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# Estimation of Heterosis of Flax (*Linum Usitatissimum* L.) by in half diallel cross

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## Abstract

In this study, eight genotypes of flax (*Linum Usitatissimum* L.) were used (Sakha 1, Sakha 2, Sakha 3, Sakha 5, Sakha 6, Syrian, Giza and Poloni) and their half crosses obtained according to the second method proposed by Griffing (1956). Genotypes (8 parents + 28 hybrids) were planted in the fields of the College of Agriculture / University of Kirkuk in the winter season (2021-2022) according to randomized complete design (RCBD) with three replications to study the studied traits (plant height, number of days flowering 50%, and number of days contracting 50 %, number of days of physiological maturity, number of branches, number of capsules, number of capsule seeds, weight of 1000 seeds, biological yield, seed yield, and harvest index). The hybrids (Sakha 5 × Sakha 6), (Sakha 1 × Giza 8) and (Sakha 1 ×thorshansity72) outperformed in hybrid heterosis based on the deviation of the second generation of the mean parents in the desired direction in the number of days to flowering, set, maturity, seed yield and harvest index. The hybrid (Sakha 2 × thorshansity72) excelled in the vigor of the hybrid based on the deviation of the second generation of the best parents for the traits of the number of days, flowering, knot, maturity, the number of seeds in the capsule and the biological yield, enables the follow-up of solitary generations and selection according to the breeding method determined by the genetic action of these traits.

Key words: flax, half cross, crossbreed heterosis of the average parents, half diallel, heterosis.

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## Introduction

Flax or Linseed is one of the oldest crops known to man, and flax belongs to the genus *Linum*, its scientific name is *Linum usitatissimum* L., and it refers to varieties of oil seeds, as well as used to obtain flax fibers. Linolenic acid (Omega-3) and Linoleic acid (Omega-6) are essential polyunsaturated fatty acids that the human body cannot synthesize and must be ingested through food. It also improves heart and bone health when consumed by humans [1]. Therefore, an interest in the study of the feder General combining ability and the components of the phenotypic variance of economically important quantitative traits such as the traits of the crop and its components emerged, because the knowledge of these components represented by the environmental and genetic variance is necessary in estimating the values of the coefficient of phenotypic and genetic variation, the heritability of values and the expected genetic advance, and from them the breeding method of the crops can be determined at different levels of competition between plants according to the seeding rates [2]. From this came the idea of adopting the program of the exchange mating system (Diallel) the second method (Half Diallel) to obtain new unions and benefit from the phenomenon of hybrid heterosis and knowledge of the dominant genetic action on the most important These traits (seed yield and its components) as well as early flowering and maturity, and according to them it is possible to trace that hybrid with high hybrid heterosis to adopt the method of selection in isolated generations. The relationship of correlation between them) is little or no, and although the increase in the heterosis of growth is one of the most prominent manifestations of the heterosis of the hybrid, the term of the heterosis of the hybrid is broader than this Where it includes an increase in yield, traits of economic quality, resistance to pests and adaptation to the prevailing environmental conditions, and it is not necessary for the emergence of hybrid heterosis that the parents of the strains used in the production of hybrids have poor growth or suffer the deterioration associated with indoor breeding, meaning that the heterosis of the hybrid appears in most types of plants, including These are self-pollinating plants and cross-pollinating plants that do not harm indoor breeding [3] . Hybrid heterosis was found in all the plants in which this phenomenon was studied [4] [5] [6] (7] [8] [9].

## Materials and Methods:

The parent of genotypes and second generation hybrids and parent [8 paternal genotypes and 28 crosses) were planted on 7 November, 2021 in the fields of the College of Agriculture _ University of Kirkuk, where the parental genotypes and their crosses were planted according to the design of complete randomized design (RCBD) with three-replications, each of them containing 36 units Experimental, the above genotypes were randomly distributed, and each experimental unit included two lines of each genotype with a length of 2 m, and the distance between one line and another was 0.3 m. Two separate experiments were planted for each plant density in the same location, the first was planting at a density of 60 plants $m^2$ and the experiment The second, with a density of 120 plants $m^2$, and the harvest took place in May 2022 according to the maturity of each experimental unit, which is represented by the ripening of the capsules and their coloration in brown color, and hearing the sounds of the seeds inside the capsule while shaking it [10]. Crop management process were carried out that included preparing the land And tillage it well, as a result of leveling, smoothing, irrigation and weed control, as super phosphate fertilizer (46% $P_2O_5$) was added at a rate of 200 kg hectare$^{-1}$ at one time when planting, and urea fertilizer (46% N) was added at a rate of 200 kg hectare$^{-1}$ in two batches, the first batch when planting The second is the beginning of flowering and supplied of Humic in two batches, the first batch after two weeks of planting and the second batch after a month of planting, in order to reduce the effect of the salinity of irrigation water amounting to 2900 parts per million. Hereditary and recorded data for the following traits.

1- Number of days flowering 50% (day).
2- The term to the contract is 50% (day).
3- Duration to maturity
4- Plant height (cm$^{-1}$ plant)
5- Number of branches m$^2$ (Branch m$^{-2}$)
6- Number of capsules m$^2$ (capsule m$^2$)
7- The number of capsule seeds (seed).
8- The weight of 1000 seeds (gm).
9- Seed yield (gm m$^2$).
10- Biological yield (gm$^2$).
11- Harvest guide (%): the harvest guide was calculated:

$$\frac{\text{Seed crop (g m2).}}{\text{Biological product(g m2)}}*100$$

Genetic statistical analysis was carried out according to [11] for general and specific combining ability, gene action, components of genetic and phenotypic variation, narrow and broad heritability, degree of dominance and Expected Genetic Advance

**Results and discussion:**

The results of Table (1), which explain the analysis of variance according to the Krvenck analysis, show that the mean squares of the genotypes were significant at the level of probability 1% in the traits of the number of days to contract, maturity, number of capsules m$^2$, weight of 1000 seeds, seed yield, in both densities, at the flowering in the second density and in the number of capsule seeds and biological yield in the first density and significant at the level of probability 5% in plant height in the two densities and in the number of seeds per capsule and biological yield in the second density. The two densities, the number of days for flowers, the weight of 1000 seeds in the first density, the number of capsule seeds, the seed yield and the biological yield at the first density and at the level of probability 5% in plant height, seed and biological yield in the second density. maturity, number of capsules m $^2$, weight of 1000 seeds, seed yield in both densities, number of days to flowering in the second density, number of seeds per capsule and for the biological yield at the first density, while the differences were at the level of probability 5% in the height of the plant, the number of seeds in the capsule and the biological yield in the second density, and the differences were significant for the source of the difference between the parents against the hybrids were significant at the level of probability 1% in the number of days to contract and maturity, the number of capsules and the weight of 1000 seeds each of densities , in the number of days to flowering and the biological yield in the second density, and at a probability level of 5%, in the number of seeds per capsule and seed yield in the first density. The significant differences between the genotypes are an important indicator of the possibility of genetic variation in them, and genetic parameters can be obtained to infer an understanding of the method of plant breeding methods in this crop and the extent of the possibility of selection in the solitary generations, although the second generation of the solitary mean trait of plants may be given a close mean, as some of them are dispersed others are close to the mean of the studied trait, and analysis and discussion will be made later for all the studied traits.

