ESTIMATION SOME GENETIC PARAMETERS, COMBINING ABILITY AND HETEROSIS IN PEA (Pisum sativum) USING HALF DIALLEL CROSS.

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ABSTRACT
Experiment of half diallel cross among six pea cultivars was conducted during may 2013. The varietal trials for F1 cross and parents with control were carried out during spring 2015 at the field college of agriculture, university. Duhok using Randomize Complete block Design with three replication. The results were revealed that the general combining ability, and specific combining ability showed significant variance for all traits except days to 50% flowering, No. of plant1 and 50-grain weight. Also, heritability in broad sense exhibited high value of whole studied traits except days to 50% flowering, whereas the heritability in narrow sense gave high value for dry weight plants and 50-grain weight, while chlorophyll exhibited moderate value and other traits gave low value of heritability.

KEY WORDS: Genetic parameters, Combining ability, Heterosis, pea (Pisum sativum), Half diallel cross

INTRODUCTION

Pea (Pisum sativum L.) Pea is a self-pollinated crop, diploid having 14 chromosome (2n=14). Pea is originated in Near East and Mediterranean regions. It is one of the most world's oldest crops cultivated as early as 9,000 years ago for human foods and animals feed (Canada, 2010). Peas is one of the four of the most important cultivated legume and largest world's legume crop in the production after soybean, peanuts and dry beans (Yoshida et al., 2007 and Smykal et al., 2012). Pea genomics has well been studied ever in since, pioneering work of Gregor Mendel in nineteenth century. Pea have certain features such as easy of cultivations, distinguishable phenotypic characters that infuriate Mendel to choose pea for his experimental study and maintain the pea as a main focus of modern genetic analysis. Many morphological traits have a simple inheritance and played a great role in increasing of pea quality and quantity (Samatadze et al., 2008). An access to wide range of cultivars and have many variability in the germplasm collection ensures better chance of producing new varieties by breeders (Pallavi et al., 2013). The most powerful tool, is diallel analysis for characterizing the genetic architecture, for plant materials and estimating the general combining ability of parent and the selection of high specific combining ability for the exploitation of heterosis (Sarker et al., 2002). Diallel analysis is helpful for intersecting the suspect of the GCA and SCA. This analysis is very helpful to predict additive and dominance effects of a population which can then be used to predict the genetic variability and heritability (Syukur et al., 2010). Al-Hamdany, (2014) reported that the General Combining Ability was significant for plant height, seed yield, 100 seed weight and pods weight but non-significant for seeds pod1, while SCA for most characters was significant in pea. Tawfiq. and Abdulla. (2014) carried out genetic analysis between seven pea in a half diallel crosses and showed that the variance due to specific combining ability was larger than that of general combining ability height, number of branches plant1 except number of days to 50% flowering, while the GCA:SCA variance ratio to be more than one in most studied traits, indicat the importance of additive gene effect in the inheritance of all characters. When a hybrid has high heterosis it is assumed that the two parents are more genetically diverse than the parents of hybrids with low or no heterosis, (Hallauer and Filho, 1988). Kosev,(2014) conducted a field
study on breeding and genetic assessment of some quantitative characters in pea and showed the highest positive value of heterosis for number of seeds pod\(^{-1}\), plant height and (Tawfiq and Abdulla, 2014) obtained negative heterosis for number of days to 50% flowering, when study the genetic analysis of pea. The main objective of the present study is to determine the hybrid which have high yield by using half diallel cross and estimate the effect of general combining ability for parents and specific combining ability for hybrids, and some genetic parameters.

**MATERIAL AND METHODS**

This study was conducted out at experimental at the field College of Agriculture, University of Duhok, from period Nov 2013-May 2015, using six cultivars of pea, according to (table 1).

| No. | Cultivar name          | Source of seeds |
|-----|------------------------|-----------------|
| 1   | Tendrilla              | UK              |
| 2   | Hurst green            | UK              |
| 3   | Jumbo                  | UK              |
| 4   | Boogie                 | UK              |
| 5   | Kelv edoa              | UK              |
| 6   | Local cultivar (Determinate) | Duhok university |

Six cultivars seeds and 12 hybrids were taken from first year Nov 2013, in next season on the 20\(^{th}\) of November 2014, the F\(_1\) hybrids with parents were arranged in Randomized Complete Block Design (R.C.B.D) with three replication in experimental field, each block was consisted of 18 treatment (6 parents + 12 hybrids). Each cultivars planted in (rows) of 2.5m (long) at 75cm between rows (1 row for dry seed yield and 2 other rows for vegetative measurement). One seed per hole were sown with spacing 25cm between plant to plant in rows.

