Genetic analysis of flowering and physiological maturity characteristics by Generation Mean Analysis of four hybrids of maize (Growth Criteria)

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Abstract

In order to find out the relative amount of the components of genetic variance and forms of Epistasis interactions using the generation mean analysis method for maize hybrids vary by the date of flowering and maturity. A field experiment was carried out at the Field Crops Research Station, College of Agricultural Engineering Sciences - University of Baghdad - Al-Jadiriyah to estimate the components of genetic action, genetic influences The non allelic effects and its interactions that control the inheritance of the growth criteria traits of the selected inbred lines and their resulting hybrids using the Generation Mean Analysis. Five pure inbred lines maize (ZA17WR, Zi17WZ, ZM74, ZM19 and ZM49W3E) were selected from fifteen different inbred lines with flowering and maturity dates. In the spring season 2019 and were cross-bred according to the target (late × late) (late × early) (early × late) and (early × early) in the second fall season (2019).It was entered into a backcross crossing program to analyze the average generations in the spring season (2020) to produce the (six generations) which are P1, P2, F1, F2, BC1 and BC2. The six generations (P1, P2, F1, F2, BC1 and BC2) for the four hybrids were evaluated in comparative experiments using a randomized complete block design (RCBD) with three replicates. in the fall season 2020. Genetic analysis was done for scaling and analysis for the six criteria, according to Mather and Jenks (1982) for the traits of the number of days to silking, Days to physiological maturity, crop growth rate and yield of area unit (ton. hector). The results showed significant differences between the six generations, as the first generation came early by reaching silking and physiological maturity. It also excelled by giving it the highest rate, crop growth rate and yield area unit. The four hybrids had a hybrid vigor and hetrosis negative in the desired direction towards early silking, and a positive hybrid vigor for the two traits of the crop growth rate and yield in the desired direction towards their increment .The results of the genetic analysis of scaling analysis showed the significant difference of the four criteria A, B, C, D according to the trait and the difference of the hybrids. This was reflected on the dominance and additive influences beside their Epistasis interactions. The first, third and fourth hybrids showed a dominance action of silking trait and the type of interaction was Duplicated Epistasis , and in the second hybrid, the hybrid showed a dominance action and the Complementary type of Epistasis interaction for the similarity of the reference to the dominance genetic action with the non-allelic interaction (dominance x dominance). As for the traits of physiological maturity, it

gave a dominance effect in the four hybrids, and the type of Epistasis differed. It was Duplicate in the first, second and third hybrid, and Complemented by the fourth hybrid. While there was no significant effect of both the dominance and additive effects in the first and second hybrids for the crop growth rate, the third and fourth hybrids showed a dominance effect and the type of Complementary Epistasis. Second. From all above, we conclude that the additive and non-additive genetic action controls the inheritance of yield , flowering , physiological maturity and the crop growth rate, therefore we recommend using the method of Reciprocal recurrent selection (RRS).

*****Research is part of PhD dissertation for first author**

Introduction

Given the importance of the maize crop this is because: for its nutritional and industrial value, it contains a high level of protein, oils and carbohydrates (starch). In addition it is used in animal feed as a concentrated feed or green forage. This led to a lot of requires work to raise the low productivity and improve the yield trait. This requires the production of elite hybrids with quantitative traits (the yield trait) and qualitative traits requires an understanding of genetic variants and their allelic interactions that control the heritability of quantitative traits (Nafziger et al., 2016).). Flowering and physiological maturity have many benefits, whether on the grain yield or subsequent agricultural operations, where early lead to saving time and effort and the possibility of exploiting the land in cultivation with other crops. On the other hand, the relationship between early flowering and late physiological maturity leads, with the end result, to the longest period of grain filling, which represents the important and critical stage in the life of the maize crop, by being responsible for producing long kernels with full and healthy grains, which leads to an increase in the yield (Al -Hadi et al., 2013). The adoption of the Generation Mean Analysis (GMA) method as a biological and statistical method at the same time and Scaling Analysis to estimate the (Epistasis) allelic interaction of the genetic action with its three types i (additive x additive), j (additive × dominance), l (dominance × dominance). Through the analysis of the six generations (P1, P2, F1, F2, BC1and BC2), which needs to backcross for several generations between the selected inbred lines and their resulting hybrids, The importance for plant breeder is to determine the most appropriate and appropriate method in the breeding programs for the maize crop (Jink and Mather, 1982). Plant breeders use genetic isolations resulting from the internal breeding of field crops, which occur in the members of the second generation F2 and third (F3 promising genotypes to produce new genotypes). , as long as there is a need for it due to the lack of genetic variations available (Al-Hadi et al., 2013), where improving the trait of the yield of the genetic structures, whether varieties or hybrids of maize, requires understanding the mechanisms responsible for the nature of the additive gene action when using the selection method, On the other hand it requires understanding the nature of the work of the dominant gene action when using the hybridization method (Dorri et al., 2014). As the early evaluation of these segregation generations is important , as plant breeders work to exclude genetic structures that do not fit with the breeding goals and improvement programs (Jalal et al., 2006: and Al-Hadi, 2013). Al-Ahmad et al. (2004) emphasized when studying four Individual hybrids and their six generations (P1, P2, F1, F2, BC1and

BC2) and at two planting dates, that the values of the strength of the hybrid compared to the mean of the two parents and the best parent for the trait of individual yield plant were positive and significant. El-Shouny et al. (2005) studied four crosses of maize and its six generations to determine the genetic indicators. The results indicated that there are high and significant differences between generations in the strength of the hybrid for the two traits of the individual yield plant . Kannosh and Al-Dulami (2014) showed when they studied the hybrid vigor for the characteristic of the crop growth rate of an diallel hybrids (6 × 4), it gave the highest positive hybrid vigor calculated on the basis of the mean deviation of the values of the best parents amounted to (23.02%). The results of both Ghallab and Al-Dulami (2014) showed When they studied the hybrid vigor for the characteristic of the crop growth rate for an diallel hybrid, the hybrid (2 × 6) gave the highest positive hybrid vigor compared to the average values of the first generation, which amounted to (133.88.%). (P1, P2, F1, F2, BC1and BC2) for the genetic action of the silking trait, the –dominant_genetic action dominated the inheritance of the studied trait. Sher et al. (2012) showed when cross-breeding a number of pure inbred lines of maize using the Generation Mean Analysis (GMA) method, studying the genetic effect of the tasselling trait; the genetic dominance action is responsible for the transmission and inheritance of the trait. The type of genetic action (dominance × Epistasis) was significant in controlling the inheritance of the studied trait. The researchers also indicated that the dominance and Epistasis of the Duplicate type have a vital role in the inheritance of the silking trait. The current study aims to determine the type and nature of the genetic action and its interactions in the transmission and inheritance of the characteristics of flowering and physiological maturity of the inbred lines and performance of the resulting hybrids ((F1) different in flowering and physiological maturity, and to determine the best inbred lines that produced the best hybrids in field characteristics. Iqbal (2009) found through his study of four Hybrids of maize and the six generations (P1, P2, F1, F2, BC1and BC2) for the components of the genetic action for the traits of plant height, ear and silking. It can be concluded in the breeding and improvement programs to obtain the most desirable and promising genotypes (hybrids).

Materials and Methods

This study was carried out in the fields of the University of Baghdad, College of Agricultural Engineering Sciences / Al-Jadiriyah, and in four consecutive seasons of spring and fall for the years (2019 and 2020). when preparing the soil we add the NPK fertilizer at a rate of 240 kg hectares^{-1}, 46% urea fertilizer was added nitrogen 360 kg N hectares^{-1} and in two stages, the first one at the elongation stage and the second at the beginning of the flowering stage (Saleh and Salman, 2005). All agricultural operations were carried out, including irrigation, hoeing, weed control and the maize stem borer controlling (Sesamia critica) by feeding the growing tops of plants with the granulated diazinon (10% active substance) at a rate of 6 kg / hectare. It was added in two stages, the first one when the plants reached a height of 20 cm, and the second two weeks after the first control (Ministry of Agriculture, 2006).