Table (1): shown the Analysis of variance between parents, crosses, and parents against crosses for the studied traits of the first and second densities

| Differences source | df | Plant Height CM | | Number of days Flowers 50% | | Number of Days Knot 50% | | Number of physiological maturity days 50% | | Number of branches $m^2$ | | Number of capsules $m^2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | First Density | Second density | First Density | Second density | First Density | Second density | First Density | Second density | First Density | plant Density | First Density | plant density |
| repeated | 2 | 1726. | 381.1 | 92.5 | 2.77 | 0.95 | 35.01 | 8.89 | 0.44 | 15891 | 1471.9 | 1478837 | 4779170 |
| Genotypes | 35 | *278.11 | *87.94 | 121.8 | **26.88 | **68.64 | **92.47 | **376.53 | **334.05 | 668.64 | 646.93 | **3345952 | **1450332 |
| Parents | 7 | 144.27 | *119.11 | 32.3 | **19.5 | **7.71 | **10.66 | **224.36 | **191.52 | 478.04 | 617.79 | **1867169 | **1206678 |
| Hybrids | 27 | 321.61 | *80.78 | 149.5 | **29.56 | **65.70 | **91.38 | **381.37 | **336.52 | 685.74 | 644.57 | **3832427 | **1425225 |
| Parents vs Hybrids | 1 | 40.64 | 63.19 | 0.04 | **6.09 | **574.49 | **694.86 | **1311.2 | **1265 | 1541.3 | 914.42 | **5626603 | **3833790 |
| Error | 70 | 201.33 | 42.29 | 92.5 | 0.20 | 0.92 | 0.009 | 8.32 | 7.85 | 467 | 793.27 | 165433 | 1502510 |

Follow table (1)

| Differences source | df | Number of capsule seeds | | Weight of 1000 grams | | Seed crop kg. H | | Biological Product kg. H | | Harvest Guide % | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | First Density | Plant Density | First Density | plant density | First Density | Second density | First Density | Second density | First Density | Second density |
| repeated | 2 | 2.53 | 11.7 | 0.43 | 0.58 | 4346.6 | 956757.6 | 4207660 | 42763520 | 96.39 | 43.06 |
| Genotypes | 35 | **6.78 | *4.89 | **0.90 | **0.67 | **260559 | **510415.8 | **2661956 | *8839287 | 70.60 | 42.22 |
| Parents | 7 | **4.88 | 4.35 | 0.43 | **0.91 | **483791 | *428400.7 | **3348213 | *11664791 | 133.35 | 51.90 |
| Hybrids | 27 | **7.27 | *5.20 | **1.007 | **0.60 | **199470 | **528874.2 | **2546726 | *7727121 | 56.56 | 39.46 |
| Parents vs Hybrids | 1 | *7.11 | 0.16 | 1.4791 | 0.80 | *347347 | 586146.1 | 1669350 | **19089254 | 10.35 | 48.82 |
| Error | 70 | 1.38 | 2.66 | 0.38 | 0.28 | 69393 | 169165.4 | 2610656 | 4961561 | 84.62 | 37.97 |

**Heterosis:**

1 Hybrid heterosis Percentage of the mean parents [12], table (2) shows the heterosis of the hybrid based on the second generation of plant height (cm), where the hybrid showed (2×4) a significant positive hybrid heterosis in the desired direction amounted to (33.81) at the probability level (1%) in In the first density, in the second density, the hybrid was in (1×3) and (1×4) with a positive, significant hybrid heterosis in the desired direction, amounting to (13.36) and (13.77) at the probability level (1%), and the hybrid (2×4) with a strong Significant positive hybrid in the desired direction amounted to (9.68) at the probability level (5%). As for the characteristic of the number of days flowering, all the hybrids in the first density were not significant, but in the second density the hybrids were (1×3), (1×6) and (1×8), (2×4), (2×6), (2×7), (4×5), (6×7), (6×8), and (7×8) had negative hybrid heterosis. Significant in the desired direction ranges from (-0.86) in the hybrid (2 × 6) to (-3.57) in the hybrid (1×6) at the probability level (1%), and in terms of the number of contract days, the hybrid (3×7) is strong The hybrid has a significant negative in the desired direction (-2.02) at the level of (1%) and the hybrid (1×8) at the level of 5% in the first density, while in the second density the hybrid (1×2), (1×6) , (1×8) (3×7), (4×5), (6×8), and (7×8). ) was of significant heterosis for the hybrid in a positive direction ranging from (1.61) in the hybrid (5 × 3) and (3×8) to (13.69) in the hybrid (1×4) at the probability level (1%), and the hybrid was (1×2), (1×6), (1×8), (3×7), (4×5), (6×8) and (7×8) with a significant negative hybrid heterosis in the desired direction, ranging between (-2.45). The hybrid (1×6) to (-0.81) the two hybrids (7×8) and (3×7) at the level of (1%) that the plant breeder can adopt those hybrids that were positively significant when selecting genotypes with a longer period to Contract, that is, to increase the period of stimulus growth, while if his goal is early in this stage, he can elect that trait that has negative hybrid heterosis and does not have non-significant special estimated effects, and its parents have a general spesific combining ability. As for those in which the special ability is moral, selection can be adopted For the highly isolated genotypes in the later generations and in terms of the number of days of physiological maturity, the hybrids are (1×2), (1×3), (1×7), (1×8), (2×3), (2×4),(2×5) , (2×7) , (2×8) , (3×4) , (5×3) , (6×3) , (7×3) , (3×8), ( (4×6), (5×6) and (5×7) are of negative and significant heterosis for the hybrid, and in the desired direction, ranging between (-2.79) for the hybrid (5×6) to (-25.40) in the hybrid (3×8) in the first density, while in the second density, the hybrids are (1×2), (1×3), (1×5), (1×6), (1×7), (1×8), (2×3), (2×4), (2×5), (2×6), (2×7), (2×8), (3×4) , (3×5) , (3×6) , (3×7) and (3×8) , (4×5) ،(4×6) , (6×5) , ( 5×7) and (5×8) with negative and significant hybrid heterosis and in the desired direction ranging from (-1.16) hybrid (1×5) to (-26.40) hybrid (3×8) at a probability level of (1%).number of Branches (M2), the hybrid (5×3) with a significant positive hybrid heterosis in the desired direction amounted to (36.44) at the probability level (1%), and the two hybrids (5×8) and (7 × 8) had a significant positive hybrid heterosis in the desired direction, reaching (28.57). ) and (24.19) at the level of probability (5%) in the first density, while in the second density, the hybrid (2×5) had a positive, desirable hybrid heterosis at the level of probability 5% amounted to (35.13). As for the characteristic of the number of capsules m 2, the two hybrids (3×6) and (4×6) with a positive, significant heterosis of the hybrid in the desired direction, reaching (89.93) and (45.97) at the level of probability (1%) and the hybrid (5×6) with a positive, significant heterosis of the hybrid (28.36) at the level of (5%) ) in the first density, but in the second density, the hybrid (2×5) has a positive, significant heterosis for the hybrid It reached (50.95) at the level of (5%). Therefore, these hybrids follow segregationally generations to select the superior combinations in the number of capsules $m^2$, especially if this hybrid has a special non-moral ability and its parents have a general moral ability, that is, the auxiliary verb is the one that controls it, but if The hybrids had special, significant effects, so selection can