At maturity three individual plants were taken at random from each entry and data for the following traits were recorded: day to 50 % flowering, plant hight (cm), number of branches plant\(^{-1}\), number of pods plant \(^{-1}\), number of seeds pods\(^{-1}\), dry seeds yield plant\(^{-1}\) 100 dry seed weight(g) and total chlorophyll percentage (it was determine by chlorophyll measurement device((chlorophyll meter)) spad-502 plus.. Heterosis was calculated for the F\(_1\) according to mid parents using:

\[
\text{Heterosis}(H)\% = \frac{\overline{F1} - \overline{M.P}}{\overline{M.P}} \times 100
\]

Where:
\( \overline{F1} \) =Mean of hybrid
\( \overline{M.P} \) =Mid-parents
\( M.P = \frac{P1 + P2}{2} \)

Analysis of variance for combining ability and additive (\(\sigma^2 A\)), dominance (\(\sigma^2 D\)) and environmental (\(\sigma^2 E\)) were calculated according to (Griffing, 1965) method I, fixed model where:

\[
\sigma^2 A = 2\overline{G.C.A}
\]

\[
\sigma^2 D = \overline{S.C.A}
\]

\[
\sigma^2 E = Mse \times r
\]

**Heritability:**

Broad and narrow sense heritability was estimated depending on the mean square of general and specific combining abilities, and experimental error according to (Singh and Chowdhry, 1985).

\[
h^2. b.s = \frac{\sigma^2 G}{\sigma^2 P} = \frac{\sigma^2 A + \sigma^2 D}{\sigma^2 A + \sigma^2 D + \sigma^2 e} = \frac{2\sigma^2 gca + \sigma^2 sca}{2\sigma^2 gca + \sigma^2 sca + \sigma^2 e}
\]
Broad sense heritability considered high when it is more than 60%, it is medium between 40% - 60% and low when it is less than 40% (Ali, 1999).

\[ h^2. \text{n.s} = \frac{\sigma^2_A}{\sigma^2_P} = \frac{\sigma^2_A}{\sigma^2_A + \sigma^2_D + \sigma^2_e} = \frac{2\sigma^2_gca}{2\sigma^2_gca + \sigma^2 sca + \sigma^2 e} \]

Narrow sense heritability considered high when it is more than 50%, medium in the range 20% - 50% and low when it is less than 20% (2).

Where:
- \( h^2. \text{b.s} \) = Heritability in broad sense.
- \( h^2. \text{n.s} \) = Heritability in narrow sense.
- \( \sigma^2_{gca} \) = The variance of general combining ability.
- \( \sigma^2_{sca} \) = The variance of the effect of specific combining ability.
- \( \sigma^2_e \) = The variance of the effect of experimental error i.e. environmental variance.
- \( \sigma^2_A \) = Additive genetic variance.
- \( \sigma^2_D \) = Dominance genetic variance.
- \( \sigma^2_G \) = Total genetic variance.
- \( \sigma^2_P \) = Phenotypic variance (genetic and environmental variance).

To estimation the average degree of dominance (\( \bar{a} \)):-

\[ \bar{a} = \frac{2\sigma^2 D}{\sigma^2 A} = \frac{2\sigma^2 sca}{2\sigma^2 gca} = \frac{\sigma^2 sca}{\sigma^2 gca} \]

If \( \bar{a} = 0 \) indicated no dominance.
If \( \bar{a} < 1 \) indicated partial dominance.
If \( \bar{a} = 1 \) indicated complete dominance.
If \( \bar{a} > 1 \) indicated over dominance.

The average degree of dominance (\( \bar{a} \)) :-

\[ \bar{a} = \frac{2\sigma^2 D}{\sigma^2 A} = \frac{2\sigma^2 sca}{2\sigma^2 gca} = \frac{\sigma^2 sca}{\sigma^2 gca} \]

RESULT AND DISCUSSION

Table (2) shows that the analysis of variance of genotypes (cultivars+ hybrids) significant for all traits except 50 grain weight and days to 50% flowering traits.

