number of seeds in the capsule (9.79) seed capsules^{-1} and the yield of the individual plant (2.69) gm plant^{-1} and the total yield (539.37) kg h^{-1} and superior hybrid (Sakha1×Syrian local), which significantly outperformed the traits of the number of capsules per plant (67.03) plant capsule^{-1}, the number of seeds in the capsule (9.77) seed capsule^{-1} and the individual plant yield (2.64) g plant^{-1} and the total yield (529.12) kg h^{-1}. The best parents in the effects of general ability is Genotype (Sakha1) for the traits of the number of vegetative branches, number of capsules per plant, number of seeds per capsule, and the superiority of the hybrid (Sakha1 × Syrian local) in the number of capsules per plant, number of seeds in the capsule, number of seeds per capsule, single plant yield and total and hybrid. Thus, it can be recommended to plant the varieties (Sakha1) (Sakha2) and (Sakha5) because their performance is distinguished in most of the traits under study.

تقييم الاداء وتقدير المقدرة الاتحادية في محصول الكتان *Linum usitatissimum* L. باستخدام التهجين العاملي

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الخلاصة

نفذت تجربة حقلية في الموسم الزراعي (2021 - 2022) في حقول احد المزارعين في منطقة العلم، بهدف تقييم الاباء والمقدرة الاتحادية في محصول الكتان باستعمال التهجين العاملي، استعملت في هذه الدراسة ثمانية تراكيب وراثية من الكتان (سخا1 و سخا2 و سخا3 و سخا5 و سخا6 و جيزة8 و سوري و بولوني) واختيرت الاباء الخمسة الاولى (ذكور) والثلاثة الباقية (اناث) للحصول على (15) هجيناً فردياً عاملياً، وطبقت التجربة باستخدام تصميم القطاعات العشوائية الكاملة وبثلاث مكررات، ودرست الصفات التالية (عدد الايام للتزهير وارتفاع النبات وعدد الافرع الخضرية وعدد الكبسولات بالنبات وعدد بذور الكبسولة و وزن 1000 بذرة وحاصل النبات الفردي والحاصل الكلي)، حيث تفوقت الاباء معنوياً ومنها الاب (سخا1) لصفات عدد الكبسولات بالنبات (65.66) كبسولة نبات$^{-1}$ وعدد البذور في الكبسولة (9.79) بذرة نكبسولة$^{-1}$ وحاصل النبات الفردي (2.69) غم نبات$^{-1}$ والحاصل الكلي (539.37) كغم ه$^{-1}$ وهذا يدل على أن هذه الاب يمتلك جينات وراثية يمكن استغلالها في تحسين هذه الصفات، وهذا ما تم ملاحظتة في الهجين (سخا1 × سوري) الذي تفوق معنويا في صفات عدد الكبسولات بالنبات (67.03) كبسولة نبات$^{-1}$ وعدد البذور في الكبسولة (9.77) بذرة نكبسولة$^{-1}$ وحاصل النبات الفردي (2.64) غم نبات$^{-1}$ والحاصل الكلي (529.12) كغم ه$^{-1}$. أنَّ أفضل الآباء في تاثيرات المقدرة العامة هو الأب (1) لصفات عدد الافرع الخضرية وعدد الكبسولات بالنبات وعدد البذور بالكبسولة وحاصل البذور الفردي والكلي، وافضل الهجن تثير للمقدرة الخاصة على الاتحاد هو الهجين (سخا3 × سوري) في المدة إلى أزهار 50% والهجين (سخا2 × جيزة8) لارتفاع النبات والهجين (سخا6 × جيزة8) في عدد البذور بالكبسولة والهجين (سخا6 × سوري) في وزن 1000 بذرة وحاصل النبات الفردي والهجين (سخا6 × جيزة8) في الحاصل الكلي للبذور، وبذلك يمكن التوصية بزراعة الاصناف (سخا1) و(سخا2) و(سخا5) لكون ادائها متميزاً في اغلب الصفات قيد الدراسة.

الكلمات المفتاحية: اشعة كاما، الكتان، التراكيب الوراثية، مكونات الحاصل، صفات النمو.

INTRODUCTION

Flax *Linum usitatissimum* L. crop is a dual-purpose product that is of obtaining oil or fiber or both, and its seeds are classified among the important functional foods due to their abundance of many nutrients compared to other vegetable oils, such as unsaturated fatty acids and protein. Therefore, it is unique among oilseeds for its high Its high content of fixed oils ranges from (30-45)% of the oil, which constitutes about 57% of the total fatty acids (Simmons et al., 2011). The cultivated area of flax in the world for the year (2019) reached about (15.128 million hectares) only and produced about (501.14) million tons of seeds, the total annual production (STATA FAO, 2019). In Iraq, the cultivated areas of this crop are almost It is non-existent, for many reasons, the most important of which is the concentration in the production of strategic winter crops, Plant breeders this crop aims to develop the inputs to produce promising varieties that will outperform the existing ones in yield and quality traits. Accordingly, plant breeders focused their interests in finding new varieties with high production specifications as well as good fiber properties by using different mating systems, including the cross-breeding system.