be made in the late isolation generations. As the number of capsule seeds, it is noted that the hybrids (1×3), (1×4), (1×5), (1×6), and (2×8) are of high quality. The heterosis of the hybrid is positive and significant in the desired direction, ranging from (57.47) in the hybrid (1×3) to (123.39) in the hybrid (2×8) at the probability level (1%) in the first density, while in the second density, the hybrid is (2×7), (2×8), (3×7) and (6×7) with positive, significant heterosis of the hybrid, ranging from (66.59) in the hybrid (2×7) to (49.82) in the hybrid (7×6) at the level of ( 5%), and it is noted that the hybrids that had the heterosis of the hybrid in the positive direction in the number of capsules were most of them in the opposite direction in the number of seeds per capsule, and in the weight of 1000 seeds, the two hybrids (1×4) and (3×5) had a heterosis of the hybrid positive. Significant (11.64) and (15.13) at the (5%) level, respectively, and camels (1 × 7), (2 × 5), (3 × 6) and (7×8) with a positive, significant hybrid heterosis ranging from (19.94) in the hybrid (1×7) to (16.67) in the hybrid (7×8) at the level of (1%) in the first density, while in the second density the hybrid (2×8) Positive and significant for the hybrid, which amounted to (15.33) at the level of (1%). In terms of seed yield, the hybrids are (1×6), (2×5), (2×8), (3×6), and (4×5) The heterosis of the hybrid is positive and significant, ranging from (41.89) in the hybrid (1×6) to (63.60) in the hybrid (4×5) at the probability level (1%) and the hybrid (1×4) And (2×4) and (2×6) with positive and significant hybrid heterosis amounted to (33.20), (42.79) and (33.38) at the level of probability (5%) in the first density, while in the second density, the hybrids are (2×4 ) and (3 × 7) and (5 × 6) the heterosis of the hybrid is significant positive in the desired direction (77.80), (47.72) and (39.89) at the probability level (1%) and the hybrid (2 × 8) the heterosis of the hybrid is significant positive (41.64) At the probability level (5%).

It is noted that the hybrid (2×4) and (2×8) had a significant superiority in the two densities, which can be selected for under the influence of environmental competition to increase the high yield, and the father 2 was involved in both, which means that the father 2 could unite with the father 4 and 5 to increase The characteristic is the hybrid of the biological yield, all the hybrids did not reach the statistical significance level in the first density, but in the second density, the hybrid (2×4) and (2×8) with the heterosis of the hybrid positively significant amounted to (63.91) and (91.61) at the level of probability (1%) and the hybrids (1×8) and (3×8) with positive and significant hybrid heterosis reached (47.74) and (59.55) at the probability level (5%). The hybrid (4×5) has a positive, significant hybrid heterosis (91.45) at the probability level (1%) in the first density, but in the second density, there is no hybrid among those that has reached the level of significance in the desired positive direction, and the hybrid was given (4×5) Effects of hybrid vigor as the mean of the parents for the characteristics of number of days flowering, maturity, seed yield, number of capsules, followed by the hybrid (1×6) for the traits number of days flowering, maturity, seed yield and biological yield [23], [13], [14], [15] and [16].

Table (2): Heterosis percentage at the mean parent of the firsit and second density

| Hybrid | Plant Height cm | | Number Of Days Flowering 50% | | Number Of Contract Days50% | | Number of days to physiological maturity50% | |
|---|---|---|---|---|---|---|---|---|
| | First Density | Second Density | First Density | Second Density | First Density | Second Density | First Density | Second Density |
| 1×2 | 4.56 | 7.12 | 1.28 | 0.43 | -0.41 | **-0.86 | *-3.12 | **-3.10 |
| 1×3 | 7.24 | **13.36 | 0.43 | **-1.32 | **8.13 | **6.88 | **-6.74 | **-6.15 |
| 1×4 | 3.04 | **13.77 | -0.86 | **2.20 | **11.93 | **13.69 | *2.42 | **2.12 |
| 1×5 | 13.51 | 6.85 | 5.82 | **4.48 | **12.65 | **13.46 | 0.87 | **-1.16 |
| 1×6 | -0.89 | 1.56 | -1.73 | **-5.57 | -0.13 | **-2.45 | -2.06 | **-3.52 |
| 1×7 | -11.63 | 0.40 | 1.29 | **-0.28 | **3.67 | **4.80 | **-7.05 | **-7.14 |
| 1×8 | 10.49 | 7.54 | -3.53 | **-3.56 | -1.21 | **-0.40 | **-5.04 | **-6.19 |
| 2×3 | -4.93 | 6.94 | 1.72 | **4.42 | **6.93 | **6.12 | **-7.96 | **-6.78 |
| 2×4 | **33.81 | *9.68 | 1.27 | **-1.76 | **3.30 | **5.43 | **-6.09 | **-5.19 |
| 2×5 | 6.80 | *-10.22 | 4.42 | **3.53 | **9.01 | **10.28 | **-9.14 | **-7.64 |
| 2×6 | 6.19 | 5.25 | 1.28 | **-0.86 | **6.50 | **9.09 | 0.89 | **-2.95 |
| 2×7 | 1.27 | 3.29 | -7.69 | **-3.89 | **2.45 | **4.56 | **-5.32 | **-4.19 |
| 2×8 | *-29.05 | 7.48 | 0.43 | **0.87 | **4.06 | **6.17 | **-5.07 | **-5.63 |
| 3×4 | -5.88 | -3.61 | -0.43 | **3.60 | **4.48 | **4.09 | **-7.16 | **-6.35 |
| 3×5 | 12.57 | 4.96 | 3.60 | 0 | **2.02 | **1.61 | **-7.77 | **-7.52 |
| 3×6 | 13.25 | 8.48 | 0.43 | **2.63 | **6.82 | **6.88 | **-8.93 | **-8.68 |
| 3×7 | 3.764 | 2.05 | 1.73 | **2.20 | **-2.02 | **-0.81 | **-14.20 | **-11.61 |
| 3×8 | 11.82 | 5.58 | 4 | **3.57 | **2.008 | **1.61 | **-25.84 | **-26.40 |
| 4×5 | 2.709 | -1.37 | -1.33 | **-1.80 | **4.09 | **-0.82 | -2.005 | **-2.01 |
| 4×6 | -7.09 | -3.32 | 1.72 | **0.87 | **4.87 | **6.22 | **-8.93 | **-8.40 |
| 4×7 | 0.003 | 5.75 | 0.42 | **1.32 | **10.65 | **11.66 | **4.02 | **6.15 |
| 4×8 | 3.49 | 3.07 | 1.75 | **3.57 | **10.56 | **13.22 | *4.34 | **3.48 |
| 5×6 | 5.54 | -2.28 | 3.13 | **0.87 | 0.80 | **2.85 | *-2.79 | **-3.91 |
| 5×7 | -15.34 | *-10.21 | 4.46 | **3.96 | **5.69 | **7.37 | **-14.20 | **-11.86 |
| 5×8 | 0.23 | -7.80 | 9.58 | **8.92 | **2.41 | **5.69 | 0.74 | **0.84 |
| 6×7 | -9.87 | -8.25 | -29.29 | **-3.86 | **5.64 | **6.17 | 0.28 | 0 |
| 6×8 | -1.27 | -5.88 | -1.76 | **-2.60 | **2.4 | **-1.22 | 0.56 | *0.28 |
| 7×8 | -6.18 | -3.01 | -2.20 | **-3.05 | -0.80 | **-0.81 | 0.84 | **0.85 |
| SE(H) | 10.03 | 4.59 | 6.80 | 0.3 | 0.68 | 0.02 | 2.04 | 0.212 |