General combining ability was substantially significant for whole traits with exception 50 grain weight, NO. of pod plant\(^1\) and days to 50% flowering. Similar finding were recorded by Similar findings were reported by (Mitu et al., 2004 and Borah, 2009).

The specific combining ability was significant in all traits except 50 grain weight and days to 50% flowering. These results are in agreement with (Bisht and Singh, 2011and Dagla et al., 2013).
Table (2): Mean square of variance analysis of GCA and SCA for cultivars, F1 half diallel crosses for studied traits in pea.

| Source of variation | Characters | Grain yield plant \(^{-1}\) | No. of grain pod \(^{-1}\) | Weight plant \(^{-1}\) | No. of tillers | Plant Height cm | Chlorophyll | No pod plant \(^{-1}\) | 50-grain Weight (g) | Days to %50 Flowering |
|---------------------|------------|-----------------------------|---------------------------|---------------------|----------------|----------------|-------------|-------------------|-----------------|-------------------|
| Replication         |            |                             |                           |                     |                |                |             |                   |                 |                   |
|                      |            | 29.95                       | 0.00                      | 84.48               | 1.01           | 125.08         | 30.60       | 0.01              | 0.00            | 9.63              |
| Genotypes           |            | 347.05**                    | 1.78**                    | 2143.52**           | 1.23**         | 90.39**        | 87.11**     | 330.71*           | 0.00            | 17.09             |
| GCA                 |            | 111.42**                    | 2.93**                    | 3280.87**           | 1.24*          | 83.58**        | 112.03**    | 44.07             | 0.00            | 2.51              |
| SCA                 |            | 425.59**                    | 1.40*                     | 1764.40**           | 1.23**         | 92.66**        | 78.81**     | 426.25*           | 0.00            | 21.95             |
| \(\sigma^2\)        |            | 15.93                       | 0.61                      | 76.80               | 0.36           | 18.16          | 5.64        | 21.20             | 0.00            | 11.43             |

Table (3) Revealed the mean value of parents and their hybrids for nine traits. In grain yield traits show that parent (5) and hybrid (1x5) gave high values (41.20) and (66.87) respectively. The heighest no. grain pod given by parent (4) and hybrid (2x4) give (8.13) and (8.80) respectively. It can be noticed that parent (5) was the highest for weight/plant and give (132.63) and (145.30) for hybrid (3x5). The large no of tiller was produced from parent (2) and hybrid (3x6) gave (3.40) and (4.80) respectively. The result provide that parent (2) had the value (77.00) and (2x4) while the longest hybrid which gave (76.30). The highest percentage of chlorophyll was given by parent (6) (45.00) and hybrid (1x2) (55.33). The largest no of pod/plant was reached (33.13) height by parent (5) and (52.30) by hybrid (1x2). The highest 50-grains weight was obtained (18.60) in parent (2) and (71.70) in hybrid (3x6). From the results above the parent (4) and hybrid (2x3) gave (136.67) and (138.67) respectively. These results were in agreement with those of (Sarawat et al., 1994 and Brar et al., 2012).
To evaluate the parents and hybrids according to their combining ability. The effect of general combining ability for hybrids was estimated in table (4). It is obvious that parent (1) was good combiner for No of grain pod^{-1} and chlorophyll. And its effect was negatively significant for grain yield plant^{-1}, weight plant^{-1}, No. of tillers, plant height and flowering of 50%. On the other hand parent (2) was significantly good combiner in the desirable direction with No. of tillers, height of plant, No of pod plant^{-1} and flowering of 50%, but it was significant in an un desirable direction with No. of grain pod^{-1} and chlorophyll. It was found that parent (3) had significant gca effect for grain plant^{-1}, No of grain pod^{-1}, No of tillers and in the un desirable direction for height of plant, chlorophyll and No. pod plant^{-1}. As for parent (4) its general combining ability was toward the desirable direction for grain yield plant^{-1} and No. of grain pod^{-1} and revealed un desirable direction for No. of tillers, chlorophyll and No. pod plant^{-1}. It was noticed that parent (5) was significantly good combiner for grain yield plant^{-1}, weight plant^{-1} and No pod plant^{-1} and in an un desirable direction for No. grain pod^{-1}, No of tillers and chlorophyll. It was found that parent (6) had significant desirable gca effect for weight plant^{-1}, No. of tillers and chlorophyll and in the un desirable direction for grain yield plant^{-1}, No of grain pod^{-1} and height of plant.