The factor proposed by Comstock and Robinson, 1948) as this type of cross-breeding is one of the important systems in obtaining genetic variations that may lead to genetic improvements as it includes making all possible crosses between two different groups of parents, group (A) is used as male parents and group (B) is used as mothers, It also gives solid and reliable estimates of the components of genetic variance. Many researchers have been interested in this mating system and studied by Kumari (2015), Chaure et al. (2016), Dhirhi and Mehta (2019), Rastogi and Shukla (2019), the general combining ability can be known. It is the average performance of a strain in a group of its hybrids that is under the control of the additional genetic action of genes, and gives a general indication of the variety about its ability to hybrid union, while the special combining ability represents a deviation of

a specific hybrid mean from the average general combining ability of the two strains in the hybrid, which is under the control of genetic action Non-additional genetics, (Al-Jubouri, 2013), Among the previous studies that dealt with combining ability are the study of El-Refaie et al. (2012), Wadikar et al. (2019), and Ahmad et al. (2021).

The aim of this study is to assess the performance of genotypes with their crosses, in addition to identifying the crosses that It can be effective and distinctive for its multiplication to be the nucleus of promising varieties and has a high possibility of production and of good quality in the future.

MATERIALS AND METHODS

A field experiment was conducted in the fields of a farmer in the Al-Alam area, northeast of the city of Tikrit, Salah al-Din Governorate, according to its coordinates. The experiment included conducting all possible global crosses between two different groups of parents, the details of which are shown in Table (1), and the genotypes were selected: Sakha 1, Sakha 2, Sakha 3, Sakha 5, and Sakha 6. (male) and genotypes were selected Giza 8, Syrian local and Thorshansity72 (female),The seeds were sown in the field on 15/11/2021 with three dates to ensure the compatibility of the flowers for the largest possible period.

Table (1) origin, lineage and source of the genotypes used in the study

No	Genotype name	Origin	lineage	source
1	Sakha 1	Egyptian	I.1485 x Bombay	College of Agriculture, Cairo University
2	Sakha 2	Egyptian	Hera × 1.123	College of Agriculture, Cairo University
3	Sakha 3	Egyptian	(Belinka (2E) × 1.2096)	College of Agriculture, Cairo University
4	Sakha 5	Egyptian	(Belinka (R3) ×1.2569	College of Agriculture, Cairo University
5	Sakha 6	Egyptian	S.420 x bombay (I. USA)	College of Agriculture, Cairo University
6	Giza8	Egyptian	(Giza6 × Senta Catalina	College of Agriculture, Cairo University
7	Syrian	Syrian	Imported	College of Agriculture, Salah adin University
8	Thorshansity72	Poloni	Imported	College of Agriculture, Salah adin University

All soil and crop service operations were conducted according to the recommendations of the used reproductive system. Parents and hybrids were harvested at full maturity and the seeds were saved for planting in the winter season (2021-2022). Triple superphosphate fertilizer was added at an amount of 80 kg h^{-1} in the form of one batch when the ground was prepared and nitrogen fertilizer was added Urea $(NH_2)_2$ CO (46%). Nitrogen 200 kg h^{-1} in two batches, the first one month after planting and the second before flowering (Hassan and Shaker, 2013), and after preparing the experimental land by tilled and smoothing it, and each experimental unit was designed with dimensions (2 x 1) m and a distance of (0.50) m a line and a line, and the distance between one plant and another (0.10) m. The experiment was applied using Randomized Complete Block Design with three replications.

Data were collected, it was statistically analyzed for the traits studied, the evaluation of parents, their hybrids, and the Public and private ability to unite in the experiment according

to the design used, according to what was mentioned by (Al-Rawi and Khalaf Allah, 2000). Calculated, and the genetic statistical analysis was carried out according to the design of the factorial mating proposed by Comstock and Robinson (1948) and that the equation of the equation of the mathematical model for the analysis of combining ability is as follows:

$$Y_{ijk} = \mu + R_k + M_i + F_j + (mf)_{ij} + e_{ijk}$$

Variance of gca2 and sca2 words was estimated for each hybrid as reported by Singh and Chaudhry (1987).

Effect of General Ability to Union for Each male: $mi = \bar{yi}.. \_ \bar{y}...$

Effect of General Ability to Union for Each female: $fj = \bar{y}.j. - \bar{y}...$

Effect of General Ability to Union for Each hybrid: $mfij = \bar{yij}. - \bar{yi}.. - \bar{y}.j. + \bar{y}...$

Significance of the effects for general and specific power was tested by relying on the equations proposed by Singh and Chaudhary (1987).