First Season (Spring 2019)

The experimental soil was prepared from plowing, smoothing, leveling and tamping, and the seeds of the fifteen

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pure inbred lines mentioned were planted on the furrows , the length of the furrows is 6 meters, and the distance between them is 0.8 m, by planting six lines for one inbred line, and in a hole at a distance of 0.25 m between one hole and another on 19-3-2019. For crossing program in next season we are calculating days to tasselling, silking, physiological maturity and flowering compatibility, developing the inbred lines by making self-pollinating between inbred lines. For cultivation in the next season the aim of increasing genetic purity, as well as selecting the inbred lines with good growth characteristics and yield.

Second Season (Fall 2019)

The seeds of the fifteen inbred lines were sown in the fall season on July 16, 2019 and the crossing experiment was conducted. The field designated for the experiment was divided into two parts. The first part was planted with half of the grains of the fifteen inbred lines on furrows, the distance from one to another (0.8) m, and in a hole, one from the other (0.25 m) at a rate of (6) furrows and at a rate of 2 seeds per hole, it was thinned out to One plant in the hole. A week after planting, the second part of the field was planted with the same grains, to ensure that flowering was compatible between the inbred lines and to obtain pollen with effective vitality throughout the crossing period. When the plants reached the flowering stage, the female inflorescence was wrapped before the emergence of the silk with paper bags to obtain the required pollination and to avoid open pollination between inbred lines. The male inflorescence was wrapped in paper bags one day before the start of the inoculation process between the pure inbred lines. On the next day, pollen grains were collected and what was ready from the female inflorescences to receive pollen were pollinated with it. This process was continued until all the required crosses were made between the pure inbred lines used in the study. Inbred lines were multiplied among themselves, and the number of male and female flowering days and physiological maturity for each inbred line were recorded. This is because, to select the resulting hybrids, according to the research objective (late × late), (late×early), (early × late) and (early × early). The process of self-pollination of the inbred lines was also carried out for the purpose of multiplying their seeds, and the process continued until the required crosses were completed and an average of (8-10) ears was obtained for each cross as a minimum to ensure that sufficient numbers of seeds were obtained for the experiment of the next season. At the end of the spring season and at full maturity, the hybrid ears and the self-pollinated parents were harvested individually. Four hybrids were selected, which were characterized by the success of the required cross-fertilization and obtaining the largest number of seeds sufficient for planting. The hybrids were as follows: the first hybrid (late × late) for the two inbred lines (**(Zi17WZ x ZA17WR)**), the second hybrid (early × late) for the two inbred lines (**(ZM49W3E× ZM74)**), and The third hybrid (late × early) for the two inbred lines (**ZM19 x ZM74**), and the fourth hybrid (early × early) for the two inbred lines (ZM19×ZM49W3E).

Third Season (Spring 2020)

The planting took place in this season on March 17, 2020, as the four hybrids and their parents were planted with 10 furrows for each parent and for each hybrid the length of the furrows was 4 m. The crossing of the first generation F1 was carried out with the first parent P1 and the second parent P2 to produce BC1 and BC2 seeds respectively, and plants were also pollinated The first

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generation F1 self to produce the seeds of the second generation F2. The process of self-pollination of the parents was carried out for the purpose of multiplying their seeds and using them in the comparison experiment and according to the recommendations, the process continued until the required crosses were completed and a rate of (10-15) ears was obtained for each cross and self-pollinated as a minimum to ensure that sufficient numbers of seeds were obtained from the six generations (P1, P2 , F1, F2, BC1 and BC2) for each of the four hybrids, and introduced into a comparative experiment in the next season.

Fourth Season (Fall 2020)

The comparison experiment was conducted during the autumn season (2020), where the seeds of the six generations were sown for each hybrid, on July 22, using a randomized complete block design (RCBD) with three replications. 50 thousand plants per hectare. Three seeds were sown in each hole and thinned to one plant after 15 days of emergence, and all agricultural operations were carried out as in the previous seasons. When the plants reached the stage of harvest maturity, 20 plants were selected from the guarded middle lines for each (P1, P2, F1) and 40 plants for the second generation (F2) and 30 plants for each of (BC1, BC2) and the following traits were calculated for them.

Studied traits

1- Number of days from planting until 75% of silking (day): according to the appearance of the female inflorescence in 75% of the plants taken for each generation.

2- The number of days from planting until 90% physiological maturity (day): It was calculated from the first irrigation until the plants reached 90% physiological maturity (Elsahookie, 2009).

3- Crop growth rate (gm.plant^{-1}.day^{-1}): It was calculated by dividing the dry weight by the number of days to physiological maturity (El-Sahookie, 2009) for plants taken for each generation and for each hybrid under study.

4- Grain yield per area unit (tons. hectares^{-1}): by dividing the yield of a single plant by the area occupied by the plant and converting it to ton units. Hectares $^{-1}$.

Generation Mean Analysis (GMA)

The averages of the six generations (P1, P2, F1, F2, BC1 and BC2) for the above-mentioned design and for the traits that showed significant differences were entered into the analysis of Scaling test as stated by Mather (1949) and (Hayman and Mather, 1955) by calculating the amount of each of A, B, C and D and their variances according to the equations:

$A=2\underline{B1}-\underline{P1}-\underline{F1}$

$B=2\underline{B2}-\underline{P2}-\underline{F1}$

$C=4\underline{F2}-\underline{2F1}-\underline{P1}-\underline{P2}$

$D=2\underline{F2}-\underline{B1}-\underline{B2}$

The significance of A and B indicates the presence of all types of non-allelic interactions, while the significance of C indicates the significance of the dominant× dominant interaction, the significance of D indicates the significance of the additive × additive, and the significance of both C and D indicates the significance of both.

Generation Mean Analysis according to(Mather and Jenks, 1982) model according to the following mathematical model:

$Y=m+\alpha[d]+\beta[h]+\alpha2[i]+2\alpha\beta[j]+\beta2[1]$

Whereas

Y = generation average

m=Average of each of the possible symmetric lines that you get by multiplying

[l] , [j], [i], [h], [d] net direct effects additive, dominance, additive x

additive, additive x dominance, and dominance x dominance.
It has been calculated according to Hayman (1958) and according to (Singh and Chaudry, 1985).

m=mean=$\underline{F2}$
d=Additive effect=$\underline{B1}$-$\underline{B2}$
h=Dominance effect=$\underline{F1}$-4$\underline{F2}$-0.5$\underline{P1}$-0.5$\underline{P2}$+2$\underline{B1}$+2$\underline{B2}$
i=Additive × Additive type of gene interaction =2$\underline{B1}$+2$\underline{B2}$- 4$\underline{F2}$
j= Additive× dominance type of gene action =$\underline{B1}$-0.5$\underline{P1}$-$\underline{B2}$+0.5$\underline{P2}$
l=dominance × dominance type of gene action =$\underline{P1}$+$\underline{P2}$+2$\underline{F1}$+4$\underline{F2}$-4$B1$-4B2
The standard errors of the above effects were calculated in the following equations:
SE (m) = (Vm) 0.5
SE (d) = (Vd) 0.5
SE (h) = (Vh) 0.5
SE (i) = (Vi) 0.5
SE (j) = (Vj) 0.5
SE (l) = (Vl) 0.5

Results and Discussion

First Hybrid (Late x Late) (Zi17WZ x ZA17WR)

Number of days from planting to 75% silking

Among the environmental factors that influence and control the flowering of maize inbred lines and hybrids (temperature and duration of radiation), there are about 11 QTL Quantitative Trait Loci responsible for the traits of silking. The number of days to silking was defined as the number of days from sowing to the emergence of 75% of heat in the female inflorescence. The emergence of the female inflorescence, (the beginning of the appearance of the silken), and its ready to pollen grains receive (Wallace and Yan, 1998). that there are significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the number of days from sowing to 75% silking of the hybrid(Zi17WZ×ZA17WR) resulting from crossing of late parents (femle and male) in flowering and physiological maturity. The first generation F1 outperformed by its early arrival to silking than its parents, and its back crosses reached 60.33 days, 0.33 and 2.67 days different from the first parent P1 and the second P2, and the second back cross BC2 was delayed by reaching silking by 67 days than the remaining generations (Table 10) these Results agree with findings from AL-Mulhmi (2017) and El-Schneiter (2018). In their study, they showed significant differences between the genotypes in the number of days from sowing to 75% silking. The hybrid (Zi17WZ×ZA17WR) gave a negative hybrid vigor in proportion to the earliest parents that amounted to (0.55%) and relative to the average of the two parents (-2.43%), and this indicates the existence of overdominance or partial dominance over the average of the first generation over the earliest parents and their mean. These results are in agreement with Karmullah et al. (2011), Saudi (2013) and Hassan et al. (2019). Table (11) data for the Scaling test for the four criteria A, B, C and D indicated that there were high significant effects of the non-allelic interactions that controlled the genetic heterogeneity of the six generations of the hybrid(Zi17WZ×ZA17WR). The significance of any of the four criteria indicates the presence of non- allelic interactions, and this is evident from Table (12), which showed highly significant values for the effect of the mean of the second generation (m), and this indicates the genetic divergence between the two inbred lines included