Table (3): Mean parents and hybrids for various studied characters.

| Characters       | Grain yield plant^{-1} | No. of grain pod^{-1} | Weight plant^{-1} | No. of tillers | Height of Plant | Chlorophyll | No. of pod plant^{-1} | Weight of 50% grain | Flowering of %50 |
|------------------|------------------------|-----------------------|--------------------|----------------|-----------------|-------------|-----------------------|---------------------|-------------------|
| 1                | 27.63                  | 8.10                  | 66.63              | 2.90           | 70.43           | 41.80       | 15.63                 | 12.22               | 131.67            |
| 2                | 31.73                  | 7.13                  | 98.30              | 3.40           | 77.00           | 36.13       | 26.00                 | 18.58               | 134.00            |
| 3                | 37.90                  | 7.93                  | 76.63              | 2.77           | 66.50           | 32.93       | 11.10                 | 18.39               | 133.33            |
| 4                | 39.20                  | 8.13                  | 88.60              | 2.67           | 70.43           | 29.53       | 20.93                 | 15.34               | 136.67            |
| 5                | 41.20                  | 6.13                  | 132.63             | 2.33           | 67.23           | 36.20       | 33.13                 | 15.40               | 132.33            |
| 6                | 39.23                  | 7.43                  | 106.60             | 3.23           | 65.93           | 45.00       | 28.63                 | 16.94               | 133.67            |
| 1x2              | 66.87                  | 7.50                  | 108.60             | 3.70           | 64.30           | 50.33       | 52.30                 | 9.64                | 133.00            |
| 1x3              | 26.90                  | 8.43                  | 63.30              | 2.80           | 68.93           | 47.40       | 28.63                 | 8.57                | 132.33            |
| 1x4              | 40.00                  | 8.50                  | 90.00              | 2.93           | 61.13           | 43.53       | 39.10                 | 7.92                | 135.33            |
| 1x5              | 32.80                  | 7.93                  | 71.63              | 2.27           | 59.60           | 46.53       | 26.00                 | 12.18               | 137.67            |
| 1x6              | 26.23                  | 7.30                  | 60.00              | 2.93           | 62.13           | 47.40       | 21.80                 | 10.24               | 138.00            |
| 2x3              | 32.55                  | 7.60                  | 99.93              | 3.17           | 61.30           | 37.10       | 20.80                 | 12.38               | 138.67            |
| 2x4              | 43.30                  | 8.80                  | 114.57             | 4.50           | 76.30           | 43.73       | 31.60                 | 16.85               | 133.00            |
| 2x5              | 38.50                  | 8.30                  | 118.30             | 3.57           | 72.23           | 46.20       | 28.30                 | 13.44               | 137.33            |
| 2x6              | 27.83                  | 5.63                  | 85.00              | 3.13           | 62.63           | 39.53       | 17.43                 | 17.45               | 137.33            |
| 3x4              | 47.40                  | 8.30                  | 66.63              | 2.73           | 60.30           | 46.07       | 23.63                 | 15.80               | 135.00            |
| 3x5              | 50.80                  | 8.30                  | 145.30             | 3.87           | 61.80           | 42.30       | 36.13                 | 18.69               | 136.00            |
| 3x6              | 60.70                  | 8.10                  | 143.30             | 4.80           | 68.63           | 39.60       | 49.80                 | 70.17               | 136.67            |
| 4x5              | 44.13                  | 8.30                  | 109.93             | 2.80           | 66.93           | 35.83       | 24.50                 | 18.74               | 135.00            |
| 4x6              | 35.23                  | 7.63                  | 124.93             | 2.70           | 56.80           | 44.60       | 24.63                 | 16.76               | 131.00            |
| 5x6              | 49.70                  | 7.30                  | 104.93             | 3.20           | 71.50           | 42.53       | 41.30                 | 12.85               | 131.33            |

L.s.d %5 6.59 1.29 14.46 0.99 7.03 3.92 7.60 427.87 5.58
Hybrid (1x2) showed specific combining ability effect in the desirable direction for grain yield plant$^1$, weight plant$^1$, No. of tillers, chlorophyll and No. of pod plant$^1$ and in un desirable direction only for height of plant.