S.E. ($\hat{gi}$) = $\sqrt{\frac{2\sigma^2 e}{r}}$ male S.E. ($\hat{gi}$) = $\sqrt{\frac{4\sigma^2 e}{r}}$ female S.E = $\sqrt{4\sigma^2 e/r}$ hybrid

Data were analyzed for statistical and genetic analysis using SAS and Excel (2010).

RESULTS AND DISCUSSION

Table (2) shows the results of the analysis of variance for the genotypes (parents and hybrids) for the studied traits, and it was noted that there are significant differences between the genotypes at the probability level (1%) for all traits, and this is an indication of the presence of genetic differences between the genotypes and thus it is possible to study the general ability These results are in agreement with those of Chaure et al. (2018), Dhirhi and Mehta (2019), and Rastogi and Shukl (2019).

Table (2) Analysis of variance represented by mean squares of growth and yield traits and their components

S.O.V	Traits D.f	Duration to 50% flowering (day)	Plant height (cm plant $^{-1}$)	Number of vegetative branches (plant branch $^{-1}$)	Number of capsules (plant capsule $^{-1}$)	Number of seeds (seed capsule $^{-1}$)	seeds 1000 weight (g)	Seed yield (gm plant1-)	Duration to 50% flowering (day)
Replications	2	0.105	1.242	0.003	3.448	0.003	0	0.001	72.974
Genotypes	22	** 7.3	** 103.4	** 1.1	**104.0	** 1.2	** 0.433	** 0.231	** 9286.
Error	44	0.318	0.635	0.003	1.851	0.002	0.001	0.002	69.811

(**) and (*) are significant at 1% and 5% probability levels, respectively

Table (3) shows the values of the averages of the parents and their hybrids for the traits studied, as the early flowering trait is one of the most important phenotypic traits affecting the yield of the plant. It was significant and in the desired direction is the genotype (2) is the genotype (2), and therefore he is considered the earliest in flower (50%) at 109.19 days, which differed significantly from the rest of the genotypes except for the genotype (6), while the genotype (4) was later than the rest of the genotypes, reaching 114.65 days, we also note

the superiority of the hybrid (2×7) by giving it the least number of days for flowering, which amounted to 108.55 days, followed by the hybrid (2×8) and (2×6), which gave the least flowering period of 109.06 and 109.29 days, respectively, while the hybrid (4×7) The hybrids were the most late and achieved the longest period from planting until 50% flowering, amounting to 113.08 days, and the rest of the hybrids were intermediate between them. This is due to the variation in the genetic structures in the early flowering of the genetic factors that affect this trait and the speed of growth as a result of cell division (Elayan et al., 2015), These results were consistent with the results of (AL- Raheem and Anees, 2024). Regarding the trait of plant height, which is an important trait in the flax plant, because its increase leads to an increase in the percentage of leaves and an increase in the efficiency of the photosynthesis process. For its efficiency in collecting the dry matter reflected from the increase in the percentage of leaves as a result of an increase in the rate of photosynthesis or attributed to the nature of the genetic factor, while the genotype (3) gave the lowest average of 68.23 cm, and the hybrids (3x7) outperformed all the hybrids by giving it the highest value 81.24 cm, followed by the two hybrids (3×8) and (3×6), which gave the highest plant height of 80.87 and 80.34 cm, respectively, and who differed significantly from the hybrid (4×8), which gave the lowest average plant height of 63.92 cm, when comparing the general average of the crosses, which amounted to 73.30 cm, with the general average of the parents, which reached 71.11 cm, we find that it was lower in height, which indicates that the crosses did not respond towards increasing plant height.

The trait of the number of vegetative branches is one of the important traits that has to do with the increase in the total seed yield in the flax crop and its relation to the other components of the yield, meaning that the more this trait will have the greater number of capsules in the plant, and this leads to an increase in the yield, as the results of the same table indicated that there are significant differences among the averages of the genotypes, the genotype (7) gave the highest average of 3.60 branches plant^{-1}, but the genotype (3) scored the lowest number of vegetative branches, which was 2.57 branches plant^{-1}, and the hybrid (1×7) was also given the highest average number of branches that reached 3.35 branches plant^{-1}, which It did not differ significantly from the hybrid (2×7) that gave 3.34 branches plant^{-1}, and the superiority of the hybrid (1×7) is attributed to having at least one high genotype in this trait and the transfer of its genes to the hybrids resulting from it.