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in this hybrid, while the remaining five criteria were Significantly high except for the Epistasis effect j (additive ×dominance). As it appears from the same table that the dominance gene action had a high positive effect of 26.50, while the additive effect was less valuable and had a negative sign, and this confirms the greater dominance contribution to the heterogeneity of the trait. The hybrid also gave a negative Epistasis effect l (dominance × dominance), which indicates the presence of Duplicate Epistasis, as the hybrid showed an Epistasis effect i(additive × additive) and this indicates the contribution of the additive genetic action to the inheritance of the trait in a secondary contribution.

Number of days from sowing to 90% physiological maturity (day)

The number of days from planting and up to 90% of physiological maturity means that the maximum dry weight of the grain has been reached and is represented by the appearance of a black scar at the base of the grain located at the tip of the embryo (one of the signs of maturity). The results of table (1) indicate that there are significant differences between (genotypes) of the six generations (P1, P2, F1, F2, BC1 and BC2) for the traits of the number of days to 90% physiological maturity of the hybrid (Zi17WZ×ZA17WR) resulting from crossing of late parents (male and female) with flowering and physiological maturity. The first generation F1 was earlier in its physiological maturity than its parents and its backcross reached 131.00 days with a difference of 1.67 and 5.00 days than the first parent P1 and the second P2, and the second back cross BC2 gave 145.67 days to reach physiological maturity by 145.67 days than the remaining generations. The hybrid (Zi17WZ×ZA17WR) gave a negative hybrid vigor with a percentage of the earliest parents that amounted to -1.25% and a ratio of the means parents to -2.48%. The early physiological maturity is attributed to early silking. These results are consistent with previous studies carried out by AL-Mulhmi (2017) and El-Schneiter (2018), this indicates the existence of over - dominance or partial dominance of the genetic action for the Epistasis of the average of the first generation over the earliest parents and their mean. From the data of Table (11) for the Scaling test for the four criteria A, B, C and D, it is clear that there are high significant effects of the non-allelic interactions that control the genetic variance of the six generations of the hybrid(Zi17WZ×ZA17WR). We find that the characteristic of the number of days from cultivation up to 90% of physiological maturity was significant in A, B, and insignificant in C and D. The significance of any of the four criteria indicates the presence of non-allelic interactions, and this is evident from Table (12), which showed highly significant values of the effect of the mean of the second generation (m), and this indicates the genetic divergence between the two inbred lines included in this cross for this trait. As for the remaining five criteria, they were highly significant, as it appears from the same table that the dominance genetic action had a high positive effect of 36.00, while the additive effect was less valuable and had a negative sign, and this confirms the greater dominance contribution to the heterogeneity of the trait. The hybrid also gave an Epistasis effect l (dominance × dominance) is negative, and this indicates the presence of Duplicate Epistasis, as the hybrid showed an Epistasis effect i (additive × additive) and this indicates the contribution of the additive genetic

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action to the inheritance of the trait in a secondary contribution. Thus, it behaved similarly to the tasselling and silking traits in its inheritance.

Crop growth rate (gm plant^{-1} day^{-1})

The trait of the crop growth rate (CGR) is one of the important quantitative traits that plant breeders work on improving the maize crop, and it expresses the resulting increase in the dry weight of the maize crop per area unit per time (gm.plant^{-1}.day^{-1}) . it is possible to estimate the extent of the plant's response to the formation of the number of grains under a wide range of soil and crop management processes under the surrounding environmental conditions during the growing season. Table (1) data indicated that there were significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the characteristic of the crop growth rate of the hybrid(Zi17WZ×ZA17WR) resulting from crossing mothers and parents late in flowering and physiological maturity. As the first generation F1 outperformed it by giving the highest average for the crop growth rate than its parents and its backcross, and it reached 4.70 gm plant^{-1}.day^{-1} with a difference of 1.25gm plant^{-1}.day^{-1} and 1.28gm plant^{-1}.day^{-1} than the first parent P1 and The second P2 respectively (Table 10), while the first back cross BC1 gave the lowest average for the trait, which was 2.95 gm plant^{-1}.day^{-1} than the remaining generations. The hybrid (Zi17WZ×ZA17WR) gave a positive Heterosis with a percentage of the highest parents that amounted to 35.99% and a percentage of the average parents of 36.62%. This indicates the presence of the over-dominance of the genetic action to the Epistasis of the average of the first generation over the highest and parents mean, this confirms what was obtained by Kannosh, and Al-Dulami (2014) and Ghallab and Al-Dulami (2014). The results of Table (2) of the Scaling test for the four criteria A, B, C and D showed that there were significant effects of the non-allelic interactions that controlled the genetic variance of the six generations of the hybrid(Zi17WZ×ZA17WR). We find that the characteristic of the crop growth rate was significant in A, B and C, and insignificant in D. Significance of any of the four criteria indicates the presence of non-allelic interactions, and this is evident from Table (3) which showed highly significant values for the effect of the mean of the second generation (m), and this indicates the genetic divergence between the two inbred lines included in this cross. As for the remaining five criteria, they were not significant, except for the effect i (additive x additive). The hybrid also gave a positive Epistasis effect l (dominance × dominance), which indicates the presence of Duplicate Epistasis. The hybrid also showed an i (additive × additive) outperformance on the contribution of the additive genetic action to the inheritance of the trait.

Grain yield per area unit (ton. hectare^{-1})

The trait of grain yield and area unit is among the most goals that plant breeders to increase by following the most appropriate method in breeding and improvement programs, by following scientific methods in soil and crop management and obtaining genotypes (inbred lines, hybrids and varieties) from the maize crop with high yield (Quantitative traits) and good qualitative traits in terms of transferring the carbonate synthesis to the downstream, such as the ears number and the weight of the grain through keeping the leaves green for a longer period and increasing their efficiency in carbonization (El-Sahookie,2009). It appears from

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Table (1) that there are significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the trait of grain yield and area unit of the hybrid (Zi17WZ×ZA17WR)) resulting from crossing between late mothers and parents with flowering and physiological maturity. As the first generation F1 gave the highest average yield per area unit of 9.16 tons. Hectares^{-1} compared to their parents and their backcross, with a difference of 2.38 tons. Hectares^{-1} and 2.81 tons. Hectares^{-1} , from the first parent P1 and the second P2 respectively. While, the lowest value was for the second backcross BC2 gave 4.13 tons ha^{-1}. The hybrid (Zi17W2×ZA17WR) gave positive hybrid vigor with a percentage of the highest parents amounting to 35.10%, and a ratio to the average of the two parents account for 39.54%. The average of the first generation has the highest and average parents. The results of Table (2) of the Scaling test for the four criteria A, B, C and D indicate that there are highly significant effects of the non-allelic interactions that control the genetic heterogeneity of the six generations of the(Zi17W2×ZA17WR) hybrid. The four criteria indicate the presence of non-allelic interactions, and this is evident from Table (3), which showed highly significant values for the effect of the second generation average (m), and this confirms the genetic divergence between the two inbred lines included in this cross. As for the remaining five criteria, they were highly significant, as it appears from the same table that the dominance genetic action had a high positive effect, amounting to 6.25, while the additive effect was less, reaching 2.13, and this confirms the greater dominance contribution to the heterogeneity of the trait. The hybrid also gave a superior effect l (dominance × dominance) is positive, and this indicates the presence of Complementary Epistasis, as the hybrid showed a Epistasis effect i (additive × additive) and this indicates the contribution of the additive genetic action to the inheritance of the trait in a secondary way. This confirms the results of both Aziz (2008) Wuhaib and Hadi (2016).