Follow Table (2):

| Hybrid | Number of branches $m^2$ | | Number of Capsules $m^2$ | | Number of Seeds per capsules | | Weight of 1000 seeds, gm | |
|---|---|---|---|---|---|---|---|---|
| | First Density | Second Density | First Density | Second Density | First Density | Second Density | First Density | Second Density |
| 2×1 | -10.40 | -3.39 | *-21.41 | 13.67 | 16.13 | -11.02 | -7.71 | 0.74 |
| 3×1 | -9.83 | -17.94 | **-31.26 | 32.56 | **57.47 | -9.40 | -0.49 | -4.85 |
| 4×1 | -3.81 | -14.06 | **-37.73 | 8.55 | **107.29 | 7.91 | *11.64 | -8.51 |
| 5×1 | 17.35 | -2.60 | **-29.71 | 13.25 | **81.85 | -27.49 | 1.41 | -4.02 |
| 1×6 | 8.95 | -2.52 | **-37.33 | 5.18 | **121.15 | 8.06 | 0.75 | -9.21 |
| 1×7 | -5.26 | -5.08 | 7.55 | 21.96 | *-37.61 | 2.55 | **19.94 | 0.80 |
| 1×8 | -10.23 | -2.98 | -4.57 | 3.29 | 21.28 | 3.18 | 6.76 | -1.63 |
| 2×3 | -11.71 | 15.04 | 17.94 | 41.26 | -27.09 | -6.03 | -3.96 | *-10.33 |
| 2×4 | 21.66 | 6.45 | -18.03 | 39.36 | 50.79 | 19.34 | 9.50 | 1.01 |
| 2×5 | 1.81 | *35.13 | 9.83 | *50.95 | 28.86 | -31.14 | **16.86 | -0.86 |
| 2×6 | 2.44 | 6.34 | 12.74 | 22.05 | 21.43 | 17.33 | -2.98 | -5.03 |
| 2×7 | 18.03 | 17.54 | 8.92 | -21.32 | -15.39 | *66.59 | 0.90 | 6.79 |
| 2×8 | 10.34 | 3.07 | **-38.05 | -20.07 | **123.39 | *58.24 | 3.06 | **15.33 |
| 3×4 | 11.10 | 8.94 | -15.82 | 7.24 | 45.96 | -33.23 | -4.17 | 1.34 |
| 3×5 | **36.44 | 9.09 | 10.81 | -3.74 | -0.63 | 28.62 | *15.13 | -3.98 |
| 3×6 | 11.66 | 17.54 | **89.93 | 10.26 | *-36.91 | 3.93 | **19.51 | -7.46 |
| 3×7 | 14.28 | 11.50 | -20.57 | 0.85 | -6.01 | *52.20 | 3.39 | -7.54 |
| 3×8 | 16.81 | -11.63 | -19.96 | 34.88 | 16.49 | -33.81 | 1.97 | -1.45 |
| 4×5 | 3.44 | 12.36 | 10.95 | 37.66 | 29.05 | -23.38 | 2.98 | -5.41 |
| 4×6 | -3.87 | 19.99 | **45.97 | 37.5 | -2.44 | -24.18 | *-12.97 | **-18.15 |
| 4×7 | -1.56 | 1.61 | *-20.18 | 9.96 | -0.56 | 11.63 | 1.28 | -4.34 |
| 4×8 | 6.55 | -42.07 | -5.91 | 13.85 | 25.25 | -21.98 | 1.77 | -1.73 |
| 5×6 | 19.32 | 16.07 | *28.36 | 44.74 | -25.61 | -2.33 | 8.90 | 0.50 |
| 5×7 | -1.69 | 18.91 | 16.54 | -13.36 | **-39.45 | -6.99 | 0.62 | -36.81 |
| 5×8 | *28.57 | -14.96 | -6.81 | 9.05 | 5.84 | -11.47 | -0.40 | -2.72 |
| 6×7 | -8.39 | 16.52 | *-21.35 | -16.80 | -3.87 | *49.82 | -2.27 | -3.86 |
| 6×8 | 12.001 | 8.39 | -1.20 | -14.56 | 0.30 | -7.37 | 2.61 | 1.68 |
| 7×8 | *24.19 | 15.38 | 27.39 | -18.76 | -26.05 | 16.21 | **16.67 | 8.77 |
| SE(H) | 15.28 | 11.49 | 287.6 | 333.03 | 0.83 | 1.15 | 0.43 | 0.37 |