Table (3): Arithmetic averages of genotypes (parents + hybrids) for the studied traits

Traits Genotypes	Duration to 50% flowering (dav)	Plant height (cm plant $^{-1}$)	of vegetative branches (plant	of capsules (plant	Number of seeds (seed capsule	seeds 1000 weight (g)	Seed yield (gm plant1-)	Seed yield (kg h^{-1})
1	110.02	73.65	3.33	65.66	9.79	6.69	2.69	539.37
2	109.19	74.27	3.1	62.72	8.93	6.09	2.09	419.64
3	110.11	68.23	2.57	57.49	9.44	6.4	1.92	385.14
4	114.65	86.46	3.06	59.46	9.59	7.25	2.34	469.49
5	110.81	79.79	3.06	49.48	9.53	6.7	1.96	392.21
6	109.26	79.08	2.99	57.75	8.9	5.49	1.9	381.69
7	110.38	79.28	3.6	63.58	9.77	6.88	2.37	475.03
8	110.81	71.41	2.96	58.98	9.64	6.63	1.91	382.56
Genotypes average	110.65	76.52	3.083	59.39	9.44	6.50	2.14	430.64
Hybrids								
6 X 1	110.46	69.65	3.23	65.56	9.74	6.53	2.56	512.91
7 X 1	109.52	69.99	3.35	67.03	9.77	6.52	2.64	529.12
8 X 1	110.05	71.09	3.34	66.25	9.72	6.65	2.57	515.77
6 X 2	109.29	75.15	2.9	64.73	8.79	5.93	2.03	401.12
7 X 2	108.55	77.49	2.92	65.34	8.73	5.98	1.94	389.91
8 X 2	109.06	76.87	2.94	64.23	8.74	6.02	1.96	393.61
6 X 3	112.26	80.34	2.60	54.81	9.36	6.3	1.88	378.42
7 X 3	112.54	81.24	2.78	56.35	9.35	6.24	1.93	382.99
8 X 3	111.86	80.87	2.63	55.56	9.34	6.19	1.91	383.89
6 X 4	112.16	64.63	2.88	55.91	8.85	6.83	2.19	438.97
7 X 4	113.08	64.79	2.83	54.39	8.87	6.68	2.15	430.38
8 X 4	113.03	63.92	2.84	54.67	8.89	6.72	2.21	442.95
6 X 5	110.1	74.53	2.87	49.73	7.85	6.31	1.81	363.67
7 X 5	110.13	74.48	2.85	50.27	7.86	6.49	1.87	375.49
8 X 5	109.96	74.56	2.94	49.89	7.49	6.43	1.89	378.17
Hybrids average	110.80	71.11	2.83	52.91	8.45	6.52	2.00	401.93

The traits of the number of capsules per plant is one of the important traits that contribute significantly to determining the yield of seeds in the plant, and from the same table it becomes clear the results of the arithmetic averages of the parents, where the genotype (1) scored significantly by giving the highest average of the trait amounted to 65.66 plant capsules $^{-1}$, and it differed significantly with the rest of the parents, followed by Genotype (7), who gave an average of 63.58 capsules plant^{-1}. It is worth noting that the superiority of parents (1) and (7) in increasing the number of capsules is the result of the increase of these two parents in the traits of the number of vegetative branches, as they gave the highest average of the branches reached (3.33 and 3.60) capsules plant^{-1}, respectively, and in the averages of the hybrids, we notice the superiority of the hybrid (1×7) by giving it the highest average for the trait that reached 67.03 capsules plant^{-1} with a significant difference with the rest of the hybrids, while it did not differ significantly with the hybrid (1×8). Which averaged 66.25 capsules plant^{-1}.

It is evident from the presentation of the arithmetic averages of the parents and hybrids shown in Table (3) for the traits of the number of seeds in the capsule, where the genotype (1) had the largest number of seeds that reached 9.79 seed capsules^{-1} and with a significant difference from the genotype (7) the next with an average of 9.77 seeds capsule $^{-1}$ and this is

due to giving them the best flowering period Which encouraged the increase of pollination and fertilization under suitable environmental conditions and was reflected in the increase in the number of seeds in the capsule. As for the hybrids, the hybrid (1×7) gave the highest average of 9.77 seed capsule^{-1}, which did not differ significance from the hybrids (1×6) and (1×). 8), and from this it becomes clear that the genes of the higher genotype, including the genotype (1), who transferred his genes to the superior hybrid, which excelled in this trait, as well as the superiority of the hybrid (1×7) in this trait and in addition to the trait of the number of capsules.

The trait of seeds 1000 weight is an indication of the downstream efficiency in absorbing the source products in the storage sites in the seed, which is one of the important traits and represents one of the main yield components. The weight of the seeds for genotype (4) is due to its efficiency in the photosynthesis process, which enhanced the transfer of dry matter to the seed with a significant difference from the rest of the parents, while genotype (6) gave the lowest value for this trait amounted to 5.49 g, and the genetic differences between the parents were reflected in their resulting offspring. From its different crosses, from the averages of the hybrids, we find the highest seeds 1000 weight, which reached 6.83 g for the hybrid (4×6), as we note that the genotype (4) has outperformed the genotype (6) in transferring his genes to the hybrid, It is worth noting that the averages of the crosses were higher than the averages of the genotypes, which explains the presence of hybrid strength in such crosses, and for the presence of these differences, it is possible to continue studying the combining ability.