Second Hybrid (ZM49W3E× ZM74) (Early ×Late)

Number of days from planting to 75% silking (day)

The results of the analysis in Table (4) indicated that there were significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the number of days to 75% silking of the hybrid (ZM49W3E×ZM74), which resulted from crossing of early female and Late male in silking and physiological maturity, as the first generation F1 came earlier in the silking, taking 53.00 days less than the silking than its parents, and its backcross were 3.66 days and 10.66 days than the first parent P1 and the second P2 respectively. The second BC2 backcross was delayed by 62.00 days to reach silking than the remaining generations. The hybrid (ZM49W3E× ZM74) gave negative hybrid vigor with a percentage of the earlier parents that amounted to -6.47% and a percentage of the parents mean of -11.91%. In compositions of maize, there were negative values for several traits, including silking, and this indicates the early silking and the presence of partial dominance of the genetic act for the Epistasis of the average of the first generation over the earlier parents and parents mean. Table (5) shows the results of the scaling test for the four criteria A, B, C and D, which are significant for all the criteria for the silking trait of the hybrid

(ZM49W3E× ZM74) resulting from early female and late male with silking and physiological maturity. Positive is emphasizing his contribution to the heterogeneity of the character. It appears clear from Table (6), which showed highly significant values of the effect of the average of the second generation (m), and this is another confirmation of the dissimilarity that exists between the parental inbred lines. As for the remaining five criteria, they were highly significant, as it appears from the same table that the dominant genetic action had a high positive effect of 15.50, while the additive effect was less valuable and had a negative sign, and this confirms the greater dominance contribution to the heterogeneity of the trait. The hybrid also gave a Epistasis effect l (dominance × dominance) is positive, and this indicates the presence of Complementary Epistasis. The hybrid also showed a Epistasis effect i (additive × additive) positive and high (22.66), and this indicates the contribution of the additive genetic action to the inheritance of the trait in a secondary way, and accordingly, this trait can be improved for crosses by conducting hybridization.

Number of days from planting to 90% physiological maturity

The table (4) shows that there are significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the trait of the number of days to 90% physiological maturity of the hybrid (ZM49W3E×ZM74) resulting from hybridization cross of early female and Late male in silking and physiological maturity, as the first generation F1 took 109.00 days to reach physiological maturity different from its parents and its back crosses 9.66 days and 3.00 days different from the first parent P1 and the second P2 respectively. An indication of the genetic dissimilarity of the parents, in other words the presence of genetic divergence and genetic variations that led to the dissimilarity. The hybrid (ZM49W3E×ZM74) gave a negative hybrid vigor relative to the earliest parents that amounted to (-5.49%) and relative to the average of the two parents (-2.67%), indicating the presence of the partial and over-dominance of the genetic action for the Epistasis of the average of the first generation over the earliest parents and of the two parents average. These results are similar to those of previous studies conducted by AL-Mulhmi (2017) and El-schneiter (2018). Based on the results of the analysis of Table (5) of the scaling test for the four criteria A, B, C and D, high significant effects appeared for the non-allelic interactions that controlled the genetic variance of the six generations of the hybrid (ZM49W3E× ZM74 Number of days from sowing up to 90% of physiological maturity were significant in A, B and D and not significant in C. None of the four criteria indicate the presence of non-allelic interactions. To understand the non-allelic effect more clearly, we find it in Table (6) that showed highly significant values for the effect of the mean of the second generation (m), and this indicates the genetic divergence between the two inbred lines included in this hybrid. As for the remaining five criteria, they were highly significant except for the j effect (additive × dominance), as it appears from the same table that the dominant genetic action had a high positive effect of 35.66, while the additive effect was less valuable and had a negative sign, and this confirms the greater dominance contribution to the heterogeneity of the trait. The hybrid also gave a negative (dominance × dominance) effect, which indicates the presence of Duplicate Epistasis, and the hybrid showed a high positive effect i(

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additive× additive), which indicates the contribution of the additive genetic action to the inheritance of the trait in a secondary way, and this confirms what was obtained both (Hadi , 2016) and Wahaib et al. (2016).

Crop growth rate (gm plant^{-1} day^{-1})

The results of table (4) showed that there were significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the crop growth rate for the hybrid (ZM49W3E×ZM74) resulting from crossing early mother's and late parent's with flowering and physiological maturity. The first generation F1 scored the highest average for the trait of 5.gm.plant^{-1}.day^{-1}, Epistasis to its parents by a difference of 1.03gm.plant^{-1}.day^{-1} ،0.69 gm.plant^{-1}.day^{-1} than the first parent P1 and the second P2 respectively(Table 4). While the second back cross of BC2 gave the lowest rate of the trait, was 4.01 gm. Plant^{-1}.Day^{-1} than the remaining generations. The hybrid (ZM49W3E× ZM74) gave a positive hybrid vigor with a percentage of the highest parents that amounted to 15.69% and a percentage of the average parents of 20.25%. These results are in agreement with what was stated by Kannosh and Al-Dulami (2014) and Ghallab and Al-Dulami (2014), as they indicated the existence of a partial or over-dominance of genetic action to the Epistasis of the first generation average over the highest and parents average The trait of the crop growth rate for the studied hybrids. It is clear from the data of Table (5) of the Scaling test for the four criteria A, B, C and D that there are high significant effects of the non-allelic interactions that control the genetic variance of the six generations of the hybrid (ZM49W3E×ZM74). We find that the traits of the crop growth rate was significant in A and B and insignificant in C and D. It was shown from Table (6) that the effect of the average of the second generation (m), had high significant values confirming the genetic divergence between the two inbred lines included in this cross, and the remaining five criteria were not significant except for the Epistasis effect (dominance ×dominance) little contribution for both effects.

Grain yield per area unit (ton hectare^{-1})

It is clear that there are significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2 for the trait of area unit for the hybrid (ZM49W3E× ZM74) resulting from crossing early females and late males with silking and physiological maturity. The first generation F1 had the highest rate of this trait reached 5.088 tons.ha^{-1}, significantly different from its parents with a difference of 1.031 tons.ha^{-1} and 0.69 tons.ha^{-1} than the first parent P1 and the second parent P2 respectively (Table ,4). Whereas the first back crosses BC1 gave an average of 3.65 tons. Hectare^{-1} differs from the remaining generations. While the first backcross BC1, gave an average of 3.65 tons. Hectare^{-1} differs from the remaining generations. The hybrid (ZM49W3E× ZM74) gave positive hybrid vigor with a percentage of the highest parents that amounted to 11.82% and a percentage of the parent's means 15.90%. These results were in agreement with the findings of Al-Roumi (2016) and Wuhaib et al. (2016 a), in that they obtained a significant deviation in the performance of hybrids in the trait the total yield compared to its parents in terms of the hybrid vigor of the cross and the percentage of hetrosis. The results shown in Table (5) for the Scaling test for the four criteria A, B, C and D indicate the presence of significant effects of the non-allelic interactions that control the genetic

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variance of the six generations of the hybrid (ZM49W3E×ZM74). It was significant in A and B and not significant in C and D, significant for any of the four criteria indicates the presence of non-allelic interactions, and this appears clear from Table (6) which showed highly significant values for the effect of the second generation average (m), and this indicates the genetic divergence between the two inbred lines included in This cross, and the remaining five criteria were non-significant, except for the Epistasis effect (dominance ×dominance), and this indicates contributions to the dominance influence and contributions that did not reach the level of significance for the additive influence in the inheritance of the trait of the yield.