Follow Table (2):

| Hybrid | Seed Yield kg. h | | Biological Yield kg. h | | Harvest Index % | |
|---|---|---|---|---|---|---|
| | First Density | Second Density | First Density | Second Density | First Density | Second Density |
| 1×2 | -14.79 | -4.15 | -34.10 | 7.61 | 33.05 | -11.28 |
| 1×3 | 10.47 | 13.48 | -10.57 | 3.90 | 15.16 | -19.04 |
| 1×4 | *33.20 | 15.80 | -5.49 | -19.70 | 37.25 | 2.23 |
| 1×5 | 23.24 | -14.70 | 4.98 | 1.41 | 20.52 | -17.61 |
| 1×6 | **41.89 | 10.44 | 12.73 | 17.30 | 1.28 | -7.35 |
| 1×7 | -14.23 | 28.35 | -19.81 | 13.35 | 4.52 | 13.68 |
| 1×8 | 19.78 | 12.66 | 25.40 | *47.74 | -6.81 | **-46.10 |
| 2×3 | -16.43 | 21.41 | 27.27 | 51.91 | -7.23 | -22.90 |
| 2×4 | *42.79 | **77.80 | 8.31 | **63.91 | 23.18 | 1.93 |
| 2×5 | **62.13 | 3.73 | 17.47 | 4.52 | 37.99 | -1.83 |
| 2×6 | *33.38 | 32.80 | -1.86 | 25.55 | 34.15 | 4.81 |
| 2×7 | -5.25 | 17.82 | 2.30 | 29.79 | -6.78 | -12.14 |
| 2×8 | **44.90 | *41.64 | 22.65 | **91.61 | 14.26 | -14.46 |
| 3×4 | 22.48 | -29.20 | 7.80 | -20.56 | 11.45 | -7.88 |
| 3×5 | 28.68 | 0.70 | 41.25 | 6.77 | -11.94 | -8.68 |
| 3×6 | **44.62 | -12.11 | 27.95 | 15.82 | -10.25 | -22.84 |
| 3×7 | -20.46 | **47.72 | 28.57 | 34.54 | -34.41 | 29.57 |
| 3×8 | -7.38 | -6.77 | -6.75 | *59.55 | 10.26 | -44.47 |
| 4×5 | **63.60 | 5.89 | -16.66 | 14.23 | **91.45 | -9.39 |
| 4×6 | 29.61 | -18.12 | 8.75 | -27.96 | 18.64 | 10.81 |
| 4×7 | -12.37 | 27.50 | 11.05 | 15.06 | -22.50 | 9.84 |
| 4×8 | 26.11 | -2.09 | 22.54 | -9.45 | -2.71 | 7.40 |
| 5×6 | 6.26 | **39.89 | -19.62 | 26.66 | 38.88 | 9.82 |
| 5×7 | *-27.52 | -27.12 | -15.49 | *-39.90 | -13.77 | 22.03 |
| 5×8 | -3.40 | -2.57 | -9.69 | 0.11 | -1.56 | 4.27 |
| 6×7 | *-23.80 | 23.70 | -3.58 | 11.28 | -23.23 | 9.98 |
| 6×8 | 2.70 | -14.75 | 41.23 | 4.29 | -28.99 | -14.99 |
| 7×6 | -17.51 | 5.83 | 23.80 | 13.65 | *-44.48 | -4.60 |
| SE(H) | 186.3 | 290.8 | 768.8 | 1557.0 | 2.32 | 3.05 |

**2- heterosis cross as a percentage of the best parents.**

Table (3) shows that the plant height showed the hybrid (2× 4). The heterosis of the hybrid was positive and significant in the desired direction. It reached (27.02) at the probability level (5%) in the first density, but in the second density, none of the hybrids reached the limits of statistical significance in the desired direction. Regarding the number of days to flowering, it was not believed that any of the hybrids were moral in the desired direction in the first density, while in the second density the hybrid (1 ×6), (1 ×8), (2 × 7), (4 ×5), (6 × 7) ) ، (6 × 8) and (7 × 8) with a significant negative heterosis for the hybrid in the desired direction, ranging from (-5.17) in the (1 × 6) hybrid to (-0.88) in the (6 × 8) hybrid at the probability level (1 %), and in the description of the number of days per decade, the hybrid (3 × 7) had a significant negative heterosis for the hybrid in the desired direction, reaching (-1.62) at the probability level (5%) in the first density, while in the second density, the two hybrids (1 × 6) and ( 6 × 8) of heterosis for the hybrid, negatively significant in the desired direction, reaching (-2.45) and (-0.81) at the probability level (1%) and in terms of the number of days of physiological maturity, the hybrids are (3 × 4), (3 × 5) ، (3 ×6), (3 × 7), (4 × 6) and (5 × 7) have negative significant heterosis for the hybrid in the desired direction, ranging from (-4.14) in the (3 × 4) hybrid to (-25.0) in the (3 ×8) hybrid. at the probability level (1%), and the two hybrids (2 × 3) and (2 × 4) had a significant negative heterosis for the hybrid in the desired direction, amounting to (-3.14), both at the level of probability (5%) in the first density, but in the second density, the hybrid (1×2), (1×3), (1×7), (2×3), (2×4), (2×5), (2×8), (4×6), (5×6) and (7 × 5) with a significant negative heterosis for the hybrid in the desired direction (-0.62) for the hybrid (2 ×8) to (-25.98) for the hybrid (3× 8) at the probability level (1%), and in terms of the number of branches it was The hybrid (3 × 5) has a positive, significant heterosis for the hybrid in the desired direction, which amounted to (35.18) at the level of probability (5%) in the first density, but in the second density, all hybrids were not significant, and in terms of the number of capsules, the two hybrids (3 ×6) and (4× 6) with a positive and significant heterosis for the hybrid in the desired direction, which amounted to (84.83) and (33.15) at the probability level (1%) in the first density, but in the second density, all crosses were not significant, and in terms of the number of capsule seeds, the hybrids were (1 × 4) ، (5 × 1), (1 ×6) and (2 ×8) with positive and significant heterosis for the hybrid in the desired direction, ranging from (55.18) in the hybrid (1 × 4) to (107.16) in the hybrid (2× 8) at the level of Probability (1%) in the first density as for the third density In the meantime, the hybrid (2 ×7) has a positive and significant heterosis of the hybrid amounted to (64.54) at the probability level (5%) and in the weight of 1000 seeds, the hybrids (1 ×7), (2 × 5), (3 × 5) and ( 3 × 6) with a positive, significant heterosis for the hybrid in the desired direction, ranging from (15.90) in the hybrid (2 × 5) to (13.70) in the hybrid (3× 6) at a probability level (5%) in the first density, but in the second density, the hybrid (2 × 8) with a positive, significant heterosis of the hybrid in the desired direction, amounting to (14.07) at the probability level (5%), and in terms of the seed yield, the two hybrids (1 ×6) and (2 ×5) with a positive, significant heterosis of the hybrid reached (40.69). And (47.09) at the level of probability (1%), and the two hybrids (3 × 6) and (4 × 5) with positive and significant hybrid heterosis reached (29.83) and (44.81) at the level of probability (5%) in the first density while in the second density The hybrid (5 ×6) has a positive, significant heterosis of the hybrid, which amounted to (39.15) at the probability level (1%). Probability (5%), and in terms of biological yield, none of the hybrids reached the statistically significant limits in the desired positive direction of the first density, while in the second density the hybrid was (2 × 8) with strong the trait of the hybrid was positively significant (60.43) at the level of probability (5%) and in the harvest index (%). The hybrid (4 × 5) had a positive, significant heterosis of the hybrid amounting to (84.69) at the level of probability (5%) in the first density, but in the first density In the second, all crosses had non-significant cross heterosis, the hybrid gave (1 ×6) the effects of cross heterosis on the basis of the best parents for more than the number of days flowering, set, number of seed capsules and seed yield, followed by the hybrid (2 × 8) for the number of days to ripening and number of seed capsules and the weight of 1000 seeds and the biological yield. These results agree with a number of researchers for a number of hybrids. [17], [18], [19], [20], [21] and [22].