The trait of seed yield in the plant is the main goal of the plant breeder, and it is a complex trait that depends on several components to increase it, as the increase of this trait depends on the increase of its components. (6) The lowest average amounted to 1.90 g, and the reason for the superiority of the genotype (1) is due to giving him the highest weight of the seed yield per plant resulting from the increase in the number of capsules and the number of seeds in the capsule, which was reflected in the increase in the yield of the individual plant, and for the hybrid averages, the superiority of the hybrid (1×7) was observed by giving it the highest average of 2.64 g, with a significant difference with the rest of the hybrids, The reason for the increase in seed yield per individual plant is attributed to the increase that resulted from the parents (1×7) who excelled by giving them the highest average in the traits of the number of vegetative branches, the number of capsules in the plant and the number of seeds in the capsule, which is a reflection of the best flowering date, which in turn transferred its genes to the superior hybrid, which This trait was superior to it, while the lowest average of the yield was 1.81 g for the hybrid (5 x 6), and when comparing the average of the parents with the average of the hybrid (2.14 and 2.10) g, respectively, we note that the hybrids did not respond to the increase in seed yield as a result of the lack of hybrid vigour in some of the hybrids that did not match genes that increase this traits.

As for the trait of total seed yield, we notice that genotype (1) was significantly superior, as he gave the highest value of 539.37 kg h^{-1} with a significant difference from all the studied parents, followed by parents (7) and (4) who excelled in this trait and their averages reached 475.03 and 469.49 kg h^{-1} , respectively, While the lowest value was 381.69 kg h^{-1} for the genotype (6), the reason for the superiority of the genotype (1) in the total seed yield is his superiority in the yield of the individual plant, which led to the increase for this traits as a result of the increase in the components of the yield and its reflection on the seed yield of the individual and total plant, As for the hybrids, we find the superiority of the hybrid

(1×7), which gave the highest value of 529.12 kg h^{-1}, which gave the highest value of the seed yield per plant (2.64 g), which reflected the increase in yield, while the hybrid (5×6) gave the lowest average of 363.67 kg h^{-1}. and for the averages of the genotypes and the crosses, the average of the genotypes showed an average of 430.64 kg h^{-1}, which is higher than the crosses average of 421.15 kg h^{-1}, as we notice a significant difference between the two averages, and these results indicate the absence of a sovereign genetic action towards the increase in the total seed yield, Based on the above, these results are in line with what was mentioned by Kumari (2015), Dhirhi and Mehta (2019), Bindra and Paul (2016).

It is noted from Table (4) that the parents differed significantly at the level of probability (1%) in the duration to 50% of flowering, plant height, number of vegetative branches, number of capsules per plant, number of seeds in the capsule, seeds 1000 weight, individual yield of the plant and total yield. The mothers showed significant differences at the probability level (1%) in the time to maturity, the number of seeds in the capsule and the total seed yield, and they differed at the probability level (5%) for the traits of plant height, number of vegetative branches and individual plant yield, While there were no significant differences for the duration of the traits of 50% flowers, number of capsules, and seeds 1000 weight. It is noted from the source of the difference due to the hybrids that it was significant at the probability level (1%) for the traits of the duration to 50% of flowers, the number of vegetative branches, the number of seeds in the capsule, the seeds 1000 weight, the individual yield of the plant at the level (5%) in the height of the plant and the total seed yield. It reaches the limits of significance in the traits of the number of capsules in the plant, and these differences reflect the amount of genetic differences between parents and their hybrids. The presence of moral variances and for most of the traits under study is undoubtedly necessary to continue analysing the variance of the general combining ability (for parents) and special (for hybrids) in order to reach information a task, In addition to its superior performance, which helps us to reach the best parents and hybrids that can be exploited within future breeding programs, and studies conducted by Al-Rifai (2017) and Chaure et al. (2018), and Dhirhi and Mehta (2019) The presence of significant Differences between the parents and their crosses for several studied traits when conducting factorial hybridization analysis. analysing the variance of the general combining ability (for parents) and special (for hybrids) in order to reach information a task, in addition to its superior performance, which helps us to reach the best parents and hybrids that can be exploited within future breeding programs, and studies conducted by Al-Rifai (2017) and Chaure et al. (2018), and Dhirhi and Mehta (2019) The presence of significant differences between the parents and their crosses for several studied traits when conducting factorial hybridization analysis. analysing the variance of the general combining ability (for parents) and special (for hybrids) in order to reach information a task, In addition to its superior performance, which helps us to reach the best parents and hybrids that can be exploited within future breeding programs, and studies conducted by Al-Rifai (2017) and Chaure et al. (2018), and Dhirhi and Mehta (2019) The presence of significant differences between the parents and their crosses for several studied traits when conducting factorial hybridization analysis.