The effect of sca in hybrid (1x3) is show significant in desirable direction for No. of grain pod$^1$, plant height and chlorophyll and in un desirable direction for grain yield plant$^1$, No. of tillers plant$^1$ and days to 50% flowering. It was observed that hybrid (1x4) has a specific combining ability effect in desirable direction for grain yield plant$^1$, No of tillers plant$^1$ and No. pod plant$^1$ and in un desirable direction for height of plant. Hybrid (1x5) showed specific combining ability effect in the desirable direction for No. of grain pod$^1$, chlorophyll and flowering 50%. Hybrid (1x6) showed sca effect in the desirable direction for flowering 50% only and in un desirable direction for grain yield plant$^1$, No. of grain pod$^1$, No of tillers and No. of pod plant$^1$. Hybrid (2x3) recorded specific combining ability effect in desirable direction for flowering 50% only and in the un desirable direction for all traits except weight$^1$plant and weight of 50 grain. As for hybrid (2x4) it had specific combining ability effect for all studied traits except weight of 50 grain had no significant and flowering 50% in the

un desirable direction. Hybrid (2x5) had sca effect in desirable direction for No. of grain pod$^1$, No of tillers and chlorophyll. Hybrid (2x6) had specific combining ability effect in the un desirable direction for all studied traits except weight of 50 grain and flowering 50%. The effect of specific combining ability in hybrid (3x4) is show negatively un desirable direction for No. of grain pod$^1$, weight plant$^1$, No. of tillers and height of plant, but it was in the desirable direction for chlorophyll only. Hybrid (3x5) had sca effect in the desirable direction for all studied traits except weight of plant, weight of 50 grain and flowering 50%. The specific combining ability effect for hybrid (3x6) show positively desirable direction for all traits except chlorophyll and flowering 50% and hybrid (4x5) show positive combining ability in the desirable direction only for grain yield plant$^1$ and No. of grain pod$^1$. Hybrid (4x6) had sca effect in un desirable direction for all studied traits except No. of pod plant$^1$ and weight 50 grain and in desirable direction only for chlorophyll. It was noticed that hybrid (5x6) had sca effect in desirable direction for No. of grain pod$^1$, No. of tillers and chlorophyll. These results are in agreement with other researchers (Ceyhan and Avci, (2005); Al –Hamdany, (2014) and Dixit, (2003).

### Table (4): Estimation of general and specific combining ability effects of parents and hybrids for studied characters.