Table (3) Heterosis at best parentbest parents for the studied traits of the first and second densities

| Hybrid | Plant Height cm | | Number Of Days Flowering 50% | | Number Of Contract Days50% | | Number of days to physiological maturity50% | |
|---|---|---|---|---|---|---|---|---|
| | First Density | Second Density | First Density | Second Density | First Density | Second Density | First Density | Second Density |
| 1×2 | 3.07 | 5.42 | 2.60 | **0.86 | 0 | 0 | -2.51 | **-2.5 |
| 1×3 | 1.30 | 11.08 | 0.87 | **0.90 | **9.01 | **8.19 | -1.24 | **-1.23 |
| 1×4 | -0.81 | 7.76 | 0 | **4.50 | **12.39 | **15.12 | **4.96 | **3.70 |
| 1×5 | 11.40 | 0.22 | 9.25 | **7.20 | **13.11 | **13.93 | **6.83 | **4.32 |
| 1×6 | -3.55 | -5.42 | -1.73 | **-5.17 | 1.09 | **-2.45 | *3.10 | **1.23 |
| 1×7 | -16.18 | -5.08 | 1.73 | **0.86 | **4.09 | **5.23 | -1.86 | **-3.70 |
| 1×8 | 7.87 | 3.02 | -1.80 | **-1.77 | 0 | 0 | -0.62 | **-1.85 |
| 2×3 | -8.96 | 3.17 | 3.50 | **6.30 | **8.26 | **8.33 | -1.88 | **-1.25 |
| 2×4 | *27.02 | 2.33 | 1.70 | 0 | **3.30 | **5.88 | *-3.14 | **-3.12 |
| 2×5 | 6.32 | **-17.04 | 9.25 | **5.40 | **9.91 | **11.66 | *-3.14 | **-1.87 |
| 2×6 | 1.91 | -3.43 | 2.60 | 0 | **8.26 | **10 | **6.91 | **2.5 |
| 2×7 | -5.23 | -3.81 | -6.89 | **-.47 | **3.30 | **5 | 0.62 | 0 |
| 2×8 | *-29.74 | 1.40 | 3.60 | **1.76 | **5.78 | **7.5 | 0 | **-0.62 |
| 3×4 | 14.24 | -6.90 | 0.87 | **3.60 | **5.78 | **6.72 | **-4.14 | **-2.99 |
| 3×5 | 8.26 | 0.37 | 6.48 | 0 | **2.43 | **2.43 | **-7.77 | **-7.26 |
| 3×6 | 4.27 | 2.97 | 0.87 | **5.40 | **7.25 | **8.19 | **-8.42 | **-8.42 |
| 3×7 | -6.72 | -1.62 | 2.63 | 0 | *-1.62 | **0.84 | **-13.96 | **-10.34 |
| 3×8 | 8.10 | 3.17 | 5.40 | **4.50 | **2.41 | **2.43 | **-25 | **-25.98 |
| 4×5 | -2.91 | -2.39 | 2.77 | **-1.80 | **4.95 | **0.84 | 1.18 | **1.79 |
| 4×6 | -8.15 | -5.02 | 2.60 | **3.60 | **6.61 | **7.56 | **-6.50 | **-5.38 |
| 4×7 | -1.49 | 5.53 | 0.86 | **3.60 | **11.57 | **12.60 | **7.10 | **8.38 |
| 4×8 | -2.66 | 1.86 | 4.50 | **4.50 | **12.39 | **15.12 | **6.50 | **6.58 |
| 5×6 | 0.85 | -3.03 | 6.48 | **3.60 | *1.62 | **3.27 | -2.24 | **-3.37 |
| 5×7 | -21.11 | *-10.95 | 8.33 | **6.30 | **5.69 | **8.26 | **-13.20 | **-10.34 |
| 5×8 | -0.3 | -9.82 | 11.11 | **9.90 | **3.25 | **5.69 | 1.89 | **1.69 |
| 6×7 | -12.21 | -9.71 | **-28.99 | **-3.44 | **6.50 | **6.61 | 0.56 | **1.14 |
| 6×8 | -6.14 | -8.63 | 0 | **-0.88 | **2.4 | **-0.81 | 1.13 | **0.56 |
| 7×8 | -13 | -4.35 | 0 | **-1.77 | 0 | 0 | 1.70 | **1.72 |
| SE(H) | 11.58 | 5.31 | 7.85 | 0.37 | 0.78 | 0.078 | 2.36 | 0.25 |

Follow Table (3):