Third Hybrid (Late x Early) (ZM19 x ZM74)

Number of days from planting to 75% silking (day)

The results of the table(7) indicate that there are significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the number of days to 75% silking of the hybrid (ZM74×ZM19), which resulted from crossing of late females and early males with flowering and physiological maturity. As the plants of the first generation F1 took the least period to reach silking, which was 55.00 days, outstanding to their parents by a difference of 8.66 days and 2.66 days than the first parent P1 and the second P2 respectively (Table, 18), while the second backcross BC2 was delayed by 63 days by reaching silking for the other of the generations. These results agreed with the findings of AL-Mulhmi (2017) and El-Schneiter (2018), as they showed that there are significant differences between the six generations in the character of the number of days to 75% of silking. The hybrid (ZM74×ZM19) gave a negative hybrid vigor with a percentage of the parents earliest that amounted to -4.62% and a percentage of the parents means to 9.34 %, which confirms that this trait is under the control of the over dominance or the partial dominance genes of the parents earliest. These results are in agreement with the findings of Karmullah and Mohammed (2011) , Saudi (2013) and Hassan et al. (2019), as they indicated that the presence of hybrid vigor values in compositions of maize were negative values for silking trait. The results of the genetically analysis in Table (8) of the Scaling test for the four criteria A, B, C and D indicate that there are significant effects of the non-allelic interactions that control the genetic variation of the six generations of the hybrid (ZM19×ZM74). We find that the trait of the number of days to silking was significant in A, B, C and D. And that the significance of any of the four criteria indicates the presence of non-allelic interactions, and this is evident from Table (9), which showed highly significant values for the effect of the second generation average (m), and this indicates the genetic divergence between the two inbred lines included in this cross, late and early flowering and maturation. As for the remaining five criteria, they were highly significant, as it appears from the same table that the ~~dominance~~ dominant genetic action had a high positive effect of 19.66, while the additive effect was less valuable and had a negative sign, and this confirms the greater dominance contribution to the heterogeneity of the trait. The hybrid also gave a superior effect l (dominance × dominance) is negative, and this indicates the presence of (Duplicate Epistasis) as the hybrid showed ~~a~~ an Epistasis effect i (additive × additive) and (additive × dominance), and this indicates the contribution of the additive genetic action to the inheritance of the trait in a secondary way. This confirms the results of Kannosh et al. (2014) and Hassan et al. (2020).

Number of days from planting to 90% physiological maturity (day)

The results shown in table7 significant demonstrate the differences between the six generations (P1, P2, F1, F2, BC1 7 and BC2) for the traits of the number of days to 90% physiological maturity of the hybrid (ZM19×ZM74) resulting from crossing inbred lines of late mother's and early parent's with flowering and physiological maturity. The second parent P2 in reaching physiological maturity, taking a period of 110.00 days, is morally different from the remaining generations. While the first generation recorded F1 (17.00) days, while the second BC2 reaction took a longer period to reach physiological maturity with a period of 122.16 days than the rest of the generations (Table, 7). The hybrid (ZM19×ZM74) gave a negative hybrid vigor, a percentage of the parents earlier amounted to -1.93% and a percentage of the parents average to -2.62%. All of the aforementioned results agree with all that was mentioned by AL-Mulhmi (2017) and El-Schneiter (2018), as they showed the over -dominance genes The superiority of the early parent and the parents means entering in this cross. Based on the genetic analyzes of Table (8) of the Scaling test for the four criteria A, B, C and D for the hybrid (ZM74×ZM19). We find that the character of the number of days from sowing up to 90% of physiological maturity was significant in B, C, D and insignificant A. Significance of any of the four criteria indicates the presence of non-allelic interactions, and this is evident from Table (20) which showed highly significant values for the effect of the second generation mean (m), and this indicates the genetic divergence between the two inbred lines included in this cross. As for the remaining five criteria, they were highly significant, except for the effects i (additive × additive), as it appears from the same table that the dominant genetic action had a high positive effect of 16.09, while the additive effect was less valuable and had a negative sign, and this confirms the greater dominance contribution to the heterogeneity of the trait. The hybrid gave a negative Epistasis effect l (dominance x dominance). This indicates the presence of Duplicate Epistasis, as the hybrid showed a negative effect i (additive × dominance), and this indicates that the additive genetic action contributed less to the inheritance of physiological maturity.

Crop growth rate (gm.plant^{-1}.day^{-1})

It is clear from the data of table (7) that there are significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the trait of the crop growth rate for the hybrid (ZM74×ZM19) resulting from crossing inbred lines late female and early males with flowering and physiological maturity. The second parent P2 was outstanding in giving the highest average for the trait, which amounted to 4.93 gm. plant^{-1}.day^{-1}, Epistasis to the six generations and close to the first generation (Table, 18). While the second back cross BC2 gave the lowest average of the crop growth rate of 4.469 gm. plant^{-1}.Day^{-1}. The hybrid ((ZM74×ZM19) gave a negative hybrid vigor with a percentage of the highest parents that amounted to -1.93-1%, and a percentage to the parents means of 3.90%. This explains the negative hybrid vigor of the over_dominance genes from the higher parent in the inheritance of the trait. The positive Heterosis value indicates the dominance of the partial dominance

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genes in the inheritance of the trait. these Results agree with the results of several studies: Kannosh and Al-Dulami (2014), Ghallab and Al-Dulami (2014) and Mesribet (2017). Table (8) of the Scaling test for the four criteria A, B, C and D shows that there are significant effects of the non-allelic interactions that control the genetic variance of the six generations of the hybrid (ZM74×ZM19). Non-significant in A and B, significant in and c and D. To know the type of the remaining interactions, we find it in Table ( ) which showed highly significant values for the effect of the second generation mean m), This is evidence of genetic divergence between the two inbred lines included in this cross, as for the rest of the criteria, they were significant except for the additive effect d The Epistasis effect (additive × dominance).It also appears from the same table that the dominance genetic action had a positive and significant effect of 0.355, while the additive effect was not significant, and this confirms the largest dominance contribution to the heterogeneity of the trait. The hybrid also gave a Epistasis effect l (dominance × dominance) and this indicates the presence of Complementary Epistasis, as the hybrid showed a Epistasis effect i (additive × additive) and this indicates the contribution of the additive genetic action to the inheritance of the trait in a secondary way. This is in agreement with Abed et al. (2017) and Mesribet (2017).

Grain yield per area unit (ton Hectare^{-1})

The results in table (7) showed that there were significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the trait of grain yield area unit of the hybrid (ZM74×ZM19) resulting from crossing inbred lines of late females and early males in flowering and physiological maturity. The first generation outperformed F1, gave the highest mean for the trait of grain yield per area unit amounted to 7.635 tons.ha^{-1} distinct from its parent, by a difference of 0.268 tons.ha^{-1} and 0.514 tons.ha^{-1} from the first parent P1 and the second parent P2 respectively. While the second back cross BC2 gave the lowest rate for the trait amounted to 6 .787 tons— hectares^{-1} for the remaining generations. The hybrid (ZM74×ZM19) gave a positive hybrid vigor with a percentage of the highest parents amounting to 4.10% and a percentage to the parents means 5.14%, and this indicates the presence of the over- dominance and partial dominance of the genetic action that dominance this trait to the Epistasis of the average of the first generation over the highest and average parents. This is similar to what was indicated by Al-Roumi (2016) and Wuhaib —etal. (2016a). Table (8) of the Scaling test for the four criteria A, B, C and D indicates that there are significant effects of the non-allelic interactions that control the genetic heterogeneity of the six generations of the hybrid (ZM74×ZM19). The trait of grain yield per area unit was significant in A, B, C and D, significant in any of the four criteria indicating the presence of non-allelic interactions, and this is evident from Table (9) which showed highly significant values for the effect of the second generation mean (m), and this indicates genetic divergence Between the two inbred lines included in this cross. As for the remaining five criteria, they were highly significant except for the Epistasis effects (additive × dominance), as it appears from the same table that the genetic dominance action had a high negative effect of -0.25, while the additive effect was greater in value and with a

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positive sign of 3.82, and this confirms the greater additive contribution in variation of the trait. The hybrid also gave a positive (dominance × dominance) effect, and this indicates the presence of Duplicate Epistasis. The hybrid also showed a significant effect i(additive × additive), this confirms the participation of the dominance genetic action in the inheritance of the trait to a lesser extent.