| Characters | Grain yield plant$^1$ | No. of grain pod$^1$ | Weight plant$^1$ | No. of tillers | Height of Plant cm | Chlorophyll | No.pod plant$^1$ | Weight of 50 grain | Flowering of %50 |
|------------|-----------------------|----------------------|------------------|---------------|-------------------|-------------|------------------|------------------|------------------|
| Genotypes |                       |                      |                  |               |                   |             |                  |                  |                  |
| 1          | 3.55-                 | 0.19                 | 19.88-           | 0.21-         | 0.65-             | 3.32        | 0.36             | 32.30-           | 0.53-            |
| 2          | 0.49-                 | 0.28-                | 2.15             | 0.34-         | 3.58              | 0.39-       | 0.77             | 28.06-           | 0.43-            |
| 3          | 2.21                  | 0.29                 | 1.76-            | 0.09-         | 1.03              | 1.74-       | 1.88             | 57.81-           | 0.18-            |
| 4          | 1.50                  | 0.44                 | 0.32-            | 0.14-         | 0.02              | 2.43-       | 1.36-            | 28.08-           | 0.15-            |
| 5          | 1.43                  | 0.22                 | 16.40            | 0.22-         | 0.15              | 0.50-       | 1.70             | 27.57-           | 0.06-            |
| 6          | 1.10-                 | 0.42                 | 3.40             | 0.14          | 1.77              | 1.73        | 0.42             | 58.20-           | 0.01-            |
| SE (g-i-g) | 0.55                  | 0.02                 | 2.67             | 0.01          | 0.63              | 0.20        | 0.74             | 2334.53-         | 0.40-            |
| 1x2        | 31.79                 | 0.18                 | 28.30            | 0.41          | 4.45              | 5.56        | 23.59            | 22.51-           | 1.83-            |
| 1x3        | 10.88                 | 0.19                 | 13.10            | 0.25-         | 4.78              | 3.98        | 2.57             | 64.43-           | 2.24-            |
| 1x4        | 2.93                  | 0.11                 | 12.16            | 0.13          | 4.06              | 0.80        | 12.52            | 20.81-           | 1.09-            |
| 1x5        | 4.20                  | 0.20                 | 22.93            | 0.47-         | 5.42              | 1.88        | 3.64             | 24.57-           | 3.21-            |
| 1x6        | 8.24-                 | 0.24                 | 21.56            | 0.16-         | 1.27              | 0.51        | 6.55             | 63.14-           | 3.59-            |
| 2x3        | 8.29-                 | 0.17                 | 1.51             | 0.43-         | 7.07              | 2.61-       | 5.68             | 64.86-           | 3.13-            |
| 2x4        | 3.17                  | 0.88                 | 14.70            | 1.14          | 6.88              | 4.71        | 4.61             | 25.50-           | 2.20-            |
| 2x5        | 1.55-                 | 1.04                 | 1.72             | 0.28          | 2.98              | 5.25        | 1.75             | 21.59-           | 1.92-            |
| 2x6        | 9.70-                 | 1.44                 | 38.58-           | 0.51-         | 5.00              | 3.65-       | 11.34            | 60.17-           | 1.96-            |
Table (5) Exhibited the additive, dominance, environment and phenotypic variance. It is noticed that dominance genetic variance were higher than additive genetic variance in all studied characters.

| Variance       | Grain yield plant $^1$ | No. of grain pod $^1$ | Weight plant $^1$ | No. of tillers | Height of Plant | Chlorophyll | No.pod plant $^1$ | Weight of 50 grain | Flowering of %50 |
|----------------|------------------------|-----------------------|-------------------|----------------|----------------|-------------|-------------------|-------------------|-----------------|
| $\sigma^2$ A   | 15.83                  | 0.01                  | 0.00              | 0.00           | 7.43           | 19.65       | 0.19              | 0.00              | 0.14            |
|                | 6.86 ± 0.18 ± 201.71 ± | 0.08 ± 0.08 ± 016±   | 6.89± 2.77± 3509.10±| 0.35±          |            |            |                  |                  |                 |
| $\sigma^2$ D   | 136.55                 | 0.26                  | 562.53            | 0.29           | 24.84          | 24.39       | 135.32            | 2201.29           | 3.50            |
|                | 57.93 ± 0.20 ± 240.19 ±| 0.17 ± 12.71± 10.74± | 58.03± 0.00      | 3.14±          |            |            |                  |                  |                 |
| $\sigma^2$ E   | 5.41                   | 0.20                  | 25.60             | 0.12           | 6.05           | 1.88        | 7.07              | 22411.51          | 3.81            |
|                | 4.11 ± 0.16 ± 19.83±   | 0.09± 4.69± 1.46±    | 5.47± 0.00       | 2.91±          |            |            |                  |                  |                 |
| $\sigma^2$ p   | 157.69                 | 0.48                  | 18411.20          | 0.41           | 38.32          | 45.92       | 142.99            | 0.00              | 7.45            |

Table 6) Estimate the average of degree dominance and heritability in broad and narrow sense. Average degree of dominance were more than one for all studied traits except weight plant$^1$ and 50-grain weight. The heritability in broad sense show high value in all studied traits except flowering of 50% showed moderate heritability similar record found by (Singh et al., (2007); Pallavi et al., (2013) and Tawfiq and Abdulla, (2014)).