| Hybrids | Number of branches $m^2$ | | Number of Capsules $m^2$ | | Number of Seeds | | Weight of 1000 seeds, gm | |
|---|---|---|---|---|---|---|---|---|
| | First Density | Second Density | First Density | Second Density | First Density | Second Density | First Density | Second Density |
| 1×2 | -17.64 | 0 | **-35.82 | 5.88 | 10.68 | -26.50 | -8.11 | -3.59 |
| 1×3 | -19.11 | -21.31 | **-41.96 | 19.36 | 41.93 | -12.91 | -1.75 | -5.29 |
| 1×4 | -7.35 | -17.91 | **-41.35 | 4.62 | **75.22 | 0.33 | 7.33 | -9.14 |
| 1×5 | 4.44 | -8.19 | **-42.38 | 7.50 | **55.18 | -27.84 | 1.01 | -8.82 |
| 1×6 | 7.35 | -4.92 | **-45.84 | 3.32 | **93.16 | 5.11 | -2.95 | -9.51 |
| 1×7 | -7.35 | -8.19 | 2.04 | 10.18 | **-52.95 | -14.44 | *15.81 | -2.73 |
| 1×8 | 16.17 | -10.95 | -18.61 | -5.10 | 7.60 | 1.24 | 5.08 | -6.85 |
| 2×3 | -14.03 | 14.03 | 13.14 | 36.19 | -31.25 | -19.80 | -5.59 | *-13.83 |
| 2×4 | 15.87 | -1.49 | **-29.64 | 34.50 | 22.57 | -6.87 | 5.71 | -2.69 |
| 2×5 | 1.75 | 31.58 | 9.31 | 47.97 | 14.68 | *-43.34 | *15.90 | *-9.66 |
| 2×6 | -4.54 | 5.42 | 5.37 | 15.61 | 10.76 | 5.16 | -6.16 | -8.83 |
| 2×7 | 10.76 | 17.54 | -7.10 | -33.28 | *-33.96 | *64.54 | -2.97 | 5.88 |
| 2×8 | 8.47 | -8.21 | **-41.23 | -31.16 | **107.16 | 32.72 | 1.008 | *14.07 |
| 3×4 | 3.17 | -0.002 | *-25.07 | -0.07 | 13.43 | *-40.15 | -9.001 | 1.07 |
| 3×5 | *35.18 | 7.14 | 6.79 | -8.96 | -6.57 | 23.05 | *14.11 | -9.15 |
| 3×6 | 1.51 | 15.51 | **84.83 | 0.90 | -39.11 | -2.70 | *13.70 | -7.56 |
| 3×7 | 4.61 | 10.52 | **-29.78 | -16.99 | -23.25 | 31.25 | 1.09 | -10.42 |
| 3×8 | 11.86 | -21.92 | -20.89 | 12.67 | 14.44 | -35.19 | 1.66 | -6.30 |
| 4×5 | -4.76 | 25.92 | -4.38 | 35.49 | -3.98 | -28.44 | -1.36 | *-10.73 |
| 4×6 | -6.06 | 29.30 | **33.15 | 34.85 | -26.06 | -27.62 | *-13.13 | **-18.45 |
| 4×7 | -3.07 | 10.52 | -20.79 | -3.86 | -32.83 | -12.10 | -5.84 | -7.08 |
| 4×8 | 3.17 | -17.05 | -15.38 | 1.14 | -3.87 | -28.72 | -3.62 | -6.33 |
| 5×6 | 7.57 | 12.06 | 20.51 | 39.76 | -27.61 | -4.24 | 4.49 | -4.81 |
| 5×7 | -10.7 | 15.78 | -0.21 | -25.29 | **-47.95 | -22.71 | -2.46 | **-13.04 |
| 5×8 | 22.03 | -26.02 | -11.20 | -4.45 | 1.21 | -13.54 | -1.58 | *-12.23 |
| 6×7 | -9.09 | 15.51 | **-28.76 | -26.02 | -19.22 | 22.26 | -8.99 | -6.94 |
| 6×8 | 6.06 | -2.74 | 2.73 | -22.78 | -1.48 | -11.53 | -2.65 | -3.41 |
| 7×8 | 18.46 | 2.73 | -17.28 | -20.24 | **-38.75 | -1.53 | 14.41 | 6.67 |
| SE(H) | 17.81 | 13.27 | 332.1 | 384.5 | 0.96 | 1.33 | 0.49 | 0.43 |

Follow Table (3):

| Hybrid | Seed Yield kg. h | | Biological Yield kg. h | | Harvest Index % | |
|---|---|---|---|---|---|---|
| | First Density | Second Density | First Density | Second Density | First Density | Second Density |
| 1×2 | -28.46 | -26.39 | *-43.13 | -16.91 | 1.713 | -11.40 |
| 1×3 | -0.06 | 0.06 | -30.22 | 13.60 | -3.01 | -23.03 |
| 1×4 | 9.37 | 14.29 | -20.54 | -30.01 | 35.84 | -11.16 |
| 1×5 | 12.99 | -16.28 | -1.98 | -2.38 | 17.44 | -19.17 |
| 1×6 | **40.69 | 7.83 | 3.65 | 10.78 | -8.12 | -10.34 |
| 1×7 | **-28.69 | 15.71 | -25.78 | 7.21 | -19.05 | -2.74 |
| 1×8 | 11.18 | 11.90 | -0.37 | 33.46 | -21.76 | **-48.46 |
| 2×3 | -23.14 | 3.31 | 12.78 | 34.20 | -22.51 | -26.79 |
| 2×4 | 38.91 | *37.82 | 5.0003 | 14.20 | 20.70 | -11.33 |
| 2×5 | **47.09 | -21.37 | 7.90 | -21.42 | 35.81 | -3.57 |
| 2×6 | 11.21 | 0.30 | -8.46 | -6.86 | 20.59 | 1.57 |
| 2×7 | **-31.30 | -1.77 | -5.20 | -3.60 | -28.32 | -24.76 |
| 2×8 | 29.90 | 9.29 | 11.06 | *60.43 | -4.83 | -18.32 |
| 3×4 | 9.85 | *-36.85 | -1.76 | *-39.33 | -5.34 | -23.31 |
| 3×5 | 26.77 | -12.63 | 16.28 | -11.56 | -27.38 | -14.74 |
| 3×6 | *29.83 | -24.09 | 6.72 | -5.56 | -17.41 | -28.89 |
| 3×7 | **-38.89 | *44.09 | 6.63 | 9.83 | *-40.9 | 6.30 |
| 3×8 | -9.94 | -17.30 | -8.99 | 49.95 | 9.86 | **-44.80 |
| 4×5 | *44.81 | 2.58 | -25.58 | 3.003 | *84.69 | -19.95 |
| 4×6 | 5.72 | -21.08 | -1.44 | -33.86 | 8.63 | -0.89 |
| 4×7 | **-37.53 | 16.33 | 0 | 5.48 | *-39.54 | 7.84 |
| 4×8 | 10.33 | -2.72 | 14.20 | -27.58 | -17.62 | 10.15 |
| 5×6 | -3.31 | **39.15 | -20.93 | 24.18 | 23.09 | 8.31 |
| 5×7 | **-43.73 | *-35.38 | -16.24 | -40.98 | -34.43 | 6.10 |
| 5×8 | -4.68 | 5.02 | -24.18 | -12.58 | -19.05 | -2.10 |
| 6×7 | **-36.21 | 9.17 | -4.26 | 11.10 | -35.73 | -3.22 |
| 6×8 | -5.40 | -17.31 | 20.18 | -10.46 | -34.87 | -21.22 |
| 7×6 | -35.34 | -4.006 | 4.73 | -2.29 | *-49.81 | -21.37 |
| SE(H) | 215.09 | 335.82 | 887.7 | 1818.7 | 2.68 | 3.53 |

## References


[1] Gulla, B., Jadhav, V., & Dudhare, M. S. (2021). Assessment of genetic diversity and physiochemical analysis of linseed (*Linum usitatissimumL.*) genotypes. TPI 2021; 10(2): 328-331.

[2] Rajanna, B., Gangaprasad, S., Shanker Goud, I., Dushyantha Kumar, B. M., Girijesh, G. K., & Sathish, K. M. (2020). Genetic variability, heritability and genetic advance of yield components and oil quality parameters in linseed (*Linum usitatissimum* L.). IJCS, 8(1), 1768-1771.

[3] Aziz, M Jassim and Yaser H. Homadia .(2019).Combining ability and heterosis of qualitative traits in bread (*Triticum aestivum* L.) wheat. Journal of Kirkuk Univercity for Agricultural Sciences… Vol (10) No. (1) 2019.

[4] Hassan, Ahmed Abdel Moneim. (2012). Basics of plant breeding. The Arab House for Publishing and Distribution, the second administrative.

[5] Esmail, Akram Othman, Haifa Sadik Yaseen Akrawi and Bahar Jalal Mahmood.(2018). Effect of levels of phosphorus and iron on growth, yield and quality of flax (*Linum usitatissimum L.*). Journal of Kirkuk university for agricultural scince .Vol (9) No. (3) 2018.