Fourth Hybrid (Early ×Early) (ZM19× ZM49W3E)

Number of days from planting to 75% silking

The results of the table(10-) indicated that there were significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the number of days from sowing to 75% flowering of the hybrid (ZM19×ZM49W3E) resulting from crossing inbred liens of early female × early male by flowering and physiological maturity. The earliest generation The first F1 took the least period of time to reach 75% of silking, which amounted to 50.66 days, outstanding to its parents and its backcross by a difference of 6.00 days and 5.34 days for the first parent P1 and the second parent P2 respectively (Table, 22). The second back cross BC2 delayed of silking from its parents by 57.66 days. These results agree with the findings of Al-Malhamii (2017) and El-Schneiter (2018) as they showed that there are significant differences between the genotypes in the character of the number of days from sowing to 75% of silking. The hybrid (ZM19×ZM49W3E) gave a negative hybrid vigor in proportion of the two parents earlier amounting to -7.88% and relative of the two parents average – 8.74%, and this indicates the existence of an over or partial dominance of the genetic action to the Epistasis of the first generation average over the earlier and average parents, Karmullah et al. 2011), Saudi (2013) and Hassan et al. (2019) obtained similar results, as their results showed a significant difference in the hybrid vigor from the best parents for the number of days from sowing to 75% silking. it is clear from the data of Table (11) of the Scaling test for the four criteria A, B, C and D that there are high significant effects of the non-allelic interactions that control the genetic heterogeneity of the six generations of the hybrid (ZM19 × ZM49W3E). The presence of non-allelic interactions, and to understand this interference, we find it in Table (12), as the effect of the second generation average (m),) gave a high significant value, which shows the genetic divergence between the two inbred lines included in this cross. As for the remaining five criteria, they were highly significant, as the dominance gene action had a high positive effect of 13.66. While the additive effect gave a lower value and had a negative sign, and this confirms the greater dominance contribution to the heterogeneity of the trait. The hybrid also gave a negative (dominance ×dominance) effect, and this indicates the presence of Duplicate Epistasis. The hybrid also showed an Epistasis effect i (additive × additive) and a Epistasis effect (additive ×dominance), and this indicates the contribution of the additive genetic action to the inheritance of the trait in a secondary way. This confirms the findings of Anees and Daoud (2011) and Hassan et al. (2020).

Days to physiology maturity

The results of table(10) indicated that there were significant differences between the six generations (P1, P2, F1, F2, BC1 and BC2) for the characteristic of the number of days from sowing to 90% physiological maturity of the hybrid

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(ZM19×ZM49W3E) resulting from crossing inbred lines of early female and male with flowering and physiological maturity. The first generation F1 reached physiological maturity with a period of 108.33 days and differed significantly from its parents by a difference of 1.67 days and 3.67 days from the first parent- P1 and the second- parent P2 respectively. While the second backcross BC2 was delayed by reaching physiological maturity by 121.00 days later than the remaining generations. The hybrid (ZM19×ZM49W3E) gave negative hybrid vigor in proportion to the earlier of the two parents, which amounted to 1.51-%, and relative to the two parent's average of -2.40%. The negative value of the hybrid vigor indicates the outstanding of the earlier parent in controlling the trait, and this is consistent with what was found by Hadi et.al (2018) and El-Schneiter (2018).The results of the analysis from data in Table (11) for the Scaling test for the four criteria A, B, C and D indicated that there are significant effects of the non-allelic interactions that control the genetic variation of the six generations of the hybrid (ZM19×ZM49W3E). As for the remaining five criteria, they were highly significant, with the exception of the effect d (additive) and j (additive × dominance). We also note from the same table that the dominance genetic action had a high positive effect of 24.66, while the additive effect was less valuable and had a negative sign, and this confirms the greater dominance contribution to the heterogeneity of the trait. The hybrid also gave a positive Epistasis effect l (dominance x dominance), which indicates the presence of Complementary Epistasis. The hybrid also showed a highly significant i (additive x additive) Epistasis effect, which indicates the contribution of the additive genetic action to the inheritance of the trait, but in a secondary way. This is consistent with what was found by Mesribet (2017) and Hadi et al. (2018).

Crop growth rate (gm.plant^{-1}.day^{-1})

Table (10) shows the presence of significant differences between the six generations(P1, P2, F1, F2, BC1 and BC2)for the trait of the crop growth rate for the hybrid (ZM19 × ZM49W3E) resulting from crossing inbred lines of female and male early in flowering and physiological maturity. The first generation F1 gave the highest mean for the crop growth rate trait of the hybrid (ZM19×ZM49W3E) reached 5.41 gm.plant^{-1}.day^{-1}, different from its parents and its back– crosses, as it outperformed its parents by a difference of 0.87gm.plant^{-1}.day^{-1} and 0.55gm.plant^{-1}.day^{-1} from the first parent P1 and the second P2 respectively (Table 10). While the first back cross BC1 gave the lowest rate of the trait, which was 3.77 gm.plant^{-1}.day^{-1}, lower than the remaining generations The hybrid (ZM19×ZM49W3E) gave positive hybrid vigor, with a percentage of the highest parents amounting to 11.43%, and a percentage of the parents' mean being 15.25%. Significantly positive values for the performance of hybrids compared to their parents in terms of hybrid vigor and percentage of crosses for the growth rate trait of the crop. The data in Table (11) for the Scaling test for the four criteria A, B, C and D indicate that there are significant effects of the non-allelic interactions that control the genetic heterogeneity of the six generations of the hybrid (ZM19×ZM49W3E). We find that the characteristic of the crop growth rate was significant in A, B, C, and D, significance for any of the four criteria indicating the presence of non-allelic interactions, and this appears clear from Table (12), which showed highly significant values for the effect of the second generation mean (m), and this indicates the genetic divergence between The two inbred lines included in this cross. As for the remaining five criteria, they were not significant except for the two effects d (additive) and j (additive × dominance), as it appears from the same table that the genetic dominance action had a significant negative effect of 1.28, while the additive effect was less valuable and has a negative sign as well, and this confirms the contribution of a greater dominance in the heterogeneity of the trait. The hybrid also gave a positive moral Epistasis l (dominance × dominance), and this indicates the presence of Duplicate Epistasis. The hybrid also showed an Epistasis effect i (additive × additive) and this indicates the contribution of the additive genetic action to the inheritance of the trait in a secondary way and this is similar to what was obtained by Kannosh and Al-Dulami (2014) and Mesribet (2017).

Grain yield per area unit ton ha^{-1}

Based on the results of the table (10), significant differences appeared between the six generations (P1, P2, F1, F2, BC1 and BC2) for the trait of grain yield area unit of the hybrid (ZM19 × ZM49W3E) resulting from crossing inbred lines of female and male earlier in flowering and physiological maturity. Table (10) showed that plants in the first generation F1 outperformed by giving the highest average grain yield per area unit of 5.876 tons ha^{-1} outstanding to its parents and its backcross by a difference of 0.783 ton ha^{-1} and 0.795 ton ha^{-1} than the first parent P1 and the second parent P2 respectively. For the first backcross BC1, it gave the grain yield per area unit amounted to 3.53 tons.ha^{-1}, lower than the remaining generations. The hybrid (ZM19×ZM49W3E) gave positive hybrid vigor, with a percentage of the highest parents amounting to 15.36%, and to the parent's average ratio accounted for 15.50%. The results of the current study confirmed previous studies, including Al-Roumi (2016), Wahaib et al. (a2016), and Khan et al. (2019), in obtaining a hybrid vigor and a positive and significant Heterosis ratio for the trait of grain yield per unit area. It is evident from the data of Table (11) of the Scaling test for the four criteria A, B, C and D that there are significant effects of the non-allelic interactions that control the genetic variance of the six generations of the hybrid (ZM19×ZM49W3E). It was significant in A, D and C, and did not reach the level of significance in B, The significance of any of the four criteria indicates the presence of non-allelic interactions, and to know their type, we note in Table (12), which showed highly significant values for the effect of the second generation mean (m), and this confirms the genetic divergence between the two inbred lines included in this cross, which appears clearly in a table (12). The remaining five criteria were highly significant except for the effects h (dominance) and i (additive × additive). It also appears from the same table that the additional genetic act had a negative effect, while the sovereign effect had a non-significant value and had a negative sign, and this confirms the greater additive contribution to the heterogeneity of the trait. The hybrid also gave a positive Epistasis effect l (dominance× dominance), and this indicates the presence of Duplicate Epistasis. The hybrid also showed an Epistasis effect i(additive × dominance), and this indicates the contribution of the dominant genetic action to the inheritance of the trait in a secondary way. This is similar to what was found by Abed and Hammadi (2018) and Hassan et al. (2020).