It is noticed that the heritability in narrow sense showed high value in weight plant$^1$ and weight of 50 grain and chlorophyll showed moderate heritability and other traits showed low heritability. These results are similar to the finding obtained by (Ceyhan and Avci, 2005).

| characters | Grain yield plant $^1$ | No. of grain pod $^1$ | Weight plant $^1$ | No. of tillers | Height of Plant | Chlorophyll | No.pod plant $^1$ | Weight of 50 grain | Flowering of %50 |
|------------|------------------------|-----------------------|-------------------|----------------|----------------|-------------|-------------------|-------------------|-----------------|
| A          | 2.94                   | 5.31                  | 0.18              | 14.68          | 1.83           | 1.11        | 12.20             | 0.06              | 5.03            |
| h.b.s      | 0.97                   | 0.57                  | 1.00              | 0.71           | 0.84           | 0.96        | 0.95              | 0.96              | 0.49            |
| h.n.s      | 0.10                   | 0.02                  | 0.97              | 0.00           | 0.19           | 0.43        | 0.01              | 0.96              | 0.02            |
| GA         | 2.22                   | 0.02                  | 231.18            | 0.00           | 2.11           | 5.10        | 0.13              | 1345.48           | 0.09            |

(*) Additive genetic variance negative, then equal zero.
Table (7) show the estimation of heterosis for the studied traits that are calculated according to the differences between the average value of the hybrids and the mean parent value. For the grain yield plant \(^1\) it is clearly observed that significant and positive heterosis at 5% existed for six hybrids (1x2, 2x4, 3x4, 3x5, 3x6 and 5x6) and at 1% level for one hybrid only (1x4).

As for No. of grain pod \(^1\) and weight plant \(^1\) traits did not attain to significant level for all hybrids and gave positive and negative values. In the case for the No. of tillers hybrid 1x4 gave a significant and positive increase at level 1% six hybrid gave significant in desirable direction at 5% (1x2, 2x4, 3x4, 3x5, 3x6 and 5x6). Hybrid 1x4 showed significant heterosis but in undesirable direction at level 1% for height at plant and three hybrid (2x4, 3x6 and 5x6) showed significant increase in desirable direction at level 5%, while the hybrid (1x2, 3x4 and 3x5) showed significant decrease in undesirable direction at level 5%.

For chlorophyll trait five hybrids show significant increase in desirable direction at level 5% (1x2, 3x4, 3x5, 3x6 and 5x6), while hybrids (1x4 and 2x4) show significant increase in desirable direction at level 1%. The similar results were found by (Ceyhan et al., (2008); Patil et al., (2011); Rai and Mishra, (2013) and (Yoshida et al., 2007).

### Table (7): Estimation of heterosis at mid parents for hybrids by half diallel crosses.

| Characters         | Grain yield plant \(^1\) | No. of grain pod \(^1\) | Weight plant \(^1\) | No. of tillers | Height of Plant | Chlorophyll | No pod plant \(^1\) | Weight of 50 grain | Flowering of %90 |
|--------------------|--------------------------|------------------------|---------------------|----------------|----------------|-------------|---------------------|-------------------|------------------|
| hybrids            |                         |                        |                     |                |                |             |                     |                   |                  |
| 1x2                | 125.27 **                | 1.53-                   | 31.69               | 17.46 **       | 12.77- **      | 29.17 **    | 151.24              | 37.40-            | 0.13             |
| 1x3                | 17.90                    | 5.20                    | 11.63               | 1.18-          | 0.68           | 26.85       | 114.21              | 43.98-            | 0.13             |
| 1x4                | 19.70*                   | 4.72                    | 15.95               | 5.39 *         | 13.20- *       | 22.06 *     | 113.86              | 42.53-            | 0.67             |
| 1x5                | 4.70-                    | 11.48                   | 28.10               | 13.38-         | 13.41-         | 19.32       | 6.63                | 11.80-            | 4.29             |
| 1x6                | 21.54-                   | 6.01-                   | 30.73               | 4.35-          | 8.87-          | 9.22        | 1.51-               | 29.77-            | 4.02             |
| 2x3                | 6.52-                    | 0.88                    | 14.25               | 2.70           | 14.56-         | 7.43        | 12.13               | 33.01-            | 3.74             |
| 2x4                | 22.09 **                 | 15.28                   | 22.60               | 48.35 **       | 3.50 **        | 33.20- **   | 34.66               | 0.64-             | 1.72             |
| 2x5                | 5.58                     | 25.13                   | 2.45                | 24.42          | 0.16           | 27.74       | 4.28-               | 20.89-            | 3.13             |
| 2x6                | 21.56-                   | 22.65-                  | 36.55               | 5.53-          | 12.36-         | 2.55-       | 36.18-              | 1.74-             | 2.62             |
| 3x4                | 22.96 **                 | 3.32                    | 19.35               | 0.61 **        | 11.93- **      | 47.49 **    | 47.55               | 6.31-             | 0.00             |
| 3x5                | 28.45 **                 | 18.01                   | 38.87               | 51.63 **       | 7.58- **       | 22.37- **   | 63.38               | 10.64             | 2.38             |
| 3x6                | 57.39 **                 | 5.42                    | 56.41               | 60.00 **       | 3.65 **        | 1.63**      | 150.67              | 3872.47           | 2.37             |
| 4x5                | 9.78                     | 16.36                   | 0.62-               | 12.00          | 2.76-          | 9.03        | 9.37-               | 21.93             | 0.37             |
| 4x6                | 10.16-                   | 1.93-                   | 28.01               | 8.47-          | 16.70-         | 19.68       | 0.61-               | 3.84              | 3.08-            |
| 5x6                | 23.58 **                 | 7.62                    | 12.28-              | 14.97 **       | 7.38 **        | 4.76**      | 33.73               | 20.53-            | 1.25-            |