Table (4) analysis of variance by factor pairing method for the studied traits

S.O.V	D.F	Duration to 50% flowering (day)	Plant height (cm plant^{-1})	of vegetative branches (plant	of capsules (plant capsule	Number of seeds (seed capsule	seeds 1000 weight (g)	Seed yield (gm plant1-)	Seed yield (kg h^{-1})
Replications	2	0.155	0.967	0.008	2.748	0.001	0	0	10.303
Male	4	** 23.329	** 350.963	** 0.489	** 435.118	** 5.178	** 0.789	** 0.806	** 32639.03
Female	2	0.032	* 2.321	* 0.011	0.536	** 0.022	0.003	* 0.004	** 216.833
Male × Female	8	** 0.558	* 1.267	** 0.010	** 1.494	0.029	** 0.018	** 0.004	* 108.477
Error	28	0.042	0.45	0.002	2.283	0.001	0.001	0.001	34.387

(**) and (*) are significant at 1% and 5% probability levels, respectively

In order to genetically evaluate the parents, the effects of the general combining estimate were estimated for each genotype, whose details are shown in Table (5). It was found that the effect of the combining estimate for the traits of the number of days to 50% flowering was negative and different from zero in the desired direction of the parents (1), (2) and (5) It was -0.791, -1.837 and -0.740, respectively, while it was not significant for parents (7) and (8) in this trait. The values of the genotypes differed among themselves in the trait of plant height, as the genotypes (2), (3) and (5) showed a positive and different effect from zero for this trait and amounted to 3.196, 7.512 and 1.216, respectively. Genotype (1) with a value different from positive zero and in the desired direction (0.380), while genotypes (3), (4) and (5) gave a value different from negative and in the undesired direction. The effect of the combining ability on the rest of the genotypes was positive and negative, but it did not reach the moral limits. And for the traits of the number of capsules in the plant, it was noted that the parents whose effect of the general combining determination was different from zero and in the desired direction for parents (1) and (2), and in the undesirable direction for parents (3), (4) and (5). The effect of the general ability to combine was different from zero for parents (1) and (3) in the traits of the number of seeds per capsule, while genotype (5) showed a different effect from zero and in an undesirable direction. In the trait of seeds 1000 weight, we find that there is an effect of the general combining determination that was positive and different from zero in the desired direction for parents (1) and (2), and it amounted to 0.179 and 0.357, respectively, while genotype (4) gave a negative and significant value and in an undesirable direction. As for the trait of seed yield per plant, it was significant and desirable for parents (1) and (4) and it reached 0.488 and 0.079, respectively, while parents (3) and (5) gave a different value from zero in the undesirable direction. As for the trait of the total seed yield, it had a positive effect and was different from zero and in the desired direction when the general ability to unite parents (1) and (4), and reached 98.11 and 16.277, respectively, while genotype (8) had a positive value and in the desired direction, but did not reach moral limits, The genotypes that were not mentioned had positive or negative values, and if they differed from zero, they were in the undesirable direction, and if they did not differ from zero, they were in the desired direction. In sum, most of the genotypes that showed a desirable union different from zero and in the desired direction showed the action of their genes for these traits through their ability to unite to their offspring, and this was what was observed in most genotypes, especially the genotype (1). Al-Rifai (2017), Dhirhi and Mehta (2019), and Al-Zayed (2021).

Table (5): Estimating the effects of the general combining ability for the studied traits

traits Genotypes	Duration to 50% flowering (day)	Plant height (cm plant $^{-1}$)	Number of vegetative branches (plant	Number of capsules (plant	Number of seeds (seed capsule $^{-1}$)	seeds 1000 weight (g)	Seed yield (gm plant1-)	Seed yield (kg h^{-1})
1	0.791-	3.065-	0.38	7.964	0.853	0.179	0.488	98.111
2	1.837-	3.196	0.004-	6.453	0.136-	0.357	0.125-	26.280-
3	1.413	7.512	0.254-	2.740-	0.46	0.142-	0.196-	39.393-
4	1.955	8.858-	0.079-	3.326-	0.019-	0.413-	0.079	16.277
5	0.740-	1.216	0.043-	8.351-	1.159-	0.018	0.246-	48.715-
S.E. (ĝi)	0.166	0.548	0.041	1.234	0.03	0.026	0.027	4.788
6	0.051	0.447-	0.030-	0.168-	0.026	0.002	0.009-	2.141-
7	0.039-	0.292	0.018	0.205	0.018	0.015-	0.010-	2.249-
8	0.012-	0.155	0.012	0.037-	0.044-	0.013	0.019	4.39
S.E. (ĝj)	0.166	0.548	0.041	1.234	0.03	0.026	0.027	4.788