[6] Shaker, Ayad T.(2020). The effect of zinc fertileizer and seeding rates on growth and yield of flax (*Linum usitatissimum* L.). Journal of Kirkuk university for agricultural scince Vol (11) No. (1) 2020.

[7] Al-Zaid, Abdulkadir Hamidi Jassim. (2021). The genetic indications of half-exchange hybrids and the stability of (*Linum usitatissimum L).* under the influence of different environments. Doctoral thesis, Field Crop Department, Faculty of Agriculture, Tikrit University

[8] Habib, Hiam Sabah. (2021). Genetic systems inheritance pattern and hybrid power in Linum (*Linum usitatissimum L*). Master's thesis, Faculty of Science, University of Kirkuk.

[9] Jabbar , Luma Jaleel , Mohamed.(2022). Genetic variations, corrlations, and path analysis of flax (*Linum usitatissimumL.*) genotypes at different concentration of NPK nano complex fertilizer. Journal of Kirkuk university for agricultural scince Vol (14) No. (4) 2022 .

[10] Abadi, Ryan Fadil Ahmed (2021). The impact of the seed rate, planting dates and composted fertilizer on growth, yield and some qualitative qualities of Linum (*Linum usitatissimum L.*). PhD thesis. Faculty of Agriculture and Forestry/Mosul University.

[11] S.Kuldip Singh , H.K.L.Chaudhary.(2007). (Deceased) on 9March.

[12] Aziz, Mohamed Jassim and Yaser H. Homadia .(2019). Combining ability analysis using half diallel cross in wheat (*Triticum aestivum* L.). Journal of Kirkuk Univercity for Agricultural Sciences… Vol (10) No. (3) 2019.

[13] Mishra, R.; S., Marker.; V., Bhatnagar and D., Mahto, (2013). Combining ability and heterosis for seed yield and its component in linseed (*Linum usitatissimum L.*). Advances in Life Sciences, Vol. 2, May, 44-47.

[14] Pali, V. I. K. A. S., & Mehta, N. A. N. D. A. N. (2014). Combining ability and heterosis for seed yield and its attributes in linseed (*Linum usitatissimum* L.). *The Bioscan*, *9*(2), 701-706.

[15] Yadav P. C., Yadav R.K., Dubey S.D., Singh H.C., Vishwanath, Yogesh P. and Sanjeev K. (2018).Study on generation mean analysis for seed yield and Its associated Traits in linseed (*Linum usitatissimum* L.). International Journal of Microbiology Research, Vol. 10 ( 3) pp.-1027-1034.

[16] Shanti Bhushan , Sanjay Kumar, Sunil Kumar, Vinay Kumar Choudhary, Anuj Kumar Choudhary and Sohan Ram.(2021) The study of heterosis and inbreeding depression for seed yield and its attributes in linseed (*Linum usitatissimum* L.). The pharma innovation jouranal ;10(10): 2265-2270.

[17] Kumar1, A., Kumar2 J., Tomar K. P. S. and Sharma P. K. (2018). Estimate heterosis for yield and yield components in linseed (*Linum usitatissimum* L.) Germplasm. Int. J. Curr. Microbiol. App. Sci 7(2): 1602-1611.

[18] Prasad, B. H. V., and Manapure, P. (2016). Screening of Linseed Genotypes for Seed Yield Against Alternaria Blight and Budfly. Advances in Life Sciences 5(7), Print: ISSN 2278-3849, 2787-279.

[19] Dhirhi, N., Mehta, N., and Singh, S. (2018). Estimation of heterosis for seed yield and its attributing traits in linseed (*Linum usitatissimum L.*). Int. J. Curr. Microbiol. App. Sci, 7(11), 2332-2341.

[20] Chaure PL., Dhone PU., Mahajan M. M. and Misal AM.(2018). Studies on heterosis for yield and yield components in linseed (*Linum usitatissimum* L.). Journal of Pharmacognosy and Phytochemistry. 7(1): 1331-1334. [21] Pradeep K., Kamboj G., Kumar R. and Singh P. K. (2018). Estimation of heterosis for seed yield, morphological traits and alternaria blight resistance in linseed (*Linum usitatissimum* L.), Int. J. Pure App. Biosci. 6(2): 664-669.

[22] Sallam, Ibrahim Mahmoud Abo-AGila. (2016). Estimation of some genetical parameters of some flax hybrids under delta soil conditions.Ph.D Thesis, University of Agriculture,Benha.pp:125.

[23] Reddy M.P., Reddy B.N., Arsul B.T. and Maheshwari J.J. (2013). Genetic variability, heritability and genetic advance of growth and yield components of linseed (*Linum usitatissimum L.*) Int. J. Curr. Microbiol.App. Sci 2(9): 231-237.

مجلة جامعة كركوك للعلوم الزراعية

# تقدير قوة الهجين لتراكيب وراثية من *الكتان* .Linum Usitatissimum L في تضريبات تبادلية نصفية

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**المستخلص**

استخدمت في هذه الدراسة ثمانية تراكيب وراثية من الكتان (.Linum Usitatissimum L) وهي (سخا1 وسخا2 وسخا3 وسخا5 وسخا6 وسوري وجيزة وبولوني ) وهجائنها التبادلية النصفية التي تم الحصول عليها وفق الطريقة الثانية الذي اقترحها كرفنك Griffing (1956). زرعت التراكيب الوراثية (8 اباء+28 هجينا) في حقول كلية الزراعة / جامعة كركوك في الموسم الشتوي (2021–2022) وفق القطاعات العشوائية الكاملة (RCBD) بثلاث مكررات لدراسة الصفات المدروسة (ارتفاع النبات و عدد الايام الازهار50% و عدد الايام العقد 50% و عدد الايام النضج الفسيولوجي و عدد الافرع و عدد الكبسولات و عدد البذور الكبسولة و وزن 1000 بذره و الحاصل البيولوجي و الحاصل البذور و دليل الحصاد). تفوقت الهجن (سخا5×سخا6) و(سخا1×جيزة8) و(سخا1×بولوني) بقوة الهجين على اساس انحراف الجيل الثاني لمتوسط الابوين بالاتجاه المرغوب في عدد الايام الى الازهار والعقد والنضج وحاصل البذور ودليل الحصاد ، الهجين (سخا2×بولوني) تفوق في قوة الهجين على اساس انحراف الجيل الثاني لافضل الابوين لصفات عدد الايام الازهار والعقد والنضج وعدد البذور بالكبسولة وحاصل البايلوجي، تمكن متابعة الاجيال الانعزالية والانتخاب وفق الطريقة التربية التي يحددها الفعل الجيني لهذه الصفات .

**الكلمات المفتاحية:** الكتان، التهجين التبادلي النصفي، قوة الهجين، التراكيب الوراثية.