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Zi17WZ x Table 1. The means of traits with their standard errors for the six generations of the first hybrid of maize late ×late (ZA17WR), the hybrid vigor and the percentage of hetrosis for the fall season 2020.

Traits	Generations						Hybrid vigor%	Hetrosis %
	P1	P2	F1	F2	B1	B2		
Days to silking	60.66±O.66	63.00±0.57	60.33±0.881	59.00±1.52	65.00±0.577	67.00±0.577	-0.55	-2.43
Days to physiology maturity	132.67±0.33	136.00±0.57	131.00±0.57	133.33±0.88	140.67±0.33	145.67±0.33	-1.25	-2.48
Crop growth rate	3.45±0.027	3.42±0.068	4.70±0.076	3.47±0.549	2.95±0.087	3.11±0.104	35.89	36.62
Yield (ton\ha)	6.78±0.138	6.35±0.136	9.16±0.22	7.40±0.72	6.26±0.491	4.13±0.160	35.10	39.54

Table 2. Scaling test with standard errors of the first cross late ×late (Zi17WZ x ZA17WR)

Traits	A	B	C	D
Days to silking	9.00±1.59 **	10.66±1.56 **	-8.33±6.42 **	-5.66±6.88 n.s
Days to physiology maturity	17.66±0.94 **	24.33±1.05 **	2.66±3.77 n.s	-2.00±4.00 n.s
Crop growth rate	-2.23±0.19 **	-1.89±0.23 **	-2.36±2.20 **	0.078±2.45 n.s
Yield (ton\ha)	-3.42±1.01 **	-7.25±0.412 **	-1.82±2.922 n.s	1.68±3.22 n.s

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Table 3. Genetic analysis of mean generations, their standard errors and estimation of genetic parameters for the first cross late × late(Zi17WZ x ZA17WR)

Traits	M	[d]	[h]	[i]	[j]	[l]	Type of eps.
Days to silking	59.00 ± 1.52 **	-2.00± 0.81**	26.50± 6.40**	28.00± 6.32**	-0.83± 0.92**	-47.66± 7.20**	Duplicate
Days to physiology maturity	33.33± 0.88 **	-5.00± 0.47 **	36.00± 3.71 **	39.33± 3.65 **	-3.33± 0.577 **	-81.33± 4.21 **	Duplicate
Crop growth rate	3.49± 0.54 **	-0.15± 0.13 n.s	-0.51± 2.21 n.s	-1.77± 2.21 n.s	-0.17± 0.14 n.s	5.91± 2.26 **	Duplicate
Yield (ton\ha)	7.40± 0.72 **	2.13± 0.51 **	6.25± 3.07 **	-8.85± 3.06 **	1.91± 0.52 **	19.53± 3.57 **	Complementary

Table 4. The means of traits with their standard errors for the six generations of the second hybrid of maize ,early ×late (ZM49W3E× ZM74), the hybrid vigor and the percentage of hetrosis for the fall season 2020.

Traits	Generations						Hybrid vigor %	Hetrosis %
	P1	P2	F1	F2	B1	B2		
Days to silking	56.66±0.333	63.66±0.333	53.00±0.577	55.33±1.201	60.00±0.577	62.00±0.577	-6.47	-11.91
Days to physiology maturity	112.00±0.577	118.66±0.333	109.00±0.577	111.00±1.527	120.00±1.154	123.00±0.577	-2.678	-5.49
Crop growth rate	4.05±0.069	4.39±0.043	5.088±0.070	4.32±0.644	3.65±0.064	4.01±0.0542	15.69	20.35

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Yield (ton\ha)	**4.057±0.069**	**4.398±0.043**	**5.088±0.070**	**4.329±0.644**	**3.653±0.064**	**4.015±0.084**	**11.82**	**15.90**

Table 5. Scaling test with standard errors of the second cross early × late (ZM49W3E× ZM74)

A	B	C	D
10.33±1.33**	**7.33±1.33****	**-5.00±4.96 ****	**-9.66±5.39****
19.00±2.449 **	**18.33±1.333****	**-4.66±6.253 n.s**	**-8.66±6.863****
-1.838±0.162 **	**-1.455±0.187****	**-1.314±2.584 n.s**	**0.203±2.885 n.s**
-1.838±0.162**	**-1.455±0.187****	**-1.314±2.584 n.s**	**0,203±2.885 n.s**
0.088±0.010 n.s	**0.048±0.018 n.s**	**-0.035±0.053 ****	**-0.013±0.058****

Table 6. Genetic analysis of mean generations, their standard errors and estimation of genetic parameters for the first cross late × late(ZM49W3E× ZM74)

Traits	M	[d]	[h]	[i]	[j]	[l]	Type of eps.
Days to silking	**55.33± 1.20****	**-2.00± 0.81****	**15.50± 5.11****	**22.66± 5.07****	**1.50± 0.84****	**+40.33± 5.94****	**Complentary**
Days to physiology maturity	**111.00± 1.52****	**-3.00± 1.29****	**35.66± 6.66****	**42.00± 6.63****	**0.33± 1.30 n.s**	**-79.33± 8.11****	**Duplicate**
Crop growth rate	**4.32± 0.64****	**-0.36± 0.10 n.s**	**-1.11± 2.58 n.s**	**-1.98± 2.58 n.s**	**-0.19± 0.11 n.s**	**5.27± 2.61****	**Duplicate**
Yield (ton\ha)	**4.32±0.64****	**-0.36±0.10 n.s**	**-1.11±2.58 ***	**-1.98±2.58 n.s**	**-0.19±0.11 n.s**	**5.27±2.61****	**Complentary**

Table 7. The means of traits with their standard errors for the six generations of the third hybrid of maize late ×early (ZM19 x ZM74), the hybrid vigor and the percentage of hetrosis for the fall season 2020.

Traits	Generations						Hybrid vigor%	Hetrosis %
	P1	P2	F1	F2	B1	B2		
Days to silking	63.66±0.33	57.66±0.33	55.00±0.57	56.00±1.00	61.66±0.88	63.00±0.57	-4.62	-9.34
Days to physiology maturity	118.66±0.881	110.00±0.577	117.33±0.881	119.33±1.452	117.66±0.333	122.66±0.666	-1.129	2.62
Crop growth rate	4.377±0.090	4.931±0.047	4.836±0.070	4.488±0.112	4.594±0.065	4.469±0.097	-1.93	3.90
Yield (ton\ha)	7.367±0.056	7.121±0.029	7.635±0.100	7.043±0.191	6.978±0.0791	6.787±0.112	4.10	5.64

Table (8) Scaling test with standard errors of the third cross (late × early) (ZM19 x ZM74)

الصفات	A	B	C	D
Days to silking	4.666±1.885**	13.333±1.333 **	-7.333±4.189 **	-9.333±4.496 **
Days to physiology maturity	-0.666±1.414 n.s	18.00±1.699**	14.00±6.164**	10.00±6.582 **

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Crop growth rate	**-0.024±0.173 n.s**	**-0.828±0.212 n.s**	**-1.026±0.483 ****	**-0.331±0.514 ****
Yield (ton\ha)	**-1.046±0.195 ****	**-1.182±0.247****	**-1.585±0.794 ****	**-0.401±0.859****

Table (9): Genetic analysis of average generations and their standard errors and estimation of genetic parameters for the third cross late × early (ZM19 x ZM74)

Traits	M	[d]	[h]	[i]	[j]	[l]	Type of eps.
Days to silking	**56.00±1.00 ****	**-1.333± 1.054 n.s**	**19.666±4.564****	**25.333± 4.521****	**-4.333±1.080 ****	**-43.333±5.944****	**Duplicate**
Days to physiology maturity	**119.333±1.452****	**-5.00±0.745 ****	**6.333±6.087****	**3.333±6.00n.s**	**-9.333±0.912****	**-20.666±6.847****	**Duplicate**
Crop growth rate	**4.488±0.112****	**0.125±0.117 n.s**	**0.355±0.515 ****	**0.173±0.508 ****	**0.402±0.127 n.s**	**0.679±0.573 ****	**Complementary**
Yield (ton\ha)	**7.043±0.191****	**2.191±0.137 ****	**-0.252±0.820 ****	**-0.643±0.814 ****	**0.067±0.140 n.s**	**2.872±0.966 ****	**Duplicate**

Table10. The means of traits with their standard errors for the six generations of the fourth hybrid of maize (early ×early) (ZM19×ZM49W3E)., the hybrid vigor and the percentage of hetrosis for the fall season 2020.