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ب دستخوشه نیتان یار امیته‌رن جنیتیکی، شیانین نیکگرتنی و هینتریوسبس ل بهرالیادا بکارینانا نیکگرتان
نیف دونه‌ییلی

یوقتیه

نیو هنن دومندن دان ل کیلگه‌یئن کومیازا چاندنی ل زانوئی دهه‌کیل توقیم‌ها ۲۰۱۳ هنی می‌یا ۲۰۱۵ بکارینانا شه‌یی جنیتی شیان‌ین بزغالی و بکارینانا نیکگرتان نیف دونه‌ییلی. هنی تیبینی گرن
شیانین نیکگرتان نین گشتی و نابیبی یا گرنگه ل هنی فرخزاراندا. چیلی کیشان ۵۰ دانو کولیکدان‌ا
۵۰٪ چ گرنگی خو نیبی، هره‌سرس چاوارائینین نیکگرتانین گل‌هان نین جینتیکی گهلک بلدرپوو ز چاوارین
زن‌دنکی نین چینتیکی له‌نی سیمه‌تن حاندی زلی کولیکدان‌ا ۵۰٪ شیانی هنین‌تا مانافن‌دن نیشاندیاده‌
لیه‌سیمه‌یئن هنرینی ل هنی ستین بهنفره‌هدا نرخ‌ها کا بلد نیشاندای له‌نی فرخزارن‌نردی خاندیچه‌ی
کولیکدان‌ا ۵۰٪ شیانین هنرینی مانافن‌دن نیشاندیاده، و شیانین هنرینی ل هنی ستین‌ن سکا کا بلد
نیشاندای کیشان‌دا په هنر روه‌وکاک و کیشان ۵۰ دانه دما کلوروفیل شیانین هنرینی مانافن‌دن نیشاندای
روخسارن‌نردی شیانین هنرینی پهیم کیم نیشاندای.

(Pisum sativum)

تقدری المعاملات الوراثیه، الجمع بين القدرة والتغاير في البازلاء

باستخدام التهجين نصف التبادلي

الخلاصة

اجريت هذه الدراسة في الحقل التجربی لكلية الزراعة، جامعة دهوك، في نوفمبر ۲۰۱۲ - مايو ۲۰۱۳،
مستخدمة ستة امتیاز وراثیة من البازلاء باستخدام التهجین نصف التبادلی. لوحظ أن قدرة الجمع العامة
والمحددة تظهر معنیة في جميع الصفات باستثناء وزن ۵۰ حبة ووزن التژهیر بنسبة ۵۰٪ غیر معنیة،
كذلك التبین الوراثی الساکن أعلى من التبین الوراثی المضاف في جميع الصفات المدروسة باستثناء
الوزن ۵۰٪ أظهرت وراثة معتدلة، أيضا التوريث بالمعنى الواسع يظهر قيمة عالية في جميع الصفات
المدروسة باستثناء ال۵۰٪ للترهیز أظهرت وراثة معتدلة، والطوریث بالمعنى الضيق أظهرت قيمة عالية
في الوزن ۱ نبات و وزن ۵۰ حبة في حين أظهر الكلوروفیل وراثة معتدلة وفي الصفات الاخری ظهر
الطوریث منخفض.