Table (6) shows the effects of the specific combining ability estimator for factorial hybrids for the studied traits, as plant breeders aim to elicit more early genotypes for flowers to obtain fertilization and full pollination under appropriate environmental conditions. The hybrids (1×7), (2×7), (3×8), and (4×6) were negative values and in the desired direction, and the parents (1) and (2) had an effect of the general combining ability and different from zero, meaning This is because this trait was governed by the additional genetic act and the direction of early flowering, while the hybrids showed (1×7), (2×8), (3×6), (4×6), (4×7) and (5×7). a specific combining estimator that is positive and different from zero by having positive values in the traits of plant height, But the hybrid (2×6) scored negative and significant values. The two hybrids (3×7) and (4×6) showed a different effect from zero in the desired direction, which amounted to 0.090 and 0.059, respectively, in the number of vegetative branches, and the genotypes included in the above crosses were with An effect of the general combining ability and this resulted from the non-additive genetic action. Thus, these hybrids can be recommended. For hybrids (1×7), (1×8), (2×6) and (2×8), their special ability was positive, but different from zero, which confirms the presence of additional effects of genetics and thus super-isolations can be genetically determined, However, none of the hybrids showed differences from zero for the number of capsules in the plant.

Table (6): Estimating the effects of the special combining estimate for the studied traits

Traits Hybrids	Duration to 50% flowering (day)	Plant height (cm plant $^{-1}$)	Number of vegetative branches (plant branch $^{-1}$)	Number of capsules (plant capsule $^{-1}$)	Number of seeds (seed capsule $^{-1}$)	seeds 1000 weight (g)	Seed yield (gm plant1-)	Seed yield (kg h^{-1})
6 X 1	0.4	0.148-	0.046-	0.556-	0.031-	0.041-	0.022-	4.218-
7 X 1	0.450-	0.548-	0.022	0.232-	0.039-	0.027-	0.008-	1.247-
8 X 1	0.05	0.696	0.024	0.787	0.069	0.068	0.03	5.465
6 X 2	0.269	0.906-	0.012	0.132	0.008	0.085	0.06	8.38
7 X 2	0.374-	0.698	0.017-	0.366	0.040-	0.048-	0.025-	2.719-
8 X 2	0.106	0.208	0.006	0.498-	0.032	0.036-	0.035-	5.661-
6 X 3	0.011-	0.028-	0.038-	0.598-	0.021-	0.057	0.019-	1.205-
7 X 3	0.359	0.129	0.09	0.573	0.015-	0.007	0.032	3.473
8 X 3	0.348-	0.101-	0.051-	0.025	0.036	0.064-	0.014-	2.269-
6 X 4	0.647-	0.628	0.059	1.084	0.045-	0.008	0.017	3.679
7 X 4	0.36	0.052	0.039-	0.805-	0.016-	0.028-	0.025-	4.803-
8 X 4	0.287	0.681-	0.020-	0.280-	0.062	0.02	0.009	1.125
6 X 5	0.011-	0.454	0.014	0.063-	0.088	0.010-	0.036-	6.636-
7 X 5	0.106	0.332-	0.055-	0.097	0.1	0.097	0.026	5.296
8 X 5	0.094-	0.122-	0.041	0.034-	0.198-	0.012	0.01	1.34
S.E.mf^	0.235	0.774	0.058	1.745	0.043	0.037	0.038	6.771

The hybrids (1×8), (3×8), (4×8), (5×6), and (5×7) had a positive combining specific estimation different from zero and desirable, while the two hybrids showed (2×7) and (4×6) a negative value and different from zero, but in an undesirable direction, and it is clear that the hybrids with significant value and in the desired direction were one of their parents or both have a special combining ability that is positive and different from zero, so they can be invested in breeding programs for the strength of the hybrid to increase the number of seeds per capsule, while the rest of the hybrids showed an effect positive and negative and did not exceed zero for the specific ability to unite, and this is the result of the additional genetic action controlling the inheritance of this trait and which can be improved by selection, We note that the effects of the special estimator on the union were different from zero but in the desired direction for the hybrids (1×8), (2×6), (3×6) and (5×7) in the seeds 1000 weight trait, and for the hybrids (1×6), (2×7) and (3×8) have shown a different effect from zero and in an undesirable direction that the crosses whose value was significant and in the desired direction, had a genotype with an effect of the general combining ability positive and moral desirable, so these crosses can identify ultra-limited isolations from them In the isolated generations in which the genetics with additional influence controlling this trait correspond, and the adoption of the method of descent to select these genotypes, effect of the specific combining estimator was positive and different from zero for the hybrid (2×6) and not significant and in the desired direction for the hybrid (1×8), (2×6), (3×7) (4×6), (4×8) and (5×7) and (5×8) in the trait of the seed yield in the plant, and that the parents of (1) and (4) of these hybrids (1×8), (4×8) and (5×8) had positive effects of the general combining determination. Thus, it may result in an additional genetic act that controls the inheritance of this trait. as for the trait of the total seed yield, the effect of the special ability on the union was different from zero and desirable for the hybrid (2×6) and different from zero and undesirable for the hybrid (5×6), while both hybrids showed (1×8) and (1×6). and (3×7), (4×6), (4×8), (5×7) and (5×8) have a non-significant effect and in the desired direction, the genotype (2) in the hybrid (2×6) gave a significant effect of the general combining ability,

which means that there are additional effects of the genes that control the quality of the seed yield. Regarding the hybrids that were not mentioned, they did not reach the limits of the statistical significance of the traits, and it is noted that the hybrid (1 × 7) was superior in the number of capsules per plant, the number of seeds in the capsule, the yield of the plant and the total yield of seeds, and that the distinct hybrids in the specific ability to unite and the largest number of traits in addition to their possession The highest averages within the performance, which concludes the possibility of adopting these hybrids in breeding programs, especially selection, to reach distinct varieties later. These results were consistent with the results of Abdal-Sadek (2015), Govind (2018) and Ahmad et al. (2021).