Traits	Generations	Hybrid vigor%	Hetrosis %

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	P1	**P2**	**F1**	**F2**	**B1**	**B2**		
Days to silking	**56.666±0.333**	**56.00±0.577**	**50.666±0.666**	**52.00±1.154**	**56.00±0.577**	**57.666±0.333**	**-7.88**	**-9.25**
Days to physiology maturity	**110.00±0.577**	**112.00±0.577**	**108.333±0.881**	**113.666±1.452**	**120.00±1.154**	**121.00±0.577**	**-1.518**	**-2.40**
Crop growth rate	**4.541±0.093**	**4.863±0.099**	**5.419±0.169**	**4.593±0.217**	**3.777±0.127**	**4.409±0.141**	**11.43**	**15.25**
Yield (ton\ha)	**5.093±0.090**	**5.081±0.111**	**5.876±0.126**	**4.544±0.246**	**3.537±0.145**	**5.094±0.116**	**15.36**	**15.50**

Table (11) Scaling test with standard errors for the fourth cross early × early (ZM19×ZM49W3E).

Traits	**A**	**B**	**C**	**D**
Days to silking	**4.666±1.374 ****	**8.666±1.105 ****	**-6.00±4.853 ****	**-8.666±5.206 ****
Days to physiology maturity	**21.666±2.538 ****	**21.666±1.563 ****	**16.00±6.128 ****	**5.333±6.548 n.s**
Crop growth rate	**-2.406±0.319 ****	**-1.465±0.344 ****	**-1.870±0.943****	**-0.218±0.981 ****
Yield (ton\ha)	**-3.895±0.330 ****	**-0.769±0.288 n.s**	**-3.749±1.028 ****	**-1.086±1.112 ****

Table (12): Genetic analysis of average generations and their standard errors and estimation of genetic parameters for the fourth early × early (ZM19×ZM49W3E). cross.

Traits	**M**	**[d]**	**[h]**	**[i]**	**[j]**	**[l]**	**Type of eps.**
Days to silking	**52.00± 1.154 ****	**-1.666± 0.666 ****	**13.666± 4.864 ****	**19.333± 4.807 ****	**-2.00± 0.745 ****	**-32.666± 5.537 ****	**Duplicate**

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Days to physiology maturity	**113.666±1.452 ****	**-1.00±1.290 n.s**	**24.666±6.433****	**27.333±6.359 ****	**0.00±1.354 n.s**	**70.666±8.013 ****	**Complentary**
Crop growth rate	**4.593±0.217 ****	**-0.631±0.190 n.s**	**-1.284±0.966****	**-2.001±0.948 ****	**-0.470±0.201 n.s**	**5.872±1.211****	**Duplicate**
Yield (ton\ha)	**4.544±0.246 ****	**-1.556±0.186 ****	**-0.126±1.065 n.s**	**-0.914±1.055 n.s**	**-1.562±0.200 ****	**5.579±1.271 ****	**Duplicate**

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التحليل الوراثي لصفات التزهير والنضج الفسلجي بتحليل متوسط الاجيال لأربعة هجن من الذرة الصفراء(معايير النمو)

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المستخلص

بهدف معرفة المقدار النسبي لمكونات التغاير الوراثي واشكال التداخلات التفوقية باستخدام طريقة تحليل متوسط الاجيال لهجن الذرة الصفراء المتباينة في مواعيد التزهيرو النضج .نفذت تجربة حقلية في محطة ابحاث المحاصيل الحقلية ،كلية علوم الهندسة الزراعية –جامعة بغداد – الجادرية لتقدير مكونات الفعل الوراثي الجيني ، التأثيرات الوراثية والتفوقية وتداخلاتها التي تسيطر على وراثة الصفات الحقلية للسلالات المنتخبة وهجنها الناتجة باستخدام تحليل متوسط الاجيال. تم اختيار خمسة سلالات نقية من الذرة الصفراء **(ZM19 ZM49W3E،ZM74 ،Zi17WZ ،ZA17WR)**، من خمس عشرة سلالة مختلفة بمواعيد التزهير والنضج في الموسم الربيعي 2019 وتم تضريبها حسب الهدف (متاخر ×متاخر ، متاخر×مبكر ومبكر×متاخرومبكر × مبكر) في الموسم الثاني خريف(2019) . ادخلت في برنامج نضريب رجعي لتحليل متوسط الاجيال في الموسم ربيعي(2020)لانتاج (الاجيال الستة)هي (**P1**و**P** 2 و **F1** و**F**2 و**BC** 1 و**BC**2 تم تقييم الاجيال الستة (**P1**و**P** 2 و **F1** و**F**2 و**BC** 1 و**BC**2) للهجن الاربعة في تجارب مقارنة باستخدام تصميم القطاعات العشوائية الكاملة المعشاة**RCBD**وبثلاثة مكررات في الموسم الخريفي 2020. تم التحليل الوراثي لاختبار **scaling** والتحليل للمعايير الستة وحسب ماذكره**Mather** و**Jinks** (1982) لصفات عدد الايام الى 75% تزهيرأنثوي وعدد الايام الى 95% نضج فسلجي ومعدل نمو المحصول وحاصل وحدة المساحة اظهرت نتائج التحليل الاحصائي وجود فروق معنوية بين الاجيال الستة اذ ابكر الجيل الاول بوصوله الى التزهير الانثوي والنضج الفسيولوجي كما تفوق باعطائه اعلى معدل ، نمو المحصول وحاصل وحدة المساحة . امتلكت الهجن الاربعة قوة هجين ونسبة تهجن سالبه بالاتجاه المرغوب نحو التبكير بالتزهير الانثوي والنضج الفسلجي ، وقوة هجين موجبة لصفتي معدل نمو المحصول والحاصل بالاتجاه المرغوب نحو زيادتهما . بينت نتائج االتحليل الوراثي لتحليل ال**scaling** اختلاف معنوية المعايير الاربع **A,B,C,D** باختلاف الصفة واختلاف الهجن ، وانعكس ذلك على معنوية التاثيرات السيادية والاضافية وتداخلاتها التفوقية ،فقد اظهر الهجين الاول والثالث والرابع فعلا سياديا لصفة التزهير الانثوي ونوع التداخل كان من النوع المضاعف **Duplicated** وفي الهجين الثاني فقد اظهر الهجين فعلا سياديا ونوع التداخل التفوقي تكميلي **complementary** لتشابه الاشارة للفعل الجيني السيادي مع التداخل غير الاليلي (سيادي ×سيادي).اما صفة النضج الفسلجي فقد اعطت تأثيرا سياديا في الهجن الاربعة واختلف نوع التفوق فقد كان من النوع المضاعف **duplicate** في الهجن الاول والثاني والثالث وتكميلي بالهجين الرابع فيما لم يظهر تأثيرا معنويا لكلا التأثيرين السيادي والاضافي في الهجينين الاول والثاني لصفة معدل نمو المحصول واظهر الهجينان الثالث والرابع تأثيرا سياديا ونوع التفوق تكميلي **complementay** اما صفة الحاصل فكانت تحت التأثير السيادي في الهجين الاول واضافي في الثالث والرابع ولم تكن هناك تأثيرات سيادية واضافية معنوية في الهجين الثاني .نستنتج مما تقدم ان الفعل الجيني المضيف و غير المضيف يسيطر على توريث صفة الحاصل وصفات التزهير والنضج الفسلجي ومعدل نمو المحصول، لذا نوصي باستخدام طريقة الانتخاب التكراري المتبادل **RRS** **Reciprocal recurrent selection(RRS)**.

كلمات مفتاحية :

***البحث مستل من اطروحة دكتوراه للباحث الاول**