CONCLUSION

It can be concluded from previously to the importance of genetic action that has an additional effect in studied characteristics inheriting, if Sakha parent possess the general combining ability in desired direction, which was reflected on the hybrid (Sakha X local Syrian), and for the specific combining ability for yield and its components characteristics. It is expected that this will last in the isolative generations and selection of the best from plants to obtain parents and hybrids that have the desired characteristics.

REFERENCES

Abd Al-Sadek, M. (2015). Diallel cross analysis for yield and its components in six flax genotypes. *Journal of Plant Production*, 6 (11):1877-1886.

Ahmad, E., Ansari, A. M. and Singh, D. N. (2021). Estimating gene action and combining ability analysis for yield and yield attributing traits in linseed (*Linum usitatissimum* L.). *Journal of Environmental Biology*, 42: 366-370.

AL- Rahem, S.E.A. and Anees, A.H.A.(2024). Effect of gamma rays on growth, yield and yield components eight traits of Flax Genotypes(*Linum usitatissimum* L.). *Tikrit Journal of Agricultural Sciences*. 24 (1): 79-93.

Al-Rawi, khashie Mahmoud and Khalaf Allah (2000). Design and analysis of agricultural experiments. University of Al Mosul. Second Edition. Ministry of Higher Education and Scientific Research.

Al-Rifai, Hummam Abd Al Rahman (2016). Genetic behavior of (*Zea mays* L) maize using factorial cross-breeding. Master Thesis. College of Agriculture - Tikrit University.

Al-Zayed, Abd Al Qadir Hamidi (2021). Genetic indicators of semi-reciprocal and stable crosses of flax genotypes (*Linum usitatissmum* L.). Under the influence of different agricultural environments. PhD thesis. College of Agriculture - University of Tikrit.

Bindra, S., Paul, S. (2016). Genetic variability and association studies in linseed (*linum usitatissimum* L). *Supplement on Genetics and Plant Breeding*, 11(3):1855-1859.

Chaure, P., Misal, A., Dhutmal, R., and Pole, S. (2016). Combining Ability Studies in Linseed. *Annals of Plant and Soil Research*, 18(2): 146-151.

Comstock, R. and Robinson, H. (1948). The components of genetic variance in populations of biparental progenies and their use in estimating the average degree of dominance. *Biometrics* 4: 254-266.

Dhirhi, N. and Mehta, N. (2019). Estimation of Genetic variability and correlation in F2 segregation generation in linseed (*Linum usitatissimum* L). Plant Archives 19 (1): 475-484.

Elayan, S., Abdallah, M., Naguib, A., and Mahmoud, D. (2015). Effect of sowing date on yield, fiber and seed quality of eight flax Genotypes. *American-Eurasian J. Agric. and Environ. Sci*., 15 (5): 886-895.

FAO STAT (2019): FAO statistical data. http://faostat.fao.org .

Hassan, Ahmed Yassin and Iyad Talaat Shaker (2013). Effect of nitrogen and iron fertilization at two levels of field capacity on growth and yield of flax (*Linum usitatissimum* L.). *Diyala Journal of Agricultural Sciences*. 5 (2): 670-681.

Kumar, N., and Paul, S. (2015). Genetic analysis of yield and yield contributing traits in linseed (*Linum usitatissimum* L.). *The Bioscan*, 10 (4): 1951-1955.

Rastogi, A,. and Shukla, S. (2019). Combining ability analysis for oil and seed parameters in linseed (*Linum usitatissimum* L.). *International journal of current microbiology and Applied Sciences*, 8(1): 1118-1148.

Simmons, C., Turk, P. Beamer, S. Jaczynski, j. Semmens, k. and Matak, k. (2011). The effect of a flaxseed oilenhanced diet on the product quality of farmed brook trout (*Salvelinus fontinalis*) fillets. J. Food Sci, 76 (3): 192–197.

Singh, R.K. and Chandhary (1987). Biometrical methods in quantitative genetic analysis . Kalyanipoblshers, New Delhi – Ludhiana: 215 - 219 .

Wadikar, P., Magar, M. and Dhare, S. (2019). Combining ability and gene action studies for yield and yield contributing traits in linseed (*Linum usitatissimum* L.) *Bull. Env. Pharmacol. Life Sci*., 8 (7): 18-22.